Burden of Cardiovascular Risk Factors, Subclinical Atherosclerosis, and Incident Cardiovascular Events Across Dimensions of Religiosity: The Multi-Ethnic Study of Atherosclerosis

Matthew Feinstein; Kiang Liu, PhD; Hongyan Ning, MD, MS; George Fitchett, PhD; Donald M. Lloyd-Jones, MD, ScM

Background—Religious involvement has been associated with improved health practices and outcomes; however, no ethnically diverse community-based study has examined differences in cardiac risk factors, subclinical cardiovascular disease, and cardiovascular disease (CVD) events across levels of religiosity.

Methods and Results—We included 5474 white, black, Hispanic, and Chinese participants who attended examination 2 of the National Heart, Lung, and Blood Institute’s Multi-Ethnic Study of Atherosclerosis (MESA). We compared cross-sectional differences in cardiac risk factors and subclinical CVD and longitudinal CVD event rates across self-reported levels of religious participation, prayer/meditation, and spirituality. Multivariable-adjusted regression models were fitted to assess associations of measures of religiosity with risk factors, subclinical CVD, and CVD events. MESA participants (52.4% female; mean age, 63) with greater levels of religious participation were more likely to be female and black. After adjustment for demographic covariates, participants who attended services daily, compared with never, were significantly more likely to be obese (adjusted odds ratio 1.57, 95% confidence interval [CI] 1.12 to 1.72) but less likely to smoke (adjusted odds ratio 0.39, 95% CI 0.26 to 0.58). Results were similar for those with frequent prayer/meditation or high levels of spirituality. There were no consistent patterns of association observed between measures of religiosity and presence/extent of subclinical CVD at baseline or incident CVD events during longitudinal follow-up in the course of 4 years.

Conclusions—Our results do not confirm those of previous studies associating greater religiosity with overall better health risks and status, at least with regard to CVD. There was no reduction in risk for CVD events associated with greater religiosity. (Circulation. 2010;121:659-666.)

Key Words: religion ■ cardiovascular diseases ■ obesity

Religious involvement has consistently been associated with improved health practices and outcomes. Longitudinal and cross-sectional studies have found a lower prevalence of smoking1–4 and lower mortality rates1,5,6 among those who attend religious services frequently. Similarly, increased frequency of prayer has been associated with better self-reported health.7 Review articles and meta-analyses have corroborated this positive association between religiosity and general health status.8–10 Religiosity has also been associated with preventive healthcare use.11

Clinical Perspective on p 666

Studies on religiosity and cardiovascular morbidity and mortality have, likewise, suggested that religious attendance is associated with lower risk;6,12–15 however, analyses of the associations between religiosity and obesity have yielded different results. Some investigators have found no significant relationship between religiosity and obesity;2–6 whereas others have found a greater prevalence of obesity among people who are religious.3,4,17

Notable limitations exist in the sampling and methodology of previous studies on religiosity and health. Longitudinal analyses have tended to draw from geographically1,5,12–15 or demographically5,12–15 limited cohorts. Because many studies on religiosity and cardiovascular disease (CVD)–related mortality have drawn from relatively limited cohorts, their conclusions may not be generalizable beyond the geographical regions,13–15 age group,15 or religion13,14 analyzed therein. One longitudinal analysis6 that associated religiosity with lower all-cause and CVD-related mortality did draw from a nationally representative sample; however, the study did not assess the full spectrum of cardiovascular risk factors and did

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not measure subclinical atherosclerosis. Another limitation of
numerous studies is their measurement of religiosity in a
unidimensional manner.\textsuperscript{1,5,6,11,18} Despite general agreement
that religiosity is, in fact, a multidimensional construct.\textsuperscript{19–22}

The primary objective of this study was to examine associations between religiosity and health status across the
spectrum of cardiovascular health and disease. The multi-
center, geographically and ethnically diverse cohort of the
Multi-Ethnic Study of Atherosclerosis (MESA) offers an
opportunity to expand on the methodology of previous
studies with a larger, more nationally representative sample.
In MESA, religiosity was treated multidimensionally; reli-
gious participation, frequency of prayer or meditation, and
spirituality were examined separately as exposure variables.
Likewise, the extensive data available in MESA regarding
CVD risk factor burden, presence and extent of subclinical
atherosclerosis, and longitudinal CVD event rates provide a
unique opportunity to examine the potentially complex asso-
ciations between religiosity and CVD.

