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Psychosocial Factors in Outcomes of Heart Surgery: The Impact of Religious Involvement and Depressive Symptoms

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This article reports a prospective study of religiousness and recovery from heart surgery. Religiousness and other psychosocial factors were assessed in 142 patients about a week prior to surgery. Those with stronger religious beliefs subsequently had fewer complications and shorter hospital stays, the former effect mediating the latter. Attendance at religious services was unrelated to complications but predicted longer hospitalizations. Prayer was not related to recovery. Depressive symptoms were associated with longer hospital stays. Dispositional optimism, trait hostility, and social support were unrelated to outcomes. Effects of religious beliefs and attendance were stronger among women than men and were independent of biomedical and other psychosocial predictors. These findings encourage further examination of differential health effects of the various elements of religiousness.

Key words: religion, heart surgery, complications, hospital length of stay, depressive symptoms, prospective study

Heart surgery, especially coronary artery bypass grafting (CABG), is rapidly becoming a routine form of treatment. It is estimated that over 355,000 patients underwent CABG in the United States in 1999 (American Heart Association, 2001). Although CABG reduces symptoms and improves quality of life for many patients, the experience exerts a psychological toll on patients and their families, both preoperatively and during postoperative recovery (Kulik & Mahler, 2002). The CABG patient population has been expanding to include more elderly and female patients and more patients with a high-risk profile. A study of over 1 million U.S. patients showed that the mean age of CABG patients increased from 63.7 in 1990 to 65.1 in 1999 (Ferguson et al., 2002). It also showed an increase in the proportion of CABG patients who are female (25.7% in 1990 compared with 28.7% in 1999) and who have a history of smoking, multiple comorbid conditions, and more serious heart disease (Ferguson et al., 2002).

Social and psychological factors have been implicated as possible contributors to adaptation in CABG patients. Perceived social support (Kulik & Mahler, 1993) and sharing a hospital room with another heart surgery patient (Kulik & Mahler, 1987) have been found to predict outcomes such as emotional adjustment. Dispositional optimism (Scheier et al., 1989) and low hostility (Jenkins, Jono, & Stanton, 1996) also may have beneficial effects in heart surgery patients. Depressive symptoms may have a negative impact (Jenkins et al., 1996), and major depression predicts cardiac events at 12 months following CABG (Connerney, Shapiro, McLaughlin, Bagiella, & Sloan, 2001).

The main purpose of this study was to examine religiousness as an additional psychosocial factor that may influence adaptation to heart surgery. Religiousness, or religious involvement, refers to subjective attributes, such as belief in religious doctrine, and behaviors, such as praying and attending religious services. Religiousness has been conceptualized and measured independently of affiliation with a particular religion or sect. The brush with death associated with heart surgery may increase the salience of religious and spiritual beliefs common to many religions, such as those involving the existence of God or an afterlife (Feher & Maly, 1999). These beliefs, in addition to religious activities such as prayer and participation in religious services, may provide patients with comfort and a means of coping (Pargament, 1997). It is surprising to note that religiousness has received little attention in research on heart surgery patients. Saudia, Kinney, Brown, and Young-Ward (1991) found that 96 of 100 CABG patients reported using prayer to cope with the stress of imminent surgery; 70 gave prayer the highest possible rating for coping effectiveness. Oxman, Freeman, and Manheimer (1995) linked a presurgical measure of feelings of religious strength and comfort to a lower rate of

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12-month mortality in CABG patients. Ai, Dunkle, Peterson, and Bolling (1998) found lower levels of depression among 1-year survivors of CABG who engaged in private prayer.

Research on religiousness in heart surgery patients is part of a larger body of work examining religion in relation to a broad range of physical health outcomes (Koenig, McCullough, & Larson, 2001). A recent review suggested that various indicators of religious involvement are associated with lower risk of all-cause mortality in large population studies (McCullough, Hoyt, Larson, Koenig, & Thoresen, 2000). In research in medical settings, religious coping has predicted better adjustment in kidney transplant patients and their significant others (Tix & Frazier, 1998). It also has been reported that religious and/or spiritual beliefs are maintained or enhanced following diagnosis of breast cancer, providing patients with a potential resource for coping with the health crisis (Feher & Maly, 1999).

Researchers have only recently begun to address questions regarding processes that may explain effects of religiousness on health outcomes. Potential psychosocial mediators include supportive social networks. For many, religious affiliation creates social ties to clergy, fellow congregation members, and religious groups and programs, all of which may facilitate adaptation to stressors. Ellison and George (1994) and Bradley (1995) found that frequent attendance at religious services is associated with significantly larger social networks, more in-person and phone contacts, and greater perceived quality of support. Siegel and Schrimshaw (2002) reported that older HIV/AIDS patients derived a sense of meaning and community from their religious and spiritual beliefs. Research also suggests that health effects of religiousness might be mediated by expectations regarding future outcomes. For example, Ai, Peterson, Bolling, and Koenig (2002) reported that private prayer during the period prior to CABG was associated with higher levels of optimism on the day before the procedure. Social ties, positive expectations, and other psychosocial correlates of religious involvement are plausible determinants of behavioral and biological processes that influence recovery from heart surgery (Contrada, Leventhal, & Anderson, 1994; Kiecolt-Glaser, Page, Marucha, MacCallum, & Glaser, 1998).

In the United States, surveys consistently find that women and older respondents attend religious services more often and also consider religion to be more important in their lives by comparison with men and younger individuals (Gallup, 1996). It follows that gender, age, and religious involvement should be examined together in research on adaptation to heart surgery. In addition to the possibility of overlapping main effects, gender and age may moderate the effects of religiousness on outcomes. That is, if female and older patients are more accustomed to using religion as a coping resource, a given level of religious involvement may have a greater impact on health in these individuals.

The present study examined the effects of religious involvement and other psychosocial factors on short-term adaptation to heart surgery. Psychosocial interviews conducted about a week prior to surgery assessed religious denomination and three dimensions of religiousness: attendance, prayer, and beliefs. They also measured dispositional optimism, social support, depressive symptoms, and trait hostility. Adaptation to surgery was assessed by measuring hospital length of stay (LOS) and incidence of postoperative complications. Initial analyses were designed to identify predictors of LOS or complications, and to determine whether psychosocial or biomedical correlates of religiousness mediated its association with either outcome. Further analysis examined postoperative complications as a mediator of associations linking predictors to hospital LOS. We also examined religious involvement in relation to religious denomination, gender, and age to determine whether these factors had effects that were masked or mediated by degree of religiousness, and to evaluate possible moderator effects in which the impact of religiousness varied as a function of religious denomination, gender, or age.

