The Association between Religious Participation and Social Isolation in Canadian Middle-and Older-aged Adults: A Longitudinal Analysis 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. I understand that my thesis may be made electronically available to the public.

Abstract

Social isolation is a modifiable risk factor for poor health outcomes, including cognitive decline, cardiovascular disease, and mental illness. Thus, researchers seek to identify exposures that are inversely associated with social isolation itself. Religious participation may be one such exposure because research has shown it to be positively associated with social support and social integration, two concepts related to decreases in social isolation. However, the association between religious participation and social isolation has not been investigated in depth. The objective of this thesis was to examine the association between religious participation and social isolation using baseline and three-year follow-up data from the Comprehensive Cohort of the Canadian Longitudinal Study on Aging (CLSA). The CLSA is an ongoing prospective cohort study of community-dwelling adults who were between 45 and 85 years old at recruitment.

Religious participation was measured via a single question, asking participants how often they participated in religious activities over the past 12 months (e.g., services, committees, choirs). Responses were recorded on a 5-point scale ranging from “at least once a day” to “never”, which served as the reference category in regression modeling. Social isolation was measured with an index computed by Menec et al., which tabulated the absence of social interactions, relationships, and a lack of participation in community activities, as well as included retirement status and marital status. Social isolation index scores ranged from 0 to 5 and were dichotomized into “socially isolated” or “not socially isolated”. Multiple logistic regression was used for the analysis. Follow-up social isolation index scores were regressed onto baseline religious participation responses while controlling for baseline social isolation, sociodemographic variables, health variables, and functional social support. The fully adjusted model was stratified by age groups and sex separately.

The analytical sample comprised 22,139 participants. Approximately 50% of participants participated in religious activities at least once a year. At baseline, 7% of participants were socially isolated, and 6% were socially isolated at follow-up.

Regression models indicated small and inverse associations between religious participation and social isolation over three years; however, none of the results were statistically significant ($\alpha = 0.05$), thereby suggesting the possibility of positive associations. The results did not identify any effect modification by age groups and sex.

Most CLSA participants were not socially isolated, which contributed to the non-significant and small associations between religious participation and social isolation. Longer follow-ups of the CLSA sample and a larger proportion of socially isolated individuals are needed to assess this association further.

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List of Abbreviations

ADL	Activities of Daily Living
AUC (ROC)	Area Under the Receiver Operating Characteristic Curve
CES-D10	Center for Epidemiological Studies Short Depression Scale
CI	Confidence Interval
CLSA	Canadian Longitudinal Study on Aging
DCS	Data Collection Site
FSS	Functional Social Support
IADL	Instrumental Activities of Daily Living
IQR	Inter-Quartile Range
MOS-SSS	Medical Outcomes Study-Social Support Survey
NuAge	Québec Longitudinal Study on Nutrition and Aging
OR	Odds Ratio
RP	Religious Participation
RDD	Random Digit Dialing
SD	Standard Deviation
SSS	Structural Social Support

1.0 Literature Review

1.1 Introduction

The relationships people establish with others become an essential part of their lives and form the structural component of a social network[1]. As people age, their social networks become increasingly crucial by providing social support, a central element in helping people adapt to the challenges of the aging process[2]. Given the importance of social networks, reductions in these networks, namely social isolation (SI), can have detrimental effects on the individual, such as increasing the risk of depression or impaired cognitive function, and decreasing life satisfaction[3]. As such, researchers seek to identify potential exposures that may mitigate the risk of SI. One such exposure is religious participation (RP); however, most published studies on the topic were cross-sectional, included highly specific population subgroups, and did not include nationwide samples. This thesis added to the current body of literature by longitudinally examining the association between religious participation and social isolation in a nationwide Canadian sample of participants, while simultaneously adjusting for a robust set of covariates.

1.2 Social Isolation

1.2.1 Definition and Statistics

Social isolation is commonly defined as the absence of social interactions or relationships, and a lack of participation in social activities[4]. One component of SI is the objective measurement of whether an individual is part of one or more social networks; this is often measured as the number, frequency, and type of acquaintances an individual reports (e.g., number of children, relatives, friends), as well as the number and type of activities an individual undertakes over a period of time[5]. The counting of acquaintances and activities is considered to be a type of structural social support (SSS). Functional social support (FSS), on the other hand, is an individual's

perception of the extent to which their acquaintances would be available to provide emotional, affectionate, and tangible support in times of need[6].

SI is also not the same as loneliness. Loneliness is the subjective feeling of being isolated, even in situations where individuals have many opportunities to interact with others and engage in social activities[7]. Similarly, one may eschew most forms of social engagement yet not 'feel' lonely (e.g., 'loners').

Any age group can experience SI; however, it is most prevalent in older adults. In Canada, seniors (≥ 65 years of age) report the highest prevalence of SI, with approximately 19% of seniors feeling isolated[8]. In addition, nearly 30% of Canadian older adults are at risk of becoming socially isolated[9]. Limited information currently exists regarding the prevalence of SI in middle-aged Canadians, which provided the impetus to examine middle- and older-aged adults in the thesis. It was important to examine whether the association of interest differed between these two age groups because it would expand one's knowledge and understanding of the association between RP and SI to an age group that has not yet been studied.

1.2.2 Adverse Health Effects of Social Isolation

SI has gained the attention of researchers on account of its relationship with poor health outcomes. Previous evidence suggests that SI is a direct stressor to the body, elevating stress-response systems in the brain[10]. SI is also a risk factor for premature death, high blood pressure, diabetes mellitus Type 2, chronic obstructive pulmonary disease, CVD and increases in overall levels of bodily inflammation[11,12]. Furthermore, socially isolated individuals have greater risks for anxiety, depression, cognitive decline and psychological distress[13–15].

1.2.3 Risk Factors for Social Isolation

1.2.3.1 Age

Individuals over 80 years of age are at a greater risk of SI due to decreased mobility and declining health, reducing opportunities for social engagement[16]. Additionally, considering that widowhood is higher among older adults, these individuals are more likely to live alone in an isolated fashion[17]. In contrast, having a partner promotes social interactions within the couple and with other couples, thereby decreasing the risk of isolation[18]. Furthermore, older age is associated with losses in cognitive function. These losses may increase the risk of SI since cognitively impaired individuals often withdraw from social activities[19].

1.2.3.2 Sex

Previous publications found sex differences with respect to SI, although the findings were equivocal. Women reported greater SI than men, which is plausible since women are more likely to be widowed due to a longer life expectancy[20]. In contrast, Vandervroot[21] found higher levels of SI in men than women: men tended to have smaller social networks than women, whereas women were more likely to be involved in interactive caregiving activities and were also more receptive to life events[21].

1.2.3.3 General Health

The relationship between SI and adverse health effects may be bidirectional. Prior studies showed that individuals with chronic diseases or disabilities had an increased risk of SI, which could then lead to adverse health effects[22–24]. Researchers believe the number and severity of health conditions can reduce opportunities for socialization with friends and family, thus increasing the risk of SI[25].

1.2.4 Measures of Social Isolation

Researchers typically use questionnaires to measure SI. These instruments generally ask about one's marital status, frequency of participation in social events, and social network strength (e.g., number of children, friends, and siblings seen with regular frequency)[24,26,27]. Question responses are assigned points and converted into indices to quantify levels of SI. Examples of well-known SI questionnaires include the Lubben Social Network Scale and the Berkman-Syme Social Network Index[28,29].

Recently, researchers developed two different SI indices using data from the Canadian Longitudinal Study on Aging (CLSA). Menec et al.'s index contained the items mentioned in the previous paragraph and an additional question about retirement status[30]. Menec et al.'s index scores range from 0 to 5, with higher scores suggesting greater social isolation[15,30]. Since no established cut-offs were found in prior studies, Menec et al.[30] created cut-offs to dichotomize the scores to classify participants as socially isolated or not. To have adequate sample sizes in each of the groups, Menec et al. decided to classify participants as socially isolated if they had scores of 2 or more[15]. Conversely, Wister et al.'s index expanded the scope of what would normally be called 'social isolation' (V. Menec, personal communication) to include measures of loneliness and FSS[30,31].

1.3 Religious Participation

Religion and spirituality are distinct constructs. According to Koenig et al., religion is described as an organized system where religious followers seek to form closer relationships with transcendent figures such as God, Allah, or other Higher Powers by participating in specific practices, beliefs and rituals[2]. Religion is noted for including particular beliefs about life after death and may also influence community traditions such as the role of women in society[32].

In comparison to the organized practices and beliefs of religion, which are typically exercised in community or group settings, spirituality is an individual experience where persons search for purpose and meaning in their lives[32]. A key concept of spirituality is the connection to something transcendent and sacred, which often involves mystical and supernatural forces that are not always bounded by the tenets of an organized religious belief system[32]. The notion of transcendence is the major common point between religion and spirituality[32].

Given that religion and spirituality are separate constructs and the CLSA, the dataset used in this thesis only provided data on religious affiliation and religious participation; this thesis did not consider spirituality.

1.3.1 Positive Impacts of Religion and Health

Religion is linked to numerous health benefits and is inversely related to the presence of mental illnesses (e.g., anxiety, depression) and is positively associated with improved biological functioning and life satisfaction[3,33,34]. Previous literature has also shown that religion is associated with decreases in cardiovascular diseases (CVD), respiratory diseases, cancer, and cognitive impairment[3,35–37].

Religion is thought to promote health through several proposed mechanisms[33,38–42], including: (1) development of beneficial coping strategies; (2) discouragement of unhealthy behaviours (e.g., excessive alcohol consumption); and (3) facilitation of social support. Each proposed mechanism is described below.

1.3.1.1 Development of Beneficial Coping Strategies

Religion may promote the development of beneficial coping strategies to reduce feelings of isolation and promote a sense of hope and well-being[32]. Religious coping methods such as

prayer help individuals find comfort in a connection to an omnipresent higher power. Prayer gives individuals a sense of hope by communicating the notion that the higher power can alter individuals' situations and deliver strength to overcome feelings of hopelessness or helplessness[41]. Additionally, religious persons may also "feel" the presence of the higher power, which gives them a sense of not being alone[41].

1.3.1.2 Discouragement of Unhealthy Behaviours

Religion provides adherents with a core set of health-promoting morals and beliefs. For instance, Christians view their bodies as "the temple of the Holy Spirit" (1 Corinthians 6:19-20) and are advised to take care of their health to glorify God. Likewise, Islam prohibits alcohol consumption, and Judaism forbids the consumption of non-kosher foods[43,44].

1.3.1.3 Facilitation of Social Support

Religion helps individuals establish faith-based social ties within a like-minded community of congregants, whom they can turn to for emotional and practical support in times of health challenges[33]. Religious communities are motivated by their faith to assist others in times of need[38]. Moreover, since religious-related activities occur regularly, frequent contact with the larger congregation provides ongoing support to members during times of turmoil[39]. Thus, individuals who frequently participate in religious activities are more likely to benefit from a buffer against the stressful effects of adverse life events. Indeed, stress contributes to six of the primary causes of death in North America (i.e., CVD, cancer, respiratory disorders, accidental injuries, liver disease, and suicide)[45].

1.3.2 Potential Adverse Impact of Religion on Health

Religion may not always promote healthy lifestyles and can be associated with adverse health outcomes. For instance, some religious communities may discourage adherents from

receiving preventive health screenings and medical treatments (e.g., blood transfusions), which may increase the risk of severe health outcomes, leading to decreased mental and physical health[46,47]. Furthermore, involvement in religious groups can also be a source of distress. Failure to conform to institutional expectations and norms may cause individuals to be excommunicated, potentially reinforcing feelings of shame, stress and anxiety[48,49].

1.3.3 Measures of Religion

To measure religion for research purposes, researchers often utilize validated instruments such as the Santa Clara Strength of Religious Faith Questionnaire or the Centrality of Religiosity Scale[50,51]. More often, religion is measured via self-reports, where researchers ask participants to indicate their level of involvement in religious activities, e.g., frequency of religious attendance[24,26,52,53], frequency of prayer[54,55], or frequency of engaging in private religious devotions[56,57].

The variety of measures of religion reflects the diversity in the meaning and form of 'religion' itself. RP (physically participating in religious activities) is distinct from religiosity (the strength of religious faith) and religious affiliation (the denomination to which one formally belongs or identifies with)[32,54,55]. This thesis focused on RP as the predictor variable of interest.

1.4 Religious Participation and Social Isolation

The objective of the literature review was to examine published evidence for the association between RP and SI in adults of any age and in any setting. The thesis candidate accepted any definition of RP as being relevant for inclusion in the review and incorporated the authors' original terminology for RP in the review (e.g., RP and 'religious attendance' are often used synonymously in the literature). Given the limited amount of research into RP and SI, articles investigating SSS and FSS as outcomes in analyses involving RP were also included in the

literature review. In total, seventeen articles were found to be relevant (see Appendices A and B) and were organized for review based on outcome variables and type of study design.

1.4.1 Religious Participation and Social Isolation or Structural Social Support

The first section of the literature review examines SI, a form of SSS. In the literature, being socially isolated is equivalent to having low levels of SSS[30,58]

1.4.1.1 Cross-sectional Studies

One Canadian study[26] and one American study[59] examined the association between RP and SI. Kobayashi et al.'s research recruited participants using a random sample of community-dwelling persons aged 65 years or over (n = 1,064) from British Columbia: average ages were 76.9 and 74.3 years for socially isolated and non-socially isolated participants, respectively[26]. Child et al.[59] studied a sample (n = 1,109) drawn from the Berkeley Social Networks Study, where participants were grouped into 50- to 70- year old and 21- to 30- year old categories.

Similarly, four American studies[27,60–62], one British study[55] and one Polish study[63] investigated the relationship between RP and SSS. The four American studies conducted secondary data analyses from existing datasets[27,60–62]. For example, Ellison et al.[62] used the Piedmont Health Survey of 2,956 adults (i.e., 18 years and older) from North Carolina; Hastings' research was based on data from multiple cross-sectional studies (n=11,162), including the 2006-2014 General Social Survey (GSS) of non-institutionalized Americans and the Portraits of American Life Study from 2006-2013[60]. Dunbar's United Kingdom (UK) research was based at the University of Oxford, where he recruited 300 participants from a market research panel (median age group: 25 to 30 years)[55]. Among the 300 participants, 236 were from the UK, 43 from the United States (US), and 21 from unspecified countries in Europe and Asia[55]. Lastly, Okruszek et al.'s study recruited 564 young Polish adults (18 to 35 years) via social media platforms[63].

1.4.1.1.1 Religious Participation Measures

Across most studies, RP was measured by the frequency of attending religious services over the past year[26,27,55,59–63]. Kobayashi et al.'s research used a 4-point scale ranging from "not at all" to "at least monthly"[26]. Ellison et al.[62] evaluated RP as a combination of attendance at services "or other religious meetings". Hastings' research considered actively attending religious services "at least several times per year" as an exposure category, whereas other studies coded such low-frequency attendance levels as unexposed[60]. Only Dunbar's research included validated tools–the Duke University Religion Index (DUREL)[64]–to assess a combined exposure of religious service attendance and frequency of private prayer[55].

1.4.1.1.2 Social Isolation Measures

The authors utilized a variety of methods to assess SI in the two studies that looked at this variable. Kobayashi et al.[20] integrated questions from both the Canadian Community Health Survey and the shorter version of the Lubben Social Network Scale to create an index[48]; Child et al.[59] asked participants to report the number of days in the previous seven days that they felt isolated.

1.4.1.1.3 Structural Social Support Measures

The six studies of SSS measured social network size. For example, McIntosh et al.[27] recorded the names of all persons who helped participants with daily activities. The five names that appeared most frequently were labelled as the participants' 'intimate network'[27]. Participants were asked how frequently they interacted and how close they lived to each member of the intimate network[27]. For Hastings' research, social connectedness was measured in the Portraits of American Life Study by asking participants how many people they felt 'close to'[60]. In the GSS, social connectedness was measured using a frequency of social interaction scale, whose questions

revolved around how often participants spent evenings with neighbours, relatives, and friends[60]. In Okruszek et al.'s study, social network size was assessed via the Social Network Index, which evaluated the number of people participants had contact with on a regular basis[63].

Furthermore, Bradley[61] and Ellison et al.[62] asked about respondents' social network sizes and the frequency of telephone and in-person contacts using Likert scales. Dunbar counted the number of participants' online friends as the sole measure of social network size[55].

1.4.1.1.4 Religious Participation and Social Isolation Results

One of the two SI studies reported an inverse association between RP and SI[26]. Kobayashi et al.[26] found Canadian older adults (65 years or over) who did not attend religious services had higher odds of being socially isolated (adjusted odds ratio [aOR]: 2.28; 95% confidence interval [CI]: 1.46-3.55) than older adults who attended at least monthly, after controlling for age, marital status, sex, birth country, income, education, living arrangement variables, and health variables. In contrast, Child et al.[59] did not find religious attendance to be significantly associated with reductions in the number of days that late middle-age participants (i.e., aged 50 to 70 years) felt isolated (incidence risk ratio = 0.99; 95% CI: 0.56-1.77), after controlling for sex, income, educational attainment, household composition, employment status, race/ethnicity, and the 'Big 5 Personality traits' (i.e., neuroticism, agreeableness, openness, extraversion, and conscientiousness)[59].