Methods

Study Participants

MESA is a National Heart, Lung, and Blood Institute–sponsored study
designed to examine the prevalence and progression of subclinical
atherosclerosis and its progression to overt CVD in a diverse,
population-based sample of 6814 men and women aged 45 to 84 years
at baseline who were free of clinical CVD. Study design, recruitment,
and procedures have been described in detail previously.\textsuperscript{23} Briefly, at
enrollment, the cohort was approximately 40% white, 30% African
American, 20% Hispanic, and 10% Asian (predominantly Chinese).
The cohort was recruited from 6 field centers and characterized
regarding presence and extent of CVD risk factors and selected
measures of subclinical CVD. Participants were then followed
longitudinally for reexamination and identification and characteriza-
tion of CVD events.

Religiosity

Religiosity was measured based on participant responses to a
questionnaire given at MESA examination 2 (which began in 2002).
Three dimensions of religiosity were measured: frequency of reli-
gious participation, frequency of prayer or meditation, and spiritu-
ality. Frequency of participation was determined by responses
(never, once or twice per year, monthly, weekly, or daily) to the
question: “How often do you attend religious services or otherwise
participate in organized religion?” Frequency of prayer or meditation
was determined by responses (never, once or twice per year,
monthly, weekly, or daily) to the question: “Within your religious or
spiritual tradition, how often do you pray or meditate?” Daily spiritual
experiences were assessed with 5 items from the Daily Spiritual
Experiences Scale. The Daily Spiritual Experiences Scale is a measure
of religiosity and spirituality designed to assess feeling close to
God (or the transcendent) and everyday experiences that grow out of that
closeness.\textsuperscript{24,25} The 5 Daily Spiritual Experiences Scale items used in
MESA were “I feel God’s presence,” “I find strength and comfort in
my religion,” “I feel deep inner peace or harmony,” “I feel God’s
love for me directly or through others,” and “I am spiritually touched
by the beauty of creation.” Responses to each question were assigned
a number (never=0, once in a while=1, some days=2, most
days=3, every day=4, many times a day=5), and these numbers
were summed to calculate spirituality scores for each participant.
Participants were then grouped a priori by spirituality levels:
nonever (0 to 5), low (6 to 15), moderate (16 to 20), and high (21
to 25). Each element within the spirituality scale correlated closely
with the overall spirituality score (Cronbach’s alpha varied from 0.86
to 0.89).

Risk Factors

Each of the 6 field centers collected information on anthropometric
measures and cardiovascular risk factors, including self-reported
history of smoking, hypertension, diabetes, and medication use,
during the baseline examination (July 2000–August 2002) and at
examination 2, concurrent with the questionnaires on religiosity. For
the present analysis, risk factor data from examination 2 were used
to assess cross-sectional associations with religiosity. Resting blood
pressure was measured using a Dinamap Pro 1000 automated
oscillometric sphygmomanometer (Critikon) 3 times with the partic-
ipant in a seated position. Hypertension was defined as a systolic
blood pressure of ≥140 mm Hg, a diastolic blood pressure of
≥90 mm Hg, or use of medication prescribed for hypertension.
A central laboratory (University of Vermont, Burlington) measured
total levels of total and high-density lipoprotein cholesterol, triglycerides,
and plasma glucose in blood samples obtained following a 12-hour
fast, as described previously.\textsuperscript{26} Hypercholesterolemia was defined
as total cholesterol ≥240 mg/dL. Diabetes was defined as a fasting
plasma glucose level ≥126 mg/dL or a history of medical treatment
for diabetes. The body mass index (BMI) was calculated as the
weight in kilograms divided by the square of height in meters. Obesity
was defined as a BMI ≥30 kg/m\textsuperscript{2}. Participants were
classified as current, former, or never smokers.

