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Forms of attrition in a longitudinal study of religion and health in older adults and implications for sample bias

R. David Hayward, PhD¹ and Neal Krause, PhD¹

¹University of Michigan, School of Public Health, Department of Health Behavior and Health Education

Abstract

The use of longitudinal designs in the field of religion and health makes it important to understand how attrition bias may affect findings in this area. This study examines attrition in a 4-wave, 8-year study of older adults. Attrition resulted in a sample biased towards more educated and more religiously-involved individuals. Conditional linear growth curve models found that trajectories of change for some variables differed among attrition categories. Ineligibles had worsening depression, declining control, and declining attendance. Mortality was associated with worsening religious coping styles. Refusers experienced worsening depression. Nevertheless, there was no evidence of bias in the key religion and health results.

Keywords

Religion; health; longitudinal analysis; attrition

The relationship between religion and health has been an area of significant research in recent decades, and as the literature in this field matures there has been a growing emphasis on improving the quality of design of this research (Koenig, King, & Carson, 2012). Although the majority of research remains cross-sectional in nature, a number of scholars have called for an increased focus on longitudinal design in order to answer questions regarding the directionality of relationships (George, Ellison, & Larson, 2002; Krause, 2008), and to counter criticism of religion and health research more generally (e.g. Sloan & Bagiella, 2002). However, increased design complexity also brings increased challenges. Researchers must consider not only whether their baseline samples reflect the populations they are studying, but also whether differential attrition changes the nature of this sample over time in ways that have an impact on the relationships between key variables. A number of findings suggest that the relationship between religion and health is especially important in older adulthood (Krause, 2006; Powell, Shahabi, & Thoresen, 2003). In this population, factors like mortality and disability have pervasive effects that must also be considered when

Direct correspondence to: R. David Hayward, Assistant Research Scientist, Department of Health Behavior and Health Education, School of Public Health, University of Michigan, 1415 Washington Heights, Ann Arbor, Michigan 48109-2029, rdhaywar@umich.edu.

R. David Hayward, PhD is an Assistant Research Scientist at the University of Michigan. His research focuses on social psychological aspects of religion and health, with a methodological focus in multilevel and longitudinal survey research.

Neal Krause, PhD is the Marshall H. Becker Collegiate Professor of Public Health at the University of Michigan. His research focuses on religion, health, and aging. He has conducted several major nationwide studies on this subject

it comes to understanding attrition bias. In this study, we examine sources of attrition in a longitudinal survey of religion and health in late life, and assess whether attrition is related to religion in such a way as to bias the results of research on this topic.

Attrition Bias in Older Adult Samples

Samples of all types of populations are susceptible to attrition, but the issue may be particularly important in samples of older adults. Older individuals are more likely to die or suffer a disabling health condition preventing participation in research. There may also be factors that make them more likely to withdraw from the study voluntarily, or to be unable to be contacted at follow up. Each form of attrition has its own implications for research validity.

Mortality

The most straightforward reason for attrition is death. Naturally, this is an especially significant source of attrition in older adult samples, and becomes increasingly problematic the more time elapses from the beginning of the study. Because people with different characteristics have different mortality risks, mortality alone may produce an increasingly biased sample over the course of a longitudinal research study, simply because those remaining are disproportionately likely to have particular traits. For example, men, members of ethnic minority groups, and people with lower socioeconomic status are at higher risk of mortality over any given time period, and thus such a sample will tend to become more heavily skewed over the course of subsequent longitudinal survey waves towards women, white individuals, and those with high socioeconomic status. Consequently, to the extent that the relationships of interest in the study are moderated by these background factors, assessments of these relationships may change over the course of a longitudinal study even if there are no changes on the individual level. With respect to health-related studies, mortality is often an important outcome in its own right (Idler & Benyamini, 1997), making bias arguably less problematic in these instances. Conversely, this form of bias may raise difficulties in research involving factors of adult development and aging (Erikson, 1968; Tornstam, 1997), for example changes in attitudes and cognition over the course of late life (Hayward & Krause, 2013a), since groups disproportionately prone to mortality may also tend to undergo different trajectories of development. Mortality will result in both under-representation of these individuals at later ages and a tendency to truncate these trajectories at earlier ages.

Disability

Cases of attrition due to physical or mental impairment are also relatively prevalent in older adult samples (Feng, Silverstein, Giarrusso, McArdle, & Bengtson, 2006), but are less clear than attrition due to mortality. The ability to accommodate otherwise ineligible participants varies greatly between studies. For example, many population surveys restrict their samples to non-institutionalized individuals; this strategy may disproportionately affect older adults due to higher risks of being hospitalized or moving to residential care facility. Other studies may take measures to include some of these individuals, but may also encounter more problems related to the onset of cognitive difficulties, potentially compromising data quality.

In addition to the problems associated with variations in patterns of risk of poor health biasing the remaining sample towards lower-risk demographic groups (as discussed with respect to risk of mortality above), attrition due to disability may also bias the sample by differentially leaving only the healthiest participants in the study.

Refusal

Previous research has found that poor health is related to the propensity to drop out voluntarily by refusing to participate in later waves of a longitudinal study (Chatfield, Brayne, & Matthews, 2005). Thus refusal may be a problematic source of attrition in older adult samples, which are likely to have a relatively high rate of health problems. Furthermore, it may serve to bias the data by selectively eliminating the least healthy individuals. Unlike mortality and disability, refusal does not in itself provide a definite indication of health status, and thus demands especially strong scrutiny as a potential source of bias.