1.4.1.1.5 Religious Participation and Structural Social Support Results

Participants who attended church services reported more extensive social networks[27,60–62]. McIntosh et al.[27] found that increases in the frequency of church attendance were associated with increases in the size ($\hat{\beta} = 0.123$; $p < 0.01$) and diversity ($\hat{\beta} = 0.347$; $p < 0.001$) of one's social network. Similarly, Bradley[61] and Ellison et al.[62] also concluded that religious attendance was

associated with an increased number of social network contacts. Ellison et al.[62] illustrated that, on average, frequent attendees (i.e., several times a week) reported 2.25 more non-kin social contacts compared to those who never attended ($p < 0.001$). Additionally, RP was positively associated with the frequency of telephone contacts and in-person contacts with members of one's social network ($p < 0.001$)[62]. Bradley[61] and Ellison et al.[62] controlled for similar variables such as age, sex, marital status, income, community size, and functional ability, employment status, household size, urban residence. Okruszek et al.[63] reported that religious attendance was significantly associated with participants' social network size [F (2.561)=11.98, ($p < 0.001$)]. Compared to religious non-attenders (15.29 ± 8.49), frequent religious attenders (20.03 ± 10.18) and infrequent religious attenders (16.85 ± 8.81) had larger social networks. The mean number of persons in one's network are stated in brackets.

In contrast to the four studies above, Hastings[60] did not report statistically significant results with social network size. Specifically, Hastings found that compared to religious non-attendees, attenders had larger social networks; however, the results were not statistically significant at the 5% level ($p > 0.05$) after controlling for age, sex, race/ethnicity, marital status, educational attainment, employment status, region of interview, political ideology, household size and year of interview[60]. Conversely, Hastings[60] found significant findings with social interaction frequency. Compared to religious attenders, religious non-attenders had significantly fewer social interactions ($p < 0.001$). Dunbar[55] did not find an association between religious attendance and the total number of online friends ($\hat{\beta} = 0.027; p = 0.457$), which was simply a frequency count of 'friends' on social media and not necessarily representative of the entirety of one's social network[55].

1.4.1.1.6 Summary

Five of the six SSS cross-sectional studies found positive associations between RP and SSS[27,60–62]. However, since the studies were cross-sectional, reverse causality bias may be present. For example, individuals with more social ties in religious communities may feel pressured to attend religious activities or may be more likely to be recruited into religious organizations[65,66].

One of the two cross-sectional SI studies reported an inverse association between RP and SI[26]. All eight studies in this section adjusted their results by age and sex[24,26,27,55,59–63]. Additional common control variables were marital status[26,61–63], employment status[59–62], household income[26,27,59,61,62], region of residence[26,27,60,61], educational attainment[26,27,59–63,67], race/ethnicity[59–62], and health status[26,27,67].

1.4.1.2 Longitudinal Studies

One American longitudinal examined the association between religious attendance and social interactions. Strawbridge et al.[67] enrolled 2,676 participants from the Alameda County Study between 17 to 65 years of age in 1965. Complete-case analysis was used, and only those who completed the 1994 follow-up survey were included in the study[67]. The authors measured religious attendance by asking participants how often they attended religious services. For the analyses, weekly religious attendance was considered to be active involvement. Social involvement was evaluated by the number of relatives and friends participants saw each month[67]. Visiting three friends or more was considered to be active social involvement.

Compared to non-attenders, active religious involvement at baseline (1965) was associated with increases in social involvement at follow-up (1994) for participants who saw less than three friends a month in 1965, while controlling for age, sex, education, and self-rated health (OR=1.62; 95% CI: 1.13-2.31)[67]. The authors stratified the association by sex; however, the stratified odds ratios were similar, suggesting that sex was not an effect modifier[67].

1.4.2 Religious Participation and Functional Social Support

Functional social support is commonly conceptualized as the perception of available support resources (e.g., instrumental, emotional, and informational) from one's social network when needed[68]. The Medical Outcomes Study-Social Support Survey (MOS-SSS) is one of the most common FSS instruments available for patients and participants[69]. The MOS-SSS contains four sections – emotional/informational support, tangible support, affectionate support, and positive social interaction[69]. FSS was included in the literature review as prior evidence indicates that FSS has an inverse relationship with SI and can therefore be expected to be positively associated with RP[70].

1.4.2.1 Cross-sectional Studies

Six American studies[22,38,71–74], one British study[74] and one Australian study[54] investigated the association between RP and FSS. Of the six American studies, four included subjects under 65 years of age[38,53,71,72]. Van Olphen et al.[71] conducted their study on 679 African American women from the east side of Detroit (mean age: 38 years). Similarly, Nguyen et al.[72] studied a sample of 1,288 American Caribbean Blacks (mean age: 41 years) from the National Survey of American Life. Harvey et al.'s research was based on 465 African American women (mean age: 51 years) recruited as part of the Learning and Developing Individuals Exercise Skills Study (LADIES)[38]. Lastly, Bradley et al.[53] based their research on 444 Americans (mean age: 56 years) residing in Miami-Dade County, Florida.

In comparison, the other two American studies focused on individuals aged 65 years or over[73,74]. Hill et al.'s study utilized data from the Hispanic Established Populations for Epidemiologic Study of the Elderly (EPESE)[75], which contained 2,479 Mexican Americans from the Southwestern United States (mean age: 73 years)[73]. Likewise, Koenig et al.[74] conducted their

study on 4,162 community-dwelling participants (mean age: 73 years) who were also drawn from the EPESE study.

Moxey et al.'s study recruited 752 community-dwelling women and men (55 to 85 years) from New South Wales, Australia (mean age: 66 years)[54]. Lastly, Dunbar recruited three hundred participants from a market research panel (median age group: 25-30 years), including 236 participants from the UK, 43 from the US, and 21 from unspecified countries in Europe and Asia.

1.4.2.1.1 Religious Participation Measures

All eight studies measured the frequency of RP by using a variety of means[22,38,54,55,71,73,74,76]. For example, Moxey et al.[54] utilized a 9-point scale ranging from "never" to "several times a week" to quantify religious service attendance. In comparison, Bradley et al.[22] included one question from the Duke University Religion Index (DUREL)[64] to ask about the frequency of attending religious services, including other religious meetings, and provided responses ranging from (0) "never" to (6) "more than once per day". Additionally, three of the studies also asked about personal religious practices such as the frequency of watching religious programs on television and meditation[71,74,76].

1.4.2.1.2 Functional Social Support Measures

Four studies employed validated FSS scales, such as the Medical Outcomes Study–Social Support Survey (MOS–SSS) and the Duke Social Support Index (DSSI)[22,54,55,74]. The MOS–SSS evaluated four categories of FSS (emotional/informational support, tangible support, affectionate support and positive social interactions), and the DSSI measured social interaction, subjective support, and instrumental support[54,74]. One study measured two of the individual components of FSS: emotional and instrumental support[73].

Nguyen et al.[72], Harvey et al.[38] and Van Olphen et al.[71] asked participants about the receipt of instrumental support, emotional support and general social support in church-based settings. Nguyen et al.[72] and Harvey et al.[38] also explored the frequency of negative interactions with other church members.

1.4.2.1.3 Religious Participation and Functional Social Support Results

Overall, six of the eight studies reported positive associations between RP and FSS[22,54,71–73]. For instance, Bradley et al.'s study demonstrated that weekly service attendance was related to increases in social support ($\hat{\beta} = 0.338$; p <0.01) compared to never attending, while controlling for age, sex, immigrant status, education, employment status, income, financial strain, marital status, race, presence of children, family difficulties, personality, interview language, health behaviours and health status[61]. Similarly, Moxey et al.[54] showed that persons who attended religious services regularly ($\hat{\beta} = 1.74$; 95% CI:1.07-2.41) or infrequently (i.e., ≤ monthly) ($\hat{\beta} = 0.78$; 95% CI: 0.22-1.34) reported better social support than those who reported never attending. Nguyen et al.[72] found that religious service attendance was associated with increases in receipt of emotional ($\hat{\beta} = 0.84; p < 0.001$) and general social support (i.e., frequency of receiving help from church-members) ($\hat{\beta} = 0.44; p < 0.001$), while controlling for age, sex, income, education, marital status, country of origin, immigration status and religious denomination. Likewise, Van Olphen et al.[71] also concluded that religious attendance was significantly associated with receipt of instrumental support from congregants (p <0.001).

Dunbar's research showed that attendance frequency was associated with the number of individuals whom respondents could depend on for emotional and social support ($\hat{\beta} = 0.209; p < 0.001$) in church settings[55]. Moreover, Hill et al.[73] found an inverse dose-response relationship between RP and low FSS: compared to participants who did not attend religious services, the odds

of being in the lowest category of social support decreased by 71% (95% CI: 0.11-0.77) for more than weekly attenders, 62% for weekly attenders (95% CI: 0.22-0.67), 59% for monthly attenders (95% CI: 0.19-0.88) and 55% for yearly attenders (95% CI: 0.24-0.86)[73].

In contrast to the six studies above, Koenig et al.[74] reported that church attendance was unrelated to social support ($\hat{\beta} = -0.01; p < 0.05$) after controlling for age, sex, race, depression and good health. Likewise, Harvey et al.[38] found that RP was negatively correlated with church-based (r = -0.13; p <0.01) and broader social support (r = -0.10; p <0.05).

1.4.2.2 Longitudinal Studies

Le et al.'s analysis of data from the Religion and Health in African American study was the sole longitudinal study to examine the association between RP, FSS, and church-based social support[77]. The study included 3,173 African Americans from across all 50 American states who were aged 21 years or older[77]. RP was measured with a religiosity scale containing nine items assessing religious beliefs and behaviours (e.g., church attendance and religiousness)[77]. Church-based social support was assessed using the Brief Multidimensional Measure of Religiousness/Spirituality for Health Research[78]. In contrast, FSS was estimated using four domains from the Interpersonal Support Evaluation List (ISEL-12)[78,79]. The four domains included tangible support, appraisal support, self-esteem support and belonging support[79].

1.4.2.2.1 Results

RP was positively associated with church-based social support at baseline and Wave 2 (p < 0.001). At Wave 2 (2.5 years post-baseline), each church-based social support subscale increased: emotional support provided (p <0.001), emotional support received (p <0.001), negative interaction (p <0.001), and anticipated support (p <0.001)[77]. Thus, the results suggested that participating in religious activities (e.g., church services, bible study classes) would increase

church-based social support among church members[77]. In contrast, RP was not statistically significantly associated with FSS at baseline and Wave 2[77]. The models were adjusted by educational attainment, sex, age, health status, and marital status[77].

1.4.2.2.2 Summary

Altogether, the consensus from the literature was that RP is positively associated with FSS. Seven of the eight articles adjusted their results by age[53,54,71–74,77], and six of the eight controlled for household income[53,54,71–73,77]. Additional covariates in the analyses were sex[22,54,72–74,77], race[53,74], marital status[53,71–73,77], employment status[22,77], educational attainment[22,54,71–73,77], and health status[71,73,74,77]. Note that Harvey et al.[38] did not report control variables in their analysis, increasing the risk of confounding bias in that study.

1.5 Mechanisms Linking Religious Participation and Social Isolation

Currently, no specific theoretical model explains the association between RP and SI. However, two relevant frameworks may relate to the relationship of interest in this thesis.

The study of religion, social integration, and suicide was started by Émile Durkheim, who concluded that Catholics were less likely than Protestants to commit suicide due to the Church's strong beliefs against suicide and the high levels of integration within the Catholic community[80]. Conversely, the lack of integration among Protestant denominations and the greater religious freedom associated with Protestant beliefs explained the higher suicide rate within Protestant communities[81]. Thus, based on Durkheim's work, social integration was thought to be one of the key pieces explaining how religion is associated with greater health and well-being.

Following Durkheim's research, sociologists continued to examine the social benefits of religion. Notably, Clarke et al.[82] concluded that social integration is promoted and encouraged

within most religious communities, as religious organizations provide regular opportunities for social relationships to develop between people with similar values and morals. Religious followers tend to participate collectively in ritual events, reinforcing common beliefs and strengthening bonds between religious congregants[82]. Furthermore, McIntosh et al.[83] suggested that through religious contacts, religious followers may become integrated into more extensive social networks that may expand out of their congregations, thus enhancing social integration. This process of integrating religious followers with one another may occur informally, for instance, as religious members exchange information about secular opportunities and join together for leisure events (e.g., dining out, going to the cinema)[84].

Likewise, the Interactional Role Theory by Stryker et al.[85] may also be relevant to how social integration is promoted through religion, as participation within religious organizations provides religious followers with important social roles. Based on the identity framework by Mead[86] and James[87], social roles are the expectations associated with positions within networks of relationships, while identities are the internalized role expectations. Thus, RP encourages people to take on prescribed roles (e.g., religious followers, church elders) within religious organizations. Since religious organizations promote and encourage social integration, individuals (e.g., religious followers) may feel the expectation to become more socially involved, thereby increasing social integration.

With regard to social integration and health, social integration is linked with increases in people's sense of belonging, trust, and social support, which can buffer the negative impacts of adverse events[88]. Integrating with other religious members is also associated with a higher sense of purpose and meaning in life. A greater sense of purpose and meaning in life is linked with increases in resilience, which also has stress-buffering effects[89]. Relating to SI, the more integrated

individuals are with each other and their social networks, the risk of SI decreases. Therefore, one theoretical framework may not directly examine the association between RP and SI, but two theoretical frameworks can be drawn upon to explain the relation between RP, social integration, health, and SI.

1.6 Conclusion

Based on the literature, previous research indicated that positive associations generally existed between RP and SSS, as well as inverse associations between RP and SI. However, across most studies, a lack of agreement existed in the measures and definitions used to explain RP. In most of the studies, RP was conceptualized as religious service attendance. However, in four of the studies, RP also included religious meetings or committees[55,62,63,74]. Additionally, a few studies included private non-organizational practices (e.g., frequency of prayer) within their measures of RP[38,55,71,74]. In the CLSA, RP included involvement in church or religious activities such as services, committees, or choirs[90].

Common to all the studies, RP was measured using 4- to 9-point scales. However, 'active religious participants' were defined inconsistently. For instance, Hastings[60] defined active RP as attending religious services "at least several times per year." At the same time, other studies considered such levels to be infrequent enough to serve as the reference category. Some authors felt active participation in religious services/meetings required "at least monthly" or "weekly" participation levels[59,62,67,74].

The two studies discussing RP and SI were cross-sectional, leaving open the question of whether RP decreased SI or if socially isolated individuals were less likely to participate in religious activities. Several studies in the review also recruited participants from specific geographical locations or population subgroups, thereby decreasing the ability to compare results

across studies or apply these results to larger components of the population. Although most studies reported statistically significant results at the 5% level, many 95% confidence intervals were wide, suggesting a lack of precision in point estimates. None of the studies provided a sample size calculation. The median sample size of the studies was 1,109 participants (range: 424 – 11,162). Two of the seventeen studies in the literature review reported longitudinal results that did not pertain directly to SI[67,91].

2.0 Study Rationale and Research Questions

2.1 Study Rationale

The association between RP and SI is complex, and past findings have been inconsistent. Therefore, this thesis utilized baseline and three-year follow-up data from the CLSA, alongside Menec et al.'s social isolation index, to address some of the gaps in the literature. Given that the CLSA is a nationwide, longitudinal study with over 50,000 middle-aged and older adults, and it gathered data on a wide variety of potential covariates, the CLSA dataset provided an excellent opportunity to research the association between RP and SI. The CLSA's features helped reduce the risks of underpowered analyses, restricted geographical samples, and reverse causality bias.

2.2 Research Questions

(1) Does an association exist between baseline religious participation and follow-up social isolation in community-dwelling, middle and older-aged adults in Canada?

(2) Does the association obtained in question 1 above remain consistent after adjusting for sociodemographic and health covariates, and functional social support?

(3) Do age and sex modify the associations obtained in Questions 1 and 2 above?

3.0 Methods

3.1 Data Source: The Canadian Longitudinal Study on Aging

3.1.1 Background

The CLSA is a strategic initiative of the Canadian Institutes of Health Research and it was formed as a platform of research to study the effects of social, biological, psychological, environmental, and physical factors on the health and wellbeing of aging individuals[92]. The primary purpose of the CLSA is to provide information to help guide policy and practice in aging and health[92].

3.1.2 Study Design

The CLSA is a nationwide, longitudinal study that recruited 51,338 Canadian men and women between 45 and 85 years old at baseline[93]. The study comprises the Tracking Cohort and the Comprehensive Cohort; participants are followed at three-year intervals for at least 20 years[93]. The baseline Tracking Cohort contained 21,241 randomly selected participants from across the 10 Canadian provinces; 17,052 participants remained in the study and provided data at the first three-year follow-up timepoint. Tracking Cohort participants provided data via a 60-minute telephone interview[93]. The Comprehensive Cohort included 30,097 participants at baseline who were randomly recruited from within 25 to 50 kilometres of 11 data collection sites; 27,765 participants remained in the study at the first follow-up[93]. Comprehensive Cohort participants provided data through in-home and in-person interviews at their closest data collection site[92,93]. Participants in both cohorts provided the same set of core information, with those in the Comprehensive Cohort supplying additional clinical, physical, and cognitive data. The CLSA's questionnaires are available online (https://clsa-elcv.ca/researchers/data-collection).

This thesis was a secondary analysis of data from the Comprehensive Cohort to take

advantage of the largest possible sample size for the longitudinal analyses (n = 27,765). To date, most published secondary analyses of CLSA data have included one cohort or the other (https://www.clsa-elcv.ca/stay-informed/publications), not both, and questions have been raised about the validity of combined analyses of both cohorts owing to differences in sample frames and the means of data collection[94].