Method

Participants

Participants were a convenience sample of 142 patients scheduled for heart surgery at the Robert Wood Johnson University Hospital in New Brunswick, New Jersey, from 1996 to 1998. All patients for whom research staff were available to conduct recruitment were considered eligible for participation unless they were non–English speaking or had neuropsychological or psychiatric conditions that would interfere with interviewing. Patients were approached whether they were scheduled for CABG, valve surgery, or both, given similarities in procedure (e.g., cross-clamp and anesthesia protocol) and course of physical and psychological recovery (Jenkins et al., 1996).

Procedure

In cases in which heart surgery was elective, participating surgeons described the study at an outpatient consultation visit. Patients were recruited and interviewed subsequently on returning to the hospital for preadmission testing. For urgent and emergent surgery patients, surgeons described the study at the hospital, and recruitment and interviewing were conducted bedside later on the same day. For all patients, the study was characterized as an investigation of social and psychological aspects of undergoing heart surgery. Graduate research assistants described the study's purposes and procedures, obtained written informed consent, and conducted the interviews. Interviewing took place an average of 6.5 days prior to surgery. A research assistant blind to psychosocial data reviewed hospital charts.

Measures

Interview. Demographic data obtained by interviewers included age, gender (coded 0 = *male*; 1 = *female*), ethnicity, marital status (coded 0 = *divorced, widowed, separated, never married*; 1 = *married*), and education (in years). Religious denomination was measured with an open-ended question. For other items, answers were obtained using response cards with numbered response options.

There were three measures of religious involvement. These included single-item measures of the frequency of religious attendance and private prayer, and a five-item measure of religious beliefs. Participation in public religious services, prayer, and adherence to shared beliefs derived from scripture are nearly universal forms of involvement in religion and spirituality.

Responses to the attendance item ("How often do you attend religious services?") were made on a 0–5-point scale (0 = *never,* 1 = *1–2 times/year,* 2 = *3–10 times/year,* 3 = *1–2 times/month,* 4 = *once/week,* and 5 = *more than once/week*). Responses to the prayer item ("How often do you privately pray or meditate?") also were made on a 0–5-point scale (0= *never,* 1 = *occasionally,* 2 = *several times/week,* 3 = *once/day,* 4 = *twice/day,* 5 = *3 or more times/day*).

Religious belief items were selected from a variety of sources (Hoge, 1972; National Opinion Research Center, 1998) to represent subjective, intrinsic religiosity (Allport & Ross, 1967). Participants used a 0–4-point

Likert-type scale (0 = *strongly disagree*, 1 = *disagree*, 2 = *not sure*, 3 = *agree*, 4 = *strongly agree*) to indicate the degree to which they agreed with the following statements: "I believe in a divine being who watches over me and to whom I am accountable," "I believe in life after death," "I feel responsibility for reducing pain and suffering in the world," "I strongly adhere to doctrines and teachings," and "Faith shapes my actions every day." Regarding the first three items, virtually all religious denominations share a belief in a divine being and afterlife and promote compassion for those less fortunate. The last two items assess the strength and salience of whatever religious beliefs the respondent holds and therefore are also widely applicable. Principal-components analysis indicated that the items reflect a single dimension (eigenvalue = 2.85) accounting for 57% of the variance and defined by item loadings that ranged from .62 to .85. Remaining eigenvalues ranged from 0.31 to 0.73. Cronbach's alpha for the belief scale was .80.

Depressive symptoms were assessed with the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), a commonly used measure of cognitive, affective, behavioral, and somatic manifestations of depression. There is evidence that depressive symptoms identify patients at risk for negative outcomes at various stages in the development and course of cardiovascular disease (Barefoot & Schroll, 1996; Frasure-Smith, Lesperance, & Talajic, 1993, 1995), including recovery and adaptation following heart surgery (Jenkins et al., 1996). In the present study, patients' BDI scores ranged from 0 to 28 ($M = 7.5$, $SD = 6.19$; $\alpha = .83$).

Perceived social support was measured using the Multidimensional Scale of Perceived Social Support (Zimet, Dahlem, Zimet, & Farley, 1988), which has been used successfully in cardiovascular patient populations (Blumenthal, Burg, Barefoot, Williams, & Zimet, 1987). Social support has been linked to positive cardiovascular health outcomes (Brummett et al., 2001), including recovery from heart surgery (Kulik & Mahler, 1993). We used the Multidimensional Scale of Perceived Social Support total score, which reflects the degree to which the respondent perceives that support is available from friends, family, and a confidante. Scores in the present study ranged from 12 to 84 ($M = 71.3$, $SD = 12.47$; $\alpha = .93$).

Dispositional optimism was assessed using the Life Orientation Test—Revised (Scheier, Carver, & Bridges, 1994), which measures generalized expectancies for positive outcomes in life. Research suggests that dispositional optimism may facilitate recovery from heart surgery (Scheier et al., 1989). Scores in the present study ranged from 13 to 30 ($M = 22.3$, $SD = 3.37$; $\alpha = .65$).

The interview included Trait Hostility and Trait Anger subscales of the Buss and Perry (1992) Aggression Questionnaire. Anger-related attributes have been linked to cardiovascular morbidity and mortality (Miller, Smith, Turner, Guijarro, & Hallet, 1996) as well as to outcomes reflecting adaptation following heart surgery (Jenkins et al., 1996). Because scores for the two Buss–Perry scales were highly correlated ($r = .67$), they were averaged together to create a single trait–hostility measure. Patients' scores ranged from 15 to 64 ($M = 33.0$, $SD = 12.15$), and $\alpha = .90$.

Hospital chart data. Hospital charts were used to derive measures reflecting patients' medical condition and surgical treatment. For the main analyses, presurgical cardiovascular health was characterized in terms of history of prior heart surgery and left-main stenosis (each coded 0 = *absent*; 1 = *present*). Other aspects of patients' health status were represented using a comorbidity index constructed as a count of the following conditions: peripheral vascular disease ($n = 13$), chronic obstructive pulmonary disease ($n = 13$), and diabetes ($n = 40$). Data were also available on renal disease, but this form of comorbidity was not present in the study sample. Surgical treatment variables were surgical status (coded 0 = *elective*, 1 = *urgent or emergent*), duration of anesthesia (in minutes), and number of grafts. Ancillary analyses were conducted for a subset of 138 patients for whom data were available on additional risk factors: hypertension, history of atrial fibrillation, current smoker (each coded 0 = *absent*, 1 = *present*) and number of vessels with greater than 70% stenosis.