Loss to Contact

In some cases, it is impossible to locate a study participant who needs to be re-contacted for a follow-up survey. Generally, the reason for this loss to contact will remain unknown. The participant may have moved without leaving any forwarding contact information, may have died or become ineligible, or may avoid responding to communication regarding the study because of respondent fatigue or some other desire not to take further part in the research. Previous research indicates that older adults in poor health are more likely to be lost to contact than those in better health (Chatfield et al., 2005). This may result in a further tendency for the sample in a longitudinal study to become healthier than the population as whole over time, as those in the worst health are differentially selected out. Because it is extremely difficult to determine the specific cause of attrition due to loss of contact in any particular case, this may be a particularly difficult form of bias to deal with.

Religion, Health, and Attrition

Religious involvement has been found to be related to a number of factors with direct relevance for health and well-being, including self-rated health (Krause & Ellison, 2009) and depression (Hayward, Owen, Koenig, Steffens, & Payne, 2012; Idler & Kasl, 1992). Especially among older adults, a key element in this relationship is the sense of personal control, which may be affected by religious factors (McCullough & Willoughby, 2009), and which may in turn have an important impact on health and the ability to remain functional in the face of challenges (Lachman, Neupert, & Agrigoroaei, 2011). There has been little research into the causes and consequences of attrition in longitudinal studies of religion and health. Nevertheless, religion may intersect with attrition in ways that have important consequences for interpretation of the results of research in this field. First, religion has been linked with lower risk of mortality in a number of studies (Hummer, Ellison, Rogers, Moulton, & Romero, 2004; Strawbridge, Shema, Cohen, & Kaplan, 2001). Thus individuals with less religious involvement may be disproportionately selected out of the sample due to earlier deaths, leaving a skewed sample in later waves. More broadly, religion has been linked with better health generally (Hackney & Sanders, 2003), and with less physical

disability in older adults specifically (Hayward & Krause, 2013b). Related to this finding, more religious individuals also tend to receive more social support as a result of their church-based social networks, which may enable older adults to continue living independently later in life and in worse health in comparison to their less-religious counterparts. Somewhat paradoxically, this may serve to underestimate health differences between those high and low in religiousness in later study waves, as relatively more low-religion individuals are selected out due to disability, in comparison to high-religion individuals who can remain non-disabled and in the study even with worse health overall. Finally, there is a plausible risk that individuals who are less interested in religion will be less likely to have motivation to remain in a longitudinal study that they know is primarily focused on religious factors. Consequently, the sample of such a study may come to be composed of disproportionately religious individuals over time. Since a number of researchers have indicated that the relationship between religion and health is stronger among more religiously-involved groups of people (e.g. Ellison, 1995; Idler et al., 2003; Krause, 2002b), this may mean that estimates of this relationship become stronger and increasingly biased in later study waves.

Hypotheses

The purpose of this study is to examine whether religion is related to attrition in a longitudinal study in a way that leads to bias in the results.

1. If attrition creates bias, means for stable personal traits will change between waves.
2. If attrition creates bias, there will be differences between groups defined by final attrition status in terms of key study variables.
3. If attrition creates bias, then the relationships between key study variables will vary across waves and between categories of attrition.
4. If attrition creates bias, then trajectories of within-person change in key variables will differ depending on final attrition status.

Methods

Data for this study came from the first four waves of a national study of religion, spirituality, and health in older adults. The first wave was conducted in 2001, and was designed to be representative of the US population aged 66 and older ($N = 1,500$). The initial sample was drawn from the beneficiary list maintained by the Centers for Medicare and Medicaid Services (see Krause, 2002a for details regarding sampling procedures). The sample was filtered in two ways. First, it was limited to individuals identifying their race as either White or Black; Black individuals oversampled to allow for power to make comparisons between these groups. Second, it was limited to individuals whose religious backgrounds met one of the following criteria: (1) currently identifying as Christian, (2) formerly identifying as Christian, but currently not religious, or (3) never identified with a religious group. This limitation was imposed because a number of religious measures were developed and validated for use only in Christian samples. Subsequent waves were conducted in 2004 ($N = 1,024$), 2006 ($N = 969$), 2008 ($N = 718$). Interviews were conducted face-to-face in

participants' homes. As in many other studies, these figures reveal that a significant amount of sample attrition has occurred over time. In fact, roughly 52 percent of the individuals who participated in the initial Wave 1 interview were lost to follow-up by Wave 4

Forms of Attrition

Attrition from the study was recorded in four categories based on case disposition in each survey wave: mortality, ineligibility, refusal, and loss to contact. Mortality was recorded based on report from an informant in the participant's household. Study ineligibility occurred when the participant no longer met the study requirements of being non-institutionalized and being physically and mentally capable of participating in the face-to-face survey procedures. Thus, ineligibility in this sample was almost always due to poor health. Refusal was recorded when a participant declined to be interviewed in a follow-up survey wave. Loss to contact includes all other cases in which the participant could not be located, so that mortality or eligibility status could not be confirmed. Attempts were made to re-contact all non-deceased participants in each wave, regardless of previous ineligibility or refusal, thus it was possible for participants to be absent in wave 2 or 3 but to return in a subsequent wave, or to have differing non-response dispositions in different waves. In these instances, the first disposition following the last complete interview was used as the basis for coding attrition (e.g., if a participant refused in wave 3 but completed wave 4, this was coded as "no attrition" but if a participant refused in wave 3 but was found to have died by wave 4, this was coded as "refused"). A summary of sources of attrition by wave can be found in Table 1.

Measurement

Religious behavior—Frequency of *attendance* at religious worship services was assessed with a single item on a 9-point scale from "never" to "several times a week." Frequency of private *prayer* and *Bible reading* were each assessed with a single item on an 8-point scale from "never" to "several times a day."