3.1.3 Thesis Sampling Frame and Eligibility Criteria

The CLSA recruited study participants for the Comprehensive Cohort from provincial healthcare registration databases, the Québec Longitudinal Study on Nutrition and Aging (NuAge)[95], and by random digit dialling of landline telephones (RDD).

The CLSA pre-established recruitment strata were based on province of residence, age group and sex. After recruitment began, the CLSA noticed that persons with low education (high school or less) were underrepresented in the sample. Therefore, census dissemination areas with high proportions of people with lower levels of education were oversampled to correct the imbalance. The CLSA developed baseline sampling weights and geographical strata variables to represent each participant's probability of being selected for the study[96]. Sample weights for the three-year follow-up data are currently under development.

Participants were ineligible if they resided in one of the Canadian territories or on a First Nations reserve or settlement[92]. Additional exclusion criteria pertained to individuals who did not speak or read either French or English, those residing in long-term care institutions, or persons who were full-time members of the Canadian Armed Forces[92].

Based on the three primary recruitment sources, roughly 10% of people who were contacted agreed to enrol in the Comprehensive Cohort[96]. At baseline, the Comprehensive Cohort

enrolled 30,097 participants. During the first follow-up, 1,365 (4.54%) participants dropped out and 967 (3.21%) formally withdrew from the study[97]. Thus, the full thesis sample contained 27,765 participants with baseline and follow-up data.

3.1.4 Analytical Sample

The analytical sample (n = 22,139) was derived from a total sample of 27,765 participants. Participants were removed from the analytical sample if they were missing any baseline RP data, baseline or follow-up SI data, or responses to any baseline covariate. See Appendix C for the flowchart illustrating the formulation of the analytical sample.

3.2 Measures

3.2.1 Measurement of Social Isolation

Participants in the Comprehensive Cohort answered a series of questions about their social networks and social activities. These questions were incorporated into a SI index computed using Menec et al.'s published guidance (see Appendix D)[30]. The two main groups of questions included in the index were drawn from the CLSA's social networks and social participation module[30]. Within the social participation module, the question about RP was removed from the SI index since RP was the predictor variable in this thesis. The SI index is scored on a 5-point scale, with higher scores representing greater SI. For the analysis, participants with social isolation index scores in the range of 0-1 were not socially isolated, whereas participants with scores between 2-5 were considered to be socially isolated[15].

3.2.2 Measurement of Religious Participation

Religious participation was measured with a question from the CLSA's social participation module[37]. Participants were asked how often they participated in religious activities over the past

12 months (i.e., church or church-related activities including services, committees, choirs)[37,60,84]. Responses were recorded on a 5-point scale ranging from "at least once a day" to "never (referent)". In the analysis, the responses were recoded into three categories: Daily to Weekly, Monthly to Yearly, and Never. The recoded responses were to avoid small cell counts in the analysis.

3.2.3. Covariates

This thesis included ten baseline covariates in the analysis between RP and SI (see Appendix E). Three covariates were included to account for the CLSA's complex survey design, i.e., participants' province of residence, sex, and age group. Moreover, baseline SI was also included as an independent variable in all regression models to account for the confounding effect of participants' baseline SI status. The addition of the six other covariates were based on findings from prior studies that researched the association between RP and SSS[22,27,59,71,73,77,84].

The six additional covariates were organized into three groups: (1) sociodemographic (education and annual household income), (2) health (functional status [Basic Activities of Daily Living or ADL, Instrumental Activities of Daily Living or IADL], depressive symptoms, and general self-rated health), (3) functional social support (FSS).

3.2.3.1 Sociodemographic Variables

Sex was evaluated by asking participants if they were female or male. *Age* in years was categorized into four groups: 45-54 years, 55-64 years, 65-74 years, and 75 years or older. *Total annual household income* was examined on a five-level measure: less than $20,000, between $20,000 to $49,999, between $50,000 to $99,999, between $100,000 to $149,999, and $150,000 or greater. *Education* was evaluated on a four-level measure: less than high school, high school

diploma, some post-secondary education, and post-secondary degree/diploma. At recruitment, interviewers recorded participants' *Province of residence*.

3.2.3.2 Health Variables

Functional status was measured using the ADL and IADL scales based on the Older Americans Resources and Services (OARS) Multidimensional Assessment Questionnaire[98]. The ADL questionnaire assessed one's capability to execute seven basic daily tasks, including bathing and feeding[98]. The IADL evaluated participants' ability to conduct seven high-level daily functions, including money handling and shopping[98]. The CLSA combined the ADL and IADL responses to create a derived variable that ranges from 1 (no functional impairment) to 5 (total impairment). For this thesis, *functional status* was dichotomized into 0 (no functional impairment) and 1 (at least mild impairment).

The Center for Epidemiologic Studies Short Depression Scale (CES-D10) was used to assess participants' *depressive symptoms*. The scale contained ten questions, which asked participants how often they experienced feelings of loneliness, depression, restless sleep, and problems with concentration on a four-point scale: 0 (rarely or never), 1 (some of the time), 2 (occasionally), and 3 (all of the time). The scores ranged from 0 to 30, with scores greater than 10 indicating the presence of depressive symptoms[93]. The CES-D10 score was dichotomized for this thesis, with scores greater than 10 indicating depressive symptoms: 1 (positive depressive symptoms), 0 (no depressive symptoms)[99].

For individuals' self-rated *general health*, participants were asked whether their health was excellent, very good, good, fair, or poor. These five responses were used in the analysis.

3.2.3.3 Functional Social Support

Functional social support was evaluated with the Medical Outcomes Study-Social Support Survey (MOS-SSS)[69]. The MOS-SSS is a 19-item, self-administered scale which measures overall FSS, as well as four subtypes of FSS: emotional/informational (8 items), tangible (4 items), affectionate (3 items), and positive social interactions (3 items)[69]. This thesis only used the overall social support score, which was the average score across all nineteen questions. Scores ranged from 0 to 100 and were dichotomized into two groups: Low (scores < 75), High (scores ≥ 75). The cut-off scores were informed by previous research, which were based on the distribution of FSS scores amongst participants within the CLSA[97,100]. These cut-off scores were then transformed using the original authors' formula to convert the cut-offs to the 0 to 100 scale[69].

3.2.3.4 Baseline Social Isolation

Baseline Social Isolation index scores were included as a covariate in the model. This variable was measured and operationalized identically to the follow-up social isolation index score described in Section 3.2.1 above.

3.3 Data Analyses

For all statistical analyses, the thesis candidate used SAS Studio v9.4 (The SAS Institute, Cary, NC) and the SURVEY procedures, including SURVEYFREQ, SURVEYMEANS, and SURVEYLOGISTIC. The SURVEY procedures were employed to adjust for the CLSA's sampling weights and the geographical strata variable. Furthermore, R v4.0.2 (The R Project for Statistical Computing, Vienna, Austria) and the "ggplot2" package were used to create visual displays of data. For all analyses, $\alpha = 0.05$ served as the threshold of statistical significance.

3.3.1 Descriptive Analysis

Baseline descriptive statistics were computed for baseline and follow-up SI, baseline RP, and all ten covariates. The Rao-Scott chi-square test was used for weighted bivariate analysis to

compare the distribution of baseline RP and the ten covariates, stratified by SI (socially isolated versus not socially isolated). All descriptive analyses included the CLSA's trimmed weights and the geographical strata variable.

3.3.2 Regression Analysis

To address each research question, the thesis candidate employed multiple logistic regression models that contained the CLSA's analytical weight and geographical strata variables to account for the complex survey design. Odds ratios (OR) and 95% CI served as the measure of association and quantification of random error, respectively. The analytical plan for research questions one and two are presented in Appendix F.

RP (exposure variable) was included in each model to address the research questions. In total, five models were built. The first model consisted of the base model, including RP, baseline SI, sex, age group, and the province of residence. The additional covariates were added to the first model in thematic blocks: sociodemographic (Model 2), health (Model 3), and functional social support (Model 4). The fully adjusted model (Model 5) included all three covariate-themed blocks and was stratified separately by age group and sex.

This thesis utilized Cuzick's approach to assess for effect modification in the stratified regression models. According to Cuzick, the correct approach to evaluate effect modification was to establish whether the subgroups' effect sizes significantly differed from the main effect size. Forest plots were created to visually display the subgroups' effect sizes. If the confidence intervals from the subgroups overlapped the main effect size, this would suggest that the variable (i.e., sex or age groups) was not an effect modifier[101].

The Mann-Whitney U test statistic for the area under the receiver operating characteristic (AUC) curve was used to assess model fit for each model, with AUC $\geq$ 0.5 suggesting an acceptable model fit[102]. Moreover, residual and observed versus predicted plots were also examined to evaluate model fit.

3.3.3 Missing Data

Complete-case analysis was the approach used in the thesis, and therefore participants with missing data on the exposure, outcome, or any covariate of interest were removed from the regression analysis. Additionally, bivariate analyses were used to analyze the differences in the distribution of RP responses among persons with and without SI data. Also, the distribution of SI responses was compared between respondents with complete RP data and respondents with missing RP data. The Rao-Scott chi-square test was used to examine the statistical significance of these comparisons.

3.4 Ethics

The thesis candidate received approval from the CLSA to access the data used for this thesis (access # 2010005); the University of Waterloo's Office of Research Ethics cleared the thesis in September 2020 (file # 42510). The CLSA has research ethics board approval from all institutions in the Comprehensive Cohort that host Data Collection Sites.

4.0 Results

4.1 Participant Characteristics

4.1.1 Distribution of Sociodemographic, Health, and Functional Social Support Variables

The analytical sample contained 22,139 (unweighted) and 2,413,779 (weighted) participants. The process used to derive the analytical sample from the full sample is described in Appendix C.

Weighted sociodemographic, health and FSS characteristics for the analytical sample are presented in Table 1. Nearly 74% of participants were under the age of 65 years, and 74% of participants had at least some post-secondary education. Furthermore, 58% of the weighted sample were from Québec and British Columbia, followed by 29% from Ontario and Alberta. Females constituted approximately 52% of the sample, and 39% of participants reported household incomes of $100,000 or more.

Regarding participants' health and FSS, approximately 91% of the sample reported having good or better self-reported health, 70% of participants reported high FSS, 18% reported the presence of severe depressive symptoms, and 7% reported functional impairments. The weighted descriptive characteristics for the full baseline comprehensive sample (n = 30,097 unweighted; n = 3,273,750 weighted) were similar to the weighted analytical sample (see Appendix G).

Table 1. Baseline Sociodemographic, Health, Functional Social Support Characteristics of the Analytical Sample: Overall and by Follow-up Social Isolation (n = 2,413,779)

Sociodemographic Characteristics	Total (%)	Socially Isolated (%)	Not Socially Isolated (%)	χ^2	P-value[1]
Age group (years)				18.46	0.0004
45-54	41.94	33.70	42.50		
55-64	31.72	31.84	31.71		
65-74	16.94	22.32	16.58		
75+	9.40	12.14	9.22		
Sex				3.78	0.0518
Male	47.62	52.49	47.29		
Female	52.38	47.71	52.71		
Province				27.63	0.0001
Alberta	10.86	7.42	11.09		
British Columbia	27.36	34.55	26.87		
Manitoba	6.79	4.60	6.94		
Newfoundland and Labrador	1.90	1.77	1.91		
Nova Scotia	3.69	4.22	3.66		
Ontario	18.49	18.32	18.50		
Québec	30.91	29.12	31.03		
Income				48.05	<0.0001
<$20,000	5.77	13.19	5.27		
≥$20,000 and <$50,000	21.02	25.23	20.73		
≥$50,000 and <$100,000	33.93	29.09	34.26		
≥$100,000 and <$150,000	20.95	19.01	21.08		
≥$150,000	18.32	13.47	18.65		
Education				7.73	0.0520
Less than high school	14.93	19.80	14.60		
High school diploma	11.08	9.03	11.22		
Some post-secondary education	9.54	10.27	9.49		
Post-secondary degree/diploma	64.45	60.89	64.69		
General Health				21.38	0.0003
Poor health	1.41	3.26	1.29		
Fair health	8.06	11.54	7.83		
Good health	32.40	35.67	32.17		
Very good health	40.61	35.95	40.93		
Excellent health	17.52	13.58	17.78		
Functional Status				9.86	0.0017
No functional impairment	92.70	89.15	92.95		
Functional impairment	7.30	10.85	7.06		
Depressive Symptoms				18.30	<0.0001
No depressive symptoms	81.60	73.73	82.13		
Depressive Symptoms	18.40	26.27	17.87		
Overall Functional Social Support				21.89	<0.0001
Low	29.64	40.10	28.94		
High	70.36	59.90	66.56		

[1] $\alpha = 0.05$

Note: The chi-square and p-value relate to the comparison of the distributions of each characteristic across socially isolated and not socially isolated groups.

4.1.2 Distribution of Religious Participation Variable

Eighteen percent of CLSA respondents participated in religious activities at least weekly, 32% participated monthly to yearly, and 50% never participated in religious activities (Table 2). Compared to men, a slightly greater proportion of women participated in religious activities at least weekly: 20% of women (versus 15% of men). Thirty-two percent of women and men participated in Monthly to Yearly RP. Lastly, approximately 47% of females and 53% of males reported never participating in religious activities.

Table 2. Distribution of Religious Participation Responses by Sex at Baseline (Weighted)

Religious Participation	Total	Male (%)	Female (%)	χ^2	P-value[1]
Daily to Weekly	435,405 (18.04)	174,528 (15.07)	260,877 (20.63)	40.98	<0.0001
Monthly to Yearly	762,101 (31.57)	365,736 (31.57)	405,365 (32.06)		
Never	1,216,273 (50.39)	618,114 (53.36)	598,158 (47.31)		

[1] $\alpha = 0.05$

Note: The chi-square and p-value relate to the comparison of the distribution of religious participation across sex.

As shown in Table 3, participants who were aged 75 years or older were the most likely group to participate in religious activities, with 59% of respondents participating at least yearly, compared to the other age groups. In comparison, participants between the ages of 55-64 years old were the least likely age group to participate in religious activities, with 47% of respondents participating at least yearly. For participants between 45-54 years and 55-64 years old, Monthly to Yearly RP was the most common reported frequency, with 36% and 31%, respectively; Daily to Weekly RP for these two age groups was 13% and 16%, respectively. Likewise, for persons between 65 and 74 years old, Monthly to Yearly RP was slightly more prevalent than Daily to Weekly RP (27% versus 24%). Within the 75 years or older group, Daily to Weekly RP was the most common response, with 37% of respondents participating in religious activities at least

Weekly (versus 22% in the Monthly to Yearly group).

Table 3. Distribution of Religious Participation Responses by Age Group at Baseline (Weighted)

Religious Participation	Total	45-54 Years (%)	55-64 Years (%)	65-74 Years (%)	75+ Years (%)	χ^2	P-value[1]
Daily to Weekly	435,405 (18.04)	133,210 (13.16)	120,755 (15.77)	98,202 (24.01)	83,239 (36.68)	265.37	<0.0001
Monthly to Yearly	762,101 (31.57)	361,646 (35.73)	241,112 (31.49)	109,261 (26.72)	50,082 (22.07)		
Never	1,216,273 (50.39)	517,425 (51.11)	403,766 (52.74)	201,468 (49.27)	93,614 (41.25)		

[1] $\alpha = 0.05$

Note: The chi-square and p-value relate to the comparison of the distribution of religious participation across age groups.

4.1.3 Distribution of Social Isolation Index Scores by Sociodemographic Characteristics

The weighted bivariate results describing the association between sociodemographic characteristics and SI are presented in Table 1. Among all four age groups in the analytical sample, just over 40% of participants were between the ages of 45-54 years old. Fewer socially isolated respondents were in the youngest age group (i.e., 45-54 years), whereas, in the two oldest age groups, more respondents were in the socially isolated group. In the 55-64 years age group, there was roughly an equal distribution of participants in both the socially isolated and non-socially isolated group (32%).

Regarding biological sex, a slightly larger percentage of males reported being socially isolated compared to females (52% versus 48%), whereas a greater percentage of females reported being not socially isolated compared to males (53% versus 47%). In terms of province, a greater percentage of participants from British Columbia were in the socially isolated group compared to the non-socially isolated group (35% versus 27%). The six other provinces either had approximately equal distributions of participants in the socially isolated and non-socially isolated groups or had slightly more participants in the non-socially isolated group (i.e., Alberta and Manitoba).

For annual household income, a larger percentage of lower-income participants (i.e., < $20,000, ≥ $20,000 and < $50,000) reported experiencing SI; among higher-income groups (i.e., ≥ $50,000 or greater), a larger proportion of participants reported not being socially isolated. Turning to education, a greater percentage of participants with less than a high school education reported being socially isolated than not socially isolated (20% versus 15%). In comparison, the participants in the most educated group (i.e., post-secondary degree) were less likely to be socially isolated. Respondents in the two middle groups (i.e., high school diploma, some post-secondary education), were approximately equally distributed across the non-socially isolated and socially isolated groups.

With respect to participants' self-rated general health, a larger proportion of participants reported "Poor" or "Fair" health in the isolated group compared to the non-socially isolated group (15% versus 9%). In contrast, the percentages of participants who reported "Very Good" and "Excellent" general health were higher in the non-isolated group relative to the isolated group (59% versus 50%). Moreover, a larger percentage of participants with either functional impairments (11% versus 7%) or depressive symptoms (26% versus 18%) reported being socially isolated rather than not socially isolated. For overall FSS, a greater percentage of participants reported "Low" overall FSS in the socially isolated group compared to the non-isolated group (40% versus 29%), whereas the concentration of participants who reported "High" overall FSS was greater in the non-socially isolated group compared to the socially isolated group (67% versus 60%).