Subclinical CVD

Coronary artery calcium, common carotid intima-media thickness,
and left ventricular mass were obtained at the baseline examination,
and an ankle brachial index (ABI) was obtained at examination 2.
Each of these measures is associated with different manifestations of
vascular and myocardial pathology: Coronary artery calcium is most
closely associated with coronary atherosclerosis and coronary risk,
common carotid intima-media thickness is a measure of atheroscle-
rosis that associates most closely with stroke risk, and left ventricular
mass is associated with risk for heart failure and stroke. Each of the
6 MESA field centers measured the amount of coronary calcium with
the use of either an electron-beam CT scanner or a multidetector CT
system; scans were then read centrally.\textsuperscript{26} Images of the right
and left common carotid and internal carotid arteries were captured using
high-resolution B-mode ultrasound; images were then read centrally,
and common carotid intima-media thickness values were determined
according to previously described methods.\textsuperscript{27} End-diastolic left
ventricular mass was assessed by 1.5 T magnetic resonance scanners
and then adjusted for body size.\textsuperscript{28} ABI was determined by using a
hand-held Doppler instrument with a 5-MHz probe to measure systolic
blood pressure at the bilateral brachial, dorsalis pedis, and
posterior tibial arteries. Brachial artery pressures were averaged to
obtain the ABI denominator; the highest brachial artery pressure was
used as the denominator when the 2 brachial artery pressures differed
by 10 mm Hg or more. For each lower extremity, the ABI numerator
used was the highest pressure from that leg.

CVD Events

At intervals of 9 to 12 months, an interviewer contacted each
participant or a family member by telephone to inquire about interim
hospital admissions, outpatient diagnoses of CVD, and deaths.
To verify self-reported diagnoses, we obtained medical records for
participants who had been hospitalized or received an outpatient
diagnosis of CVD. Interviews were conducted with the next of kin
and copies of death certificates were requested for participants who
had died of cardiovascular causes outside the hospital. Two physi-
cian members of the MESA Mortality and Morbidity Review
Committee independently classified events and assigned incidence
dates.

A CVD event was defined as the first occurrence of a coronary
heart disease (CHD) event (CHD death, myocardial infarction, or
hospitalized unstable angina), stroke, transient ischemic attack,
congestive heart failure, or other CVD death. The diagnosis of
myocardial infarction was based on a combination of symptoms,
electrocardiographic findings, and cardiac biomarker levels.\textsuperscript{29} We
used hospital records and family interviews to determine whether
deaths were related to CHD. Deaths were considered related to CHD if they occurred within 28 days after a myocardial infarction, if the participant had experienced chest pain within the 72 hours before death, or if the participant had a history of CHD and there was no known nonatherosclerotic, noncardiac cause of death. Adjudicators graded hospitalized unstable angina based on their clinical judgment; definite angina required clear and definite documentation of symptoms distinct from myocardial infarction diagnoses.

Statistical Analysis
All of the analyses were performed using SAS statistical software version 9.2 (SAS Institute; Cary, NC). Participants were stratified into 5 groups by self-reported levels of religious practice or spirituality: never, 1 to 2 times per year, monthly, weekly, and daily. Baseline characteristics were compared across these groups using general linear models for continuous variables and $\chi^2$ tests for categorical variables. For multivariate analyses, the association of religiosity levels and CVD risk factors was examined using linear and logistic regression models with adjustment for demographic information (age, sex, race, education, and income), using the frequency level of “never” as the referent group. Similar analyses were performed examining the association of religiosity levels with subclinical CVD with adjustment for demographic covariates as well as CVD risk factor levels. To examine the prospective association between religiosity levels and CVD events, we used Cox proportional hazards regression models. The model was fitted to assess the association of the religiosity measurements and CVD events; it was adjusted for age, sex, race, education, and income, as well as blood pressure, total cholesterol, high-density lipoprotein cholesterol, BMI, smoking status, diabetes status, and treatment for hypertension and hyperlipidemia. A 2-tailed $P<0.05$ was considered statistically significant.