Religious coping—Religious coping was measured using items from the RCOPE scale (Pargament, Koenig, & Perez, 2000). Coping responses can be classified as either positive (sample item: "I look to God for strength in a crisis") or negative (sample item: "I think about how stressful situations are God's way of punishing me for the things I have done wrong"). Each scale included 5 items, and each item was scored on a 4-point scale, from "not at all" to "a great deal," with respect to the frequency with which each response was used. Scale scores were computed by adding item responses for the corresponding scale questions. Reliability was $\alpha = 0.88$ for positive religious coping and $\alpha = 0.72$ for negative religious coping.

Commitment—Religious commitment is measured with a 3-item scale (sample item: "my faith shapes how I think and act each and every day"). Responses to each item were on a 4-point agreement scale. Higher scores indicate greater religious commitment. Reliability was $\alpha = 0.94$.

Health—Self-rated health was measured with a 3-item scale. The first item measured perceived overall health, on a 4-point scale (poor, fair, good, or excellent). The second and third items asked respondents to rate their health in comparison to “most people your age” and to themselves a year ago; each had 3-point response scales (worse, about the same, or better). Higher scores on this scale indicate better self-rated health. Reliability was $\alpha = 0.70$.

Depression—Symptoms of depression were measured using an 8-item version of the Center for Epidemiological Studies Depression Scale (CES-D), which is used to screen for depression (Radloff, 1977). Each response is scored on a 3-point scale. Higher CES-D scores indicate greater presence of symptoms of depression. Reliability was $\alpha = 0.89$.

Sense of control—Four items from the internal-external locus of control scale (Rotter, 1966) were used to measure participants’ sense of personal control (sample item: “I have a lot of influence over most things that happen in my life”). Each response was on a 4-point agreement scale. Higher scores indicate greater control. Reliability was $\alpha = 0.87$.

Demographics—Age, gender, race, and education (in years) were collected as demographic controls.

Imputation of Missing Data

Because listwise deletion of cases with missing data would have resulted in excluding as much as 35.4% of the sample for some analyses, we used multiple imputation to deal with item non-response, (i.e., items missing in a wave in which the individual participated; values were not imputed in cases for which an entire wave was missing). Imputation was conducted using the Markov Chain Monte Carlo procedure, which imputes values by simulating a series of random selections from distributions of the target variable based on the observed joint distributions of all other variables in the dataset (Horton & Lipsitz, 2001). Analyses are performed separately using each set of imputed values, and the results are pooled. Five imputations were computed, commensurate with simulation studies demonstrating that this number is sufficient to maintain a very high degree of relative efficiency when the missing fraction is less than 0.10 (Graham, Olchowski, & Gilreath, 2007), whereas the fraction of data missing in the present analyses was 0.047.

Results

Descriptive statistics by wave are presented in Table 2. There were a total of 4,192 observations of 1,500 individuals over the course of 4 waves. Of these, 354 completed a single wave, 218 completed two waves, 310 completed three waves, and 618 completed all four waves. Note that this is not the same as the 718 participants who are counted as having no attrition from the study, because a number of people were excluded during one or both of waves 2 and 3 due to temporary ineligibility, refusal, or non-contact, but subsequently returned to the study.

The first step in examining whether or not selective attrition results in increasing bias in the sample over time is to examine whether means for the remaining sample change between waves. Table 2 presents descriptive statistics for the sample by wave; different superscripts

indicate significant mean differences. As would be expected, age increased significantly between each study wave, $F(3,4188) = 138.70, p < .001$. There is also evidence that less educated individuals were lost from the sample at a somewhat higher rate than more educated ones, as there is a slight difference in the means for education in Wave 1 and Wave 4, $F(3,4188) = 3.64, p = .012$. Regarding religious variables, there is evidence of a decrease in mean attendance between Wave 1 and subsequent waves, $F(3,4188) = 4.32, p = .005$. Similarly, negative coping decreased after Wave 1, $F(3,4188) = 202.66, p < .001$. For the remaining religious variables – prayer, Bible reading, positive coping, and commitment – there were either no changes, or changes that were minor and inconsistent in direction. In terms of health and well-being outcomes, the sample mean for subjective health appeared to decline slightly over time, $F(3,4188) = 6.56, p < .001$, whereas there were significant but inconsistent changes in depression, $F(3,4188) = 14.99, p < .001$, and the mean sense of personal control remained stable.

The second step in assessing attrition bias is examining whether there were baseline differences among groups of participants who would eventually leave the study for various reasons. Table 3 presents descriptive statistics at Wave 1 by final attrition category. There were a number of demographic differences between attrition groups. For example, participants who went on to experience mortality were older on average, more likely to be black, more likely to be male, and had lower average levels of education in comparison with those who remained in the study. Participants who later became ineligible were also older and had lower educational attainment in comparison to those who remained in the study, but did not differ in terms of race or gender composition. More pertinent to the question of attrition bias, there were no demographic differences between those who remained in the study and those who refused, but those who were later lost to contact tended to be older, less educated, and more likely to be white and female in comparison to those who remained in the study until Wave 4. Individuals who remained in the study had somewhat higher mean levels of attendance at religious services compared with other groups (except those who later refused), and read the Bible somewhat more often than those who left due to mortality, but there were no other significant baseline religious differences between attrition groups. Individuals who later experienced mortality generally had worse mean subjective health, more symptoms of depression, and a weaker sense of personal control in comparison with other attrition categories except for those who became ineligible (who tended to fall in between).