4.1.4 Distribution of Social Isolation Index Scores

As presented in Table 4, approximately 7% of the weighted sample reported being socially isolated at baseline, and 6% of participants reported being socially isolated at follow-up. At baseline (Table 5), for Daily to Weekly RP, the proportion of participants in the non-socially isolated group was slightly larger than the proportion in the socially isolated group (18% versus 15%). Similarly, for Monthly to Yearly RP, the concentration of participants was greater in the non-socially isolated group compared to the socially isolated group (32% versus 23%). A larger proportion of participants who reported never participating in religious activities were in the socially isolated group versus the non-socially isolated group (61% versus 50%).

Table 4. Dichotomous Distribution of Social Isolation Responses (Weighted) (n = 2,413,779)

	Baseline Timepoint (%)	Follow-up Timepoint (%)	χ^{2}[1]	P-value[2]
Social Isolation Status			45464.37	<0.0001
Socially Isolated	177,374 (7.35)	152,993 (6.34)		
Not Socially Isolated	2,236,405 (92.65)	2,260,786 (93.66)		

[1] McNemar's Test

[2] $\alpha = 0.05$

Note: The chi-square and p-value relate to the comparison of the distribution of social isolation across timepoints.

Table 5. Baseline Social Isolation by Religious Participation Responses (Weighted) (n = 2,413,779)

Religious Participation	Total (%)	Socially Isolated at Baseline (%)	Not Socially Isolated at Baseline (%)	χ^{2}	P-value[1]
Daily to Weekly	435,406 (18.04)	27,261 (15.37)	408,145 (18.25)	28.31	<0.0001
Monthly to Yearly	762,101 (31.57)	41,474 (23.38)	720,627 (32.22)		
Never	1,216,272 (50.39)	108,638 (61.25)	1,107,634 (49.53)		

[1] $\alpha = 0.05$

Note: The chi-square and p-value relate to the comparison of the distribution of religious participation across socially isolated and not socially isolated groups.

At follow-up (Table 6), for both Daily to Weekly (18% versus 16%) and Monthly to Yearly RP (32% versus 28%), a larger concentration of participants were in the non-socially isolated group than in the isolated group. Also, a greater percentage of participants in the socially isolated group never participated in religious activities relative to the non-socially isolated group (57% versus 50%).

Table 6. Follow-up Social Isolation by Religious Participation Responses (Weighted) (n = 2,413,779)

Religious Participation	Total (%)	Socially Isolated at Follow-up (%)	Not Socially Isolated at Follow-up (%)	χ^2	P-value[1]
Daily to Weekly	435,405 (18.04)	24,012 (15.69)	411,393 (18.20)	6.04	0.0489
Monthly to Yearly	762,101 (31.57)	42,463 (27.75)	719,638 (31.83)		
Never	1,216,273 (50.39)	86,518 (56.55)	1,129,755 (49.97)		

[1] $\alpha = 0.05$

Note: The chi-square and p-value relate to the comparison of the distribution of religious participation across socially isolated and not socially isolated groups.

Turning to the continuous SI index scores, the weighted baseline and follow-up scores were right-skewed (Figures 1 and 2). Over the 3-year follow-up, 61% of participants' SI index scores remained unchanged, 21% reported reductions in levels of SI (i.e., decreases in SI index scores), and 17% reported increases in levels of SI (i.e., increases in SI index scores) (Figure 3).

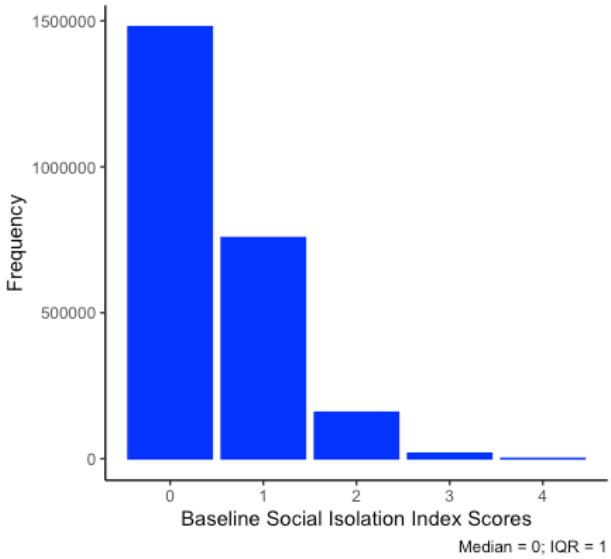

Figure 1: Distribution of Baseline Social Isolation Index Scores - Weighted Analytical Sample (n = 2,413,779)

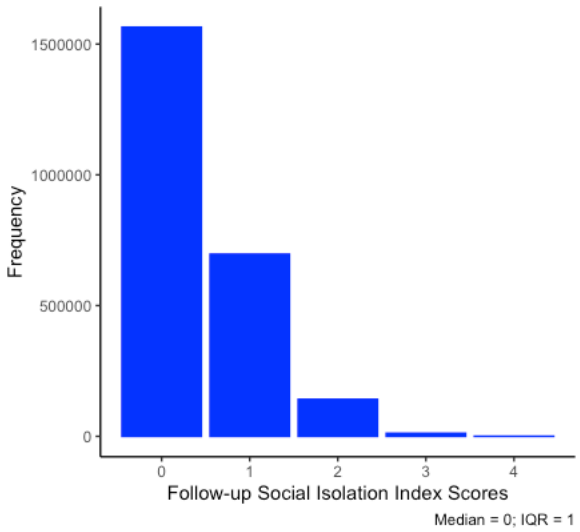

Figure 2: Distribution of Follow-up Social Isolation Index Scores - Weighted Analytical Sample (n = 2,413,779)

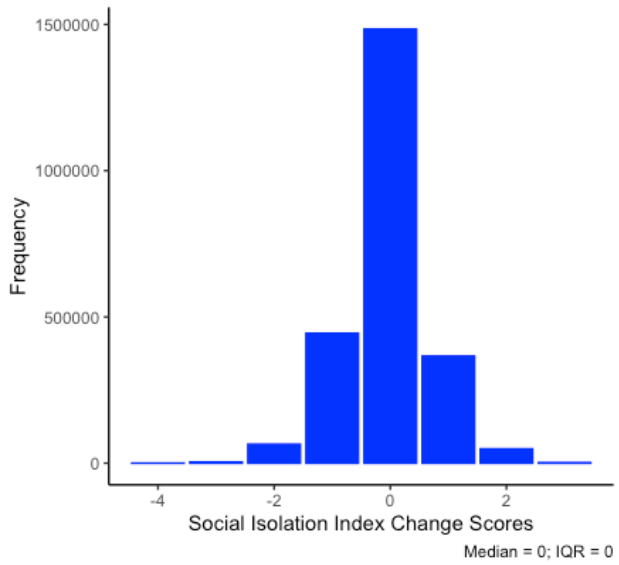

Figure 3: Distribution of Social Isolation Index Change Scores - Weighted Analytical Sample (n = 2,413,779)

4.2 Regression Analyses

4.2.1 Base Model

For the base model, the association between baseline RP and SI at follow-up was not significant at the 5% level (Daily to Weekly versus Never: OR = 0.85, 95% CI: 0.63-1.13; Monthly to Yearly versus Never: OR=0.85, 95% CI: 0.70-1.03). Although these odds ratios indicated an inverse relation between baseline RP and SI at follow-up, the 95% confidence intervals encompassed the null value of 1, meaning the log-linear association is not significantly different from zero (Table 7). Moreover, Monthly to Yearly versus Daily to Weekly RP was not statistically associated with SI (OR = 1.00, 95% CI: 0.73-1.37) (Table 8).

In the base model with 'never participating' in religious activities as the reference category, baseline SI and province of residence were the only statistically significant predictors at the 5% level. SI at baseline was positively associated with being socially isolated at follow-up (OR=8.16; 95% CI: 6.79-9.80). Regarding province, living in Manitoba or Québec, compared to Ontario, was

associated with reduced odds of SI (Manitoba: OR = 0.67, 95% CI: 0.47-0.95; Québec: OR = 0.73, 95% CI: 0.55-0.97).

The ROC curves (AUC), residual and observed versus predicted plots for all the regression models reported in Section 4.3 are in Appendices H, I, and J. For the base model, the AUC was 0.703, which with the residual plots indicated an adequate model fit[103]. On the contrary, the observed versus predicted plots suggested a lack of fit; therefore, the concordant selection rate between the observed SI versus predicted SI was calculated. For both weighted and unweighted data, the concordant selection rate was approximately 80%, suggesting minimal discrepancies between observed versus predicted values and thus an acceptable model fit.

Table 7. Base and Adjusted Regression Models for the Association between Religious Participation and Social Isolation

	Base Model OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
Religious Participation					
Daily to Weekly	0.85 (0.63-1.13)	0.82 (0.62-1.09)	0.86 (0.65-1.15)	0.86 (0.64-1.16)	0.84 (0.64-1.11)
Monthly to Yearly	0.85 (0.70-1.03)	0.88 (0.72-1.07)	0.86 (0.71-1.04)	0.86 (0.71-1.05)	0.89 (0.73-1.08)
Never (reference)	1.00	1.00	1.00	1.00	1.00
Baseline Social Isolation					
Socially Isolated	**8.16 (6.79-9.80)**	**7.78 (6.46-9.37)**	**7.82 (6.51-9.39)**	**7.93 (6.58-9.56)**	**7.58 (6.30-9.13)**
Not Socially Isolated (reference)	1.00	1.00	1.00	1.00	1.00
Sex					
Female	0.84 (0.71-1.00)	**0.79 (0.66-0.95)**	**0.82 (0.69-0.98)**	0.84 (0.70-1.03)	**0.78 (0.65-0.94)**
Male (reference)	1.00	1.00	1.00	1.00	1.00
Age Group					
55-64 years old	1.21 (0.96-1.52)	1.14 (0.900-1.45)	1.20 (0.95-1.51)	1.19 (0.94-1.50)	1.14 (0.90-1.45)
65-74 years old	1.34 (1.05-1.71)	1.20 (0.91-1.57)	1.34 (1.05 – 1.72)	1.33 (1.04-1.70)	1.23 (0.94-1.62)
75 years and older	1.40 (1.05-1.86)	1.18 (0.84-1.67)	1.35 (1.01 -1.82)	1.33 (0.99-1.79)	1.18 (0.83-1.68)
45-54 years old (reference)	1.00	1.00	1.00	1.00	1.00
Province					
British Columbia	1.30 (0.99-1.72)	1.26 (0.96-1.66)	1.31 (0.99-1.74)	1.32 (1.00-1.74)	1.29 (0.98-1.69)
Manitoba	**0.67 (0.47-0.95)**	**0.64 (0.45-0.91)**	**0.66 (0.46-0.94)**	**0.66 (0.46-0.94)**	**0.63 (0.44-0.91)**
Newfoundland and Labrador	0.94 (0.63-1.40)	0.90 (0.60-1.33)	0.93 (0.63-1.39)	0.94 (0.63-1.40)	0.91 (0.61-1.36)
Nova Scotia	1.16 (0.85-1.58)	1.14 (0.85-1.55)	1.15 (0.84-1.57)	1.20 (0.88-1.63)	1.17 (0.87-1.58)
Alberta	0.72 (0.50-1.03)	0.74 (0.52-1.04)	0.73 (0.51-1.05)	0.72 (0.50-1.03)	0.74 (0.52-1.05)
Québec	**0.73 (0.55-0.97)**	**0.63 (0.45-0.86)**	**0.72 (0.54-0.96)**	**0.73 (0.55-0.97)**	**0.64 (0.46-0.88)**
Ontario (reference)	1.00	1.00	1.00	1.00	1.00
Income					
≥$20,000 and <$50,000		**0.50 (0.33-0.77)**			**0.54 (0.35-0.84)**
≥$50,000 and <$100,000		**0.39 (0.26-0.60)**			**0.45 (0.29-0.70)**
≥$100,000 and <$150,000		**0.37 (0.23-0.60)**			**0.44 (0.27-0.71)**
≥$150,000		**0.32 (0.20-0.51)**			**0.38 (0.23-0.62)**
< $20,000 (reference)		1.00			1.00

Table 7. Continued

Education					
High school diploma		0.90 (0.60-1.34)			0.90 (0.60-1.36)
Some post-secondary education		0.98 (0.64-1.49)			0.97 (0.63-1.50)
Post-secondary degree/diploma		0.98 (0.68-1.40)			0.98 (0.67-1.42)
Less than high school (reference)		1.00			1.00
General Health					
Poor health			1.50 (0.82-2.71)		1.24 (0.69-2.22)
Fair health			1.11 (0.76-1.59)		0.92 (0.64-1.32)
Good health			1.10 (0.86-1.41)		0.99 (0.79-1.24)
Very good health			0.98 (0.81-1.20)		0.97 (0.79-1.18)
Excellent health (reference)			1.00		1.00
Functional Status					
Functional impairment			1.17 (0.90-1.50)		1.08 (0.83-1.40)
No functional impairment			1.00		1.00
Depressive Symptoms					
Depressive Symptoms			1.33 (1.08-1.65)		1.13 (0.88-1.45)
No depressive symptoms (reference)			1.00		1.00
Functional Social Support					
Low				**1.51 (1.24-1.83)**	**1.30 (1.08-1.57)**
High (reference)				1.00	1.00
AUC	0.7031	0.7073	0.7088	0.7139	0.7159

AUC: Area Under the Curve
OR: Odds Ratios
CI: Confidence Interval
Statistically significant values ($p<0.05$) are bolded

4.2.2 Full Models

4.2.2.1 Unstratified

Like the base model, in the fully adjusted model (Table 1 – Model 5), the association between RP and SI was not significant (Daily to Weekly: OR = 0.84, 95% CI: 0.64-1.11; Monthly to Yearly: OR = 0.89, 95% CI: 0.73-1.08). Although the odds ratios suggested that baseline RP was inversely related to SI at follow-up, the 95% confidence intervals included the null value of

1, meaning one could not rule out a positive association. For the fully adjusted model, the AUC was 0.716.

Regardless of the mix of covariates included in the regression models (Table 7 – Models 2-4), the main association of interest in Model 5 largely remained unchanged, with the odds ratios ranging from 0.82 to 0.86 for Daily to Weekly RP and 0.85 to 0.89 for Monthly to Yearly RP (versus never participating as the reference category). Moreover, baseline Monthly to Yearly versus Daily to Weekly RP was not statistically significantly associated with follow-up SI in any of the covariate models (odds ratios ranged from 1.00 to 1.07 [Table 8]).

Regarding the covariates in the fully adjusted Model 5, the direction of most covariates was in the anticipated direction. Females had reduced odds of SI compared to males, while controlling for the other covariates (OR=0.78, 95% CI: 0.65-0.94), which agrees with recent work by Chatters et al.[104] The adjusted odds of SI decreased with every increasing annual household income bracket, which agrees with a Dutch study by Hortulanus et al.,[105] who found that low-income individuals were six times more likely to be socially isolated.

The regression models showed expected directions of association for the health covariates. Participants with poor self-rated general health, functional impairments, or depressive symptoms had higher odds of SI. Earlier studies showed that individuals with chronic pain, cardiovascular diseases, or psychological issues engaged in reduced levels of social activities compared to healthier individuals, thereby increasing the risk of SI[106,107]. Moreover, consistent with prior research, participants with functional impairments in the thesis had 8% higher odds of SI than those without functional impairments, while controlling for all other variables in the full model (95% CI: 0.83-1.40). von Soest et al.[108] found that individuals with physical impairments tended to have fewer friends, which may leave them susceptible to being socially isolated. In addition,

people with functional impairments may restrict their social activities or avoid leaving their homes due to a fear of falling, thereby increasing the risk of SI[104].

Previous findings by Ge et al.[109] indicated that poor social connectedness was associated with increased depressive symptoms. In the thesis results, respondents who reported depressive symptoms had 13% higher odds of SI than those without depressive symptoms after controlling for all other covariates (95% CI: 0.88-1.45).

Regarding FSS, higher levels were linked to reduced odds of SI. Compared to those with high FSS, participants with low FSS had 30% higher odds of SI while controlling for all other covariates (95% CI: 1.08-1.57). Previous research showed that socially isolated adults reported less of each of the FSS subtypes (emotional, effective, tangible support, and positive social interactions), thereby affirming the thesis results[70,110].

Education was the only variable in the model that produced unexpected results relative to prior literature, with the odds ratios in the thesis suggesting the absence of an association between educational attainment and SI. In comparison, other research found that higher educational levels were associated with more diverse social networks and a decreased risk of SI[111–115]. Most participants in the study were not socially isolated to begin with, meaning the distribution of socially isolated individuals may not have differed substantially enough across the education categories to detect any effects in the regression models.

Table 8. Base and Adjusted Regression Models for the Association between Religious Participation and Social Isolation

	Base model OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
Religious Participation					
Monthly to Yearly	1.00 (0.73-1.37)	1.07 (0.80-1.43)	1.00 (0.73-1.36)	1.00 (0.73-1.37)	1.06 (0.79-1.40)
Daily to Weekly (reference)	1.00	1.00	1.00	1.00	1.00
AUC	0.7031	0.7073	0.7088	0.7139	0.7159

Note: Odds ratios are adjusted for all covariates shown in Table 1.
AUC: Area Under the Curve
OR: Odds Ratios
CI: Confidence Interval
Statistically significant values ($p<0.05$) are bolded

4.2.2.2 Stratified by Age

Following the stratification of Model 5 by age group (Table 9), no evidence of effect modification was present. As shown in the forest plots (Figures 4 and 5), the stratum-specific point estimates differed between the models; however, the confidence intervals encompassed the odds ratio from the unstratified full model (Model 5), indicating that age group was not an effect modifier based on Cuzick's approach to assess effect modification[101].

