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Indicators of the Social Environment and Cognition in an Older Population of Puerto Rican Adults

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INDICATORS OF THE SOCIAL ENVIRONMENT AND COGNITION IN AN
OLDER POPULATION OF PUERTO RICAN ADULTS

by

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A THESIS

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INDICATORS OF THE SOCIAL ENVIRONMENT AND COGNITION IN AN
OLDER POPULATION OF PUERTO RICAN ADULTS

ERIN E. BALLARD

MEDICAL/CLINICAL PSYCHOLOGY

ABSTRACT

Isolation and other indicators of poor social environment have been associated with a

higher risk of cognitive decline. Overall evidence for this association is mixed, with most

studies being conducted in Western, educated, industrialized, rich, and democratic (aka

"WEIRD") societies. Religiosity may moderate this relationship between less robust

social environments and cognition by buffering the negative effects of stress. The

primary aim of this study is to assess the relationship between indicators of the social

environment and psychological distress (depressive symptoms) and cognitive decline in a

population-based sample of older Puerto Rican adults (n=3,557) across two time-points.

Social environment included living alone (objective isolation) and familial social network

(FSN; assessed through proportion of children and siblings living in PR, and total number

of individuals in the family network). Psychological distress was measured using the 15-

item Geriatric Depression Scale (GDS), and religiosity was measured via three variables:

degree of religiosity and coping; religious engagement; and a sum of these two variables

for overall religiosity. Regression analyses were based on a hypothesized model whereby

isolation and FSN would have a direct relationship to cognition and an indirect

relationship through psychological distress (depressive symptoms). Religiosity was

examined as a moderator of the relationship between social environment and outcomes of

interest. Living alone was associated with higher depressive symptoms, and this

association was buffered by religiosity; there was no association between living alone and depressive symptoms in those with higher religiosity. However, none of the social indicators predicted cognition at follow-up, and religiosity did not moderate any relationships with cognitive change. Change in living situation (i.e., living alone vs. with others) was significantly associated with follow-up cognition, where those who were newly with others at follow-up had more cognitive decline compared to those who were alone at both timepoints. Results provide evidence for the isolation-psychological distress relationship, including support for religiosity as a buffer for negative effects of isolation. Further, findings highlight complex associations between cognition and living situation, whereby older people in Puerto Rico with cognitive decline are more likely to move in with others.

Keywords: Aging, Puerto Rico, Social Environment, Depressive Symptoms, Cognitive Decline, Religion

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INTRODUCTION

Many countries are seeing their populations rapidly age and are therefore experiencing increases in age-related cognitive decline and dementia (Christensen, 2009). With no broad cure for dementia available, current research focuses on mitigating risk factors for cognitive decline and the amelioration of dementia symptoms. More research on risk and protective factors for cognitive decline is needed to not only help reduce strain on the world's healthcare systems, but also to improve quality of life with aging. Puerto Rico is currently experiencing rapid aging of its population, and even though it is a territory of the United States, the island experiences much harsher socioeconomic realities compared to the US. This makes it a unique population that is less "WEIRD" (Western, educated, industrialized, rich and democratic) (Henrich et al., 2010) than the mainland US and is often overlooked by researchers (Perez and Ailshire, 2017). Even more than 20 years ago, Zsembik & Bonilla (2000) noted that there was a simultaneous increase in older adults and a reduction in the number of family caregivers.

Various aspects of the social environment have been examined in relation to older adults' cognition. For example, both isolation and social networks are important facets of the social environment, with the former acting as a risk factor and the latter acting as a protective factor for cognitive decline in some studies. In the current study, we aim to further understand the relationships between indicators of isolation, social network, and religiosity in relation to depressive symptoms and cognition in a sample of older Puerto

Ricans. Prior literature and the current study will be discussed through the lenses of the stress buffering hypothesis, environmental enrichment, and the cumulative advantage/disadvantage (CAD) theory, which ultimately help create our theoretical model. The stress-buffering hypothesis relates to the potential effects of isolation on psychological distress and later cognition. Environmental enrichment is related to potential direct effects of isolation on cognitive functioning and overall brain health, and CAD theory helps put these findings into context for our population of interest, Puerto Rican older adults.

Social Support – The Stress Buffering Hypothesis, Depressive Symptoms, and Religiosity

Social support is an important psychosocial factor when studying aging and health outcomes in the context of a social environment. The APA defines social support as "the provision of assistance or comfort to others, typically to help them cope with biological, psychological, and social stressors" (*APA Dictionary of Psychology*). Social support describes the resources available to an individual from their larger social network and community. Lower levels of social support have been associated with declines in cognitive performance in some studies (Dickinson et al., 2011). A review suggests that social support may be protective for a variety of physical and mental illnesses, including reduced risk of developing PTSD after exposure to combat trauma and decreasing functional impairment in those with depression (Ozbay et al., 2007). Social support may be a protective factor through buffering the effects of physiological and psychological stress, noted by a theory known as the stress buffering hypothesis.

Stress Buffering Hypothesis

The hypothalamic-pituitary-adrenal (HPA) axis is responsible for regulating human responses to internal or external stress through hormones such as cortisol. Dysregulation in the HPA axis has been related to depressive/anhedonia-type symptoms in both animal models and in humans (review, see Nandem et al., 2020), and higher cortisol and stress levels have been associated with lower hippocampal volume and decreased activity in the orbital prefrontal cortex (Dedovic et al., 2009). Further, research in humans has found that dysregulation in the HPA axis due to chronic stress has negative outcomes within specific disorder groups (Alzheimer's disease, Parkinson's disease, etc.) and normal aging (see review, Canet et al., 2019). The stress buffering hypothesis suggests that having social ties and further social support helps individuals cope with stressful situations; Thotis (2011) reviews the mechanisms for how social support may reduce perceived stress. Different actors within a social network help in different ways; ultimately reducing physiological stress and improving well-being. In a recent study of older adults with dementia and their caregivers, the relationship between stress and quality of life was moderated by social support, again suggesting its protective nature (Gellert et al., 2018).

Social Support and Depressive Symptoms

There is also a wide array of evidence for the protective nature of social support specifically on depressive symptoms in many populations. In a sample of older adults, perceived social support buffered against disability in relation to depressive symptoms (Taylor & Lynch, 2004). Among older Black adults in the US, social support from family was a protective factor against depressive symptoms and psychological distress (Chatters

et al., 2015). Social support was also related to reduced depression in individuals during the COVID-19 pandemic (Grey et al., 2020), and in individuals with heart failure (a review; Lucinda & Grant, 2013). Overall, social support appears to protect against a myriad of stressors when related to depression and depressive symptoms.

Social Support and Religiosity

A positive relationship between religiosity and social support has been well documented, with the earliest studies showing an increase of social support with religiosity (Bradley, 1995; Ellison & George, 1994). Social support has been a significant mediator between religiosity and life satisfaction (Park et al., 2011), and as a significant mediator between religiosity and mental health (Hovey et al., 2014). Both social support and social integration have been shown to act as a mediator for the relationship between religiosity and loneliness by integrating individuals into communities and providing social support, ultimately reducing loneliness (Rote et al., 2013).

Participating in a religion is likely a way in which individuals connect with their larger community through social events with, and outside of, their family. Research on religiosity and the social network focuses more on relationships between individuals in the community, as opposed to relationships with religious figures. Ellison and George (1994) reported that individuals who were frequent churchgoers had larger social networks, more contact with members of their social network, and better perceptions of the quality of their social relationships. Malone and Dadswell (2018) argue religion and spirituality are aspects of positive aging, helping older adults with the challenges of growing older. Their 2018 qualitative study of older adults in West London cites a theme of older adults receiving social support through their community via religion. Religion

has also been found to protect well-being against the negative effects of lower socioeconomic status (Hoverd and Sibley, 2013) and the severity of pain in chronic pain patients (Dezutter et al., 2010). Overall, religion helps increase social ties and may help buffer against the negative effects of stress as a form of social support.