Results
Study Sample
We included 5474 white, black, Hispanic, and Chinese participants who attended examination 2 of the MESA study and had complete data on the 3 measures of religiosity. Participants were excluded if they did not attend examination 2 of the MESA study. Participants who attended examination 1 but did not attend examination 2 were more likely to be Chinese and Hispanic and less likely to have attended college, but were generally similar to those participants who attended examination 2 with regard to comorbidities and atherosclerosis burden. Baseline characteristics of the study sample are shown in Tables 1 and 2, stratified by the frequency of religious participation and spirituality score, respectively. Results for frequency of prayer or meditation were similar to those for frequency of religious participation (data not shown). In unadjusted analyses, those who practiced religion more frequently tended to be older, female, and black (Table 1). Systolic blood pressure and BMI were generally higher, whereas prevalence of smoking was lower, among those who practiced more frequently. Those indicating higher levels of spirituality were more likely to be female and black; they also had higher systolic blood pressure and BMI, but a lower prevalence of smoking (Table 2).

Frequency of Religious Participation, Risk Factors, and Subclinical Atherosclerosis
As shown in Table 3, after adjustment for demographic covariates (including age, sex, race, education, and income), more frequent religious participants were more likely to be obese and less likely to smoke than those who did not participate at all. Compared with those who never participate in religious activities, each group of religious participants (once or twice per year, monthly, weekly, and daily) was significantly more likely to be obese. Weekly and daily participants had a significantly lower prevalence of smoking than those who never participate. After further adjustment for demographics and smoking status, more frequent religious participants remained significantly more likely to be obese than less frequent participants. The associations of religious participation with obesity and smoking were not attenuated by adjustment for an emotional social support index measured at examination 1. After adjustment for demographics and risk factor levels, there were no consistent associations observed between frequency of religious participation and prevalence or severity of subclinical CVD (Table 3), as measured by coronary artery calcium, common carotid intima-media thickness, left ventricular mass, and ABI. Results stratified by frequency of prayer/meditation were similar to those stratified by frequency of religious participation (data not shown).

Spirituality, Risk Factors, and Subclinical Atherosclerosis
After adjustment for demographics, those with the highest levels of spirituality were significantly more likely to be obese and less likely to smoke (Table 4). There was also a significantly greater prevalence of obesity and lesser prevalence of smoking among those with low and moderate spirituality, compared with the referent group classified as having no spirituality. After further adjustment for demographics and smoking status, those with greater spirituality remained more likely to be obese. The associations of spirituality with obesity and smoking were not attenuated by adjustment for an emotional social support index measured at examination 1. There were no statistically significant associations observed between any level of spirituality and prevalence or extent of subclinical CVD.

Joint Effects of Religious Participation and Spirituality
In a secondary analysis, to assess whether frequency of religious participation or spirituality may have a greater association with obesity or smoking, we adjusted for both dimensions of religiosity simultaneously. For smoking, the magnitude of association was attenuated for both dimensions of religiosity with simultaneous adjustment. For obesity, however, the magnitude of effect and statistical significance for both frequency of participation and spirituality were maintained.

Dimensions of Religiosity and Incident CVD Events
During a mean follow-up of 4.1 years, there were 152 incident CVD events, including 9 CVD deaths, 42 myocardial infarctions, 53 hospitalizations for unstable angina, 11 transient ischemic attacks, 13 cases of congestive heart failure, and 24 strokes. After adjustment for demographics and risk factor levels, none of the dimensions of religiosity appeared to be associated consistently with CVD events (Figure). As expected, there were no differences observed between religi-
osity and specific CVD event types (data not shown) given the low numbers of some types of events.

