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The relationship between religiosity and cardiovascular risk factors in Japan: a large-scale cohort study

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Abstract

The goal of this study was to examine the relationship between religiosity and cardiovascular risk factors in a Japanese population. A retrospective cohort study was conducted involving individuals who underwent annual health check-ups at St. Luke's International Hospital from 2005 to 2010. Data collected included self-reported demographics, clinical information, and health habits, as well as religiosity, baseline examination, and laboratory measures. We conducted multivariable regression analyses to examine the associations between religiosity and cardiovascular risk factors at baseline and longitudinally. The analyses were performed in 2012. A total of 36,965 participants were enrolled, and 13,846 (37.8%) reported being at least somewhat religious. Compared with those who were not religious at baseline, religious participants ($n = 3685$) were less likely to be current smokers (odds ratio [OR], 0.59; 95% confidence interval [CI], 0.53–0.67) and to report excessive alcohol consumption (OR, 0.74; 95% CI, 0.67–0.82), and more likely to exercise at least three times a week (OR, 1.27; 95% CI, 1.16–1.39) and to be obese (OR, 1.32; 95% CI, 1.19–1.47). There were no significant differences in the rate of hypertension, diabetes mellitus, or dyslipidemia prevalence. In longitudinal data analyses, religiosity was associated with a lower likelihood of smoking and excessive alcohol consumption, and a higher likelihood of regular exercise and a lower incidence of diabetes over time. Individuals who were more religious were significantly more likely to have favorable health habits and fewer cardiovascular risk factors, except for a higher prevalence of overweight/obesity at baseline. Religiosity was also associated with better health habits over time and less likely to be associated with future diabetes but not with blood pressure or lipid levels.

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Keywords

Cohort study; diabetes; obesity; religious people

Introduction

Previous studies have reported positive relationships between religiosity, general health, and mortality.¹ Some studies suggested that more frequent participation in religious activities led to lower rates of smoking,^{2,3} and others reported that practicing religion may be related to lower all-cause mortality.^{4,5} Three systematic reviews and meta-analyses supported these associations,^{6–8} with most studies using cross-sectional data.¹ More recent studies, however, have shown conflicting results. A recent large prospective cohort study challenged the positive relationships between greater religiosity and reduced cardiovascular risk factors.⁹ Moreover, while some studies reported that religiosity was associated with increased obesity,^{9,10} others did not find this association.¹¹ The relationship between religiosity and lower blood pressure also conflicted.^{12,13} Therefore, additional evidence is necessary to further evaluate these relationships.

Religiosity may improve health through several mechanisms. Religiosity may improve stress levels by providing an outlet to cope; it also encourages people to live healthy lives, including the prevention of substance or alcohol abuse. Social support among believers may also provide positive effects on their health. Prayer and meditation as a part of religious activities may also be a form of relaxation.

Most prior studies on relationship between religiosity and cardiovascular risk factors have been conducted in Western and American populations. Few studies have examined populations in Asian countries, including Japan, where religiosity may be different and have a different cultural context. Japan has a different religious profile in comparison to Western countries where the most common religious practices are based on the Judeo-Christian tradition. One national Japanese survey reported that 51% of the Japanese population identified themselves with the Shinto religion,¹⁴ 42% with Buddhism, and only 1% with Christian.¹⁵ Another study suggested that the majority practiced a mixture of Shinto religion and Buddhism.^{16,17} There are some similarities between Christianity and Buddhism or Shinto. For instance, people gather at religious places to commemorate someone's death with sacred songs. However, most practices in Eastern-based religions are quite different from those of Western religions. For one, there are almost no regular institutionalized participation in religious practices similar to a regular Saturday or Sunday worship in the Judeo-Christian tradition.¹⁷ In addition, gatherings with snacks among believers are less common in Japanese religious culture, while they are held frequently in Christian culture. As a result, there may be less social support relating to health in Eastern religions. However, Japanese tend to visit religious places, such as temples, shrines, and mountains independently, instead of in a group. Although there is no specific rule to gather in these places, they come together to share a common sense of unity. These spirituality may be different between Japanese and Western cultures. The goal of this study was to examine the

cross-sectional and longitudinal relationship between religiosity and cardiovascular risk factors in a Japanese population.