Loneliness, Isolation, the Social Environment, and Religion in Relation to Cognitive Decline

Loneliness and isolation may be directly related to cognitive decline for two main reasons: 1) stress may have negative effects on brain aging and 2) social engagement may keep older adults' brains active and healthy (environmental enrichment theory, or "use it or lose it"). A review by Campagne (2019) discusses how increased isolation and loneliness were associated with indicators of high stress (cortisol, pro-inflammatory NF-xB-related gene expression in leukocytes). Reviews of animal studies have shown that environmental enrichment is associated with improved memory and learning, reductions in age related cortical thinning, and increased brain plasticity (Mora, 2022). Recent studies in humans have found social engagement to be associated with higher grey matter integrity in brain areas implicated in dementia (Felix et al., 2020) and reviews have shown that social engagement is related to cognitive stimulation, which is theoretically related to maintenance of brain health (Cartenson and Hartel, 2006). Research on loneliness and isolation, and their relationship to various social interactions and environments has used a variety of different measures; for the purpose of this study, however, we focus primarily on the roles of objective isolation (living alone) and the familial social network. More detail on loneliness, isolation, and the social environment follows.

The Relationship Between Loneliness, Isolation, and Cognition

Loneliness has been found to be associated with higher rates of cognitive decline (Wilson et al. 2007; Boss et al., 2015; Shankar et al., 2011), negative views of social interactions (Cacioppo & Hawkley, 2009), and increased levels of psychological distress (Menec et al., 2020; Wilson et al., 2005). In a longitudinal study of non-institutionalized adults aged 50 and older in Spain, those who scored higher on loneliness measures experienced decreased cognitive functioning at a three-year follow up (Lara et al., 2019). Wilson et al. (2007) found that loneliness doubled the risk for developing clinical Alzheimer's disease (AD) and that depressive symptoms were positively associated with loneliness. However, when depressive symptoms were controlled for in the loneliness-AD relationship, the association was reduced only modestly (less than 20%), compared to a more dramatic reduction in association between depressive symptoms and AD (more than 50%) when loneliness was controlled. These studies suggest loneliness may create potential risks for cognition through increased psychological distress; however, loneliness (subjective isolation) may be a less important variable to discuss in relation to cognitive decline when compared to objective isolation.

Griffin et al.'s (2018) study, using data from the Health and Retirement Study (HRS), conceptualized loneliness as a "dimension of subjective isolation" and objective social isolation as the frequency of contact with members of their social network (family and friends included). They found that decreased cognitive functioning was associated with both subjective and objective isolation, however, only objective isolation was associated with accelerated cognitive decline. Shankar et al. (2011) studied loneliness and social isolation together, defining social isolation as a measure of network size, diversity,

and contact frequency, and loneliness as perceived isolation. In their longitudinal study of 6,034 older adults in England, the authors found that social isolation and loneliness were significantly and positively correlated, and although the association was small, they significantly interacted with each other to predict cognition. Individuals who were more isolated performed worse on a memory delay recall task as loneliness increased. Baseline isolation alone, however, was associated with decreases in all their measures of cognitive function (learning, memory, and a measure of global function); loneliness was negatively associated with scores on only learning and memory but not global cognition. These findings indicate that, although closely related, isolation may act as a more robust indicator of negative outcomes when compared to loneliness.

In addition, measures of subjective isolation are more susceptible to response biases, such as socially desirable responding (SDR) compared to measures of objective isolation (i.e., living alone)(Braun et al., 2002; van de Mortel, 2008); therefore, objective isolation may be just as or even more important in predicting outcomes such as psychological distress and cognitive decline compared to loneliness (Griffin et al., 2018).

Social Environment, Social Networks, and Cognition

Active social environments and social network size have also been associated with cognition in several studies, providing further evidence for how environmental enrichment acts as a protective factor for cognition in older adults. In one of the first and most highly cited studies related to the "use it or lose it" hypothesis, older individuals in France who regularly participated in social or leisure activities had a decreased risk of developing dementia up to three years later (Fabrigoule et al., 1995). In another study, older adults who had no social ties, i.e., those who were "socially disengaged", as

compared to those with five or six social ties, were at an increased risk of incident

cognitive decline (Bassuk, et al., 1999). In this study, social environment measures

included marital status, having contact with at least three family members or friends once

a month, having contact with at least 10 family members or friends per year, attending

religious services once a month, belonging to a community-based group besides religion,

and participation in recreational social activities. Further, those who were frequently

socially active had lower rates of cognitive decline compared to infrequently socially

active older adults (James et al., 2011). A study of older adult women also suggested that

larger social networks have a protective relationship with cognitive functioning (Crooks

et al., 2008). Being active in one's social environment, i.e., simply engaging with other

individuals regularly or having the opportunity to do so, is suggested as being protective

against cognitive decline. The authors above suggest this may be due to positive self-

image/self-esteem through feeling connected with others, increased self-care (Bassuk et

al., 1999), access to healthcare (Crooks et al., 2008), and maintenance of neural networks

due to complex interpersonal changes (James et al., 2011). Finally, receiving support

from a partner/spouse and from friends has been shown to alleviate loneliness (Chen &

Feeley, 2014) and both social isolation and reduced participation in religious activities

have been associated with greater loneliness (Taylor, 2020). Therefore, participation in a

religion is likely an indicator of an individual's available social support and social

network.

Religiosity and Cognition

Regarding religiosity's relationship with cognition, the evidence is mixed.

Religiosity has either had no association (Ritchie et al., 2014) or has been related to

reduced cognitive decline or development of dementia like other measures of social support (Hill et al., 2006; Van Ness & Kasl, 2003; Kaufman et al., 2007; Agli et al, 2015). In a study of older Mexican Americans, a population where religion historically plays an important cultural role, those who attended church at least once a month exhibited slower rates of cognitive decline (Hill et al., 2006). Conversely, a recent study showed that individuals who attended religious services more often over their lifespan exhibited poorer working memory and mental status, and better self-rated memory (Hill et al., 2020). The authors of this paper suggest religious beliefs may encourage automatic processing and discourage analytical processing. Researchers have also investigated racial/ethnic subgroups' relationship to religiosity and cognition. Kraal et al. (2019), using data from the Health and Retirement Study, examined the relationships between different aspects of religiosity and episodic memory among Black, Hispanic, and non-Hispanic Whites. They found that both Black and Hispanic individuals reported more private prayer and higher religious attendance compared to their non-Hispanic White counterparts, both of which were associated with better initial memory performance. Black and Hispanic individuals also reported more religious belief, which was associated with lower memory performance initially; these individuals also demonstrated slower decline than their non-Hispanic white counterparts. Overall, frequently attending religious services and increased private prayer were independently associated with better memory performance initially. However, these independent religious variables were not associated with rate of memory change.