Discussion

Principal Findings

Our results do not confirm those of previous studies associating greater religiosity with overall better health risks and status at least with regard to CVD. The finding that greater religiosity is associated with obesity has been described previously, and the negative association found between religiosity and smoking corroborates much of the literature on the topic. We observed fairly similar risks for the presence and extent of subclinical CVD across a broad range of strata in several dimensions of religiosity, including frequency of participation, frequency of prayer/meditation, and spirituality. Likewise, there was no clear reduction in risk for CVD events associated with greater religiosity.
Religiosity and Obesity

The association found between religiosity and obesity was consistent throughout our study. Each dimension of religiosity was associated to an extent with a greater risk of obesity than no religiosity, with general trends of higher levels of religiosity associating more strongly with obesity than lower levels.

Although some recent studies have found no association between religiosity and obesity, these are countered by our results and by a number of recent studies finding increased prevalence of obesity among more religious individuals. Geographic and demographic sampling considerations may, in part, account for differences in study findings regarding an association between religiosity and obesity. One study finding no association included a sample of medical beneficiaries in 5 Alabama counties, whereas the other was a sample of only middle-aged and elderly women. By comparison, our study benefited from inclusion of the MESA cohort, a geographically and demographically diverse sample, which may suggest greater external validity for our

Table 2. Characteristics of Participants by Frequency of Feelings of Spirituality (N=5474)

<table>
<thead>
<tr>
<th></th>
<th>Never (N=279)</th>
<th>Low (N=1306)</th>
<th>Moderate (N=911)</th>
<th>High (N=2978)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>64.2±9.9</td>
<td>62.8±10.2</td>
<td>62.9±10.1</td>
<td>63.9±9.9</td>
<td>&lt;0.01</td>
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<tr>
<td>Female sex, %</td>
<td>41.9</td>
<td>38.4</td>
<td>52.0</td>
<td>60.1</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>48.0</td>
<td>50.9</td>
<td>47.0</td>
<td>30.2</td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>35.6</td>
<td>21.9</td>
<td>11.0</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>9.0</td>
<td>12.3</td>
<td>20.0</td>
<td>36.3</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>7.5</td>
<td>14.8</td>
<td>22.0</td>
<td>26.8</td>
<td></td>
</tr>
<tr>
<td>Education, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Less than high school</td>
<td>16.5</td>
<td>13.2</td>
<td>14.3</td>
<td>18.3</td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>12.2</td>
<td>13.7</td>
<td>17.7</td>
<td>20.2</td>
<td></td>
</tr>
<tr>
<td>College or bachelor's</td>
<td>41.6</td>
<td>47.9</td>
<td>48.0</td>
<td>46.6</td>
<td></td>
</tr>
<tr>
<td>Graduate or professional</td>
<td>29.7</td>
<td>25.2</td>
<td>20.0</td>
<td>14.9</td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure, mm Hg</td>