Hospital charts also were used to obtain measures of the two dependent variables. Postoperative hospital LOS was measured (in days) from date of surgery to date of discharge. The hospital LOS following major surgery provides a multiply determined but useful index of physical recovery. Although influenced by institutional factors, LOS also reflects individual differences in the physical impact of surgical procedures and in medical and behavioral aspects of surgical recovery, and it provides an indication of health care use and associated costs.

The incidence of complications is a surgical outcome in itself and also one determinant of LOS. We created an index of postsurgical complications as a count of the following (incidence in study sample given in parentheses): atrial fibrillation (39), reoperation for bleeding (7), postoperative renal failure (4), irregular heartbeat (1), pneumothorax (3), pneumonia (2), stroke (2), and congestive heart failure (1). Data available on a set of additional complications indicated that these complications did not occur in the study sample (i.e., delirium, deep sternal wound infections, perioperative myocardial infarction, postoperative hypotension).

Results

Descriptive Data

Demographic and medical data are presented in Table 1. Of the participants, 81% (115) were men and 19% (27) were women. Patients ranged in age from 32 to 88, with a mean of 64.9 years. Women were slightly but nonsignificantly older than men. Patients were White (83.8%), Black (7.7%), Asian (4.9%), Hispanic (2.8%), or other (0.7%); married (76.8%), separated (0.7%), divorced (6.3%), widowed (12%), or never married (4.2%); and well educated ($M = 13.5$ years). Most underwent surgery on an elective basis (85.2%) and received isolated CABG (75.3%). With regard to biomedical outcomes, LOS ranged from 3 to 84 days, with a

Table 1
Descriptive Statistics

Variable and demographic	*n*	%	*M*	*SD*	Range
Age			64.9	10.6	32–88
Male	115	81	64.5	10.1	
Female	27	19	66.9	12.3	
Race/ethnicity					
White	119	83.8			
Black	11	7.7			
Asian	7	4.9			
Hispanic	4	2.8			
Other	1	0.7			
Marital status					
Married	109	76.8			
Separated	1	0.7			
Divorced	9	6.3			
Widowed	17	12.0			
Never married	6	4.2			
Education (years)			13.5	3.3	1–21
Surgical status					
Elective	121	85.2			
Urgent/emergent	21	14.8			
Type of surgery					
CABG	107	75.3			
Valve	20	14.1			
Both	15	10.6			
Complications			0.42	0.6	0–3
Length of stay (days)			7.47	8.1	3–84

Note. $N = 142$. CABG = coronary artery bypass grafting.

mean of 7.47. Scores on the complications index ranged from 0 to 3, with a mean of 0.42. Because LOS showed a positive skew in the present study, as would be expected (Marazzi, Paccaud, Ruffieux, & Beguin, 1998), a log transformation was performed to create a distribution more suitable for multiple regression analysis. Scores on the complications index also were skewed but to a lesser extent than was the case for LOS. Perhaps as a consequence, transformation had little effect on skewness for complications, and so the raw (untransformed) values were used in statistical analysis.

To evaluate sample representativeness, we examined data for the population of over 1,000 patients who underwent and survived elective CABG and/or valve surgery at the Robert Wood Johnson University Hospital from 1996 through 1998. Age in the larger population ranged from 28 to 92 years (M = 65.0 years, SD = 10.8). Of the patients, 71% were men and 29% were women; 89.1% were White, 4.2% were Black, 3.9% were Asian, 2.8% were Hispanic, and 0.1% were other. Postoperative LOS ranged from 3 to 218 days (M = 8.94, SD = 13.2) and the incidence of complications ranged from 0 to 6 (M = 0.46, SD = 0.7). These data suggest that our sample was demographically similar to the larger population from which they were drawn except for a somewhat greater proportion of male study patients. With regard to surgical outcomes, our sample fared somewhat better than did the larger population, and the LOS distribution was somewhat less skewed.

Religious Denomination and Religious Involvement

Patients reported that they were Christian (n = 119, 83.8%), including 75 who were Roman Catholic (52.8%), 40 who were Protestant (28.2%), and 4 who were Eastern Orthodox (2.8%); were Jewish (n = 12, 8.5%); were Hindu (n = 4, 2.8%); or were of no religion (n = 7, 4.9%). One-way analyses of variance indicated significant differences among these groups on all three measures of religious involvement, Fs(5, 136) > 4.21, ps < .001. Patients with no religious affiliation reported the lowest levels of religious attendance, prayer, and beliefs (Ms = 1.4, 2.1, 2.9, respectively). Jewish patients also had low values on all three measures (Ms = 2.4, 2.6, 3.3, respectively), whereas Roman Catholics (Ms = 3.8, 3.7, 4.1, respectively) and Protestants (Ms = 3.7, 4.2, 4.3, respectively) reported greater religious involvement.

Associations Between Religiousness and Other Predictors

Table 2 presents intercorrelations of religious and other psychosocial measures. Coefficients ranging from .41 to .50 indicated that religious attendance, prayer, and beliefs were related but separable. Correlations among the other psychosocial factors also indicated relationships of moderate magnitude. The strongest association was between dispositional optimism and (low) trait hostility (r = −.56). Remaining coefficients were smaller (rs = −.37 to .43) and reflected significant relationships in expected directions. Of greater relevance to the purposes of this study were significant correlations of very modest magnitude linking stronger religious beliefs to higher levels of social support (r = .20), greater dispositional optimism (r = .20), fewer depressive symptoms (r = −.17), and less trait hostility (r = −.25) and correlations indicating no significant relationships between either religious attendance or prayer and the psychosocial factors (rs = −.16 to .14, *ns*). These data indicate a degree of independence between religiousness and other psychosocial factors, permitting each to have unique effects on outcomes.

We also examined associations between religiousness and demographic factors. Older age was modestly but significantly positively correlated with greater attendance (r = .18, p < .05) and stronger beliefs (r = .19, p < .05), but not with more frequent prayer (r = .12, *ns*). Women reported more frequent prayer than did men (Ms = 4.56 and 3.39, respectively; p < .001). There were no gender differences for attendance or beliefs, nor was marital status or education related to any of the religiousness measures (p > .20).