There are two important confounds from within the religiosity and cognition literature: first, there is no consistent operationalization of religiosity, and second,

disability is a possible confound for religious attendance. Inconsistencies in the

relationship between religiosity and cognition may be due to the differences in the

operationalization of religion or religiosity across studies. Operationalizations include

single-item measurement of attendance of services (Van Ness and Kasl, 2003), self-report

measures that assess organizational and private religious practices (for example, the

DUREL; Kaufman et al., 2007), and measures of spirituality, which is also difficult to

define (Agli et al., 2015). These differences in how religiosity is has been measured and

conceptualized in the literature makes it difficult to piece together a cohesive argument

one way or the other in its relationship to cognition. For this study, we will be using three

different variables to measure religion: religiosity, which includes degree of belief and

coping; engagement, which focuses on attendance of service and religious events; and

total religiosity, which sums the two aforementioned variables. Using the different

variables will allow us to assess which aspect of religion may be related to cognition.

Further, a possible confounding variable for religious attendance is disability. The

relationship that some studies have found, i.e., attending religious services is related to

slower cognitive decline, could be because those who are cognitively declining faster are

less likely to be able to attend church. In fact, Hendershot (2006) found that individuals

with disabilities are less likely to attend religious services. Therefore, for this study we

will be including difficulty attending church (i.e., whether the individual needs help with

transportation) as a covariate when we examine the relationship between religiosity and

outcomes of interest.

Studying Puerto Rico

Cumulative disadvantage theory suggests there are systematic differences between individuals that compound over time, such that these differences become even greater in older age (Dannefer, 2003). Individuals in Puerto Rico have been living with social and economic disadvantages for decades, putting them at even greater disadvantage compared to same-age individuals in more advantageous contexts. Despite being a territory of the United States, Puerto Ricans on the island are often treated as second class citizens, having unequal rights as those on the mainland. They receive less funding for federal programs, must live with disadvantageous shipping laws, and their U.S. citizenship comes with inferior rights and representation in US government (Valle et al., 2018). These structural social and political disparities are likely to increase the level of stress that Puerto Ricans on the island experience and may detrimentally affect health outcomes.

Compared to those in the United States, people living in Puerto Rico experience much higher levels of poverty and unemployment (Perez & Ailshire, 2017). Perez and Ailshire (2017) compared Puerto Ricans and mainland US citizens (NHWs, Hispanics, and Blacks) via the PREHCO and HRS studies respectively. The authors found that Puerto Ricans were more likely to report hypertension and diabetes. However, Puerto Ricans were also less likely to report a myriad of other diseases/conditions, including heart disease, stroke, and disability, despite higher levels poverty and unemployment. Perez and Ailshire (2017) cite Puerto Rico's universal health coverage, healthcare reform, and more protective cultural resources as possible reasons for the health discrepancies. While PREHCO and HRS do not have clinical diagnoses of dementia, a

different study of veterans in Puerto Rico vs. mainland US found the prevalence rate of dementia in Puerto Rican veterans was higher compared to veterans who live in the US (Carrion-Baralt et al., 2010). The differences in health between individuals living in the US and in Puerto Rico underscore the importance of studying Puerto Ricans specifically, especially given the lack of inclusion Puerto Ricans have faced in research studies conducted in the US.

Migration Effects and Loss of the Social Network in Puerto Rico

Migration from Puerto Rico to the United States is helping to fuel the rapid increase in percent of the Puerto Rican population over age 65 years (Matos-Moreno et al., 2021). Despite having similar sociodemographic indicators to other Caribbean countries such as Cuba, Jamaica, and Trinidad and Tobago, Puerto Rico showed much quicker growth in the percentages of older adults after 2010. This is likely due to a significant decrease in the net migration rate that Puerto Rico experienced; the percentage of adults over 65 years doubled between 2010 and 2020. As a result, Matos-Moreno suggested that migration of younger adults and their families to the United States is driving the aging of the Puerto Rican population. These changes in migration patterns may leave older individuals who tend to stay in Puerto Rico at even greater risk of isolation, as their younger family members leave the island.

Loneliness and Isolation

In a study of loneliness in relation to mortality across Latin America, China, and India and including 16,685 adults 65 years and older, Puerto Rico had one of the highest prevalence rates for loneliness at 32.2%, second only to Mexico at 32.4%. The authors included common sociodemographic variables (e.g., age, gender, socioeconomic status)

in their analyses, and found an association between loneliness and mortality, whereby depression did not have a significant effect when added to the model. This suggests loneliness is independent of depression in its association with mortality (Gao et al., 2021). Although this study utilized loneliness (subjective isolation) as opposed to objective isolation, it reveals a potential disconnect between desire for interaction with others and actual interaction in Puerto Rico. Since subjective and objective isolation are correlated, this study suggests isolation may also be a significant factor affecting the health and wellness of older individuals living on the island of Puerto Rico.

Religion as a Protective Factor for Older Adults in Puerto Rico

As stated above, many Puerto Ricans remaining on the island are exposed to high levels of socioeconomic stress via its relationship with the US and migration. Since religion has been found to increase social support (Bradley, 1995; Ellison & George, 1994), increase social network size (Ellison & George, 1994), and protect against lower socioeconomic status (Hoverd and Sibley, 2013), it may help reduce the effects of socioeconomic status and migration (i.e., loss of family memory) on older adults' psychological distress and subsequent cognitive decline among those who are still living in Puerto Rico. In previous Hispanic samples, social support reduced the relationship between stress and depression in younger adults (Raffaelli et al., 2012) and buffered against life stress (Rodriguez et al., 2019); family support was highlighted as an important contributor in both samples. Therefore, religion, as an aspect of social support, may help mitigate the negative effects of higher socioeconomic stress and loss of family networks in Puerto Rican older adults.

Current Study

We will attempt to capture social environment via an index, given that there is no direct measure of a familial social network in the PREHCO study. Determining an individual's religiosity will function in largely the same way, combining questions about whether an individual sees themselves as religious and how often they go to church to create an index of religiosity. Using these indexes, we will examine social environment in relation to depressive symptoms cross-sectionally and cognition over time.

Hypothesized Mechanism for Cognitive Decline

We hypothesize that the mechanism for the relationship between social environment and lowered cognition is primarily through greater psychological distress (Figure 1). Essentially, individuals who are living alone and have a smaller FSN would be likely to have greater distress (Bassuk, et al., 1999; Fabrigoule, et al., 1995; Crooks et al., 2008). In turn, this psychological distress may increase the risk for cognitive decline (Wilson et al. 2007; Boss et al., 2015; Shankar et al., 2011; Lara et al., 2019). More isolation and smaller FSN may also have a direct impact on cognition due to less active social environments. The conceptual model guiding our analyses is shown in Figure 1. In addition, following the environmental enrichment theory of aging (Dannefer, 2003) and the "use it or lose it" adage (Salthouse, 2006), we also included a potential direct pathway between social environment and cognition in Figure 1.

Aims

The overall goal of this study is to examine indicators of social environment in relation to cognitive decline through our hypothesized mechanism of psychological distress (Figure 1). We split this goal into three aims. The first is to examine the cross-

sectional relationship between isolation/FSN and psychological distress and investigate whether religiosity buffers the effect of isolation on distress. The second aim is to examine the relationship between isolation/FSN and cognitive decline. The third aim is to test interactions with religiosity in the relationship between isolation/FSN and cognition.

Hypotheses

Based on prior research, we hypothesized that individuals who are more isolated (i.e., living alone) will have more psychological distress (i.e., depressive symptoms), and that religiosity will protect against psychological distress in individuals who are more isolated. Next, we anticipated that those who were objectively isolated and with less extensive FSNs would show significantly greater cognitive decline. Further, we hypothesized that distress would partially explain this association, and that religiosity will be a significant moderator of the relationship between isolation/FSN and cognition. We expected that people with isolation or lower FSN but with higher levels of religiosity would show less cognitive decline compared to individuals in similar environments but with lower levels of religiosity.