Table 9. Association between Religious Participation and Social Isolation Stratified by Age Group

Religious Participation	45-54 Years OR (95% CI)	55-64 Years OR (95% CI)	65-74 Years OR (95% CI)	75+ Years OR (95% CI)
Daily to Weekly	1.12 (0.60-2.12)	0.73 (0.51-1.05)	0.77 (0.54-1.09)	0.71 (0.46-1.10)
Monthly to Yearly	1.03 (0.70-1.51)	**0.72 (0.54-0.95)**	0.88 (0.61-1.27)	1.00 (0.64-1.56)
Never (reference)	1.00	1.00	1.00	1.00
Monthly to Yearly	0.91 (0.48-1.72)	0.98 (0.66-1.45)	1.15 (0.78-1.69)	1.40 (0.88-2.24)
Daily to Weekly (reference)	1.00	1.00	1.00	1.00

Note: stratification was undertaken on the full model (Model 5 in Table 1)
OR: Odds Ratios; CI: Confidence Interval
Statistically significant values ($p<0.05$) are bolded

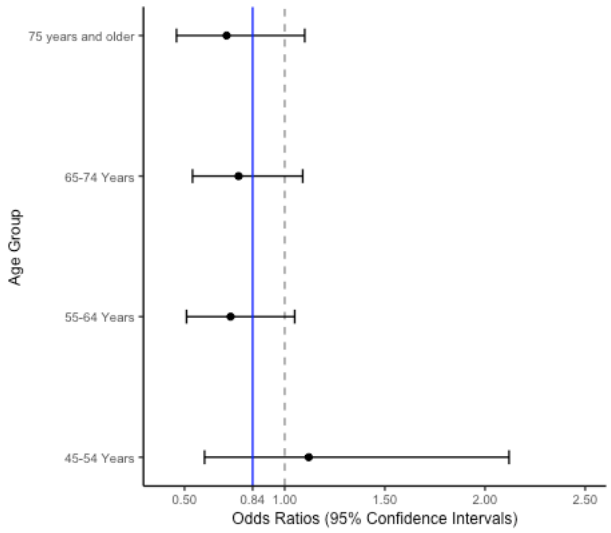

Figure 4: Daily to Weekly Religious Participation (versus Never) and Social Isolation Stratified by Age Groups

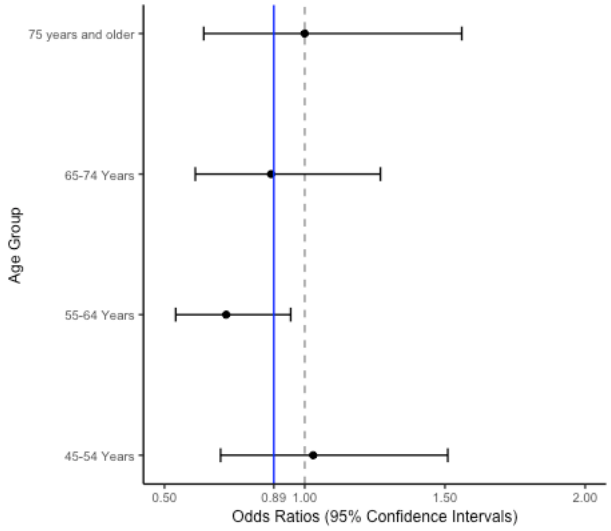

Figure 5: Monthly to Yearly Religious Participation (versus Never) and Social Isolation Stratified by Age Groups

4.2.2.3 Stratified by Sex

After stratification of Model 5 by sex (Table 10), no evidence for effect modification existed. The stratum-specific odds ratios differed between the models (Figures 6 and 7); however, the confidence intervals all included the odds ratio from the unstratified full model (Model 5), thereby indicating no effect modification according to Cuzick's approach[101].

Table 10. Association between Religious Participation and Social Isolation Stratified by Sex

Religious Participation	Male OR (95% CI)	Female OR (95% CI)
Daily to Weekly	0.86 (0.57-1.30)	0.86 (0.64-1.14)
Monthly to Yearly	0.82 (0.72-1.31)	0.96 (0.71-1.30)
Never (reference)	1.00	1.00
Monthly to Yearly	0.95 (0.62-1.45)	1.12 (0.81-1.57)
Daily to Weekly (reference)	1.00	1.00

Note: stratification was undertaken on the full model (Model 5 in Table 1)
OR: Odds Ratios; CI: Confidence Interval
Statistically significant values ($p<0.05$) are bolded

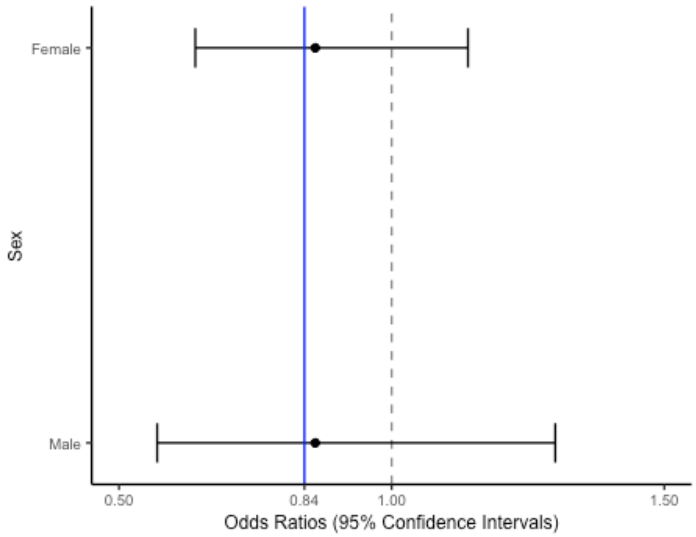

Figure 6: Daily to Weekly Religious Participation (versus Never) and Social Isolation Stratified by Sex

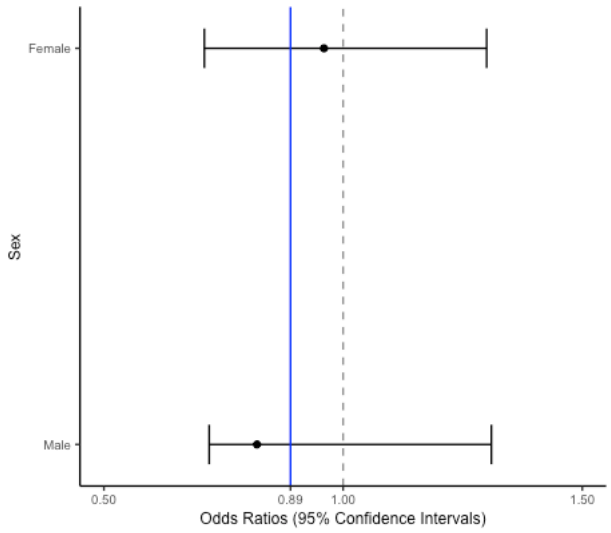

Figure 7: Monthly to Yearly Religious Participation (versus Never) and Social Isolation Stratified by Sex

4.3 Missing Data Analyses

The missing data analyses identified slight differences in the proportions of socially isolated versus non-isolated participants at follow-up, when SI was stratified according to whether participants' RP data were missing or not (Table 11). The highly significant p-value in the table is likely a result of the large sample size. Given the small differences in proportions across the two strata, one concludes that a clinically important difference in the distribution of SI does not exist according to whether RP data were missing or non-missing.

Table 11. Percentages of Participants with Missing Religious Participation Data and Follow-up Social Isolation

Social Isolation at Follow-up	Religious Participation (%)			
	No Missing Data	Missing Data	χ^2	P-value[1]
Not Isolated	93.58	92.15	19.73	<0.0001
Isolated	6.42	7.85		

[1] $\alpha = 0.05$

Note: The chi-square and p-value relate to the comparison of the distribution of social isolation status across missing and not missing data groups.

In contrast, a higher proportion of participants with missing baseline SI data reported never participating in religious activities, compared to participants with no missing data (Table 12). A similar finding was observed for missing SI data at follow-up, although the difference in proportions were less pronounced than at baseline (Table 13)

Table 12. Percentages of Participants with Missing Baseline Social Isolation Responses and Religious Participation

Religious Participation	Baseline Social Isolation			
	No Missing Data	Missing Data	χ^2	P-value[1]
Daily to Weekly	18.80	10.69	9779.13	<0.0001
Monthly to Yearly	31.13	12.44		
Never	50.07	78.87		

[1] $\alpha = 0.05$

Note: The chi-square and p-value relate to the comparison of the distribution of religious participation across missing and not missing data groups.

Table 13. Percentages of Participants with Missing Follow-up Social Isolation Responses and Religious Participation

Religious Participation	Follow-up Social Isolation			
	No Missing Data	Missing Data	χ^2	P-value[1]
Daily to Weekly	18.76	17.45	618.07	<0.0001
Monthly to Yearly	31.01	28.42		
Never	50.23	54.13		

5.0 Discussion

5.1 Summary of Findings

5.1.1 Research Question (1)

Does an association exist between baseline religious participation and follow-up social isolation in community-dwelling, middle and older-aged adults in Canada?

According to the base model, an inverse association existed between baseline RP and SI at follow-up; however, the association was not statistically significant, and the direction of effect could therefore be positive.

5.1.2 Research Question (2)

[1] $\alpha = 0.05$

Note: The chi-square and p-value relate to the comparison of the distribution of religious participation across missing and not missing data groups.

Does the association obtained in question 1 above remain consistent after adjusting for sociodemographic and health covariates, and functional social support?

The odds ratios and confidence intervals in the fully adjusted model (Model 5) were comparable to those of the base model. None of the adjusted odd ratios for follow-up SI were statistically significant.

5.1.3 Research Question (3)

Do age and sex modify the associations obtained in Questions 1 and 2 above?

Evidence for effect modification by age and sex was not evident. The confidence intervals for the stratum-specific odds ratios for RP all included the unstratified odds ratio from the full model (Figures 4 to 7)

5.2 Explanation of Findings

5.2.1 Association between Religious Participation and Social Isolation

The association between baseline RP on SI at follow-up was highlighted by small and largely nonsignificant odds ratios. Several factors may explain this finding. First, compared to other studies in the field, the analytical sample used in the thesis reported less participation in religious activities. Previous studies examining the association between RP and SI enrolled participants from religious communities or included larger quantities of participants who attended religious activities. In one study, 58% of the sample participated in religious activities at least a few times a month, with 63% of the sample affiliated with Conservative Protestants, known to be highly religious[84]. In another study, 77% of the sample attended religious services at least a few times a year, while 53% of the sample attended religious services at least once a week[61]. In comparison, in the analytical sample from the thesis, 32% of respondents participated at least monthly and 18% participated at least weekly in religious activities. As a result, the muted association between RP and SI in the thesis could partially be explained by the absence of recruitment bias, as prior studies may have recruited people who were more likely to be religious and report high levels of participation, thereby leading to overestimates of an inverse association with SI.

Second, most of the analytical sample from the thesis was not socially isolated, likely due to volunteer bias. Individuals in the Comprehensive Cohort were required to undertake an in-home interview and visit one of the CLSA's data collection sites. These requirements may have created obstacles to prevent socially isolated individuals from participating in the study, especially in relation to travelling up to fifty kilometres to attend the site visit. Thus, non-isolated individuals who felt they could commit to visiting a study site over a 20-year period were overwhelmingly

more likely to volunteer for the CLSA. Since participants mainly reported not being socially isolated, regardless of their levels of RP, the thesis results could well have been biased to the null.

Third, given that most of the sample was not socially isolated, a three-year follow-up was unlikely to be enough time to detect changes in SI index responses. To be considered socially isolated in the current study, participants were required to score at least two points on the SI index; therefore, three years may have been too short a time for participants' SI index responses to change. Longer follow-ups may provide more opportunities for additional participants to become socially isolated and permit the thesis candidate to observe changes in SI index scores. To the thesis candidate's knowledge, no population-based longitudinal study has been completed investigating RP and SI. In the literature review, two articles conducted a longitudinal study; however, they did not directly pertain to the main outcome variable of interest. In the literature review, one study focused on FSS, while the other study examined SSS[67,77].

Fourth, the regression models in this thesis included a larger set of covariates than most previous studies in the field. This meant the thesis results could have been subject to a lower degree of residual (unadjusted) confounding than other studies. The impact of unadjusted confounding could lead to biases away from the null, thus either overestimating positive or inverse effects. Since this study minimized residual confounding compared to most previous studies, the thesis results may be closer to the true effect. In this thesis, 10 covariates were included (see Section 3.2.3), whereas among the 17 articles in the literature review, 16 included age[22,26,71–74,84,116,27,54,55,59–61,63,67],16 included sex[22,26,67,71–74,77,27,54,55,59–63],13 included educational attainment[22,26,72,73,77,27,54,59–62,67,71], 10 included income[22,26,54,59,61,62,71,73], 4 controlled for functional impairment[22,26,27,71], 3 adjusted for general self-rated health status[22,26,67] and 2 controlled for depressive symptoms[73,74]. None of the studies in the literature review included all the covariates in the current study.

As mentioned above, the impact of unadjusted confounding in other studies may have overestimated the effects of RP on SSS or SI. Most noticeably, FSS was not included as a confounder in previous studies looking at SSS or SI. RP may provide individuals with social resources, such as FSS (i.e., affectionate, tangible, emotional/informational), thereby contributing to increased feelings of belonging and bonding with others[32,39]. As a result, changes in SSS or SI may not only be due to RP. If previous studies adjusted for FSS, the studies' significant and large effect sizes may have been reduced. In the current study, the thesis candidate controlled for FSS, which may have been one factor that contributed to smaller effect sizes and non-significant results. Future studies could explore whether FSS is a mediator or mediated moderator.

One of two studies illustrated inverse results between RP and SI in the literature review. Kobayashi et al.'s study of 1,064 Canadians (age ≥ 65 years) from British Columbia found that persons who attended religious services were less likely to be socially isolated. Although their study reported significant results, the authors did not adjust for FSS, increasing the likelihood for unadjusted confounding. Additionally, Kobayashi et al.[26] focused on older adults from small towns and cities, thus reducing the likelihood their results could be made generalizable to the rest of the Canadian population or more urbanized areas.

Furthermore, readers should note that six of the studies[27,60–63,67] mentioned in the literature review examined associations between RP, social network size, and frequency of interactions, which are components of SI. Therefore, the results of these studies cannot be directly compared to the thesis. To be consistent with the thesis hypothesis, though, one would expect positive associations between RP and social network size or frequency of interactions in these other studies, with larger networks and more frequent interactions implying decreased SI. In fact, these seven studies reported results that aligned with the hypothesis, as described in the next paragraph below.

Ellison et al.[62] found that religious attendance was positively associated with increases in social network size (specifically, non-kin ties) in 2,956 participants aged 18 years or older (mean age of 43 years) from North Carolina. Similarly, McIntosh et al.[27] reported that the frequency of church attendance increased the size, frequency, and interaction of social networks in 424 Hispanic Americans aged 58 years or older. Bradley[61] examined 3,617 Americans (age ≥ 18 years) and found that religious attendees reported more extensive social networks and higher contact frequencies with people in their networks. Hastings[60] compared social network interactions between people (age ≥ 25 years) who were (i) religious and attended services (Attenders), (ii) religious yet did not attend services (RNA), (iii) spiritual yet not religious (SBNR), and (iv) neither spiritual nor religious (NSNR) (n = 11,162). Hastings found that Attenders had more frequent social interactions with others and larger social network sizes than RNA and SBNR. Similarly, Okruszek et al.[63] studied 564 Polish young adults (ages 18 to 35 years) during COVID-19 and found that frequent religious attendees (FA) and infrequent religious attendees (IA) reported larger social networks than non-attenders (NA). Strawbridge et al.[67] conducted a longitudinal study from 1965 to 1994 with 2,676 participants (ages 17 to 65 years) from the Alameda County Study. The authors found that baseline religious attendance was associated with increased social involvement at follow-up, compared to participants who attended less than weekly or not at all[67].

5.2.1.1 Equivocal or Null Associations between Religious Participation and Social Isolation or Structural Social Support

One study in the literature review reported equivocal findings between RP and SI. Child et al. found equivocal results in 1,109 participants (ages 21 to 70 years) from the UC Berkeley Social Networks Study. In their cross-sectional study, no association was reported between religious attendance a few times a year or religious attendance about every week and the number of days

participants felt isolated. In contrast, religious attendance a couple of times a month was associated with increases in the number of days participants felt isolated. However, none of these results were statistically significant and the 95% confidence intervals were wide. The authors believed their results could be region-specific and not applicable to other regions of the United States. In addition, the measurement of SI was subjective because participants were asked to specify the number of days they felt isolated in the previous seven days[59].

A second study in the literature review found null findings between RP and social network size. Dunbar's cross-sectional study of 300 participants from a market research panel (median age: 25 to 30 years old) did not find an association between religious attendance and total number of friends on a social media website. This study's results should be interpreted cautiously because the outcome variable does not capture overall social network size and the author adjusted his models for only age and sex, thereby increasing the likelihood of residual confounding[55].