Further analysis revealed little evidence of associations between religiousness and biomedical predictors. The only significant relationship was a small, inverse association between attendance and number of grafts (r = −.19, p < .05). The religiousness measures were unrelated to anesthesia time, surgical urgency, history of cardiac surgery, presence of left-main stenosis, and comorbidity (ps > .18).

Prospective Associations With Surgical Recovery

We used multiple regression analysis (Cohen & Cohen, 1983) to identify significant predictors of postoperative LOS and surgical

Table 2
Correlations of Psychosocial and Religious Variables

Measure	1	2	3	4	5	6	7
Psychosocial variables							
1. Depressive symptoms	—	−.37	−.24	.43	−.16	−.02	−.17
2. Dispositional optimism		—	.29	−.56	.05	.03	.20
3. Perceived social support			—	−.27	.14	.11	.20
4. Trait hostility				—	−.14	−.13	−.25
Religious variables							
5. Attendance					—	.41	.49
6. Prayer						—	.50
7. Beliefs							—

Note. Coefficients with an absolute value greater than or equal to .17 are significant at p < .05.

complications. Initially, the two dependent measures were examined separately. For each, we first evaluated a main effects model constructed by entering four sets of predictors in the following sequence:

1. demographics (age, gender, marital status, and education),[1]
2. biomedical factors (number of grafts, duration of anesthesia, surgical urgency, previous heart surgery, left-main stenosis, and comorbidity),
3. psychosocial factors (depressive symptoms, dispositional optimism, perceived social support, and trait hostility), and
4. religiousness (attendance, prayer, and beliefs).

Results were examined at each step in view of the likely causal priority of the earlier predictor sets and as a means of identifying possible mediational pathways. However, the final estimate for each predictor was based on results obtained at Step 4, with simultaneous control of all other predictors. Analyses then were conducted to determine whether the incidence of complications influenced LOS and whether in doing so it mediated effects of the predictors on LOS. We then added religious denomination to the analysis to determine whether it predicted LOS and complications, either as a main effect or in interaction with the three measures of religiousness. Finally, we tested interaction terms to determine whether any significant main effects were qualified by gender or age.

Main effects model for postoperative hospital LOS. The main effects analysis of LOS is summarized in Table 3. Demographic factors entered in Step 1 of the analysis accounted for 10.8% of the variance ($p < .01$). Significant effects for age and gender indicated that older patients had longer postoperative hospital stays than younger patients, and female patients had longer postoperative hospital stays than male patients ($ps < .05$). Entry of the biomedical predictors in Step 2 accounted for an additional 8.5% of the variance ($p < .05$). Only anesthesia time showed a significant, independent relationship with hospital LOS ($p < .001$), with longer anesthesia times predictive of longer hospital LOSs. Entry of biomedical predictors did not alter results for demographic factors. The psychosocial predictors entered in Step 3 accounted for an additional 5.8% of the variance ($p < .05$). The only significant effect was for depressive symptoms, with higher BDI scores derived from the preoperative baseline interview predicting longer hospital LOSs ($p < .05$). As with biomedical predictors, entry of psychosocial factors had no effect on results for variables entered in earlier steps. Entry of religious involvement measures in Step 4 accounted for an additional 6.1% of the variance ($p < .05$). Significant effects emerged for the preoperative measures of attendance and beliefs. Patients who reported more frequent attendance at religious services subsequently had longer postoperative hospital LOSs ($p < .01$). Results for beliefs indicated shorter postoperative hospital LOSs among patients with higher scores on the religious beliefs scale ($p < .05$). Thus, both beliefs and attendance were prospectively associated with LOS, but in opposite directions, with stronger beliefs predicting shorter hospital LOSs, and more frequent religious attendance predicting longer hospital LOSs. Once again, the effects for predictors entered in earlier steps remained unaltered.

Table 3
Regression Analysis for Length of Hospitalization (in Log Days)

Predictor set and individual predictor	ΔR^2 for step	β (full model)	β (trimmed)
1. Demographics			
Age		.269**	.268**
Gender (female)		.202*	.146†
Marital status (married)		.042	
Education (years)	.108**		
2. Biomedical variables		.101	
No. of grafts		−.031	
Anesthesia time		.280***	.245**
Surgical urgency		.052	
Previous surgery		−.015	
Left main stenosis		−.024	
Comorbidity index	.085*	.118	
3. Psychosocial variables			
Depressive symptoms		.206*	.217**
Dispositional optimism		−.002	
Perceived social support		.100	
Trait hostility	.058*	.092	
4. Religious involvement			
Attendance		.268**	.255**
Prayer		−.081	
Beliefs	.061*	−.214*	−.233**
Model R^2		.311*	.274*

Note. Betas are taken from Step 4 and reflect independent effects controlling for all other predictors.
† $p < .10$. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

The model that resulted from entering all four sets of main effects (see Table 3, full model) was subsequently trimmed to determine whether overparameterization (i.e., a high ratio of predictors to cases) had inflated statistical significance. All predictors were removed except for the six involved in significant effects at $p < .05$ or better. In the resulting trimmed model, the standardized regression coefficients showed no change in sign and very little change in magnitude (see Table 3, trimmed). Moreover, only in the case of gender did an association that was statistically significant in the full model fall short of statistical significance in the trimmed model ($p = .056$).

That successive entry of predictor sets had no impact on effects for variables entered in prior steps is consistent with the bivariate associations reported earlier indicating little intercorrelation among predictors. It also addresses hypotheses regarding mediational pathways. Because age and gender effects remained undiminished on subsequent entry of the remaining predictors, it can be concluded that those effects were not mediated by biomedical, psychosocial, or religiousness factors (Baron & Kenny, 1986). Similarly, because the effect of anesthesia time when initially entered was unchanged in subsequent steps in the analysis, there

[1] Race/ethnicity was not included as a predictor in the main analyses because the vast majority (83.8%) of study patients were White. Coding each of the remaining groups separately would have required either the use of four dummy variables to represent very small groups or the creation of a smaller number of arbitrary categories.

was no evidence of overlap between that effect and those for depressive symptoms or religious involvement. The situation for psychosocial factors was the same. The effect for depressive symptoms when initially entered was virtually identical to that obtained in the full model. This indicates that religious involvement did not mediate effects of depressive symptoms.