Methods

Study Participants

Our study included all individuals who participated in the annual health check-up program in 2005 provided at the Center for Preventive Medicine of St. Luke's International Hospital in Tokyo, Japan. The purpose of this program was to promote health through the early detection of chronic diseases, related risk factors, and cancers in individuals. As a part of the annual health check-up, participants completed a questionnaire eliciting demographic information, health habits, religiosity, and medical history. Then they underwent physical examinations and laboratory testing. We collected the same information from members at each subsequent annual check-up they attended between 2006 and 2010. Approximately 80% of the participants were employees of various companies and local governmental organizations in Tokyo or their affiliates. The other 20% of participants independently registered for the program at the center. We excluded those who had past medical history of cardiovascular disease, cerebrovascular disease, and pulmonary disease, including lung cancer. We excluded adults with prior chronic diseases since we suspected that a subset of participants who develop chronic disease may be more religious, which would bias our findings. This study was conducted retrospectively, and all data were extracted from electronic medical records.

The St Luke's International Hospital Ethics Committee institutional review board and the Committee on Clinical Investigation at Beth Israel Deaconess Medical Center approved this study.

Measures

Religiosity—Religiosity was determined by the response to a question about the participants' degree of religiosity (translated from Japanese: “Are you religious? [Religious, somewhat, slightly, and not at all.]”). We classified participants into four groups based on their answers: religious, somewhat religious, slightly religious, and not religious at all.

Health Habits—Participants were asked about the types of alcohol they consumed in a week, the frequency of consumption in a week, and the number of servings on a typical day. We classified the subjects into two categories, excessive alcohol consumption versus non-excessive alcohol consumption. Excessive alcohol consumption was defined as consuming more than 28 g/d (two drinks) for males and 14 g/d (one drink) for females, based on the recommendation of the Centers for Disease Control and Prevention.¹⁸ Participants were also asked about the number of years they smoked and the average number of cigarettes smoked in a day. Participants were classified as current smoker, former smoker, and never smoker. Participants were also asked how many times they exercised in a week and were classified as those who exercised regularly (at least three times a week) versus those who exercised less than three times a week.

Clinical Factors—Clinical factors were assessed by the participants' self-reported medical history, physical examination, and laboratory tests of the annual check-ups at baseline and at follow-up screenings. These included blood pressure measurement, diabetes-related blood tests, and lipid levels. We defined participants with hypertension as those who had a self-reported medical history of hypertension, and those with measured systolic blood pressure (SBP) greater than 140 mm Hg or diastolic blood pressure (DBP) greater than 90 mm Hg.¹⁹ Similarly, participants with diabetes mellitus were defined as those who have had a self-reported medical history of diabetes, or those with a fasting blood sugar (FBS) greater than 126 mg/dL or hemoglobin A1c (HbA1c) greater than 6.5%.²⁰ Dyslipidemia was defined as those who self-reported a history, or those who had low-density lipoprotein (LDL) cholesterol more than 140 mg/dL, or high-density lipoprotein (HDL) cholesterol less than 40 mg/dL, or triglyceride (TG) more than 150 mg/dL, based on the criteria of the Japan Atherosclerosis Society.²¹

Overweight/Obesity—We calculated body mass index (BMI) based on measured height and body weight. We defined overweight/obesity as having a BMI greater than 25 kg/m² based on the World Health Organization criteria.²²

Other Measures—Participants were asked about their occupation. Based on the answer, participants' occupations were divided into three categories; unemployed, non-physical job, and physical job. Women who did not have an outside job were classified as unemployed.