<td>122.0±21.5</td>
<td>121.1±19.3</td>
<td>122.4±20.0</td>
<td>125.8±21.4</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Diastolic blood pressure, mm Hg</td>
<td>70.3±10.4</td>
<td>70.4±9.9</td>
<td>69.9±9.9</td>
<td>70.5±10.2</td>
<td>0.41</td>
</tr>
<tr>
<td>Total cholesterol, mg/dL</td>
<td>190.6±32.8</td>
<td>188.9±35.9</td>
<td>191.5±34.2</td>
<td>193.1±36.5</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>HDL cholesterol, mg/dL</td>
<td>52.7±16.0</td>
<td>51.5±15.2</td>
<td>51.5±15.1</td>
<td>52.0±14.9</td>
<td>0.46</td>
</tr>
<tr>
<td>Triglycerides, mg/dL</td>
<td>127.0±74.1</td>
<td>129.9±78.6</td>
<td>134.8±84.5</td>
<td>131.8±82.6</td>
<td>0.42</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>26.2±4.6</td>
<td>27.0±4.9</td>
<td>28.2±5.6</td>
<td>29.1±5.6</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Smoking status, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Never</td>
<td>44.1</td>
<td>42.3</td>
<td>42.7</td>
<td>50.2</td>
<td></td>
</tr>
<tr>
<td>Former</td>
<td>42.3</td>
<td>45.5</td>
<td>43.9</td>
<td>40.4</td>
<td></td>
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<tr>
<td>Current</td>
<td>13.6</td>
<td>12.2</td>
<td>13.4</td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>Diabetes, %</td>
<td>11.8</td>
<td>11.5</td>
<td>15.8</td>
<td>15.2</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>41.2</td>
<td>36.7</td>
<td>43.4</td>
<td>49.6</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>HDL level, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.36</td>
</tr>
<tr>
<td>High</td>
<td>27.6</td>
<td>25.9</td>
<td>26.2</td>
<td>25.6</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>52.0</td>
<td>52.4</td>
<td>52.9</td>
<td>55.4</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>20.4</td>
<td>21.7</td>
<td>20.9</td>
<td>19.0</td>
<td></td>
</tr>
<tr>
<td>Total cholesterol level, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>&lt;200 mg/dL</td>
<td>65.2</td>
<td>65.2</td>
<td>61.1</td>
<td>59.5</td>
<td></td>
</tr>
<tr>
<td>200–239 mg/dL</td>
<td>28.0</td>
<td>26.9</td>
<td>31.2</td>
<td>31.2</td>
<td></td>
</tr>
<tr>
<td>≥240 mg/dL</td>
<td>6.8</td>
<td>7.9</td>
<td>7.7</td>
<td>9.3</td>
<td></td>
</tr>
<tr>
<td>ABI &lt;0.9, %</td>
<td>3.6</td>
<td>3.5</td>
<td>3.3</td>
<td>4.6</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Common carotid IMT, mm</td>
<td>0.87±0.21</td>
<td>0.85±0.18</td>
<td>0.85±0.19</td>
<td>0.87±0.19</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>LV mass index, g/m²²</td>
<td>35.4±7.3</td>
<td>35.6±7.7</td>
<td>36.0±7.9</td>
<td>36.8±8.2</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>ABI</td>
<td>1.13±0.12</td>
<td>1.13±0.12</td>
<td>1.13±0.13</td>
<td>1.11±0.13</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>CAC &gt;0, %</td>
<td>61.6</td>
<td>59.8</td>
<td>54.5</td>
<td>52.9</td>
<td>0.04</td>
</tr>
<tr>
<td>IMT &gt;90th percentile, %</td>
<td>10.8</td>
<td>8.2</td>
<td>8.5</td>
<td>10.5</td>
<td>0.03</td>
</tr>
<tr>
<td>LV mass index &gt;90th percentile, %</td>
<td>7.9</td>
<td>7.8</td>
<td>9.3</td>
<td>11.0</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Abbreviations as in Table 1.
finding that greater religiosity is associated with a higher risk of obesity.