The possibility remains, however, that biomedical or psychosocial factors partially mediated effects of religious involvement. Under this set of hypotheses, effects for the religiousness predictors would be stronger if assessed prior to entering other predictors (Baron & Kenny, 1986). In addition, although demographics almost certainly did not mediate effects for religious involvement (religion cannot affect age or gender and there was no effect of marital status or education on LOS), it is possible that main effects for demographic and religiousness variables overlapped statistically given small but significant associations linking age and female gender to religiousness measures. Additional analysis ruled out both sets of possibilities. Effects for the three religious involvement variables remained unaltered when they were entered prior to demographic, biomedical, and psychosocial predictors.

Data for a subset ($n = 138$) of patients were reanalyzed, adding to the full main effects model current smoking status and extent of coronary artery disease, two potential predictors of LOS (Peterson et al., 2002) that were not available for the full sample. Race/ethnicity (0 = *White*, 1 = *other*) also was included in view of evidence that White people may have shorter hospital days than people of other groups (Peterson et al., 2002). None of these variables was significantly associated with LOS ($ps > .12$), nor did their inclusion in the model alter results for other predictors obtained in the main analysis summarized in Table 3, producing virtually no change in regression coefficients or p values.

Main effects model for postoperative complications. The main effects analysis for postoperative complications is summarized in Table 4. As a set, demographic factors entered in Step 1 of the analysis accounted for a nonsignificant 4.1% of the variance. However, a significant effect for age ($p < .01$) indicated that older patients had a greater incidence of complications than younger patients. The sets of biomedical and psychosocial factors entered in Steps 2 and 3 contributed little explained variance ($\Delta R^2 = .027$ and .028, respectively, *ns*), and none of the individual predictors showed a statistically significant association with complications. However, entry of religious involvement measures in Step 4 accounted for an additional 6.6% of the variance ($p < .05$). A significant effect emerged only for the preoperative measure of beliefs, reflecting a lower incidence of complications among patients with higher scores on the religious beliefs scale ($p < .01$).

As with postoperative LOS, the full main effects model for complications was subsequently trimmed by eliminating nonsignificant predictors. The regression coefficients for age and religious beliefs were only slightly reduced in magnitude, and remained statistically significant ($ps < .01$). Also as with LOS, there was no evidence of mediation or other forms of overlap in the effects for the 4 sets of predictors. Significant effects for age and religious beliefs, and nonsignificant effects for other predictors, were unaffected by the sequence in which these variables were entered into the model.

A subsequent analysis examined the single outcome of atrial fibrillation separately, given that it was the most frequent form of complication in the sample ($n = 39$). Logistic regression analysis was used to accommodate the dichotomous nature of this outcome. It was conducted using data for the subset ($n = 138$) of patients for whom information was available on additional risk factors that included history of atrial fibrillation and hypertensive status, two possible predictors of postoperative atrial fibrillation (Maisel, Rawn, & Stevenson, 2001) not available for the full sample. When these two variables were added to the full main effects model that had been used to analyze the complications index, neither was significantly associated with postoperative atrial fibrillation ($ps > .40$). Their inclusion did not alter results obtained for other predictors, which were virtually identical to those summarized in Table 4, except for a trend in which postoperative atrial fibrillation was more frequent among more hostile patients ($p = .091$).

Complications as a mediator of religiousness effects on LOS. Postoperative complications are an important determinant of LOS in surgery patients. It is therefore possible that the impact of age and religious beliefs on LOS was mediated by their effects on complications. This hypothesis was addressed using procedures described by Baron and Kenny (1986). The bivariate correlation between complications and LOS was consistent with this line of thought ($r = .51$, $p < .001$). When the complications index was added to the main effects analysis (full model) for LOS, it was found to be a significant independent predictor of LOS ($\beta = .434$, $p < .001$). After complications was entered, the effect for religious beliefs was eliminated, reduced from $\beta = -.214$ ($p < .05$) to $\beta = -.074$ (*ns*), indicating that the effect of religious beliefs on LOS was mediated by the effect of beliefs on complications. In addition, the effect for age was reduced from $\beta = .269$ ($p < .01$) to $\beta = .161$ ($p < .05$), indicating that the relationship between age and LOS was partially mediated by the effect of age on complications.

Table 4
Regression Analysis for Postoperative Complications

Predictor set and individual predictors	ΔR^2 for step	β (full model)	β (trimmed)
1. Demographics			
Age		.250**	.229**
Gender (female)		.067	
Marital status (married)		.050	
Education (years)	.041		
2. Biomedical variables		.013	
No. of grafts		−.008	
Anesthesia time		.055	
Surgical urgency		.116	
Previous surgery		−.074	
Left main stenosis		.074	
Comorbidity index	.027	−.060	
3. Psychosocial variables			
Depressive symptoms		.141	
Dispositional optimism		.048	
Perceived social support		.151	
Trait hostility	.028	.021	
4. Religious involvement			
Attendance		.043	
Prayer		.116	
Beliefs	.066*	−.324**	−.227**
Model R^2		.162	.084**

Note. Betas are taken from Step 4 and reflect independent effects controlling for all other predictors.
* $p \leq .05$. ** $p \leq .01$.

Adding complications had virtually no impact on effects of other LOS predictors (gender, anesthesia time, depressive symptoms, or religious attendance), as was expected given that these factors were not predictive of complications.

To evaluate more directly the pathway whereby strength of religious beliefs influenced LOS through its association with complications, we used a statistical test described by Baron and Kenny (1986). This involves computing the cross product of the two regression coefficients and dividing it by an appropriate error term, which generates a Z score. For the present data, $Z = 2.75$ ($p < .01$). This indicates that the relationship linking the religious beliefs measure to LOS through its effect on complications was statistically significant. A similar analysis for the pathway linking older age to longer hospital stays through its effect on complications also yielded a significant effect, $Z = 2.49$ ($p < .05$).

Religious denomination. Next we examined religious denomination as a predictor of LOS and complications. Denomination was represented in this analysis through the use of dummy codes (Cohen & Cohen, 1983). Entry of these dummy codes into the regression model summarized in Tables 3 and 4 (full models) generated no evidence of a main effect of religious denomination for either outcome. The same result was obtained whether denomination was entered as the first or last step of the analysis.

We then sought to determine whether religious denomination interacted with any of the religiousness measures. Following procedures described by Aiken and West (1991), we centered the data and constructed product terms to represent interactions between denomination and each measure of religious involvement. Dummy codes representing main effects of religious denomination, and the product terms, were added to the full main effects models described in Tables 3 and 4. There was no significant Denomination × Religiousness interaction for either dependent measure. This issue was examined further by estimating the religiousness main effects for LOS and complications separately in Catholic and Protestant patients, the two largest religious subgroups. Regression coefficients obtained separately within the two groups were highly similar to each other and to those for the full sample.