METHODS

Participants

Participants were non-institutionalized community-dwelling older adults (target sample N = 4,291, 59.54% female) from the Puerto Rican Elderly: Health Conditions (PREHCO) study. This longitudinal study was originally conducted in two waves, one in 2002-2003 and the other in 2006-2007 (a third wave was completed in 2021-2022). The original investigators used multistage probabilistic sampling by clusters, using the 2000 Population and Household Census. We excluded participants who required a proxy (e.g., due to cognitive impairment), as they did not complete the self-report measures relevant to religiosity or depressive symptoms. Of the 3,713 potential participants, baseline analyses included 3,557 individuals due to 156 participants with missing data. Age was restricted to 60 years and older, with an average age of 71.33 years old (SD = 9.02); 62% of the baseline sample was female. Of these 3,557 participants, 876 had missing-self report data for the follow-up assessment due to factors like morbidity, institutionalization, refusal to participate, and incomplete data. Of the total baseline participants, 2,681 participated in both waves of the study and had completed data collection with the measures needed for this analysis (Figure 2).

Measures

Cognitive Function

Cognitive status was assessed via the Mini Mental Cabán (MMC), which is a cognitive assessment with better sensitivity and specificity for dementia compared to a simple Spanish translation of the Mini-Mental Status Exam (MMSE). The MMC includes measures of orientation, visual memory, verbal memory, abstraction, visuospatial/executive items, and comprehension. Scores range from 0-20, with scores below 11 requiring a proxy. In addition to being validated as a dementia screening measure in Spanish, the MMC is also valid for those with lower levels of education (Sanchez-Ayendez et al., 2003). The MMC was administered to participants at both baseline and follow up.

Isolation (living alone)

Objective isolation was measured using the household roster for each individual participant. Those who lived alone were coded as objectively isolated, and those who lived with others are coded as not objectively isolated.

Familial Social Network

There are no direct measures of subjective social isolation included in the original PREHCO questionnaire. However, we created three variables from items in the questionnaire pertaining to the Familial Social Network. The questionnaire gathered information on whether the participant lived alone and the number of living children and siblings living inside and outside of Puerto Rico. With these questions, we created three individual variables: two dichotomous variables, focusing on locations of siblings and children, and one count variable, family network, i.e., the total amount of living family

members an individual has, regardless of location. For the two dichotomous variables, we first examined data regarding where a participant's living siblings and children live (in Puerto Rico or not in Puerto Rico). Then, for each participant, we divided number of siblings/children who lived in Puerto Rico by the individual's total number of siblings/children, creating a proportion of living siblings/children that were living in Puerto Rico at the time of the study. Finally, we dichotomized the variable, so that if a participant had more than half of their siblings/children in Puerto Rico, it was coded as '1', if less than half of their siblings/children were in Puerto Rico, they were coded as a '0'. For family network variable, we simply summed the amount of living children, siblings, and other related family members reported on the questionnaire.

Religious Status

PREHCO data collection used items similar to the HRS for religious status but no standardized measure for this construct. Thus, we used questions related to religiosity to create two index variables: religiosity and religious engagement, as well as a total religiosity variable that combines the two. The religiosity variable was based on the following three questions: "Do you consider yourself very religious, somewhat religious, or not religious at all?", "How helpful are your religious beliefs to you when you are struggling with health issues" [very helpful, somewhat helpful, not helpful at all], and "How helpful are your religious beliefs to you when facing other problems in life not related to your health?" [very helpful, somewhat helpful, not helpful at all]. Based on the skewed distribution of responses, we created a dichotomous yes/no variable for the question, "do you consider yourself very religious…", as few participants (1.6%) said they were not at all religious. Next, the two "how helpful are your religious beliefs"

questions were summed, creating a 2-6 point scale. Based on skewed distribution of responses, we also dichotomized this variable into whether religious beliefs were helpful (a score of 6 is helpful, scores of 2, 3, 4, and 5 were not helpful). Finally, we summed these two dichotomous variables to create the religiosity variable that ranged from 0-2. This variable was designed not only to capture the subjective measure of religiosity, but also how helpful religious beliefs are in coping with everyday problems.

Religious engagement utilized questions related to attendance at religious and non-religious, but church-sponsored, events. These questions included: "how often do you attend service?" (five-point Likert scale from once a month to every day) and "how often do you participate in social activities organized by your church?" (three-point Likert scale from frequently to never). To create the engagement index, we started by condensing the first question into a 0-2 scale (frequently, sometimes, and never) due to the distribution of responses. Next, we summed this condensed variable with the "how often do you participate in social activities…" question to create a 0-4 index, with 4 being the most engaged. As stated in the introduction, religious attendance is often complicated by disability status, so we will be accounting for disability's role in religious attendance in our analyses by including a variable that indicates whether the individual needs help with transportation. Transportation difficulties is coded "1" when having difficulties and "0" for not having difficulties. Religiosity and religious engagement were significantly and positively correlated (r=.28, p<.001), but not at the level where multicollinearity would be a concern.

To reduce the number of potential interaction analyses for religiosity variables, we created interaction terms using "total religiosity," which was a sum of the religiosity

and religious engagement variables (score of 0-6). This is the variable we used in the interaction term for our moderation analyses.

Depressive Symptoms

Depressive symptoms were assessed through a 15-item variation of the Geriatric Depression Scale where symptoms are summed and higher scores on the scale reflect a higher number of depressive symptoms.

Covariates

Education is an important covariate to include whenever cognition is being assessed; this covariate is continuous and consists of the number of years of school that have been completed. Depressive symptoms from a 15-item version of the Geriatric Depression Scale will also be used as a covariate in analyses of cognitive functioning, as there are significant relationships between depression and cognition scores. Race will also be included in the statistical models, where non-white individuals will be compared to white individuals in our models. Transportation difficulty is based on whether the individual has reported having trouble getting to and from places, which gets at the difficulty individuals with disabilities may have getting to and from church. This is a dichotomous variable, where '1' reflects difficulty getting to and from places, and '0' is no difficulty getting to and from places.

Marital Status

Previous studies that have looked at the relationship between social networks and cognition often include marital status (e.g., Bassuk et al., 1999, Chen & Feeley, 2014). When examining our data, we found that the objective isolation variable, i.e., living alone, encompassed whether someone was married, as all individuals who lived alone

were not married. Therefore, the marital status variable would be redundant with living situation and increase multicollinearity. Thus, we did not include marital status as a covariate in our analyses.

Analysis

Baseline Characteristics

The overall baseline sample was divided into those who live alone (objective isolation) and those who do not; T-tests and chi-square tests were performed where appropriate to test group differences. Spearman correlations were conducted between variables of interest.

Predicting Depressive Symptoms at Baseline

To assess predictors of depressive symptoms at baseline, we utilized linear regression with three models predicting depressive symptoms while adjusting for all pertinent variables. Model 1 included age, gender, race, and baseline cognition. Model 2 included all variables from Model 1 plus the psychosocial variables (education, transportation difficulty, living alone, FSN variables, and the religion total variable). Model 3 followed up this regression analysis by including the "total religiosity" variable as a moderator via interactions with pertinent variables (living alone, siblings, children, network). This single "total religiosity" variable was used instead of the two individual religion variables to reduce type II error. To follow-up the significant interactions, we stratified by total religiosity, and focused on high religiosity total individuals (five or six on total religiosity) versus low religiosity total individuals (lower than five on total religiosity); we hypothesized that high religiosity would act as a buffer of emotional

distress. The cutoff point of five or higher was chosen as it would reflect reporting high religiosity and high attendance of religious services.