Various mechanisms may explain the positive association between religiosity and obesity. In their 2006 analysis, Cline and Ferraro posit that one reason for this association is the relative emphasis that religious organizations place on avoiding vices such as smoking, compared with the scant attention paid to avoiding the sin of gluttony.29 They also discuss the possibility that religiosity does not lead to obesity but that obesity may actually lead to religiosity; essentially, religious organizations offer a welcoming environment for those who are obese and seeking protection from social stigma.29 Our cross-sectional study design in an older sample cannot rule out this possibility. Another possible reason for the relation-

Table 3. Adjusted Odds Ratios and β-Coefficients for Risk Factors and Subclinical Atherosclerosis by Frequency of Religious Practice (N=5474)

<table>
<thead>
<tr>
<th></th>
<th>Never (N=1032)</th>
<th>1–2 Times/y (N=1048)</th>
<th>Monthly (N=564)</th>
<th>Weekly (N=2367)</th>
<th>Daily (N=463)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adjusted Odds Ratios* (95% CI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>Referent</td>
<td>1.06 (0.87–1.28)</td>
<td>1.14 (0.91–1.44)</td>
<td>1.13 (0.95–1.34)</td>
<td>1.00 (0.78–1.28)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Referent</td>
<td>1.16 (0.88–1.52)</td>
<td>1.12 (0.82–1.54)</td>
<td>1.19 (0.94–1.52)</td>
<td>1.06 (0.75–1.49)</td>
</tr>
<tr>
<td>Current smoking</td>
<td>Referent</td>
<td>0.97 (0.74–1.26)</td>
<td>0.87 (0.63–1.19)</td>
<td>0.45 (0.34–0.58)†</td>
<td>0.39 (0.26–0.58)†</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>Referent</td>
<td>0.80 (0.59–1.10)</td>
<td>0.87 (0.61–1.25)</td>
<td>0.73 (0.55–0.96)†</td>
<td>0.72 (0.48–1.10)</td>
</tr>
<tr>
<td>Obesity</td>
<td>Referent</td>
<td>1.39 (1.16–1.72)†</td>
<td>1.43 (1.11–1.83)†</td>
<td>1.62 (1.33–1.96)†</td>
<td>1.57 (1.12–1.72)†</td>
</tr>
</tbody>
</table>

Table 4. Adjusted Odds Ratios and β-Coefficients for Risk Factors and Subclinical Atherosclerosis by Frequency of Feelings of Spirituality (N=5474)

<table>
<thead>
<tr>
<th></th>
<th>Never (N=279)</th>
<th>Low (N=1306)</th>
<th>Moderate (N=911)</th>
<th>High (N=2978)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adjusted Odds Ratios* (95% CI)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>Referent</td>
<td>0.83 (0.63–1.14)</td>
<td>1.01 (0.75–1.35)</td>
<td>1.04 (0.79–1.37)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Referent</td>
<td>0.97 (0.64–1.46)</td>
<td>1.33 (0.88–2.03)</td>
<td>1.03 (0.69–1.55)</td>
</tr>
<tr>
<td>Current smoking</td>
<td>Referent</td>
<td>0.68 (0.45–1.01)</td>
<td>0.67 (0.44–1.00)</td>
<td>0.38 (0.26–0.58)†</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>Referent</td>
<td>1.11 (0.66–1.85)</td>
<td>0.94 (0.55–1.60)</td>
<td>1.10 (0.67–1.82)</td>
</tr>
<tr>
<td>Obesity</td>
<td>Referent</td>
<td>1.23 (0.86–1.77)</td>
<td>1.33 (0.92–1.92)</td>
<td>1.53 (1.08–2.12)†</td>
</tr>
</tbody>
</table>

Table 4. Adjusted Odds Ratios and β-Coefficients for Risk Factors and Subclinical Atherosclerosis by Frequency of Feelings of Spirituality (N=5474)

<table>
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<tbody>
<tr>
<td></td>
<td>Adjusted Odds Ratios* (95% CI)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAC &gt;0</td>
<td>Referent</td>
<td>1.05 (0.69–1.28)</td>
<td>0.93 (0.66–1.29)</td>
<td>0.94 (0.69–1.28)</td>
</tr>
<tr>
<td>CC-IMT &gt;90th percentile</td>
<td>Referent</td>
<td>0.75 (0.47–1.19)</td>
<td>0.74 (0.46–1.20)</td>
<td>0.84 (0.55–1.30)</td>
</tr>
<tr>
<td>LV mass &gt;90th percentile</td>
<td>Referent</td>
<td>0.80 (0.46–1.48)</td>
<td>0.74 (0.40–1.39)</td>
<td>0.83 (0.46–1.47)</td>
</tr>
</tbody>
</table>

β-Coefficients* (SE) for Subclinical CVD

<table>
<thead>
<tr>
<th></th>
<th>Never (N=279)</th>
<th>Low (N=1306)</th>
<th>Moderate (N=911)</th>
<th>High (N=2978)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC-IMT</td>
<td>Referent</td>
<td>–0.010 (0.010)</td>
<td>–0.017 (0.011)</td>
<td>–0.010 (0.010)</td>
</tr>
<tr>
<td>LV mass</td>
<td>Referent</td>
<td>–0.505 (0.495)</td>
<td>–0.588 (0.521)</td>
<td>–0.597 (0.488)</td>
</tr>
<tr>
<td>ABI</td>
<td>Referent</td>
<td>–0.0035 (0.0079)</td>
<td>–0.0025 (0.0082)</td>
<td>–0.0045 (0.0077)</td>
</tr>
</tbody>
</table>

Abbreviations as in Table 1.