Gender- and age-related interactions. Subsequent analyses were conducted to determine whether religiousness effects were qualified by gender or age and whether there was an Age × Gender interaction for either dependent measure. As with religious denomination, this was done using centered data and product terms representing relevant interaction effects. In separate analyses for LOS and complications, we added product terms in a single step to the full main effects models summarized in Tables 3 and 4.

For LOS, this analysis revealed significant Gender × Attendance and Gender × Beliefs interactions at $p < .05$. A plot of the Gender × Attendance effect is presented in Figure 1. It can be seen that this interaction qualified the attendance main effect described earlier in that the positive association between preoperative attendance at religious services and postoperative hospital LOS was significantly stronger among female patients than it was among male patients. Predicted values in log days for women with high and low attendance scores correspond to 10.0 and 5.5 when converted to raw days by computing their antilogs. Corresponding values for men were 6.5 and 5.6.

A plot of the Gender × Beliefs effect is presented in Figure 2. This interaction qualified the beliefs main effect described earlier. By comparison with men, women showed a significantly stronger inverse association between scores on the religious beliefs scale and postoperative hospital LOS. Predicted values in log days for women with high and low belief scores correspond to 5.6 and 10.0 when converted to raw days by computing their antilogs. Corresponding values for men were 5.7 and 6.5. Thus, although effects of attendance and beliefs were in opposite directions, both were more important predictors of LOS among women than they were

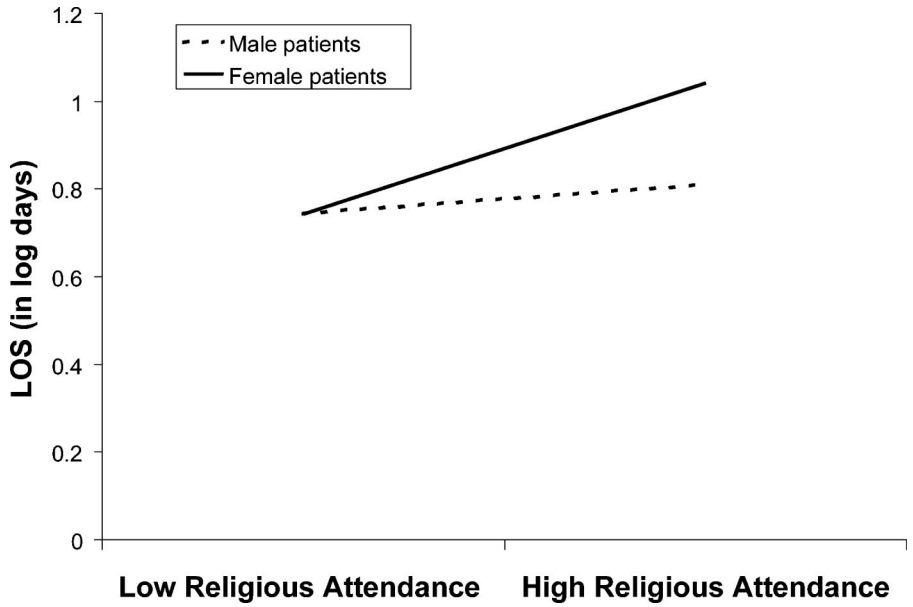

Figure 1. The interaction of gender and religious attendance for length of stay (LOS) is depicted using coefficients from the regression analysis. Predicted values of LOS are plotted for male and female patients one standard deviation above or below the mean for religious attendance.

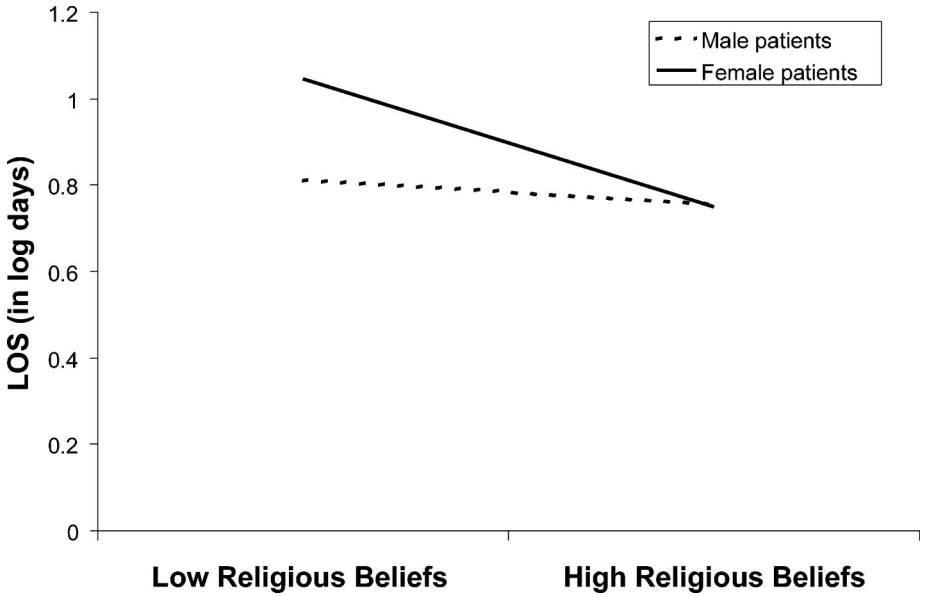

Figure 2. The interaction of gender and religious beliefs for length of stay (LOS) is depicted using coefficients from the regression analysis. Predicted values of LOS are plotted for male and female patients one standard deviation above or below the mean for religious beliefs.

among men. The Gender × Prayer and Gender × Age interactions were not significant, nor were any interactions between age and religiousness.

For postoperative complications, examination of interactions revealed a marginal Age × Beliefs effect ($p = .067$). The form of this trend was such that the inverse association between religious beliefs and the incidence of postoperative complications was stronger among older patients than among younger ones. None of the remaining interactions between age and religious involvement were significant, nor were there interactions between gender and religiousness or gender and age.