5.2.2 Association between Religious Participation and Social Isolation by Age

Based on the findings in this thesis, effect modification was not present between baseline RP and follow-up SI. While descriptive analyses showed that older adults (65-74 years and 75+ years) were more likely to be socially isolated over three years (Table 1), results from the forest plot (Figures 4 and 5) indicated no evidence of effect modification. The absence of effect modification by age in the thesis may be explained by the CLSA's data collection method, where non-isolated persons were more likely to join the study compared to isolated persons, regardless of age. Therefore, the regression models were unlikely to find differences in the proportion of isolated versus non-isolated persons across age groups after controlling for all other covariates. To the thesis candidate's knowledge, Child et al.[59] were the only group who measured SI and stratified results by age, although the strata (21 to 30 years and 50 to 70 years) differed from the thesis and,

in the case of the 50- to 70-year group, may have been too wide to detect the presence of effect modification.

5.2.3 Association between Religious Participation and Social Isolation by Sex

As shown in the descriptive analyses, a slightly higher proportion of males were socially isolated (Table 1), although effect modification by sex was not evident following the stratification of the full model (Model 5). Sex may simply not be an effect modifier of the association between RP and SI. Sample size calculations indicated that samples of 10,851 men and 11,288 women were large enough to detect significant results in the event sex was an effect modifier. Only one of the SSS studies stratified their results by sex; however, the stratified odds ratios were non-significant and the confidence intervals for the stratum-specific odds ratios substantially overlapped with one other[67].

5.3 Strengths

This study has notable strengths. First, to the thesis candidate's knowledge, this is the first study to examine the association between RP and SI longitudinally in a population-based sample. The analytical sample comprised 22,139 middle- and older-aged, community-dwelling adults from across Canada, which allowed the thesis results to be applicable to a larger target population than earlier research. Previous work generally focused on highly select populations and only two earlier cross-sectional studies looked specifically at SI as an outcome[26,59]. Second, the thesis' longitudinal design allowed the effect of RP on SI to be investigated over time, thus reducing the likelihood of reverse causality bias. Third, the thesis utilized Menec et al.'s SI index, which was developed for the CLSA and used in previous studies that employed CLSA data[15,30,70]. The similarity between Menec et al.'s SI index and other indices, such as those derived by Shankar et al.[117] and Steptoe et al.[118], permits the thesis results to be compared to other longitudinal and population-based studies

of SI as an outcome[119–127]. These aforementioned three indices were based on a particular theoretical view of SI as a multifaceted construct that is manifested through the absence of a variety of aspects of social engagement, as described in Sections 1.2.4 and 3.2.1 above[30,70,128].

Fourth, this thesis utilized RP as the primary exposure variable. RP is one of the most widely used variables to measure religious involvement in studies of religion and health, thereby increasing the ability to compare thesis results to other religion and health studies[26,27,73,74,84,116,37,38,53,59–61,71,72].

Fifth, due to the CLSA's wealth of data, the thesis candidate was able to control for various covariates included in previously published studies[22,27,77,84,54,55,59,60,71–74], and additional covariates such as depressive symptoms, functional impairments, and FSS. This approach helped minimize residual confounding.

5.4 Limitations

The thesis is not without limitations. First, selection bias was present because 92.7% of participants at baseline and 93.7% of participants at follow-up were not socially isolated. The low proportion of socially isolated participants reduced the ability to examine whether RP decreased the odds of SI over time because most participants were not socially isolated regardless of RP. Second, participants recruited into the CLSA reported higher income and education levels than the average Canadian in the 45- to 85-year age range[129]. Income and education levels are inversely associated with SI, and as a result, may have contributed to the limited proportion of socially isolated individuals recruited in the study. Therefore, caution must be applied when generalizing the results to persons beyond the analytical sample's demographic. Third, the majority of participants self-identified as white (92%), thereby, these results may not be as generalizable to individuals of other races[93]. Fourth, a single religious variable was included in the thesis as the

primary exposure because it was the only measure available in the CLSA. Therefore, one could not investigate how the findings might have changed if other measures of religion were also included in the CLSA. Furthermore, the thesis did not examine spirituality because the CLSA did not ask about this construct.

5.5 Implications

The equivocal findings of this thesis did not lend themselves to a specific set of policy recommendations. However, given point estimates of odds ratios indicating inverse associations between RP and SI, activities within religious organizations are unlikely to be harmful for reducing SI. Examples of such activities include study groups (e.g., bible groups), service to the congregation (e.g., volunteering for church activities, serving on a church's board of directors), and volunteering for church-based community outreach programs. Taken together, these activities promote social interaction with other congregants and the public, thereby helping reduce the likelihood of SI. Since SI is a risk factor for many serious health conditions (e.g., cardiovascular disease, cognitive disorders), further research is necessary to investigate the implications of the association between RP and SI for population health[130].

6.0 Conclusions

Although the findings of this thesis suggested the possibility of a protective effect for RP on SI over three years of follow-up in Canadians aged between 45 and 85 years, the effect sizes were small, and most odds ratios were not statistically significant. Alternatively, the results could suggest that no association exists between RP and SI in a population-based sample, following adjustment for a large set of relevant confounders and using a robust measure of SI. Another possibility is that a clear association between RP and SI may not have been found since the thesis contained a sample of primarily non-socially isolated participants who were followed for a brief period of three years.

This thesis serves as a steppingstone for future research into longitudinal changes in the association between RP and SI. Longer follow-up periods with larger proportions of socially isolated individuals will strengthen the understanding of this association. Future research building upon this thesis may contribute to the development of targeted interventions for mitigating the risk of SI in middle- and older-aged adults.

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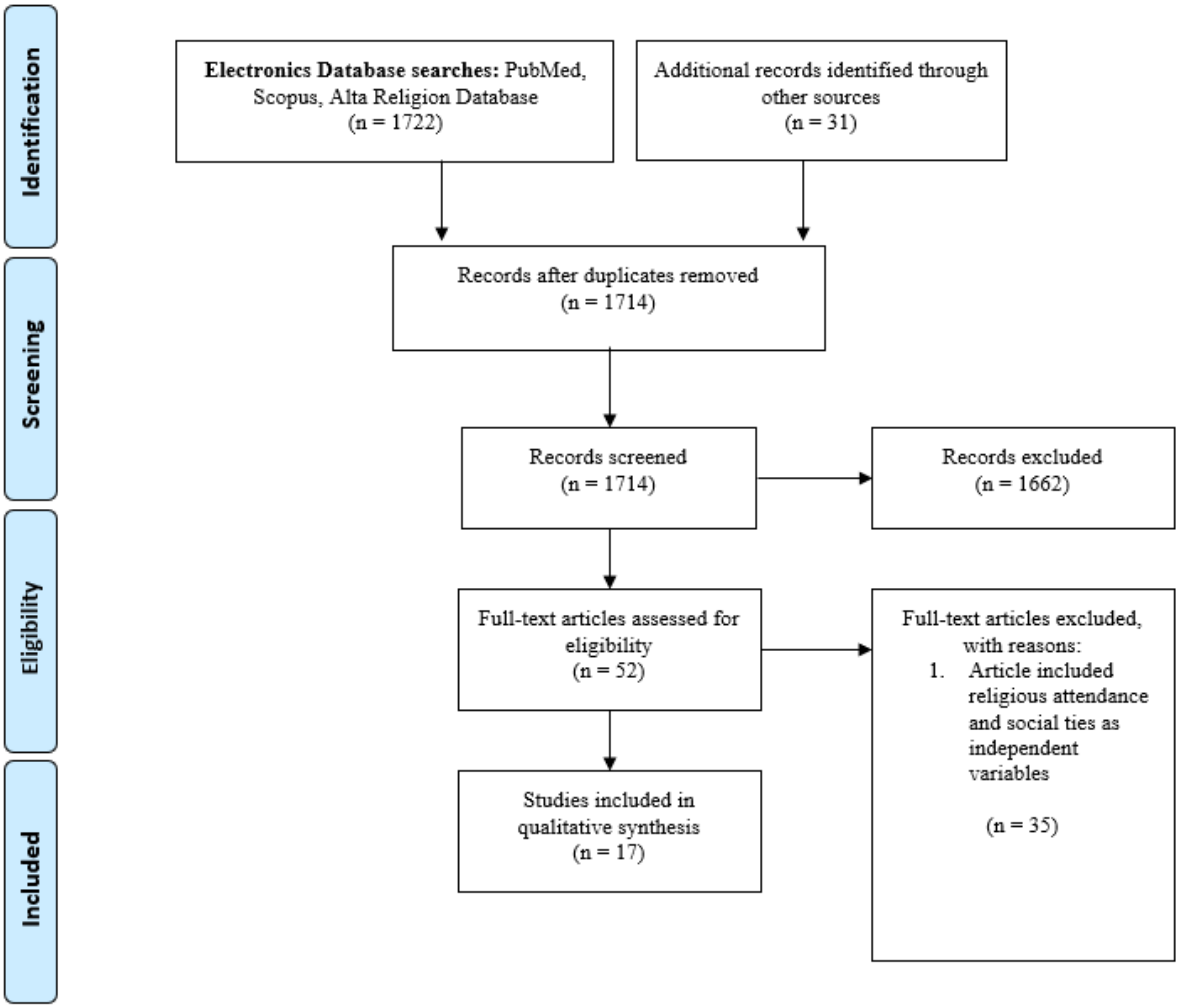
Appendices

Appendix A.

Figure A-1. Prisma Flow Diagram



Appendix B.

Table B-1. Summary of the Literature on the Association between Religious Participation and Social Isolation

First Author	Title	Study Design	Study Population	Predictor Measures	Outcome Measures	Covariates	Conclusions and Findings
Child et al. 2019	Loneliness and social isolation among young and late middle-aged adults: Association with personal networks and social participation	Cross-sectional analysis	472 (21–30 years) and 637 (50–70 years) Americans recruited from the University of California, Berkeley	Religious participation: Religious service attendance	Social isolation: Number of days participants felt socially isolated in the previous week.	Age, sex, race/ethnicity, educational attainment, employment status, income, personality traits	No clear association between religious attendance and social isolation in the late middle- aged adults' group. The results were also not statistically significant.
Kobayashi et al. 2009	Making meaningful connections: A profile of social isolation and health among older adults in a small town and small city, British Columbia	Cross-sectional analysis	1064 Canadians (65+) from British Columbia	Religious participation: Religious service attendance	Social isolation: Lubben Social Network Scale, Canadian Community Health Survey	Age, sex, marital status, birth country, rural or urban residence, living arrangements, length of residence in British Columbia, total household income, educational attainment, homeownership, self-rated health, chronic conditions, functional status, health service utilization, homecare, NurseLine	Socially isolated persons were significantly less likely to attend religious services. Persons who did not attend religious services had greater odds of being socially isolated.
The Association between Religious Participation and Structural Social Support							
Ellison et al. 1994	Religious involvement, social ties, and social support in a Southeastern community	Cross-sectional analysis	2956 Americans (18+) from the Piedmont Health Survey (North Carolina)	Religious participation: Religious service attendance	Structural social support: Network size, frequency of telephone contacts, frequency of in-person contacts, perceived quality of relationships	Age, sex, race, income, educational attainment, urban residence, marital status, household size, employment status	Religious attendance was associated with larger social networks and more frequent contact with network members. Frequent churchgoers had on average 2.2 more non-kin contacts.

First Author	Title	Study Design	Study Population	Predictor Measures	Outcome Measures	Covariates	Conclusions and Findings
Bradley 2015	Religious involvement and social resources: Evidence from the data set "Americans' Changing Lives."	Cross-sectional analysis	3617 Americans (18+) from the Americans' Changing Lives (Wave 1) study	Religious participation: Religious service attendance	Structural social support: Network size, frequency of telephone contacts, frequency of in-person contacts, perceived quality of relationships	Age, sex, race, community size, educational attainment, marital status, employment status, income, household size, region, neuroticism, extroversion	Religious attendees reported more extensive social networks, and more frequent telephone and in-person contact. These results were statistically significant.
Dunbar 2019	Religiosity and religious attendance as factors in wellbeing and social engagement	Cross-sectional analysis	300 participants from the United States, United Kingdom, and unspecified countries from Europe and Asia (Median age-group: 25-30 years old)	Religious participation: Duke University Religion Index Religiosity: Santa Clara Strength of Religious Faith Questionnaire	Structural social support: Number of Facebook friends, sympathy group size, clique group size	Age, sex	Religious participation was not associated with participants' total number of friends. However, the total number of friends were based on participants' number of friends on social media, which may not be an accurate representation of their in-person social network size. In contrast, religious participation was associated with a larger sympathy group size.
Hastings 2016	Not a lonely crowd? Social connectedness, religious service attendance and the spiritual but not religious	Cross-sectional analysis	8552 American participants from the 2006-2014 General Social Survey 2610 American participants from the Portraits of American Life Study	Religious participation: Religious service attendance Religious affiliation	Structural social support: Frequency of interactions, core discussion network, and social connectedness	Age, sex, race, ethnicity, marital status, educational attainment, political ideology, employment status, region of the interview, year of interview, household size	Religious individuals who attended religious services had larger social networks and more frequent contact with others than religious individuals who do not attend religious services, and spiritual individuals. However, the results were not statistically significant.
Okruszek et al. 2021	Take me to (the empty) church? Social networks, loneliness, and religious attendance in young Polish adults during the COVID-19 Pandemic	Cross-sectional analysis	564 Polish young adults (18-35 years)	Religious participation: Religious service attendance	Structural social support: Social Network Index (Polish version)	Age, sex, student status, place of origin, marital status, urban vs. rural environment	Religious service attendance was associated with larger social network sizes in participants who attended religious service attendance, compared to those who did not.

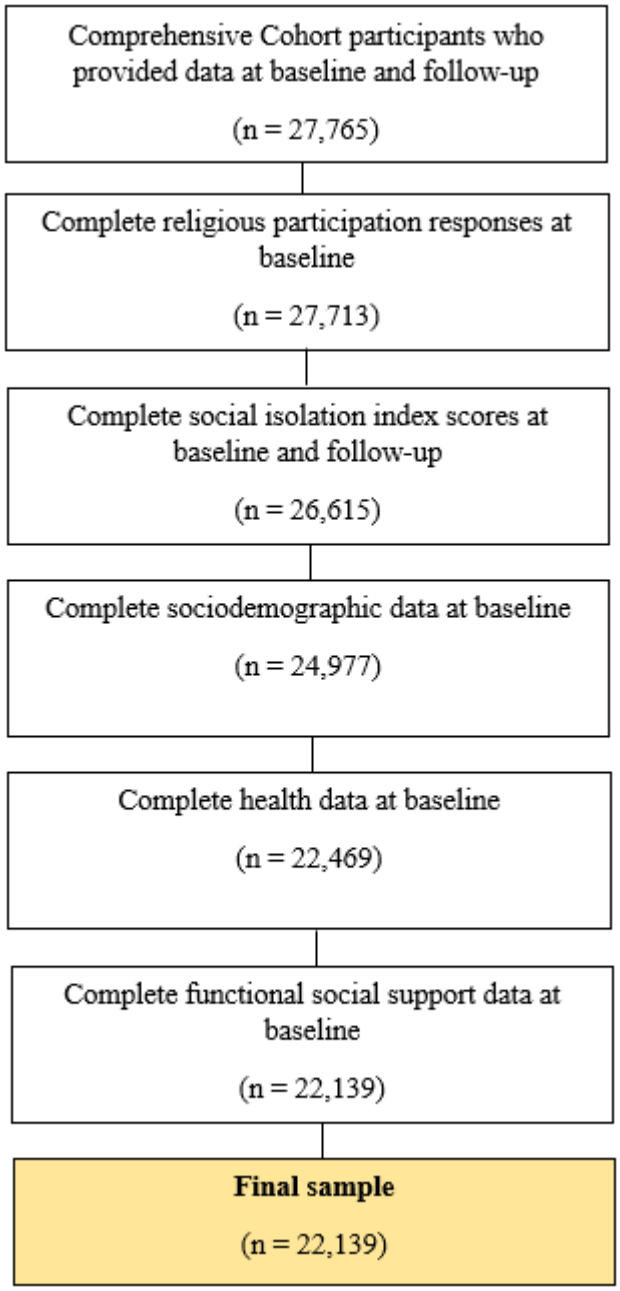
First Author	Title	Study Design	Study Population	Predictor Measures	Outcome Measures	Covariates	Conclusions and Findings
McIntosh et al. 2002	Religion and community among the elderly: The relationship between religious and secular characteristics of their social networks	Cross-sectional analysis	424 non-Hispanic American Whites (58+)	Religious participation: Religious service attendance	Structural social support: The names of people who help participants with daily activities, frequency of interaction with members in support network	Sex, income, education attainment, prestige of former occupation, place of residence, presence of chronic health problems, functional ability	Church service attendance was significantly associated with larger social networks and greater diversity of social networks. In comparison, church service attendance was not significantly associated with frequency of interaction.
Strawbridge et al. 2001	Religious attendance increases survival by improving and maintaining good health behaviours, mental health, and social relationships	Longitudinal analysis	2676 Americans (17-65 years) from the Alameda Country Study	Religious participation: Religious service attendance	Structural social support: The frequency of visiting friends or relatives in a month	Age, gender, educational attainment, self-rated health	Religious attendance was significantly associated with increases in social involvement at follow-up, compared to those who did not attend religious services regularly. Religious attendance was also significantly associated with decreases in adopting bad behaviours (i.e., reducing social relationships).
The Association between Religious Participation and Functional Social Support							
Bradley et al. 2020	Religious attendance and social support: Integration or selection?	Cross-sectional analysis	444 Americans (18+) from the 2011 Miami-Dade Health Survey	Religious participation: Duke University Religion Index (DOREL)	Functional social support: Medical Outcome Study – Social Support Survey (MOS-SSS)	Age, sex, immigrant status, interview language, educational attainment, employment status, income, financial strain, marital status, presence of children, family difficulties, personality, health behaviours, health status	Participants who attended religious services at least weekly or more reported higher social support compared to those who never attended. These results were statistically significant.