Statistical Methods

We conducted cross-sectional data analyses on baseline data in 2005 and longitudinal data analyses on data collected between 2005 and 2010 to investigate the relationship between religiosity and cardiovascular risk factors. Our risk factor outcomes included health habits (current smoking, excessive alcohol consumption, and regular exercise) and both self-reported (hypertension, diabetes mellitus, dyslipidemia, and overweight/obesity) and measured (SBP/DBP, FBS, HbA1c, total cholesterol, LDL/HDL cholesterol, and TG) clinical risk factors. We first characterized our sample at baseline using descriptive statistics. χ^2 test was used to analyze categorical measures, and *t*-test and analysis of variance were used for continuous measures. We used logistic regression to conduct the cross-sectional analyses adjusted for age, gender, occupation, marital status, BMI, relevant health habits, and clinical factors. Religiosity was analyzed as a categorical variable.

In the longitudinal analysis, all outcomes were measured repeatedly from 2006 to 2010. Adjusted odds ratios (ORs) for binominal outcomes of future cardiovascular risk factors were calculated by the model of the binominal family with logit link function. These outcomes included health status outcomes (current smoking, excessive alcohol consumption, and regular exercise) and self-reported or measured clinical factors (hypertension, diabetes mellitus, dyslipidemia, and overweight/obesity). To account for repeated observation within each participant, we used generalized estimating equation with unstructured working correlation to estimate the model. Analyses for health habits were adjusted for age, gender, marital status, occupation, and health habits at baseline and the time variable. Analyses for clinical outcomes and overweight/obesity were adjusted for age, gender, occupation, health

habits, clinical factors, and BMI at baseline and time variable. Similarly, in order to analyze our continuous outcomes, we used mixed effect models adjusting for age, gender, occupation, health habits, and BMI at baseline and the time variable. These outcomes included SBP/DBP, FBS, HbA1c, total/LDL/HDL cholesterol, and BMI. These analyses were additionally adjusted for the level of the outcomes at baseline. For example, for SBP, models were adjusted for baseline SBP; for FBS and HbA1c, models were adjusted for baseline FBS and HbA1c, and for individual lipids levels, models were adjusted the individual lipids at baseline.

All analyses were performed in 2012 using SPSS 19.0 J statistical software (IBM Japan, Tokyo, Japan) and STATA 11 (STATA Corp., College Station, TX).

Results

Of 40,035 participants who underwent an annual health check-up in 2005, 3070 participants were excluded due to past medical history of cardiovascular diseases, cerebrovascular diseases, and pulmonary disease, leading to a sample of 36,965 participants.

In our cross-sectional analysis of baseline data, 345 participants were excluded due to missing data. Of the remaining 36,620 participants, 13,846 (37.8%) reported being at least somewhat religious. Table 1 shows the participants' characteristics by degree of religiosity, and Table 2 presents characteristics stratified by gender. Those who were more religious were significantly more likely to be older, female, and married. They also had healthier habits in terms of smoking, alcohol consumption, and regular exercise before (Table 1) and after adjustment (Tables 3 and 4). With regard to clinical risk factors, there was no consistent cross-sectional relationship between religiosity and hypertension, diabetes mellitus, and dyslipidemia after adjustment. In contrast, those with greater religiosity were significantly more likely to be obese.

Of all participants, only 29,215 (79.0%) participants attended at least one annual follow-up visit; 266 participants were excluded due to missing data of the follow-up visit. The median number of follow-up visits was 4, and the mean was 4.2. The actual numbers of follow-up participants each year were 20,516 (55.5%) in 2006, 22,168 (60.0%) in 2007, 18,953 (51.3%) in 2008, 15,799 (42.7%) in 2009, and 14,722 (39.8%) in 2010. Those who did not come back for a follow-up were significantly different in many aspects (Table 5). Older participants, those who were married, never smokers, and those who exercised regularly were more likely to undergo a follow-up health check-up. Tables 6 and 7 show the longitudinal association between religiosity and cardiovascular risk factors. Those who were more religious had a more favorable profile in terms of health habits (OR for current smoker, 0.88; 95% confidence interval [CI], 0.71–1.08; OR for excessive alcohol consumption, 0.87; 95% CI, 0.77–0.98; OR for regular exercise, 1.06; 95% CI, 0.98–1.16; for religious group), and future diabetes mellitus (OR, 0.64; 95% CI, 0.57–0.71). However, religiosity was not longitudinally associated with future hypertension (OR, 0.94; 95% CI, 0.85–1.05), dyslipidemia (OR, 0.95; 95% CI, 0.84–1.07), and overweight/obesity (OR, 0.99; 95% CI, 0.89–1.11), or worsening blood pressure (β coefficient for SBP, -0.13 ; 95% CI,