Discussion

Results of this study indicate that religious involvement may influence adaptation to heart surgery. Stronger religious beliefs were associated prospectively with fewer surgical complications and shorter hospital stays. Unexpectedly, more frequent religious attendance was associated with longer hospital stays, rather than shorter ones, and frequency of prayer had no effect on recovery. Higher levels of depressive symptoms assessed prior to surgery also predicted longer hospital stays. These results were obtained while controlling statistically for demographic and biomedical factors, as well as for perceived social support, dispositional optimism, and trait hostility, which were unrelated to recovery. Controlling for surgical complications eliminated the effect of religious beliefs on LOS, suggesting a mediational pathway in which religious beliefs influenced LOS through their effects on complications. Older age predicted greater LOS, an association that was partially mediated by increased risk of complications. It also was found that effects of religious beliefs and attendance on LOS were stronger among women than among men.

Perhaps the clearest and most noteworthy finding was evidence that patients with stronger religious beliefs had fewer complications and shorter LOS, with the effect on complications mediating the effect on LOS. These results are consistent with previous findings linking various aspects of religiousness and spirituality to a variety of positive health outcomes (Koenig et al., 2001). Those findings include associations with cardiovascular outcomes, some of which were observed in heart surgery patients (Harris et al., 1995; Oxman et al., 1995). However, to our knowledge, this is the first published report of an association with indicators of recovery from heart surgery.

Although not specifically anticipated, data suggesting that religious attendance was associated with poorer recovery (longer hospital stays) are not entirely without a basis in the literature. Pargament, Koenig, Tarakeshwar, and Hahn (2001) found that, among older inpatients, those whose self-reports indicated a struggle with religious faith showed greater risk of mortality. Responses such as "wondered whether God had abandoned me" or "questioned God's love for me" carried excess 2-year mortality risks after adjustments for demographics and physical and mental health. Thus, certain forms of religious involvement may characterize medical patients who will later experience negative health outcomes.

In addition to suggesting that religiousness can have adverse effects on health, the present findings are notable in providing evidence of both positive and negative effects within the same study. These data encourage consideration of the common and distinctive aspects of indicators such as religious beliefs and religious attendance. Common elements are implied by their significant, positive correlation ($r = .49$). For some patients, strong religious beliefs and frequent attendance at services may constitute an integrated pattern of religious involvement, with low levels of

belief and attendance in other patients reflecting a similarly integrated pattern of relative noninvolvement. However, the magnitude of the relationship also allows the existence of discordant patterns of religious involvement. Some patients believe (in a divine being, an afterlife, etc.) but do not attend services regularly. For others, regular religious attendance is not accompanied by strongly held religious beliefs.

To explore this distinction, we conducted an additional analysis in which the two religiousness measures were entered separately into the regression model for LOS, rather than simultaneously as they had been in the main analysis. Results indicated that associations linking religious beliefs and attendance to LOS were in evidence only when both predictors were in the model, that is, when each variable was residualized with respect to the other. This means that the association between attendance and LOS reflected longer hospital LOSs in individuals whose frequency of religious attendance exceeded that predicted by the strength of their religious beliefs relative to those whose attendance was less frequent than would be expected on the basis of their beliefs. Similarly, religious beliefs predicted shorter hospital LOSs in individuals whose beliefs were strong relative to their attendance by comparison with those in whom beliefs were not as strong as would be predicted from their attendance.

For higher attendance rates to predict greater LOS only when residualized for beliefs suggests that attendance had a negative health effect when it was motivated by factors other than religious faith. This possibility is reminiscent of Gordon Allport's notion of an extrinsic (vs. intrinsic) religious orientation (Allport & Ross, 1967). Similarly, shorter hospital stays associated with the residualized belief measure may have reflected effects of intrinsic religiousness, that is, patients' private, personal religiousness, independent of their public practice of religion. Thus, the present data for LOS provide a parallel with evidence that religious orientations similar to those described by Allport have differential effects on mental health and well-being, with positive effects for internalized religious beliefs, and negative effects where religiousness is motivated, in part, by extrinsic factors such as desire for others' approval (Ryan, Rigby, & King, 1993).

Another finding that deserves further examination is the absence of either positive or negative effects of prayer. Previous work has suggested that prayer has a positive effect on health outcomes, perhaps operating as a coping response that ameliorates stress and its physiologic impact (e.g., Pargament, 1997). One factor that may have worked against obtaining such an effect in the present study is that patients were asked simply about the frequency with which they prayed, rather than about their use of prayer to cope with stress, either as a general practice or specifically in response to impending surgery. Thus, prayer was assessed as an ongoing behavior pattern, not a coping style or strategy. Although frequency of prayer as measured in the present study has been linked to positive health outcomes (e.g., Koenig et al., 1998), the association may be stronger for prayer that reflects coping.

Psychosocial attributes not explicitly related to religion showed a coherent pattern of intercorrelations among themselves and in relation to religious beliefs. Statistically significant, albeit modest, correlations indicated that stronger religious beliefs were associated with greater optimism, lower levels of hostility and depressive symptoms, and high levels of perceived social support. Comparable associations have been obtained previously (e.g., Koenig, 1998). That religious attendance and prayer stand apart from this pattern underscores the point discussed above regarding the potential for discordance in the meaning and health relatedness of different forms of religious involvement.

More germane to the purposes of this study were findings indicating that religiousness predicted surgical recovery with statistical control of other psychosocial factors. This observation encourages further work on possible independent effects of religion on health. It accords with previous research showing that religious involvement can predict health outcomes following adjustments for factors such as social support (McCullough et al., 2000). The independent effect for depressive symptoms is consistent with accumulating evidence linking depression to a variety of negative physical health outcomes, including several related to cardiovascular disease (Barefoot & Schroll, 1996) and adaptation following health crises, such as acute myocardial infarction (Frasure-Smith et al., 1993, 1995) or heart surgery (Jenkins et al., 1996; Scheier et al., 1999). However, on the basis of previous research involving cardiovascular outcomes, dispositional optimism (Scheier et al., 1989; Scheier et al., 1999), trait hostility (Barefoot, Larsen, von der Lieth & Schroll, 1995), and perceived social support (Kulik & Mahler, 1993) also were expected to predict the course of surgical recovery. It is possible that failure to obtain such effects in the present study is attributable to factors related to measurement, statistical power, or choice of outcome variables. Of these possibilities, timing of assessment may warrant particular attention given the changing series of adaptive tasks that heart surgery patients confront (Contrada et al., 1994). Had social psychological factors been assessed following hospital admission in the present study, they may have predicted surgical recovery (cf., Kulik & Mahler, 1987) and thereby mediated effects of presurgical religious involvement. With regard to optimism, effects might have been detected had we assessed behavioral aspects of recovery during the postoperative hospital LOS (Scheier et al., 1989), or rehospitalization following discharge (Scheier et al., 1999).