After examining these mean differences, the third step in examining attrition bias is to determine whether there are differences in the key relationships between religion and health outcomes among groups and over time. This set of analyses is especially important, because researchers in the field of religion and health are naturally more interested in relationships between these key variables than in variable means. These questions are addressed in Tables 4 and 5. A comparison of confidence intervals indicates that there is evidence that certain relationships intensified between the Wave 1 and Wave 4 samples. Specifically, attendance was more strongly related to the sense of personal control in Wave 4 in comparison with Wave 1, and frequency of private Bible reading was more strongly associated with lower depression. Additionally, the relationships between prayer and sense of control, between

Bible reading and sense of control, and between positive coping and depression became statistically significant in Wave 4 after having been nonsignificant in Wave 1 (although analysis of confidence intervals does not indicate that Wave 1 and Wave 4 coefficients differ significantly). Thus, different conclusions would be drawn from the Wave 1 and Wave 4 samples with respect to a number of key hypotheses regarding religion and well-being.

Because “natural” causes of attrition (i.e., death or disability) are in themselves useful indicators of health and well-being, the difference described above are primarily important if they reflect bias due to selection out of the sample by relatively uninterested participants (i.e., if people for whom religion is less useful have less interest in remaining in the study). Table 5 indicates that the significant relationship between religious attendance and health seen in the sample as a whole is absent among those who later refused or were lost to contact. Additionally, members of those groups exhibited a significant positive association between negative religious coping and the sense of personal control that was not present in the rest of the sample. Other associations – those between attendance and depression; negative religious coping and depression; and religious commitment and personal control – did not differ depending on type of eventual attrition.

Finally, it is especially important to examine whether differences in longitudinal patterns of change may contribute to bias in our analyses of these relationships over time. It is possible that individuals with different eventual sources of attrition tended to follow different trajectories of change on key religion and health variables. These results are presented in Table 6. Conditional growth curve models were applied using hierarchical linear modeling (West, Welch, & Galecki, 2007). In this method, measurements at each wave are treated as nested within individual participants by defining random intercept and time effects by individual. The model estimates the mean slope of within-person change over the course of the study using weighted composites of between and within-person time effects for each participant (crucially, including those who participated in some but not all waves). Factors influencing these trajectories of change can be assessed by the addition of interaction terms; a significant interaction indicates that the mean slope in the outcome is conditional on a third variable. In this study, we index time by age, rather than by study wave, an approach that is generally most appropriate when the initial ages of the participants are highly variable (Mehta & West, 2000).

Age coefficients indicate that among participants who did not experience attrition at any time during the study (who constitute the comparison group), there were significant mean within-person decreases in subjective health, symptoms of depression, sense of personal control, religious attendance, Bible reading, and use of negative religious coping. Frequency of prayer, use of positive religious coping, and religious commitment tended to remain stable over time. In several cases, there were differences in these average individual trajectories as a function of final attrition status. Most differences were found among those who died or became ineligible. Those who later died showed a pattern of decreasing positive religious coping and slower declines in negative religious coping. Those who became ineligible showed more rapid declines in the sense of personal control and in their frequency of religious attendance, and showed evidence of mean *increase* in depression symptoms.

Similarly, individuals who left the study due to refusal tended to have increasing rather than decreasing symptoms of depression. No other conditional trajectories were detected.

Discussion

Overall, the evidence from this study was consistent with the possibility of attrition bias relevant to the study of religion and health in a longitudinal study in a sample consisting of older adults. However, the implications of this possible bias for key outcomes was relatively minor. In keeping with recent studies in a number of other domains, it appeared that attrition did not result in significant bias in the key analyses (Mihelic & Crimmins, 1997; Norris, 1987; Schmidt et al., 2011; Thygesen, Johansen, Keiding, Giovannucci, & Grønbaek, 2008). Consistent with the first hypothesis, there were changes in some elements of the sample demographics and religious characteristics between baseline and later waves. However, the growth curve modeling results suggest that the most important of these differences can most likely be attributed to within-person change in terms of these variables. The average member of the sample tended to experience decreasing attendance and decreasing use of negative religious coping over time, which may explain corresponding changes in the sample means for these variables. On the contrary, the significant increase in the mean education level of the sample (when education was treated as constant within individuals) appears to indicate that less educated older adults may have been more susceptible to attrition from the study. Since education has been found in some studies to influence the relationship between religion and health, this finding may indicate one instance in which caution is needed.

Consistent with our second hypothesis, there were a number of differences at baseline between groups defined by eventual cause of attrition. Unsurprisingly, those who would later go on to die during the course of the study tended to belong to higher-risk demographic categories (i.e., older, Black, men, and with lower educational attainment), and also suffered from worse health, more depression, and lower sense of control. They were also relatively less involved in religion, particularly in comparison with those who never left the study, attending worship services and reading the Bible less often. It seems plausible that these differences were related to difficulties traveling and reading due to health, given that this group showed similar levels of religiosity on other measures. Of greatest concern, with respect to the potential for bias, was the observation that participants who remained in the study were more involved than other groups in religious attendance. Since attendance is one of the religious factors most persistently linked with health and well-being outcomes (Strawbridge et al., 2001), this creates the possibility the sample becomes skewed towards more religious individuals and thus overestimates the importance of religion for health in later waves.

An evaluation of our third hypothesis lends at least some credence to this possibility. Whereas there was a positive relationship between religious attendance and health among those individuals who never left the study, or who did so involuntarily (due to death or disability), there was no significant relationship at all among those who left the study due to refusal or loss to contact. One possible explanation for this finding may be that those for whom religion was less relevant to their experience of health were less likely to be interested

in responding to requests to be interviewed on the topic. Nevertheless, there is no evidence that this differential attrition led to a skewing of results for the entire sample over time (although the coefficient for the attendance-health relationship was somewhat larger by Wave 4 than it had been in Wave 1, this change was not statistically significant). Additionally, those who left the study voluntarily exhibited an unanticipated positive relationship between negative religious coping and a sense of personal control, which was not present in the rest of the sample. Again, this did not appear to materially affect analyses of the overall effect of religion on control, but may be an indication that individuals for whom religion is a more negative or ambiguous experience tend to select themselves out of research regarding religion and health.