Predicting Cognition at Follow-Up

To assess predictors of change in cognition, we utilized regression analysis in four models. For Model 1, we predicted cognition at follow up with age, gender, race, and cognition at baseline included in the model. Model 2 added in psychosocial variables (education, siblings, children, living alone). We were specifically interested in how depressive symptoms and transportation difficulties may affect the association between X and Y, so these were included in Model 3, along with all previous variables. Finally, we added in the interactions between the total religiosity variable (our moderator) and the variables of interest (living alone, siblings, children, and network). To complement the moderation analysis with "total religiosity" used in interaction terms and to help with interpretation, we conducted stratified analyses using high (greater than or equal to 5) and low (less than 5) total religiosity.

RESULTS

Sample Characteristics

For the full baseline sample, the average age was 71.23 years (SD=8.22) and 59.69% were female. 44.22% of the sample identified as white, with 41.50% identifying as multiracial, 6.44% identifying as Mestizo/a (indigenous), 5.40% identifying as Black, and 2.45% identifying as other. Of the 3,557 utilized for baseline analysis, 1,141 lived alone. Those who lived alone were older, more likely to be female, had less education, had higher baseline cognitive status, had more depressive symptoms, were more likely to have less than half of their siblings and less than half of their children living in Puerto Rico, and had smaller familial networks than those who lived with others (Table 1). The two groups did not differ significantly on the religious variables or race.

Bivariate Analyses

Cross-sectional correlations for variables of interest at baseline are shown in Table 2. Living alone (objective isolation) was significantly correlated with age (r=.19, p<.001), being female (r=.14, p<.001), education (r=-.07, p>.001), depressive symptoms (r=.09, p>.001), siblings in Puerto Rico (r=-.10, p<.001), children in Puerto Rico (r=-.19, p<.001), familial social network (r=-.19, p>.001), and baseline cognition (r=-.06, p<.001). Depressive symptoms (our indicator of psychological distress) were significantly correlated with age (r=.05, p<.001), being female (r=.13, p<.001), education (r=.18, p<.001), living alone (r=.09, p<.001), religiosity (r=-.05, p<.05), religious

engagement (r=-.11, p<.001), total religiosity (r=-.10, p<.001), and baseline cognition (r=-.15, p<.001).

Cross-Sectional Predictors of Depressive Symptoms at Baseline

In covariate-adjusted models, living alone (b=.44, SE=.123, p<.001) and having more than half of their siblings in Puerto Rico (b=.27, SE=.130, p<.05) predicted higher depressive symptoms at baseline. Education (b=-.04, SE=.013, p<.001), cognition (b=-.16, SE=.024, p<.001), and total religion (b=-.18, SE=.029, p<.001) predicted fewer depressive symptoms at baseline (Table 3).

Moderators of Isolation/FSN and Depressive Symptoms

In models that use total religiosity as a moderator, results show a main effect of living alone (b=.99, SE=.255, p<.001), and significant interactions between living alone and total religiosity (b=-.14, SE = .064, p<.05) and between children in Puerto Rico and total religiosity (b= -.16, SE= .067, p<.05). Having more than half of their siblings in Puerto Rico becomes non-significant in this model (b=.09, SE=.236, p=.70), and the siblings by total religiosity interaction is also non-significant.

In results stratified by total religiosity (Table 4), individuals who were high in religiosity showed no association between living alone and depressive symptoms, but in those who were low in religiosity, living alone was associated with higher depressive symptoms (b=.57, SE=.145, p<.001). Additionally, in individuals who were high in religiosity, having more than half of their children in Puerto Rico was associated with less depressive symptoms (b=-.64, SE=.245, p<.05), whereas in individuals who were low in religiosity, there was no association between depressive symptoms and proportion of children in Puerto Rico.

Predictors of Cognition at Follow-Up

Living alone at baseline did not predict cognition at follow-up in regression models adjusted for age, gender, race, transportation difficulty, education, baseline cognition, depressive symptoms, and familial social network variables (see Table 5). None of the three variables used to measure familial social network predicted cognition at follow-up in models controlling for age, gender, race, transportation difficulty, education, baseline cognition, depressive symptoms, and living alone (siblings: b=-.06, SE=.120, p=.59; children: b=-.17, SE=.115, p=.14; and network: b=.01, SE=.011, p=.52). Transportation difficulties predicted lower cognition at follow-up (b=-.36, SE=.135, p<.05).

Role of Religiosity in Isolation/FSN and Cognition Relationship

None of the interactions (alone by religiosity [b=-.01, SE=.052, p=.82], siblings by religiosity [b=.03, SE=.057, p=.60], children by religiosity [b=.07, SE=.053, p=.17], and network by religiosity [b=-.00, SE=.005, p=.39]) were significant in models predicting cognition at follow-up (Table 6).

Stratifying By Moderators. For individuals high in religiosity, none of the isolation or FSN variables predicted cognition at follow-up (alone: B=.15, SE=.218, p=.50; siblings: b=-.07, SE=.238, p=.78; children: b=-.01, SE=.240, p=.97; network: -.03, SE=.023, p=.16). None of the isolation or FSN variables were significant for individuals low in religiosity either (alone: B=-.02, SE=.130, p=.87; siblings: b=-.07, SE=.138, p=.62; children: b=-.24, SE=.132, p=.07; network: .02, SE=.013, p=.14) [see Table 7].

Post-Hoc Analyses

Sensitivity Analyses: Religiosity and Baseline Depressive Symptoms

Total religiosity significantly predicted depressive symptoms and we conducted sensitivity analyses using the two religion-based variables (religiosity and religious engagement) separately to see whether one of these variables was driving the total religiosity relationship with depressive symptoms. Using the same models and covariates as before, we found that both higher religiosity (b=-.27, SE=.072, p<.001) and higher engagement (b=-.23, SE=.04, p<.001) significantly predicted lower baseline depressive symptoms independent from covariates.

Living Situation Changes

Due to the unexpected pattern of results for the association between living alone and cognition, we conducted post-hoc analyses to examine changes in living situation in relation to cognition.

We classified changes in living situation between baseline and four-year follow-up into four distinct categories: living alone at both baseline and follow-up, living with others at both time points, newly alone at follow-up, and newly with others at follow-up. Changes in living situation categories were entered into a basic regression analysis predicting cognition at follow-up while adjusting for age, gender, and baseline cognition. We did not include depressive symptoms in this analysis, as this measure requires self-report (as opposed to proxy), and thus would have excluded our most cognitively impaired participants.

We found that compared to those who lived alone at both timepoints, individuals who moved in with others between baseline and follow-up showed significantly more cognitive decline (b=-.49, SE=.241, p<.05). Those who lived with others at both time points or who were newly alone at follow-up did not show a significant difference in

cognition compared to the reference group of living alone at both timepoints. We followed up this analysis to assess whether living situation changes was associated with incident cognitive impairment (i.e., scoring below the cut-off of 11 on the Mini Mental Cabán), as opposed to continuous cognitive decline. Results show that a change to newly living with others is associated with incident cognitive impairment; those who moved in with others (while having lived alone at baseline) were twice as likely to have incident cognitive impairment (Table 8).