–0.53–0.27), glucose (β coefficient for FBS, –0.21; 95% CI, –0.57–0.15), or lipid levels (β coefficient for LDL, 0.10; 95% CI, –0.62–0.81).

Discussion

In this study, we demonstrated that individuals who had strong religiosity were significantly more likely to have favorable health habits for smoking, alcohol consumption, and exercise, as well as a better cardiovascular metabolic profile with the exception of obesity cross-sectionally. Religiosity was also less associated with future diabetes, but was unassociated with future hypertension, dyslipidemia, overweight/obesity, and worsening blood pressure, glucose, and lipid control.

These findings support the results of several previous cross-sectional studies^{1,9,23,24} suggesting largely positive relationships between religiosity and cardiovascular risk factors, including health habits and metabolic markers. The limited number of longitudinal studies has shown mixed results. While studies consistently suggest that those with strong religiosity are more likely to stop smoking, reduce alcohol consumption, and increase exercise,^{1,2,24–26} other studies conflict regarding the impact of religiosity on obesity and metabolic risk factors such as diabetes and hypertension.^{1,27} With the exception of diabetes, our study did not show an association between religiosity and other favorable metabolic profiles over time. Our findings may be biased to some degree by pharmacologic treatment of these risk factors, as we did not and could not adjust for treatment of risk factors in our analyses. For many of the significant associations, we did not detect a dose-dependent relationship between religiosity and these outcomes. Since our measure of religiosity was crude, it may have been difficult to distinguish the different levels of religiosity well.

The reasons why religiosity was associated with better health behaviors in our study are unclear. Both the Shinto religion¹⁴ and Buddhism do not prohibit substance use, including alcohol consumption and smoking. Moreover, the practice of Shinto is different for each person because it does not have a religious scripture or an instructional book. Rather, the religion encompasses a broad range of practices related to the worship of all deities in heaven and on earth. We postulate that religion may be providing an outlet for stress,^{28,29} thereby lowering the urge to turn to maladaptive coping behaviors such as alcohol abuse or smoking. Another possible explanation may be that many Japanese religions encourage the respect for one's body, discouraging risky behaviors.³⁰ Religiosity may not have the same beneficial effect against overeating and obesity, since Japanese religions do not have the same negative attitude toward dietary overconsumption. Moreover, food and drinks are often readily available at religious gatherings.¹ Another possible reason is the relationship between religiosity and social stratification.¹⁰ Those who can commit their time to religion may be of higher socioeconomic status. Although current studies on the relationships between cardiovascular risk factors and religiosity suggest many possible theories, there is still no clear definitive explanation. The conceptualization of religion is related to the improvement of individual subjective well-being. Although previous literature mentioned possible biological mechanisms for better healthier habits such as food gathering, religiosity involving belief in a higher power may lead to subjective well-being through self-regulation, and become a buffer to negative stress. Previous research supports the direct

effect of religiosity with Japanese cohort on the well-being of individuals. In addition, religiosity may provide some support and create a sense of community. Since we did not collect information on different dimensions of religiosity, we were not able to test these hypotheses.