Finally, consistent with our fourth hypothesis, growth curve models indicated that individuals in certain final attrition categories underwent somewhat different trajectories of change in key variables. Some of these trajectories are perhaps unsurprising – people who became ineligible (generally due to disability) first tended to become more depressed, lost feelings of control, and began attending religious services less frequently. Those who later died tended to have increasing negative coping and decreasing positive coping. More problematically, participants who later refused to participate tended to exhibit worsening depression symptoms. Thus, the sample may have become biased towards less-depressed individuals over time. Combined with the previously-observed tendency for more frequent religious attenders to remain in the sample, this may create some potential for overestimating the salutary relationship between religion and depression.

Taken together, these observations suggest that the risks posed by biased attrition of various kinds is not negligible in the study of religion and health. Attrition is related to a number of key variables including religious attendance, subjective health, depression, and sense of personal control, and also to the relationships among some of these key variables. Nevertheless, it is clear that attrition bias by no means explains away the existence of these relationships in this study. The key religion-health relationships remain substantially the same even regardless of which groups of participants defined by final attrition status are included or excluded from the analyses. Thus these results raise certain points of caution for those involved in longitudinal analysis in this field, but also offer a good deal of justification for trusting existing results in spite of these risks associated with attrition bias, as well as providing comfort for those who do longitudinal research.

Limitations of this study include limited specificity for some of the causes of attrition. Although it is reasonable to assume that the vast majority of cases of ineligibility, given its definition and the nature of the sample, are due to some form of disability or other health ailment necessitating hospitalization or moving to a care institution; however, other factors may play a role in attrition due to ineligibility in some cases, and thus it would be useful to have more complete data. Refusals may occur for many different reasons, and it would be useful to be able to sort health-related refusals (e.g., those who feel too ill to be interviewed) from refusals due to lack of interest in the subject. Loss to contact also covers a broad range of possibilities, and in any given case could be due to death, disability, lack of interest in the study, or simply moving house. Additionally, it would be informative to have information

regarding the demographic and religious characteristics of sampled individuals who refused to participate in the baseline survey.

As the field of religion and health research continues to mature, it is important that more researchers undertake longitudinal studies capable of addressing outstanding issues regarding the directionality of these relationships. As the results presented in this paper may help to demonstrate, it is important to carefully consider sources of attrition and their potential to bias the sample when designing and analyzing studies of this type. We hope that these insights will serve to assist researchers engaged in this process, and will help to stimulate further exploration into the role of attrition in shaping results in this field.

References

- Chatfield MD, Brayne CE, Matthews FE. A systematic literature review of attrition between waves in longitudinal studies in the elderly shows a consistent pattern of dropout between differing studies. *Journal of Clinical Epidemiology*. 2005; 58:13–19. [PubMed: 15649666]
- Ellison CG. Race, religious involvement and depressive symptomatology in a southeastern U.S. community. *Social Science & Medicine*. 1995; 40:1561–1572. [PubMed: 7667660]
- Erikson, EH. Identity, youth, and crisis. New York: W. W. Norton; 1968.
- Feng D, Silverstein M, Giarrusso R, McArdle JJ, Bengtson VL. Attrition of older adults in longitudinal surveys: detection and correction of sample selection bias using multigenerational data. *Journals of Gerontology Series B: Psychological Sciences & Social Sciences*. 2006; 61B:S323–8.
- George LK, Ellison CG, Larson DB. Explaining the relationships between religious involvement and health. *Psychological Inquiry*. 2002; 13:190–200.
- Graham J, Olchowski A, Gilreath T. How many imputations are really needed? Some practical clarifications of multiple imputation theory. *Prevention Science*. 2007; 8:206–213. [PubMed: 17549635]
- Hackney CH, Sanders GS. Religiosity and mental health: A meta-analysis of recent studies. *Journal for the Scientific Study of Religion*. 2003; 42:43–55.
- Hayward RD, Krause N. Patterns of change in prayer activity, expectancies, and contents during older adulthood. *Journal for the Scientific Study of Religion*. 2013a; 52:17–34.
- Hayward RD, Krause N. Trajectories of disability in older adulthood and social support from a religious congregation: A growth curve analysis. *Journal of Behavioral Medicine*. 2013b; 36:354–360. [PubMed: 22569776]
- Hayward RD, Owen AD, Koenig HG, Steffens DC, Payne ME. Religion and the presence and severity of depression in older adults. *American Journal of Geriatric Psychiatry*. 2012; 20:188–192. [PubMed: 22273738]
- Horton NJ, Lipsitz SR. Multiple imputation in practice. *The American Statistician*. 2001; 55:244–254.
- Hummer RA, Ellison CG, Rogers RG, Moulton BE, Romero RR. Religious involvement and adult mortality in the United States: review and perspective. *Southern Medical Journal*. 2004; 97:1223–1230. [PubMed: 15646761]
- Idler EL, Benyamini Y. Self-rated health and mortality: A review of twenty-seven community studies. *Journal of Health and Social Behavior*. 1997; 38:21–37. [PubMed: 9097506]
- Idler EL, Kasl SV. Religion, disability, depression, and the timing of death. *American Journal of Sociology*. 1992; 97:1052–1079.
- Idler EL, Musick MA, Ellison CG, George LK, Krause N, Ory MG, Williams DR. Measuring multiple dimensions of religion and spirituality for health research: Conceptual background and findings from the 1998 General Social Survey. *Research on Aging*. 2003; 25:327–365.
- Koenig, HG.; King, DE.; Carson, VB. *Handbook of Religion and Health*. 2nd. New York: Oxford University Press; 2012.