First Author	Title	Study Design	Study Population	Predictor Measures	Outcome Measures	Covariates	Conclusions and Findings
Hill et al. 2019	Religious attendance and the social support trajectories of older Mexican Americans	Cross-sectional analysis	2479 Mexican Americans (65+)	Religious participation: Religious service attendance	Functional social support: Emotional and instrumental support	Age, sex, immigrant status, language proficiency, educational attainment, income, religious affiliation, marital status, living arrangements, contact with family/friends, secular group memberships, self-esteem, smoking, drinking, depression, cognitive functioning, physical mobility, chronic disease	A significant dose-response association was found between religious service attendance and social support. For instance, the odds of low social support was lower for participants who attended religious services at least yearly.
Koenig et al. 1997	Modeling the cross-sectional relationships between religion, physical health, social support, and depressive symptoms	Cross-sectional analysis	4162 participants (62+) from the Duke University Site of the National Institute of Health-sponsored EPESE	Religious participation: Religious service attendance, frequency of prayer, frequency of watching religious TV	Functional social support: Duke Social Support Index (DESI)	Age, sex, race, good health (self-rated health, functional status, chronic disease), depression, religious tv/radio, prayer/bible	Church service attendance was not associated with functional social support.
Moxey et al. 2011	Spirituality, religion, social support and health among older Australian adults	Cross-sectional analysis	752 Australians (55-85 years old) from Hunter Region, New South Wales	Religious participation: Religious service attendance	Functional social support: Duke Social Support Index (DESI)	Age, sex, education, income	Religious participation was significantly associated with increased social support.
Van Olphen et al. 2003	Religious involvement, social support and health among African-American women on the east side of Detroit	Cross-sectional analysis	679 African American women (18+)	Religious participation: Organizational and non-organizational activities Subjective religiousness	Functional social support: Emotional support	Age, education, income, marital status, physical functioning, church membership	Frequency of religious service attendance was significantly associated with social support. Persons who reported more frequent religious service attendance had a greater likelihood to report greater social support from fellow congregants.

First Author	Title	Study Design	Study Population	Predictor Measures	Outcome Measures	Covariates	Conclusions and Findings
Harvey et al. 2016	Exploring the relationship of religiosity, religious support, and social support among African American women in a physical activity intervention	Cross-sectional analysis	465 African American women (Mean age: 51 years)	Religious participation: Religious service attendance, other religious activities at a place of worship Private religious practices: frequency of religious tv, frequency of meditation	Functional social support: Social Provision Scale (SPS) Church-based social support: Emotional support received, emotional support provided, anticipated support, and negative interaction	None listed	Totally religiosity (i.e., private practices and religious participation) were significantly inversely associated with religious social support and functional social support.
Nguyen et al. 2016	Church-based social support among Caribbean Blacks in the United States	Cross-sectional analysis	1288 American Caribbean Blacks (Mean age: 41 years)	Religious participation: Religious service attendance	Church-based social support: receipt of emotional support, receipt of general social support, provision of general social support, and negative interaction	Age, sex, income, educational attainment, marital status, country of origin, immigration status, religious denomination	Religious service attendance was significantly associated with the receipt of emotional support and general social support.
Le et al. 2016	Religious participation is associated with increases in religious, social support in a national longitudinal study of African Americans	Longitudinal Study	3173 African Americans (18+)	Religious participation: Religious service attendance	Church-based social support: Brief Multidimensional Measure of Religiousness/Spirituality for Health Research Functional support: The Interpersonal Support Evaluation List	Age, sex, marital status, educational attainment, employment status, income, health status	Religious service attendance was associated with increased religious-based social support from baseline to Wave 2. However, religious service attendance was not associated with functional social support at baseline to Wave 2.

Appendix C.

Table C-1. Derivation of Analytical Sample



Appendix D.

Table D-1. Social Isolation Index

CLSA Module	Questions	Measurement
Social Networks	When did you last get together with any of your children who live outside of your household?	Within the last day or two Within the last week or two Within the past month Within the past 6 months Within the past year More than 1 year ago
	When did you last get together with any of your siblings who live outside of your household?	Within the last day or two Within the last week or two Within the past month Within the past 6 months Within the past year More than 1 year ago
	When did you last get together with any of your close friends who live outside of your household?	Within the last day or two Within the last week or two Within the past month Within the past 6 months Within the past year More than 1 year ago
	When did you last get together with any of your neighbours?	Within the last day or two Within the last week or two Within the past month Within the past 6 months Within the past year More than 1 year ago
	How many people, not including yourself, currently live in your household?	Provide a number
	How many people do you consider close friends?	Provide a number
	How many of your neighbours do you know?	Provide a number
	How many children do you have?	Provide a number
	How many, if any, living siblings do you have?	Provide a number
	About how many living relatives do you have?	Provide a number
Social Participation	In the past 12 months, how often did you participate… in family or friendship-based activities outside the household?	At least once a day At least once a week At least once a month At least once a year Never
	Sports or physical activities that you do with other people	At least once a day At least once a week At least once a month At least once a year Never
	Educational and cultural activities	At least once a day

		At least once a week At least once a month At least once a year Never
	Church or religious activities such as services, committees or choirs[1]	At least once a day At least once a week At least once a month At least once a year Never
	Service club or fraternal organizational activities	At least once a day At least once a week At least once a month At least once a year Never
	Neighbourhood, community or professional association activities	At least once a day At least once a week At least once a month At least once a year Never
	Volunteer or charity work	At least once a day At least once a week At least once a month At least once a year Never
	Any other recreational activities involving other people, including hobbies, gardening, poker, bridge, cards and other games	At least once a day At least once a week At least once a month At least once a year Never
Sociodemographic	What is your current marital/partner status?	Single, never married or never lived with a partner Married/living with a partner in a common-law relationship Widowed Divorced Separated
Retirement Status	At this time, do you consider yourself to be completely retired, partly retired or not retired?	Completely retired Partly retired Not retired

This social isolation index is based on previous work by Menec et al.[30]

[1] SPA_3 will be removed from the social isolation index because this is the predictor variable of interest.

Appendix E.

Table E-1. Description of Covariates

	Covariate	Measurement	Scale
Sociodemographic	Sex	Male Female	
	Age group	45-54 years 55-64 years 65-74 years 75 years or older	
	Education	Less than high school High school diploma Some post-secondary education Post-secondary degree/diploma	
	Province of residence	One of the seven provinces	
	Total annual household income	Less than $20,000 From $20,000 to under $50,000 From $50,000 to under $100,000 From $100,000 to under $150,000 $150,000 or more	
Health	ADL	0 (no assistance required for any activity) 1 (assistance required for at least one activity)	Modified OARS (Older Americans' Resources and Services – Multidimensional Assessment Questionnaire)[131]
	IADL	0 (no assistance required for any activity) 1 (assistance required for at least one activity)	
	Depressive symptoms	Scores between 1 and 30	CES-D10 (Center for Epidemiologic Studies Depression Scale)[132]
	General self-rated health	Excellent Very good Good Fair Poor	
Functional Social Support	Total functional social support	Scores between 0-100	MOS-SSS (Medical Outcome Study – Social Support Survey)[69]

Appendix F.

Table F-1. Data Analysis Plan

Model	Statistical Model	Variables
Base model	Logistic regression	*Exposure variable:* Religious participation (baseline) *Outcome variable:* Social isolation (follow-up) *Covariates:* age group, sex, province, baseline social isolation
Model 2	Logistic regression	*Exposure variable:* Religious participation (baseline) *Outcome variable:* Social isolation (follow-up) *Covariate blocks:* Sociodemographic: age group, sex, province, total annual household income, education Baseline social isolation
Model 3	Logistic regression	*Exposure variable:* Religious participation (baseline) *Outcome variable:* Social isolation (follow-up) *Covariate blocks:* Health: general self-rated health, functional impairments, depressive symptoms *Covariate:* Baseline social isolation
Model 4	Logistic regression	*Exposure variable:* Religious participation (baseline) *Outcome variable:* Social isolation (follow-up) *Covariates:* Functional social support, baseline social isolation
Model 5	Logistic regression	*Exposure variable:* Religious participation (baseline) *Outcome variable:* Social isolation (follow-up) *Covariate blocks:* Sociodemographic: age group, sex, province, total annual household income, education Health: general self-rated health, functional impairments, depressive symptoms *Covariates:* Functional social support, baseline social isolation

Appendix G.

Table G-1. Full Baseline Comprehensive Cohort

Sociodemographic Characteristics	Unweighted n = 30,097		Weighted n = 3,273,750	
	n	%	n	%
Age group (years)				
45-54	7,595	25.24	1,296,030	39.59
55-64	9,856	32.75	1,014,657	30.99
65-74	7,362	24.46	587,282	17.94
75+	5,284	17.56	375,782	11.48
Sex				
Male	14,777	49.10	1,559,307	47.63
Female	15,320	50.90	171,443	52.37
Province				
Alberta	2,957	9.82	357,395	10.92
British Columbia	6,254	20.78	912,349	27.87
Manitoba	3,113	10.34	221,958	6.78
Newfoundland and Labrador	2,214	7.36	66,593	2.03
Nova Scotia	3,078	10.23	125,150	3.82
Ontario	6,418	21.32	589,120	18.00
Québec	6,063	20.14	1,001,184	30.58
Income				
<$20,000	1,566	5.56	207,920	6.78
≥$20,000 and <$50,000	6,360	22.59	6,844,636	22.31
≥$50,000 and <$100,000	9,907	35.19	1,018,490	33.20
≥$100,000 and <$150,000	5,524	19.62	618,142	20.15
≥$150,000	4,799	17.04	538,963	17.57
Missing	1,941		205,599	

Education				
Less than high school	1,643	5.47	559,949	17.13
High school diploma	2,839	9.45	374,866	11.47
Some post-secondary education	2,238	7.45	299,033	9.15
Post-secondary degree/diploma	23,327	77.64	2,035,196	62.26
Missing	50		4,706	
General Health				
Poor health	467	1.55	58,200	1.78
Fair health	2,315	7.70	275,400	8.42
Good health	8,877	29.52	1,054,560	32.23
Very good health	12,420	41.30	1,293,705	39.54
Excellent health	5,995	19.93	589,756	18.03
Missing	23		2,129	
Functional Status				
No functional impairment	27,058	90.23	2,985,973	91.83
Functional impairment	2,931	9.77	265,777	8.17
Missing	108		22,000	
Depressive Symptoms				
No depressive symptoms	22,314	82.07	2,374,905	79.43
Depressive Symptoms	4,875	17.93	614,931	20.57
Missing	2,908		28,3913	
Functional Social Support				
Low	8712	28.95	958,003	29.72
High	20779	69.04	22,65,644	70.28
Missing	606		50,103	

Appendix H.

Receiver Operating Characteristic (ROC) Curves for Base and Adjusted Models for the Association between Religious Participation and Social Isolation

Figure H-1: ROC curve for Base Model (Area Under the Curve [AUC] = 0.70)

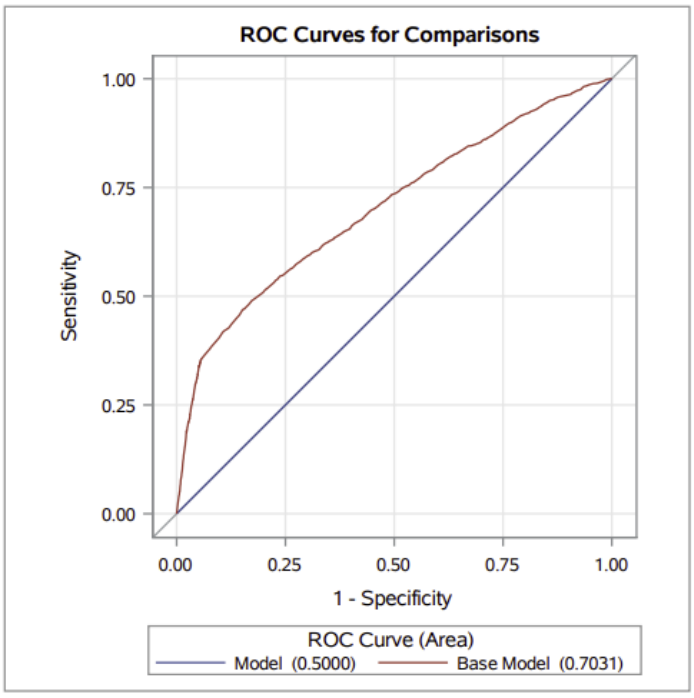


Figure H-2: ROC curve for Adjusted Model 2 (AUC = 0.71)

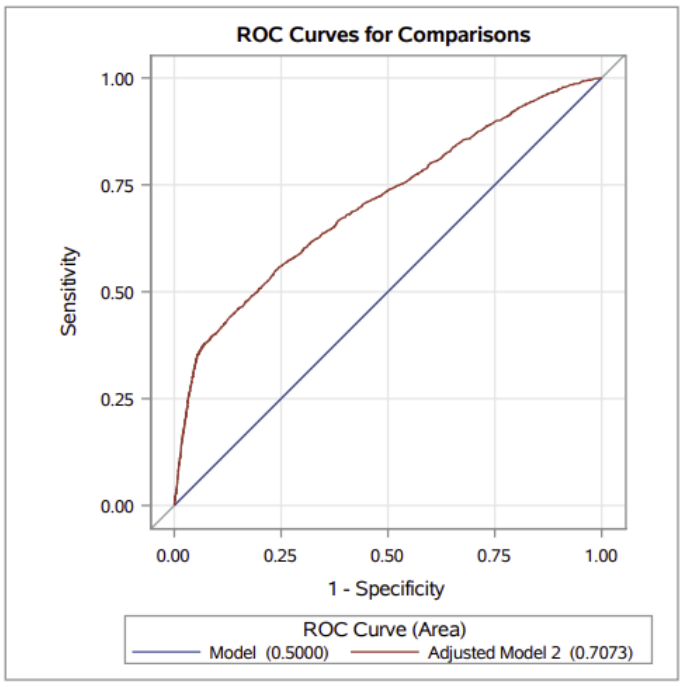


Figure H-3: ROC curve for Adjusted Model 3 (AUC = 0.71)

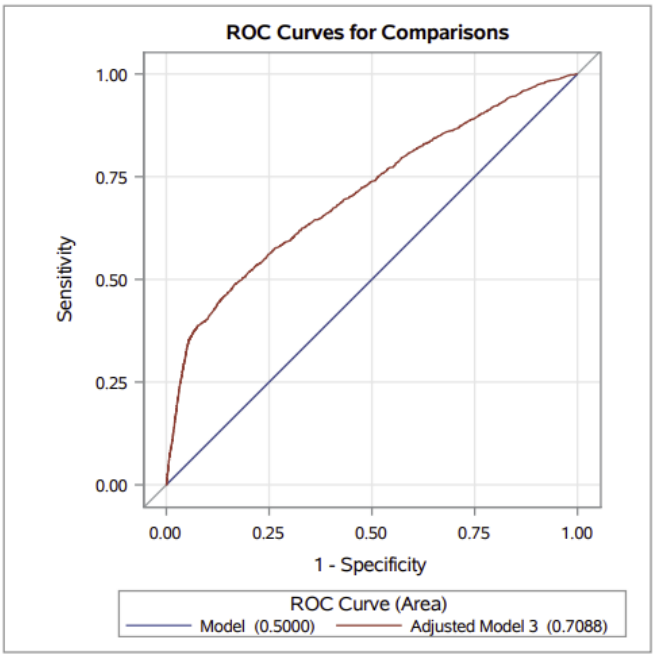


Figure H-4: ROC curve for Adjusted Model 4 (AUC = 0.71)

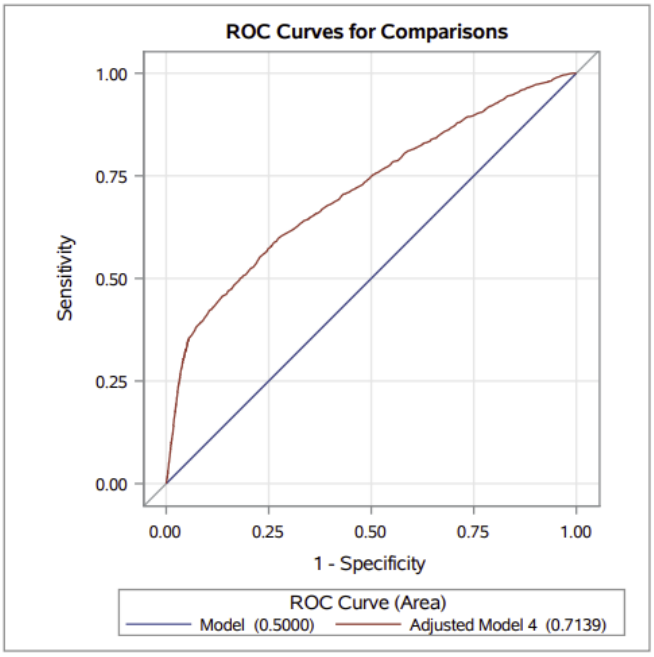
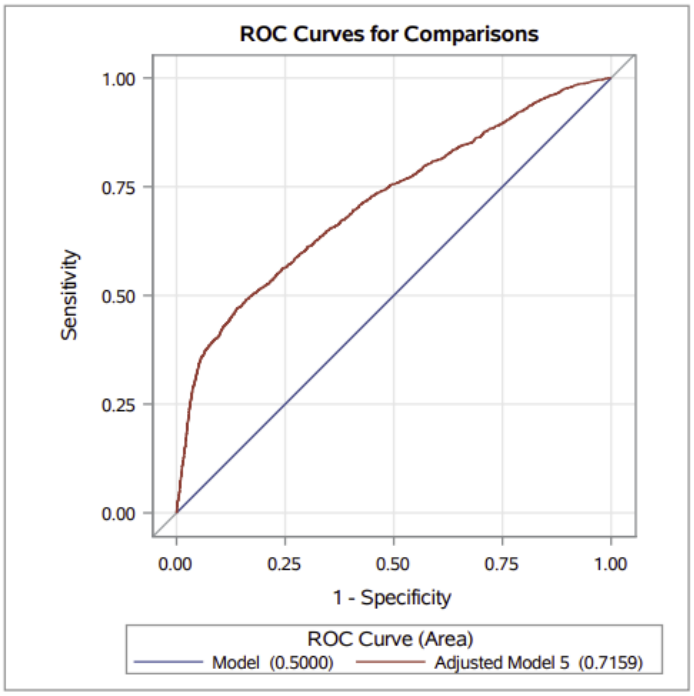


Figure H-5: ROC curve for Adjusted Model 5 (AUC = 0.72)



Appendix I.