Consistent with expectations, there was evidence that gender moderated the effects of religious involvement on surgical recovery. The inverse association between religious beliefs and LOS was significantly stronger among women than among men. In this respect, female patients in the present study appear to have benefited more from one form of religious involvement than did male patients. However, the association of more frequent religious attendance with longer hospital stays also was stronger among women than among men. Both interactions are consistent with the general proposition, suggested by survey data reviewed earlier, in which religion is of greater importance to women than to men (e.g., Gallup, 1996). Nonetheless, the fact that they were directionally opposite is noteworthy. By contrast with the attendance finding, it is the interaction involving religious beliefs that specifically accords with previous research indicating that religiousness has stronger health-promoting effects in women than in men (Koenig et al., 1999; Strawbridge, Cohen & Shema, 2000).

Evidence that age moderated the effects of religiousness was confined to a nonsignificant trend ($p < .07$). It suggested that the association between stronger religious beliefs and fewer surgical complications was slightly larger among older patients. This trend was observed in the context of fairly robust main effects indicating that older age was associated with longer hospital LOSs and a

greater incidence of complications independently of (other) demographic, biomedical, and psychosocial predictors.

Mechanisms that have been studied in relation to other psychosocial factors may explain associations between religiousness and surgical recovery. The relationships of religious beliefs with postsurgical complications and LOS may reflect psychophysiological processes whereby beliefs influence biological activity. Specifically, religious beliefs may influence cognitive appraisal and/or coping processes that are activated by impending surgery and during the postsurgical period. These processes, in turn, may modulate neuroendocrine, autonomic, and immunological activity, and this may facilitate recovery (Kiecolt-Glaser et al., 1998). Alternatively, effects of beliefs on biological factors may have involved processes less proximal to the surgical episode. Longstanding adherence to religious doctrine may have facilitated the accrual of health benefits not captured by our biomedical control variables that nonetheless buffered the impact of heart surgery. Although possible direct and indirect causal effects of religious beliefs may involve biological influences on the incidence of complications and LOS, behavioral processes also may play a role. Surgical recovery is substantially a matter of reacquiring the ability to ambulate and to perform daily activities despite pain and discomfort. It is possible that these accomplishments are motivated in some individuals by religious beliefs and commitments. Regarding the effect of depressive symptoms on postoperative LOS, the same types of biological and behavioral mechanisms may have been operating. Neuroendocrine, autonomic, and immunological correlates of depressed mood might explain slower recovery from major surgery, as might its cognitive, motivational, and behavioral concomitants (Carney, Freedland, Rich, & Jaffe, 1995).

Longer hospital stays in patients reporting more frequent religious attendance would seem to require consideration of additional mechanisms. One possibility that would accord with the extrinsic religiousness notion is that high attendance rates for those patients were accomplished despite, or even driven by, symptoms of poor health not captured by our measures. Consistent with this hypothesis, Koenig (1998) found that over 50% of medically ill older adults attended services at least once a week, despite reporting an average of five active medical problems and nine impaired activities of daily living.

That religious attendance might have reflected presurgical health raises more general questions about methodological limitations. One set of considerations concerns the possible role of unmeasured biomedical risk factors. Data on history of atrial fibrillation and hypertension were available for only a subset of the patients. Both are possible risk factors for postsurgical atrial fibrillation (Maisel et al., 2001), which was the most frequently occurring complication in the study sample. Data for another possible risk factor for postsurgical atrial fibrillation, postoperative oxygen saturation (Svedjeholm & Håkanson, 2000), were not available for any of the study participants. Similarly, with regard to LOS, possible risk factors available for only a subset of patients were cigarette smoking and extent of coronary atherosclerosis, and possible risk factors not available for any of the study participants include aortic stenosis (Peterson et al., 2002) and glycosylated hemoglobin levels (Medhi et al., 2001). It should be noted that many risk factors have small effect sizes that achieve statistical significance only in very large samples (Peterson et al., 2002). Nonetheless, not all possible risk factors for complication and LOS were measured in this study, and this may account for the relatively weak relationships we observed for biomedical predictors.

Moreover, if unmeasured risk factors contributed to poor surgical recovery, and also had the effect of increasing religious attendance or weakening religious beliefs, they may have operated as confounds, bringing about spurious associations between religious involvement and surgical recovery. Under this hypothesis, the effect of religious beliefs on LOS was eliminated by controlling for complications because aspects of presurgical health not detected by biomedical predictors produced lower religious belief scores and greater susceptibility to complications. Similarly, depressive symptoms might have predicted LOS because they reflected underlying coronary disease or other aspects of physical health. Alternatively, instead of being influenced by them, religious involvement or depression may have influenced unmeasured risk factors. Under this hypothesis, the unmeasured risk factors may have been mediators of effects of psychosocial factors on surgical recovery rather than confounds.

Another set of methodological considerations concern sample size and representativeness. The sample was neither very large nor representative of the larger population of heart surgery patients at the Robert Wood Johnson University Hospital. Study patients fared somewhat better with regard to complications and LOS, and some serious complications (e.g., deep sternal wound infections) did not occur at all. Because of the relatively low rate of complications, only postoperative atrial fibrillation could be modeled as a separate outcome. That this was the case with a sample of 142 is not unusual, however, given that the incidence of these complications is also rather low in the larger population of surgery patients. For example, estimates of the rate of occurrence of deep sternal wound infections range from 1% to 4% (Eagle et al., 1999). Nonetheless, although relatively rare, deep sternal wound infections and other complications that did not occur in our sample are clinically important outcomes. That they were not experienced within our sample means that the findings we obtained may not generalize to higher risk patients who experience more serious forms of complication.

Conclusion

Associations of stronger religious beliefs with fewer complications and shorter hospital LOSs accord with previous findings, extending them for the first time to indicators of surgical recovery. Longer hospital LOSs for patients reporting frequent religious attendance is also a novel finding and may reflect extrinsic religiosity. Stronger religion effects in women than in men, longer hospital LOSs among patients reporting high levels of depressive symptoms, and the impact of older age on both outcomes, argue for a multivariate approach to understanding adaptation to heart surgery. Limitations of this study include use of a convenience sample, less-than-comprehensive assessment of biomedical risk factors, and the ambiguities of correlational research. However, a prospective design and biomedical outcomes are important strengths. Additional research is needed to replicate and extend these findings, and to examine multiple mechanisms that may explain positive and negative associations between separable facets of religiousness and various health outcomes.

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