*Odds ratios for risk factors (hypertension, diabetes, current cigarette smoking, hypercholesterolemia, and obesity) are adjusted for age, sex, race, education, and income. Odds ratios for sub-CVD (CAC >0, CC-IMT >90th percentile, LV mass >90th percentile) and β-coefficients for sub-CVD (CC-IMT, LV mass, ABI) are adjusted for demographics and risk factors.

†P<0.05. Unless otherwise indicated, results are nonsignificant.
Considerable effort has been devoted to discussing the role of religiosity in coping with preexisting illness, but it remains unclear how religiosity relates to the incidence of new illnesses. Additional research regarding religiosity and CVD events would be helpful in determining whether our findings are reproducible. Given the relative inconclusiveness of literature on the topic, further investigation of the association between religiosity and CVD events is recommended.

**Limitations**

Some limitations of our study should be acknowledged. First, the questions used to assess religiosity in MESA may not adequately capture all aspects of this complex construct. For example, we created a spirituality score to attempt to quantify the multiple levels of responses to the questions regarding the frequency of spiritual feelings. This metric requires validation in other settings. Nonetheless, the present data do represent an advance over many prior studies that used only unidimensional measures of self-rated religiosity.

Another limitation of this analysis is its relatively short period of longitudinal follow-up and resulting low incidence of obesity, smoking, and CVD events; this restriction prevented us from determining temporal causality between religiosity and risk factors and limited our power in analyzing the association between religiosity and CVD events. For example, we had 46% power to detect the observed hazard ratio of 1.54 as significant. To detect this difference as statistically significant with 80% power, we would have needed a sample size of 4129 participants (rather than the current 1495) in the "daily" and "never" groups. With our present sample, the smallest difference that we would have detected as statistically significant with 80% power was a hazard ratio of 2.45. Finally, the external validity of the study may be limited somewhat because MESA participants represent a volunteer cohort of relatively healthy individuals at inception. Despite such limitations, these data from a well-described multiethnic sample provide important insights into potential links between religious attributes and the spectrum of cardiovascular health and disease, and they raise interesting questions that merit further exploration.

**Sources of Funding**

This research was supported by contracts N01-HC-95169 through N01-HC-95169 from the National Heart, Lung, and Blood Institute. A full list of participating MESA investigators and institutions can be found at http://www.mesa-nhlbi.org.

**Acknowledgments**

The authors thank the other investigators, the staff, and the participants of the MESA study for their valuable contributions.

**Disclosures**

None.

**References**


A variety of behaviors can benefit or harm one’s cardiovascular health, and it has been observed that religious beliefs and practices may influence one’s health behaviors significantly. We sought to determine whether and to what extent different aspects of religiosity may be associated with cardiovascular health. Using a large, ethnically diverse, community-based sample of men and women ages 45 to 84 years who were asymptomatic at baseline, we compared the prevalence of cardiovascular risk factors, the presence and burden of subclinical cardiovascular disease, and the incidence of cardiovascular events across different levels of religiosity. We adjusted for sociodemographic factors to ensure that these potential confounders were not responsible for associations found between religion and cardiovascular health. We observed that those who attended services frequently and those who prayed frequently were significantly less likely to smoke than those who never attended services or prayed. Perhaps more surprisingly, we found that frequent service attendees and those who prayed often were significantly more likely to be obese. We did not observe any significant associations between religiosity and presence/extent of subclinical disease or incident cardiovascular events. The consistent and significant association found between religiosity and obesity in this cross-sectional study raises some interesting questions. What is the temporal nature of the association? If being more religious makes one more likely to be obese, then why does this occur? Ultimately, this observation should encourage intervention between healthcare providers, public health officials, and the religious community in an effort to improve obesity education and prevention.
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Matthew Feinstein, Kiang Liu, Hongyan Ning, George Fitchett and Donald M. Lloyd-Jones

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