Observed versus Predicted Plots for Base and Adjusted Models for the Association between Religious Participation and Social Isolation

Figure I-1. Observed versus Predicted Plot for the Base Model

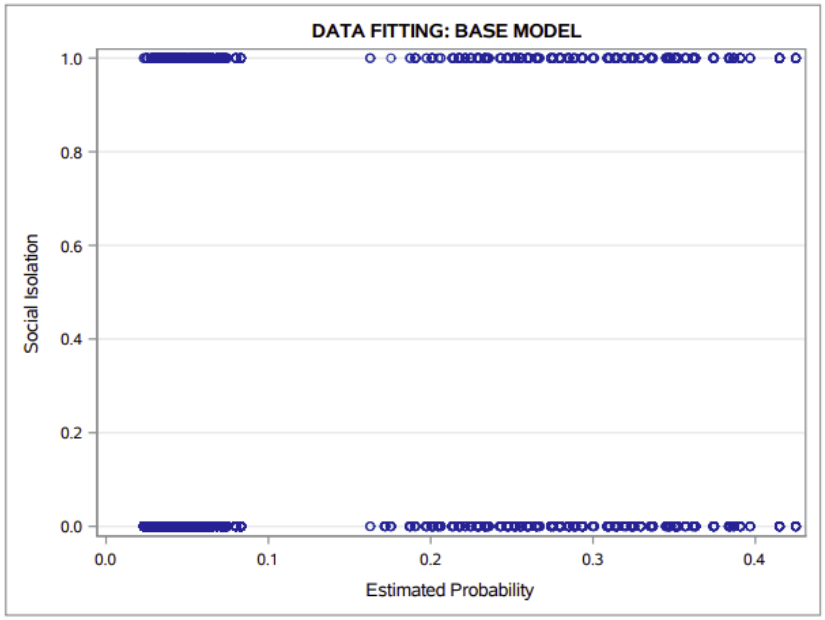


Figure I-2. Observed versus Predicted Plot for Adjusted Model 2

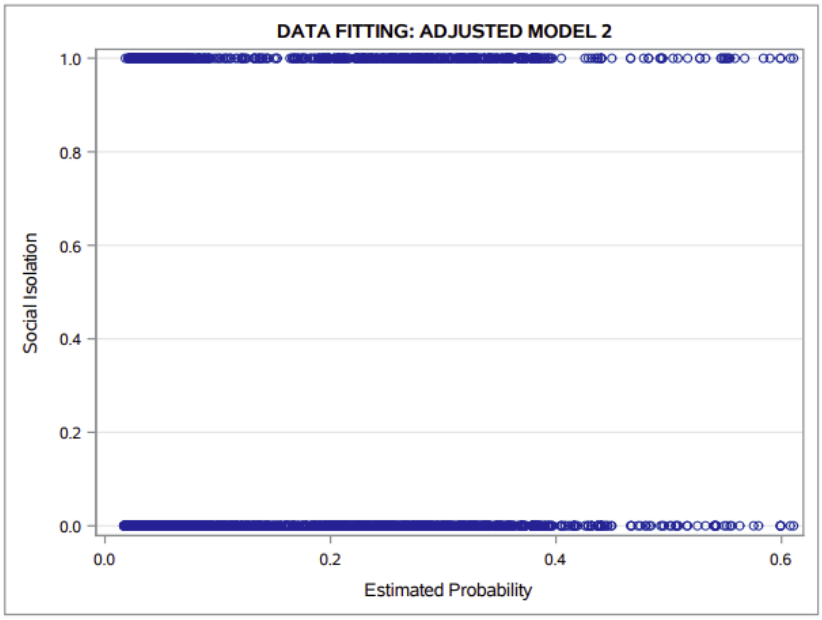


Figure I-3. Observed versus Predicted Plot for Adjusted Model 3

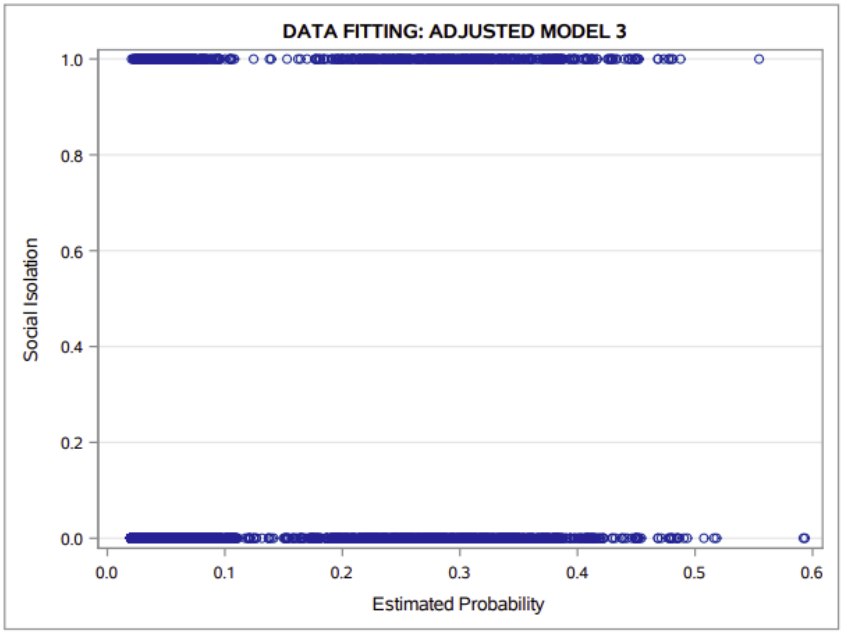


Figure I-4. Observed versus Predicted Plot for Adjusted Model 4

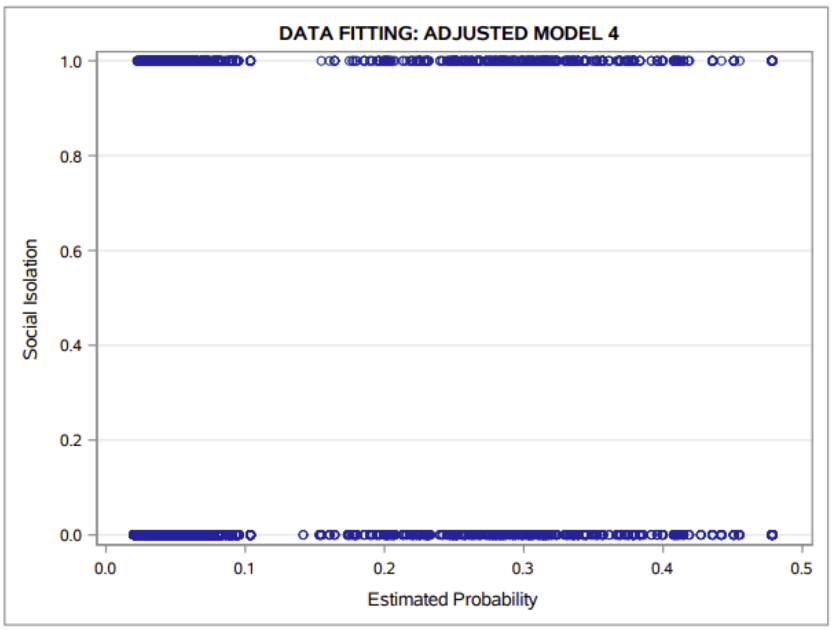
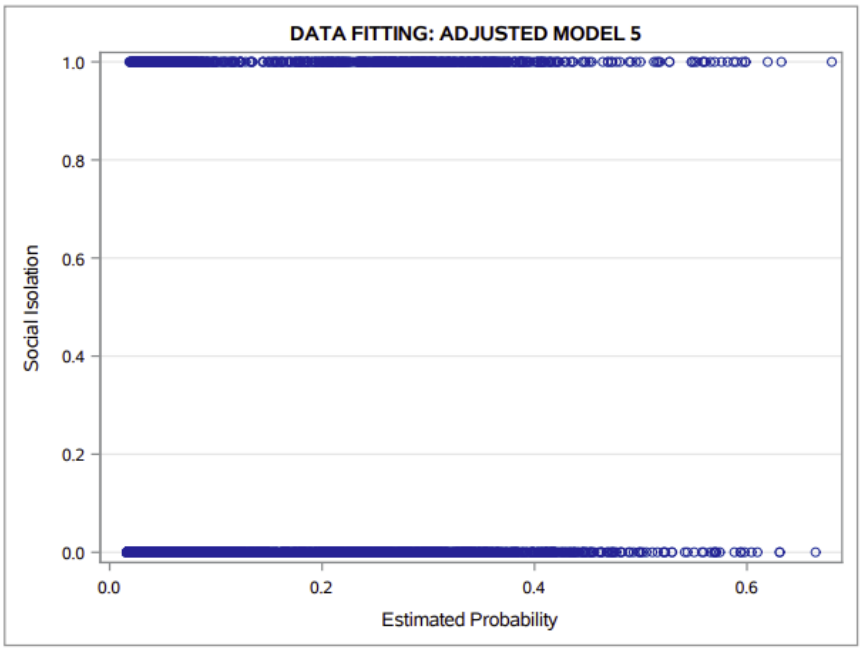


Figure I-5. Observed versus Predicted Plot for Adjusted Model 5



Appendix J.

Residual Plots for Base and Adjusted Models for the Association between Religious Participation and Social Isolation

Figure J-1. Residual Plot for Model 1

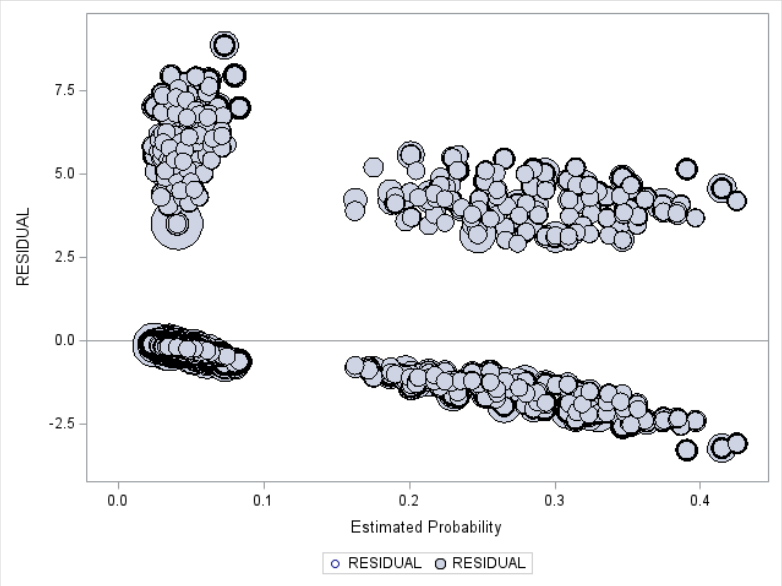


Figure J-2. Residual Plot for Model 2

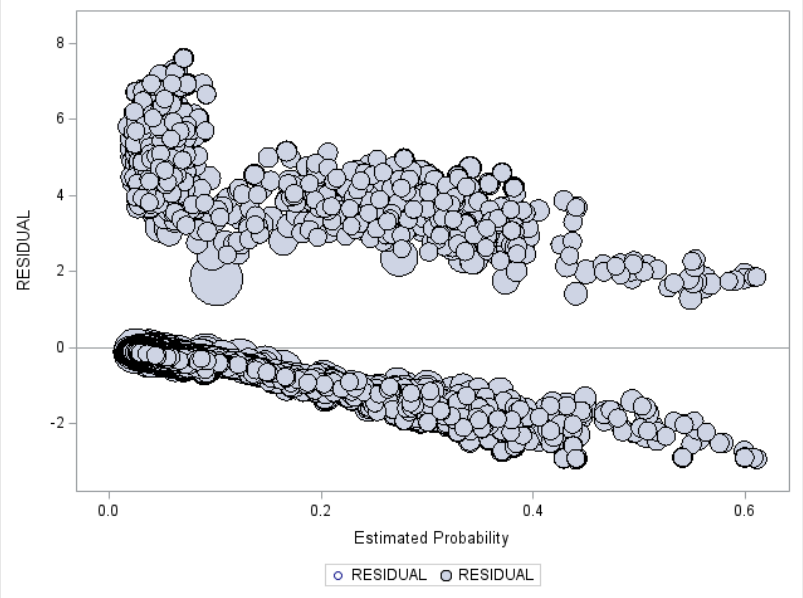


Figure J-3. Residual Plot for Model 3

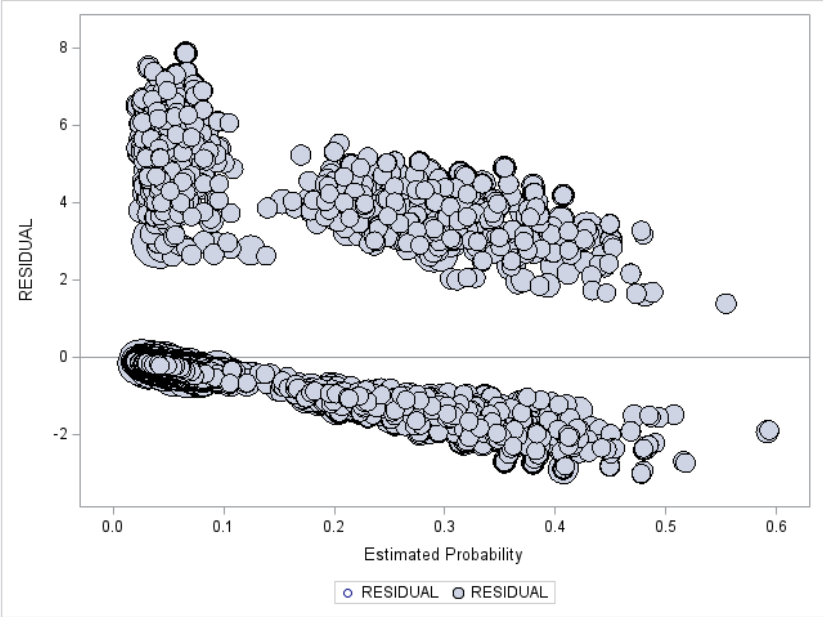


Figure J-4. Residual Plot for Model 4

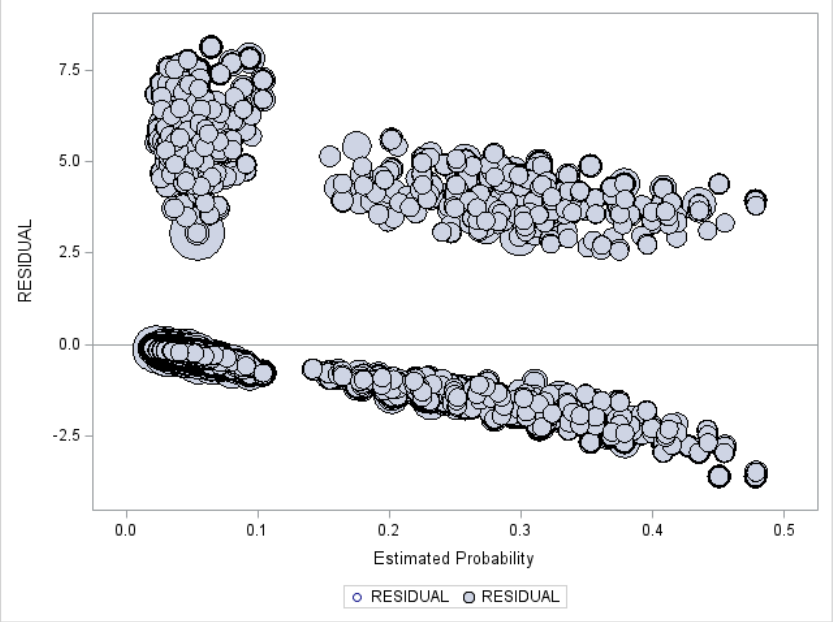


Figure J-5. Residual Plot for Model 5