DISCUSSION

In this sample of older Puerto Ricans, individuals who lived alone were more likely to be women and showed a lower proportion of siblings and children living in Puerto Rico than individuals who lived with others. In covariate-adjusted models, living alone was associated with higher depressive symptoms and higher religiosity was associated with lower depressive symptoms. In the moderation analysis, there was a main effect of living alone (associated with higher depressive symptoms) and significant interactions between total religiosity and our social environment predictors. Specifically, in those who were low in religiosity, living alone was associated with higher depressive symptoms, but this relationship did not exist in individuals with high religiosity. Further, in those with high total religiosity, having more than half of their children in Puerto Rico was associated with less depressive symptoms; this relationship did not exist in low total religiosity individuals. These results suggest that isolation and FSN variables were related to depressive symptoms at baseline, such that high religiosity may buffer the negative outcomes of isolation, in our case, depressive symptoms. This outcome provides support for the first leg of our hypothesized model, where isolation is related to psychological distress, with religiosity as a moderator of this relationship. Sensitivity showed that higher religiosity and religious engagement each predicted lower depressive symptoms at baseline, with neither appearing to drive the relationship between the religiosity combined score and depressive symptoms. The hypothesized relationships between our social environment indicators and cognitive decline were not found. However, an

important confound that we identified was that older adults who experienced cognitive decline or incident cognitive impairment were significantly more likely to move in with family members.

Religion, or the access to a religious social network, may mitigate some of the issues that come with smaller familial social networks. Lim & Putnam (2010), found that in the relationship between religious attendance and life satisfaction, adding number of congregational friendships accounts for most of this association; they suggested that those who attended services more frequently reported greater satisfaction because they had more friends in their congregations, not necessarily that they had more friends overall. Being more religious and attending church more frequently may give individuals with smaller familial social networks the opportunity to create meaningful connections with congregation members, thus having another avenue for social support.

Regarding psychological distress, our results show that in individuals with low religiosity, living alone is related to higher depressive symptoms, whereas this relationship does not exist in individuals with high religiosity. For those who are high in religiosity, having more than half of their children in Puerto Rico is associated with less depressive symptoms, whereas this relationship does not exist in individuals with low religiosity. Religiosity may help to buffer the effects of living alone in the context of depressive symptoms. These results are consistent with the theorized protective nature of religiosity against psychological distress, and the first leg of our hypothesized model (Figure 1).

In predicting cognition at follow-up, individuals who were objectively isolated did not significantly differ in cognition at follow-up compared to their not-alone

counterparts, nor did those with smaller FSNs significantly differ in cognition compared to those with larger FSNs. Since these relationships did not exist as expected, total religiosity did not buffer the relationship between objective isolation or FSNs and cognition. This result may be due to another factor: changes in living situation, which is discussed below. These results do not provide evidence for the other parts of our model, namely isolation/FSN's relationship with cognition both directly and via depressive symptoms (Figure 1). Although depressive symptoms did not predict cognition at follow-up, these results highlight the importance of religious context in research on mental health of older Puerto Ricans. Another important context of research on aging in Puerto Rico that is relevant to social environment, migration, is discussed below.

Living Situation Changes

Participants who were alone at baseline but moved in with others before follow-up showed more decline in cognitive function compared to those who were alone at both time points, and those who changed to living with others were twice as likely to have incident cognitive impairment. It suggests that when these older Puerto Ricans experienced cognitive decline, other family members moved in with them (or had the individual move into their home) to help take care of them. It is important to emphasize, however, that the true nature of the relationship we have noted is unclear. We interpret the results as older adults who experience cognitive decline move in with others, but based on the analyses conducted, we cannot confirm directionality. Either way, this relationship between cognitive decline/impairment and moving in with others is important not only because it confounds our results, as individuals with substantial

cognitive decline or impairment would be less likely to live alone, but also because it highlights a current issue with caring for the population of older adults in Puerto Rico.

The changing landscape of Puerto Rico's family caregiving systems has been noted since at least 2000, such that there are growing numbers of older adults and fewer potential caregivers (Szembik & Bonilla, 2000). Near the end of PREHCO wave 2 data collection (2006-2007), a growing number of young people were leaving Puerto Rico to find better employment and opportunity, mostly in the mainland US (Cohn, et al., 2014). However, this leaves older adults in Puerto Rico with less familial support in a place that is continually experiencing disproportionately less federal funding for health care and education, inferior voting rights compared to their US counterparts (Valle, A.J., 2018), and higher levels of poverty and higher unemployment rates (Perez & Ailshire, 2017); essentially, these factors lead to greater social and economic stress. It is for these reasons that younger adults and their children have been leaving Puerto Rico, however, older relatives may be left without familial support that would have been available for previous generations. This is especially pertinent today, as migration rates from Puerto Rico rose by three times between 2010 and 2013 (Cohn, et al., 2014), and then an estimated 200,000 residents of Puerto Rican migrated in the wake of Hurricane Maria ("Puerto Rico: The exodus after Hurricane Maria", 2018). In turn, this migration has fueled the rapid aging of Puerto Rico, where the percentage of individuals over 65 nearly doubled between 2010 and 2020 and has left the archipelago with increased economic burden (Matos-Moreno, et al., 2021). Individuals left behind may experience broken familial networks such that they are at greater risk of health problems and depressive symptoms due to increased emotional burden (Lu, 2012). The results of our study provide evidence

that greater religiosity may buffer the effects of living alone or having a reduced familial social network on psychological distress, possibly by providing individuals with more opportunities to create meaningful relationships outside of family.

Transportation Difficulties

When assessing the association between total religiosity and aging outcomes of interest, we included transportation difficulties as a covariate. It was presumed that individuals who had difficulty with transportation would be less likely to be able to attend church and church-related social events. In almost all our different statistical models, transportation difficulty was significantly associated with more depressive symptoms at baseline and lower cognition at follow-up. It is possible that individuals who need help with transportation may feel a lack of agency, or the ability to go where they want when they want, possibly increasing depressive symptoms. Schieman and Campbell (2001) found that older adults generally report lower self-efficacy and self-esteem; those with greater physical impairment and poorer global health had lower self-esteem, and those who were disabled had lower perceived health control. Not having instrumental social support could contribute to our finding that transportation difficulties are related to greater depressive symptoms. It could also be that individuals who have difficulty traveling by themselves have other health or physical difficulties that are leading to increased depressive symptoms. Either way, transportation difficulty was a strong predictor of depressive symptoms as well as cognitive decline, highlighting not only the need for access to mental health professionals and transportation, but also the importance of living with other individuals who may be more readily available to help with transportation.

Individuals who report transportation difficulties are more likely to report difficulties in other aspects of their lives as well. The literature supports a relationship between physical disability and cognition, showing faster rates of cognitive decline in individuals with disability in activities of daily living (ADLs) and instrumental activities of daily living (IADLs) (Mehta et al., 2002; Rajan et al., 2012). Our results are consistent with the literature here as well, as those with greater transportation difficulties (i.e., our proxy for disability) had lower cognition at follow-up.

Limitations

We found from our analysis of living situation during the years of the study that individuals living alone who experienced greater cognitive decline were more likely to move in with others at follow-up. This is likely because families provided support to help their older relatives. Hispanics are thought to be more likely to care for their family members due to their cultural beliefs and orientations (e.g., familism; see Falzarano et al., 2022; Knight & Sayegh, 2010); a recent study found that between 2015-2017, 13.7% of Puerto Ricans were unpaid, informal caregivers (Edwards et al., 2020). These individuals may provide resources that may help reduce cognitive decline, which would have affected the results of our study, as social activity has been associated with increased global cognition (Kelley et al., 2017). It is important to note that our analytic sample excluded individuals with global cognitive impairment at baseline. Only individuals who completed self-report measures of depressive symptoms were included. For those who scored below a pre-determined cutoff on the MMC indicating dementia, a proxy was given an abbreviated version of the questionnaire to answer questions about the target participant. Thus, self-report data about depressive symptoms and religiosity were not

completed for participants with the lowest levels of cognitive function, and these individuals were excluded from data analyses. Therefore, we were looking at individuals who had relatively healthy cognition at baseline and may be more likely to maintain cognition over the four years between data collection. Finally, this study was conducted using data gathered from older individuals in Puerto Rico, meaning that study results are not generalizable to older adults or to all Puerto Ricans, many of whom live in the mainland US.