- Krause N. A comprehensive strategy for developing closed-ended survey items for use in studies of older adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*. 2002a; 57:S263–S274.
- Krause N. Exploring race differences in a comprehensive battery of church-based social support measures. *Review of Religious Research*. 2002b; 44:126–149.
- Krause, N. Religion and health in late life. In: Birren, JE.; Schaie, KW., editors. *Handbook of the psychology of aging*. 6th. New York: Elsevier Academic Press; 2006. p. 499-518.
- Krause, N. *Aging in the church : How social relationships affect health*. West Conshohocken, PA: Templeton Foundation Press; 2008.
- Krause N, Ellison CG. The doubting process: A longitudinal study of the precipitants and consequences of religious doubt in older adults. *Journal for the Scientific Study of Religion*. 2009; 48:293–312. [PubMed: 20300487]
- Lachman, ME.; Neupert, SD.; Agrigoroaei, S. The relevance of control beliefs for health and aging. In: Warner Schaie, K.; Willis, Sherry L., editors. *Handbook of the Psychology of Aging*. 7th. San Diego, CA: Academic Press; 2011. p. 175-190.
- McCullough ME, Willoughby BLB. Religion, self-regulation, and self-control: Associations, explanations, and implications. *Psychological Bulletin*. 2009; 135:69–93. [PubMed: 19210054]
- Mehta PD, West SG. Putting the individual back into individual growth curves. *Psychological Methods*. 2000; 5:23–43. [PubMed: 10937321]
- Mihelic AH, Crimmins EM. Loss to follow-up in a sample of Americans 70 years of age and older: The LSOA 1984–1990. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*. 1997; 52B:S37–S48.
- Norris FH. Effects of attrition on relationships between variables in surveys of older adults. *Journal of Gerontology*. 1987; 42:597–605. [PubMed: 3680878]
- Pargament KI, Koenig HG, Perez LM. The many methods of religious coping: Development and initial validation of the RCOPE. *Journal of Clinical Psychology*. 2000; 56:519–543. [PubMed: 10775045]
- Powell LH, Shahabi L, Thoresen CE. Religion and spirituality: Linkages to physical health. *American Psychologist*. 2003; 58:36–52. [PubMed: 12674817]
- Radloff LS. The CES-D scale. *Applied Psychological Measurement*. 1977; 1:385–401.
- Rotter JB. Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs: General and Applied*. 1966; 80:1–28. [PubMed: 5340840]
- Schmidt CO, Raspe H, Pfingsten M, Hasenbring M, Basler HD, Eich W, Kohlmann T. Does attrition bias longitudinal population-based studies on back pain? *European Journal of Pain*. 2011; 15:84–91. [PubMed: 20542714]
- Sloan RP, Bagiella E. Claims about religious involvement and health outcomes. *Annals of Behavioral Medicine*. 2002; 24:14. [PubMed: 12008790]
- Strawbridge WJ, Shema SJ, Cohen RD, Kaplan GA. Religious attendance increases survival by improving and maintaining good health behaviors, mental health, and social relationships. *Annals of Behavioral Medicine*. 2001; 23:68. [PubMed: 11302358]
- Thygesen LC, Johansen C, Keiding N, Giovannucci E, Grønbaek M. Effects of sample attrition in a longitudinal study of the association between alcohol intake and all-cause mortality. *Addiction*. 2008; 103:1149–1159. [PubMed: 18554348]
- Tornstam L. Gerotranscendence: The contemplative dimension of aging. *Journal of Aging Studies*. 1997; 11:143–154.
- West, BT.; Welch, KB.; Galecki, AT. *Linear mixed models: A practical guide using statistical software*. Boca Raton, FL: Chapman & Hall/CRC; 2007.

Table 1**Sources of attrition by survey wave**

	Complete	Deceased (new)	Ineligible	Refused	No Contact
Wave 2	1,024 (68.2%)	208 (13.9%)	81 (5.4%)	75 (5.0%)	112 (7.5%)
Wave 3	969 (75.0%)	155 (12.0%)	17 (1.3%)	33 (2.6%)	118 (9.1%)
Wave 4	718 (63.1%)	153 (13.5%)	77 (6.8%)	61 (5.4%)	92 (8.1%)
Final	718 (47.9%)	430 (28.7%)	117 (7.8%)	84 (5.6%)	151 (10.1%)

Table 2
Descriptive statistics by wave

	Wave 1	Wave 2	Wave 3	Wave 4
N	1,500	1,019	957	716
<i>Demographics</i>				
Age	75.1 ^a (6.7)	77.5 ^b (1.2)	78.9 ^c (5.8)	80.3 ^d (5.3)
White	762 ^a (50.8%)	536 ^a (52.6%)	519 ^a (54.2%)	390 ^a (54.5%)
Female	927 ^a (61.8%)	640 ^a (62.8%)	610 ^a (63.7%)	463 ^a (64.7%)
Education	11.3 ^a (3.5)	11.5 ^{a,b} (3.4)	11.6 ^{a,b} (3.3)	11.8 ^b (3.2)
<i>Religious Factors</i>				
Attendance	5.7 ^a (2.7)	5.4 ^b (3.0)	5.4 ^b (3.0)	5.7 ^{a,b} (2.9)
Prayer	6.8 ^a (1.9)	6.8 ^a (1.8)	6.9 ^a (1.8)	6.9 ^a (1.8)
Bible reading	4.5 ^a (2.6)	4.4 ^a (2.6)	4.4 ^a (2.6)	4.4 ^a (2.7)
Positive coping	17.4 ^a (3.4)	15.7 ^b (4.3)	17.4 ^a (3.2)	17.1 ^a (3.6)
Negative coping	8.7 ^a (3.4)	5.8 ^b (2.0)	6.6 ^c (2.6)	6.4 ^c (2.0)
Commitment	10.0 ^{a,b} (1.9)	9.9 ^a (2.0)	10.2 ^b (2.0)	10.0 ^{a,b} (2.1)
<i>Explanatory Factors</i>				
Health	7.1 ^a (1.6)	6.9 ^{a,b} (1.7)	6.7 ^b (1.8)	6.8 ^b (1.8)
Depression	4.4 ^a (4.9)	3.7 ^b (4.8)	4.3 ^a (5.3)	3.2 ^b (4.4)
Control	12.2 ^a (2.0)	12.0 ^a (2.3)	11.9 ^a (2.9)	11.9 ^a (2.3)