Our study has some limitations. First, our data did not include information on different types of religions. One previous study reported that the relationship between religious involvement and cigarette smoking was different among different types of religion.²⁴ Second, our question on religiosity was general and lacked specificity. We cannot obtain specific information on religiosity, such as participation frequency and time, from the answers of this questionnaire. Since religious service attendance and other format rituals are not a feature of Shinto or Buddhism in Japan, measuring religiosity objectively in this setting is particularly challenging. Third, participants were recruited from a single institution where participants may have higher socioeconomic status in comparison to other settings; therefore, generalizability is likely be limited. In addition, there are likely some differences between those who did and did not follow-up, not only in terms of baseline characteristics but also in terms of the outcomes. A total of 29,215 participants (79.0%) were followed up at least 1 year during the study period. Therefore, the results may be biased toward those with higher risk for illness. Because this is an observational study, we cannot infer causation. Finally, we were not able to account for all other confounders such as education and treatment of cardiovascular risk factors, which may have biased some of our results toward the null, as participants who were diagnosed with hypertension, diabetes, or dyslipidemia over time may have been treated pharmacologically.

In summary, Japanese participants in our study who were more religious reported healthier lifestyles and had fewer cardiovascular risk factors at baseline, but were more likely to be obese. Religiosity was associated with better health habits and a lower rate of diabetes over time; however, religiosity was not associated with improvement in other cardiovascular risk factors longitudinally.

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References

1. Feinstein M, Liu K, Ning H, Fitchett G, Lloyd-Jones DM. Incident obesity and cardiovascular risk factors between young adulthood and middle age by religious involvement: the Coronary Artery Risk Development in Young Adults (CARDIA) study. *Prev Med.* 2012; 54:117–21. [PubMed: 22155479]
2. Strawbridge WJ, Cohen RD, Shema SJ, Kaplan GA. Frequent attendance at religious services and mortality over 28 years. *Am J Public Health.* 1997; 87:957–61. [PubMed: 9224176]
3. Lapane KL, Lasater TM, Allan C, Carleton RA. Religion and Cardiovascular Disease Risk. *J Relig Health.* 1997; 36:155–64.
4. Helm HM, Hays JC, Flint EP, Koenig HG, Blazer DG. Does private religious activity prolong survival? A six-year follow-up study of 3,851 older adults. *J Gerontol A Biol Sci Med Sci.* 2000; 55:M400–5. [PubMed: 10898257]