Advantages

The most salient advantage of this study is the unique and population-based sample. Most samples represented in the field of psychology are non-Hispanic and WEIRD – Western, educated, industrialized, rich, and democratic (Henrich, 2010; Rad, 2018). PREHCO focuses on an understudied group of older adults living in Puerto Rico. PREHCO participants are representative of the main island of Puerto Rico due to population-based sampling as opposed to the use of convenience-based samples that is common in many aging studies. PREHCO also benefits from a longitudinal design, where data is currently being gathered approximately 20 years after baseline.

Future Directions

A third wave data is currently being collected on this same sample, allowing for over 15 years of follow-up between the 2nd and 3rd wave of data collection. With this new data, we could test longer-term cognitive outcomes as well as other salient health outcomes such as mortality. Future studies may also benefit from including individuals earlier in the aging process, as relevant cognitive decline may have already begun before we started assessing our cohort of age 60+ years at baseline. Finally, a hurdle for our

study was the use of self-report measures of depressive symptoms and religiosity, which removed the more significantly cognitively impaired participants whose data was collected via proxy. Creating studies with proxy report as a feature of study in those with significant cognitive impairment (i.e., studying how well proxy report compares to true impairment) may allow for more robust study of this area. Future studies could incorporate this to assess the efficacy and use of proxy report for cognitively impaired individuals' mood symptoms.

Overall, this study provides evidence for the importance of access to social networks when an individual is isolated or separated from their family, especially due to our finding that living alone was related to higher depressive symptoms, and that religiosity moderates how FSN indicators predict these depressive symptoms. Individuals with high religiosity were buffered from experiencing psychological distress as related to living alone and having more than half of their children in Puerto Rico. This calls for highlighting an at-risk group of individuals, isolated and non-religious older adults, who are separated from their families due to current migration away from Puerto Rico. Findings related to changes in living situation highlight the need for support for Puerto Rican individuals, such as economic relief, increasing access to low-cost mental health care, and adding incentives for family members to stay in Puerto Rico, which might alleviate the additional strain on families and their older relatives.

Figures and Tables

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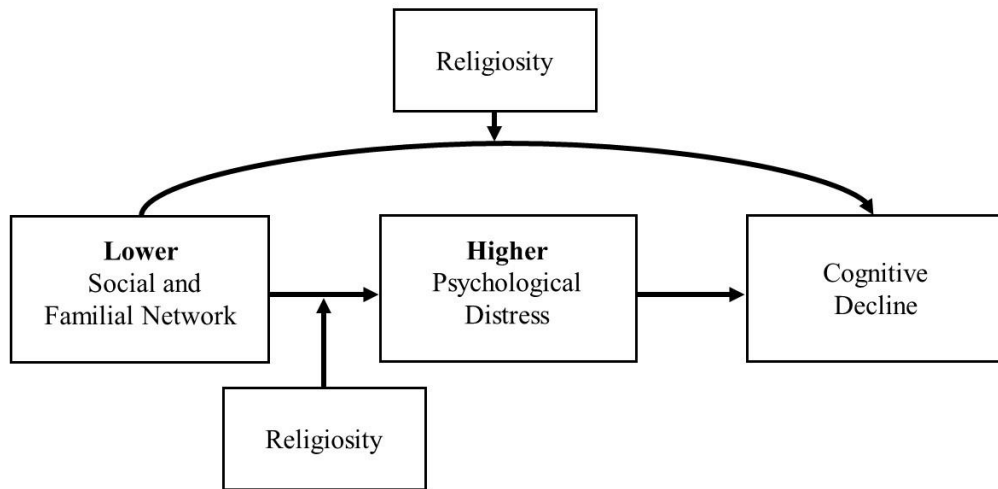
Figure 1. Hypothesized Mechanism for Cognitive Decline with Religiosity as a Moderator

Figure 2. Flow Diagram for Excluding Participants
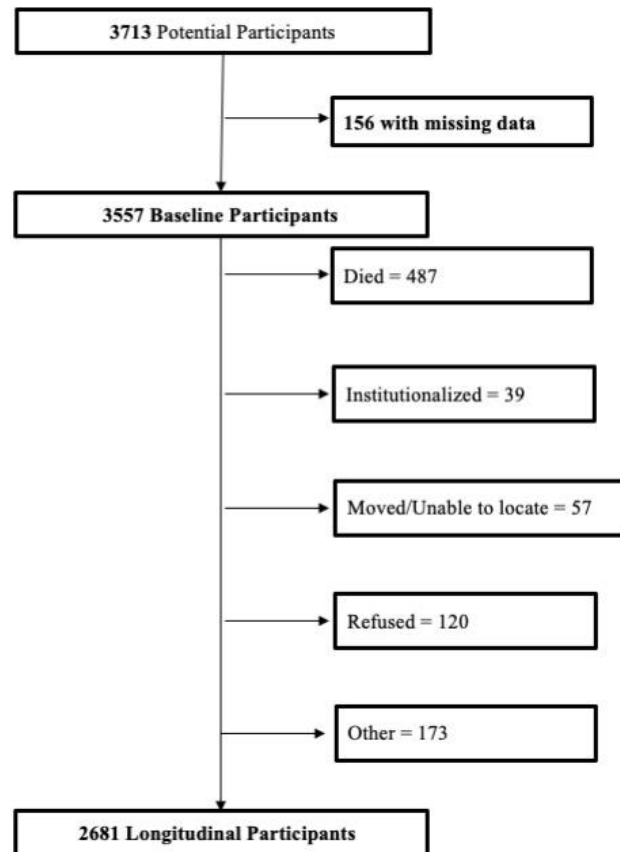
Table 1. Baseline Characteristics

	Alone n = 1141	Not Alone n = 2244	p	Full Sample N=3557
	n(%) or M(SD)	n(%) or M(SD)		n(%) or M(SD)
Age	73.60(8.23)	70.25(8.03)	<.001	71.23(8.22)
Female	799(70.03)	1324(54.80)	<.001	2123(59.69)
Race				
Black	63(5.52)	129(5.34)		192(5.40)
Multi-Racial	464(40.67)	1012(41.89)		1476(41.50)
White	523(45.84)	91050(43.46)		1573(44.22)
Mestizo/a (Indigenous)	59(5.17)	170(7.04)		229(6.44)
Other	32(2.80)	55(2.28)		87(2.45)
Transport. Diff.	261(22.87)	449 (13.41)	<.05	726(20.41)
Cognition	16.41(2.50)	16.73(2.37)	<.001	16.63(2.41)
Education (years)	7.69(4.95)	8.41(4.69)	<.001	8.18(4.79)
Depressive Symptoms	3.73(3.54)	3.14(3.35)	<.001	3.33(3.42)
Religiosity (0-2)	1.17(0.79)	1.23(0.73)	.19	1.14(.78)
Engagement (0-4)	1.74(1.41)	1.73(1.43)	.94	1.74(1.42)
Total Religion (0-6)	2.90(1.85)	2.84(1.88)	.49	2.86(1.87)
Siblings in PR*	797(69.85)	1903(78.77)	<.001	2700(75.91)
Children in PR*	695(60.91)	1911(79.10)	<.001	2606(73.26)
Network (people)	7.27(4.43)	8.89 (4.50)	<.001	8.36(4.55)