NOTE: Groups with different superscripts have significantly different means (or proportions for categorical variables)
 $p < .05$

Table 3

Descriptive statistics in wave 1, by final attrition status

	No Attrition	Deceased	Ineligible	Refused	No Contact
N	626 (41.7%)	430 (28.7%)	137 (9.1%)	115 (7.7%)	192 (12.8%)
<i>Demographics</i>					
Age	73.2 ^a (5.3)	77.9 ^{b,c} (7.5)	77.1 ^c (7.0)	72.5 ^{a,b} (5.0)	75.4 ^{b,c} (6.7)
White	342 ^a (54.9%)	209 ^b (51.3%)	65 ^{a,b} (47.8%)	59 ^{a,c} (51.3%)	109 ^c (57.4%)
Female	408 ^a (65.2%)	236 ^b (54.9%)	87 ^{a,c} (63.5%)	67 ^a (58.3%)	129 ^c (67.2%)
Education	11.8 ^a (3.3)	10.8 ^b (3.8)	10.7 ^b (3.1)	11.3 ^{a,b} (3.4)	10.9 ^b (3.5)
<i>Religious Factors</i>					
Attendance	6.3 ^a (2.7)	5.1 ^b (2.8)	5.6 ^b (2.7)	5.6 ^{a,b} (2.7)	5.4 ^b (2.9)
Prayer	6.9 ^a (1.8)	6.6 ^a (2.0)	6.8 ^a (1.7)	6.6 ^a (2.0)	6.9 ^a (1.8)
Bible reading	4.6 ^a (2.6)	4.1 ^b (2.6)	4.2 ^{a,b} (2.5)	4.3 ^{a,b} (2.5)	4.8 ^{a,b} (2.5)
Positive coping	17.5 ^a (3.5)	17.3 ^a (3.4)	17.2 ^a (3.1)	17.0 ^a (3.6)	17.5 ^a (3.4)
Negative coping	8.5 ^a (3.1)	9.0 ^a (3.7)	9.0 ^a (3.1)	8.6 ^a (3.5)	8.7 ^a (3.4)
Commitment	10.1 ^a (1.9)	10.0 ^a (1.9)	9.8 ^a (1.7)	10.2 ^a (1.9)	10.0 ^a (1.9)
<i>Explanatory Factors</i>					
Health	7.4 ^a (1.4)	6.5 ^b (1.8)	6.8 ^{b,c} (1.5)	7.3 ^{a,c} (1.5)	7.0 ^c (1.6)
Depression	3.9 ^a (4.5)	5.1 ^b (5.0)	5.2 ^{a,b} (5.5)	3.2 ^a (4.3)	4.8 ^{a,b} (5.5)
Control	12.4 ^a (2.0)	11.8 ^b (2.1)	11.8 ^{a,b} (1.8)	12.5 ^a (2.1)	12.3 ^{a,b} (2.0)

NOTE: Groups with different superscripts have significantly different means (or proportions for categorical variables), $p < .05$

Table 4
Regression coefficients relating religion and health outcomes by wave

	Health		Depression		Control	
	Wave 1	Wave 4	Wave 1	Wave 4	Wave 1	Wave 4
Attendance	0.10*** [0.06, 0.13]	0.13*** [0.07, 0.18]	-0.33*** [-0.44, -0.21]	-0.23*** [-0.36, -0.11]	0.03 [-0.02, 0.07]	0.13*** [0.07, 0.20]
Prayer	-0.05 [-0.11, 0.02]	-0.05 [-0.15, 0.05]	0.21* [0.01, 0.41]	0.49*** [0.24, 0.74]	-0.03 [-0.11, 0.05]	-0.21*** [-0.33, -0.08]
Bible reading	0.04 [-0.004, 0.08]	0.06 [-0.002, 0.12]	-0.03 [-0.16, 0.10]	-0.31*** [-0.46, -0.16]	0.04 [-0.008, 0.10]	0.10* [0.02, 0.17]
Positive coping	-0.001 [-0.04, 0.04]	0.03 [-0.03, 0.08]	-0.004 [-0.12, 0.11]	-0.16* [-0.30, -0.02]	0.03 [-0.01, 0.08]	0.06 [-0.01, 0.13]
Negative coping	-0.02 [-0.05, 0.003]	-0.06 [-0.12, 0.006]	0.28*** [0.20, 0.36]	0.42*** [0.26, 0.58]	-0.001 [-0.03, 0.03]	0.01 [-0.07, 0.09]
Commitment	-0.01 [-0.07, 0.05]	-0.08 [-0.16, 0.007]	-0.11 [-0.29, 0.07]	-0.01 [-0.22, 0.19]	0.19*** [0.12, 0.26]	0.19*** [0.08, 0.30]

NOTE: All models control for age, gender, race, and education

Table 5
Regression coefficients relating religion and health outcomes in Wave 1 by eventual attrition

	Health		Depression		Control	
	No attrition / Natural causes	Refused / Lost contact	No attrition / Natural causes	Refused / Lost contact	No attrition / Natural causes	Refused / Lost contact
Attendance	0.11*** [0.07, 0.10]	0.03 [-0.06, 0.12]	-0.33*** [-0.46, -0.21]	-0.35* [-0.66, -0.04]	0.04 [-0.01, 0.09]	-0.02 [-0.13, 0.09]
Prayer	-0.05 [-0.12, 0.03]	-0.06 [-0.21, 0.09]	0.20 [-0.02, 0.41]	0.26 [-0.25, 0.78]	-0.03 [-0.12, 0.05]	0.03 [-0.16, 0.21]
Bible reading	0.04 [-0.004, 0.08]	0.009 [-0.10, 0.12]	-0.08 [-0.10, 0.14]	0.29 [-0.08, 0.66]	0.04 [-0.01, 0.10]	0.04 [-0.09, 0.17]
Positive coping	-0.001 [-0.04, 0.04]	0.01 [-0.07, 0.10]	0.02 [-0.10, 0.14]	-0.13 [-0.44, 0.19]	0.05 [-0.002, 0.10]	-0.04 [-0.14, 0.07]
Negative coping	-0.03 [-0.05, 0.001]	-0.003 [-0.07, 0.06]	0.29*** [0.21, 0.38]	0.23* [0.005, 0.46]	-0.02 [-0.05, 0.02]	0.11* [0.02, 0.19]
Commitment	-0.02 [-0.09, 0.04]	0.04 [-0.10, 0.18]	-0.11 [-0.30, 0.09]	-0.09 [-0.56, 0.40]	0.17*** [0.10, 0.25]	0.28** [0.11, 0.45]

NOTE: All models control for age, gender, race, and education

Table 6
Linear growth curve models for health outcomes and religious variables by final attrition status

	Health	Depression	Control	Attendance	Prayer	Bible Reading	Positive Coping	Negative Coping	Commitment
Age	-0.04*** [-0.05, -0.02]	-0.04* [-0.08, -0.003]	-0.03*** [-0.05, -0.01]	-0.06*** [-0.08, -0.04]	0.01 [-0.002, 0.02]	-0.02* [-0.04, -0.003]	0.001 [-0.02, 0.03]	-0.10*** [0.58, 1.11]	0.005 [-0.01, 0.02]
Deceased	-0.80*** [-0.97, -0.62]	2.04*** [1.56, 2.53]	-0.70*** [-0.91, -0.49]	-0.92*** [-1.23, -0.61]	-0.19 [-0.37, 0.002]	-0.42** [-0.67, -0.17]	-0.11 [-0.47, 0.25]	0.84*** [0.58, 1.11]	-0.14 [-0.33, 0.06]
x age	0.02 [-0.004, 0.04]	0.05 [-0.02, 0.11]	-0.01 [-0.04, 0.02]	-0.02 [-0.06, 0.02]	-0.01 [-0.03, 0.01]	-0.008 [-0.04, 0.02]	-0.05* [-0.10, -0.008]	0.04* [0.007, 0.08]	-0.01 [-0.04, 0.01]
Ineligible	-0.63*** [-0.91, -0.35]	2.14*** [1.35, 2.94]	-0.87*** [-1.22, -0.53]	-0.69** [-1.20, 0.18]	0.19 [-0.12, 0.50]	-0.39 [-0.81, 0.03]	-0.04 [-0.62, 0.55]	0.44 [-0.003, 0.89]	-0.19 [-0.51, 0.13]
x age	-0.007 [-0.04, 0.03]	0.11* [0.005, 0.21]	-0.07** [-0.11, -0.02]	-0.08** [-0.14, -0.02]	0.004 [-0.03, 0.04]	-0.05 [-0.10, 0.002]	-0.006 [-0.08, 0.07]	0.02 [-0.03, 0.08]	0.002 [-0.04, 0.04]
Refused	-0.06 [-0.42, 0.30]	0.66 [-0.37, 1.69]	-0.01 [-0.47, 0.45]	-1.24*** [-1.89, -0.60]	-0.40* [-0.79, -0.0003]	-0.82** [-1.35, -0.28]	-0.60 [-1.34, 0.18]	0.15 [-0.46, 0.75]	-0.27 [-0.69, 0.14]
x age	0.008 [-0.04, 0.06]	0.27*** [0.11, 0.41]	-0.007 [-0.08, 0.06]	-0.05 [-0.13, 0.04]	-0.02 [-0.07, 0.03]	-0.06 [-0.13, 0.01]	-0.04 [-0.14, 0.06]	0.03 [-0.06, 0.12]	-0.02 [-0.08, 0.04]
No Contact	-0.26* [-0.51, -0.003]	1.03** [0.32, 1.75]	-0.14 [-0.46, 0.17]	-1.08*** [-1.53, -0.62]	-0.19 [-0.46, 0.09]	-0.17 [-0.55, 0.21]	-0.54 [-1.08, 0.0002]	0.50* [0.10, 0.90]	-0.21 [-0.50, 0.08]
x age	0.0004 [-0.03, 0.03]	0.0008 [-0.10, 0.10]	-0.02 [-0.07, 0.02]	-0.03 [-0.08, 0.03]	-0.03 [-0.07, 0.006]	-0.01 [-0.07, 0.04]	-0.04 [-0.11, 0.04]	0.01 [-0.05, 0.07]	-0.02 [-0.06, 0.02]

NOTE: All models contain random and fixed intercepts and fixed covariates for gender, race, and education