NOTE: Transport. Diff. = Transportation Difficulty

*More than 50% live in Puerto Rico

Table 2. Spearman Correlations for Variables of Interest

	1	2	3	4	5	6	7	8	9	10	11
1. Age	-										
2. Female	.00	-									
3. Education	-.18**	-.03	-								
4. Depressive Symptoms	.05**	.13**	-.17**	-							
5. Living Alone	.19**	.14**	-.07**	.09**	-						
6. Religiosity	.06**	.19**	.04*	-.05*	.03	-					
7. Religious Engagement	-.06**	.14**	.10**	-.11**	.00	.38**	-				
8. Total Religiosity	-.03	.19**	.09**	-.10**	.01	.70**	.92**	-			
9. Siblings in Puerto Rico	-.14**	-.01	.07**	-.01	-.10**	-.01	.04*	.02	-		
10. Children in Puerto Rico	-.01	.08**	-.01	-.02	-.19**	.05*	.04*	.06*	.08**	-	
11. Familial Social Network	-.24**	-.08**	-.16**	.02	-.19**	-.03	.07**	.04*	.20**	.13**	-

| 12. Baseline Cognition | -.20** | .06** | .30** | -.15** | -.06** | .01 | .04* | .04* | .05* | .02 | -.01 |

Note: * = p<.05; ** = p<.001

Table 3. Moderation Effect of Religiosity on Familial Social Network and Living
Alone Variables to Predict Baseline Depressive Symptoms: N=3557

	Model 1			Model 2			Model 3		
	Est.	SE	p	Est.	SE	p	Est.	SE	p
Age	-.00	.007	.98	-.03	.007	<.001	-.03	.007	<.001
Female	.95	.115	<.001	.82	.115	<.001	.82	.116	<.001
Race									
White (ref.)									
Black	.14	.256	.57	.09	.247	.73	.07	.246	.78
Multi-racial	.18	.121	.15	.00	.118	.97	-.00	.118	.99
Other	.21	.207	.31	.07	.199	.72	.07	.199	.72
Baseline Cognition	-.20	.024	<.001	-.16	.024	<.001	-.16	.023	<.001
Education (years)				-.04	.013	<.001	-.04	.013	<.001
Transportation Difficulty				2.04	.140	<.001	2.04	.140	<.001
Alone				.44	.123	<.001	.84	.224	<.001
Siblings in PR				.27	.130	<.05	.09	.236	.70
Children in PR				-.11	.126	.40	.35	.224	.12
Network				.02	.013	.15	.03	.024	.19
Religion Total				-.18	.029	<.001	-.03	.093	.71
Alone*Religion							-.14	.064	<.05
Siblings*Religion							.06	.070	.36
Children*Religion							-.16	.067	<.05
Network*Religion							-.00	.007	.56

Note. Ref. = reference group is White participants.

Table 4. Predictors of Baseline Depressive Symptoms Stratified by Total Religiosity

	Low Total Religiosity n=2694			High Total Religiosity N=825		
	b	SE	p	b	SE	p
Age	-.03	.008	<.001	-.01	.014	.32
Female	.86	.133	<.001	.49	.222	<.05
Race						
White (ref.)						
Black	.13	.291	.66	.27	.448	.54
Multi-racial	.05	.141	.71	.03	.216	.89
Other	.05	.243	.84	.35	.384	.36
Baseline cognition	-.16	.028	<.001	-.16	.046	<.001
Education (years)	-.04	.015	<.05	-.07	.022	<.05
Trans. diff.	2.10	.161	<.001	1.82	.285	<.001
Alone	.57	.145	<.001	-.01	.229	.97
Siblings in PR	.24	.153	.11	.30	.245	.23
Children in PR	.03	.148	.83	-.64	.245	<.05
Network (people)	.02	.015	.07	-.02	.024	.41

Note. Trans. diff. = Transportation difficulty

Table 5. Predicting Cognition at Follow-Up with Living Alone and Familial Social Network; N=2681

	Model 1			Model 2			Model 3		
	Est.	SE	p	Est.	SE	p	Est.	SE	p
Age	-.11	.007	<.001	-.10	.007	<.001	-.10	.007	<.001
Female	.00	.102	.98	.08	.102	.42	.13	.103	.20
Race*									
White (ref.)									
Black	-.05	.226	.82	-.06	.219	.77	-.06	.219	.80
Multi-racial	-.32	.107	<.05	-.12	.105	.26	-.12	.105	.27
Other	.20	.181	.27	.25	.175	.15	.27	.176	.12
Baseline Cognition	.44	.021	<.001	.35	.022	<.001	.35	.022	<.001
Education (years)				.14	.011	<.001	.14	.011	<.001
Alone				.04	.111	.74	.04	.111	.69
Siblings in PR				-.06	.120	.63	-.06	.120	.59
Children in PR				-.18	.115	.11	-.17	.115	.14
Network				.01	.011	.56	.01	.011	.52
Depressive Symptoms							-.02	.015	.16
Trans. Diff.							-.36	.135	<.05

Note. Trans. Diff. = transportation difficulty

Table 6. Interaction of Religiosity with Familial Social Network and Living
Alone Variables to Predict Cognition at Follow-Up: N=2681

	Est.	SE	p
Alone*Religion	-.01	.053	.82
Siblings*Religion	.03	.057	.60
Children*Religion	.07	.053	.17
Network*Religion	-.00	.005	.39

Note. Included all variables from Model 3 in Table 5

Table 7. Predictors of Follow-Up Cognitive Decline Stratified by Religiosity, N=2504

	Low Religiosity n=2007			High Religiosity n=674		
	Est.	SE	p	Est.	SE	p
Age	-.10	.008	<.001	-.11	.014	<.001
Female	.14	.119	.24	.16	.210	.46
Race						
Black	-.02	.258	.93	-.26	.411	.53
Multi-Racial	-.02	.123	.83	-.30	.203	.14
White (ref)						
Other	.30	.200	.13	.39	.368	.29
Baseline Cognition	.32	.025	<.001	.43	.043	<.001
Education (years)	.15	.013	<.001	.11	.021	<.001
Trans. Diff.	-.56	.153	<.001	.40	.283	.16
Depressive Symptoms	-.01	.017	.54	-.05	.034	.11
Alone	-.02	.130	.87	.15	.218	.50
Siblings in PR	-.07	.138	.62	-.07	.238	.78
Children in PR	-.24	.132	.07	-.01	.240	.97
Network (people)	.02	.013	.14	-.03	.023	.16

Table 8. Predicting Follow-Up Cognition with Living Situation Changes Between
Timepoints

	Cognitive Change (n=2681)*		Incident Cognitive Impairment (n=2771)
	Est. (SE)	p	OR (95% CI)
Age	-.11 (.007)	<.001	1.14 (1.12 - 1.17)
Female	-.01 (.104)	.91	1.17 (.79 – 1.72)
Cognition at Baseline	.44 (.021)	<.001	.74 (.68 - .80)
Living Alone at Both Timepoints (reference group)			
Living with others at Both Timepoints	-.09 (.120)	.48	1.52 (.99 - 2.35)
Newly Alone at Follow-Up	-.26 (.205)	.20	.99 (.41 – 2.41)
Newly with others at Follow-Up	-.49 (.241)	<.05	2.21 (1.10 – 4.46)

Note. Cognitive change uses the same sample from former analyses.

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