5. Hummer RA, Ellison CG, Rogers RG, Moulton BE, Romero RR. Religious involvement and adult mortality in the United States: review and perspective. *South Med J*. 2004; 97:1223–30. [PubMed: 15646761]
6. Chida Y, Steptoe A, Powell LH. Religiosity/spirituality and mortality. A systematic quantitative review. *Psychother Psychosom*. 2009; 78:81–90. [PubMed: 19142047]
7. McCullough ME, Hoyt WT, Larson DB, Koenig HG, Thoresen C. Religious involvement and mortality: a meta-analytic review. *Health Psychol*. 2000; 19:211–22. [PubMed: 10868765]
8. Powell LH, Shahabi L, Thoresen CE. Religion and spirituality. Linkages to physical health. *Am Psychol*. 2003; 58:36–52. [PubMed: 12674817]
9. Feinstein M, Liu K, Ning H, Fitchett G, Lloyd-Jones DM. Burden of cardiovascular risk factors, subclinical atherosclerosis, and incident cardiovascular events across dimensions of religiosity: the multi-ethnic study of atherosclerosis. *Circulation*. 2010; 121:659–66. [PubMed: 20100975]
10. Cline KM, Ferraro KF. Does religion increase the prevalence and incidence of obesity in adulthood? *J Sci Study Relig*. 2006; 45:269–81. [PubMed: 22639467]
11. Ellis L, Biglione D. Religiosity and obesity: are overweight people more religious? *Pers Individ Dif*. 2000; 28:1119–23.
12. Gillum RF, Ingram DD. Frequency of attendance at religious services, hypertension, and blood pressure: the Third National Health and Nutrition Examination Survey. *Psychosom Med*. 2006; 68:382–5. [PubMed: 16738068]
13. Fitchett G, Powell LH. Daily spiritual experiences, systolic blood pressure, and hypertension among midlife women in SWAN. *Ann Behav Med*. 2009; 37:257–67. [PubMed: 19662465]
14. What is Shinto?. Shinto Online Network Association; 2013. Available at: <http://jinja.jp/english/s-0.html> [Accessed February 10, 2013]
15. The number of shrines, temples, churches, religious organizations, missionaries, and believers. Japanese Ministry of Education, Culture, Sports, Science and Technology; Tokyo: 2008. Available at: http://www.mext.go.jp/component/b_menu/other/_icsFiles/afieldfile/2009/07/10/1245820_005.pdf [Accessed February 10, 2013]
16. Kasulis TP. Intimacy: a general orientation in Japanese religious values. *Philos East West*. 1990; 40:433–49.
17. Musick MA, Traphagan JW, Koenig HG, Larson DB. Spirituality in Physical Health and Aging. *J Adult Dev*. 2000; 7:73–86.
18. Alcohol and Public Health. Centers for Disease Control and Prevention; 2013. Available at: <http://www.cdc.gov/Alcohol/> [Accessed February 9, 2013]
19. Joint National Committee on Prevention D, Evaluation, and Treatment of High Blood Pressure. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. NIH Publication; 2003. Contract No.: 03-5233. Available at: <http://www.nhlbi.nih.gov/files/docs/guidelines/jnc7full.pdf> [Accessed February 10, 2013]
20. Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia: report of a WHO/IDF consultation. World Health Organization; 2006. Available at: http://whqlibdoc.who.int/publications/2006/9241594934_eng.pdf?ua=1 [Accessed February 10, 2013]
21. Japan Atherosclerosis Society Guidelines for Prevention of Atherosclerotic Cardiovascular Diseases. Japan Atherosclerosis Society; 2007. Available at: <http://www.j-athero.org/en/publications/guideline2012.html> [Accessed February 10, 2013]
22. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004; 363:157–63. [PubMed: 14726171]
23. Ferraro KF. Firm believers? Religion, body weight, and well-being. *Rev Relig Res*. 1998; 39:224–44.
24. Whooley MA, Boyd AL, Gardin JM, Williams DR. Religious involvement and cigarette smoking in young adults: the CARDIA study (Coronary Artery Risk Development in Young Adults) study. *Arch Intern Med*. 2002; 162:1604–10. [PubMed: 12123404]
25. Hummer RA, Rogers RG, Nam CB, Ellison CG. Religious involvement and U.S. adult mortality. *Demography*. 1999; 36:273–85. [PubMed: 10332617]

26. Mason MJ, Schmidt C, Mennis J. Dimensions of religiosity and access to religious social capital: correlates with substance use among urban adolescents. *J Prim Prev.* 2012; 3:229–37. [PubMed: 23139081]
27. Reeves RR, Adams CE, Dubbert PM, et al. Are religiosity and spirituality associated with obesity among African Americans in the southeastern United States (the Jackson Heart Study)? *J Relig Health.* 2012; 51:32–48. [PubMed: 22065213]
28. Williams DR, Larson DB, Buckler RE, et al. Religion and psychological distress in a community sample. *Soc Sci Med.* 1991; 32:1257–62. [PubMed: 2068608]
29. Koenig HG, George LK, Siegler IC. The use of religion and other emotion-regulating coping strategies among older adults. *Gerontologist.* 1988; 28:303–10. [PubMed: 3396911]
30. Mechanic D. Promoting health. *Society.* 1990; 27:16–22.

Table 1

Participants' characteristics according to religiosity*

Characteristics	Total Sample (n = 36,620)	Not Religious at All (n = 8646)	Slightly Religious (n = 14,128)	Somewhat Religious (n = 10,161)	Religious (n = 3685)
Age, y $\pm$ SD	46.9 $\pm$ 11.9	42.4 $\pm$ 10.9	45.9 $\pm$ 11.1	49.9 $\pm$ 11.8	52.4 $\pm$ 12.8
Female, %	48.7	44.1	45.9	53.6	56.4
Married, %	71.6	66.0	72.2	74.6	74.4
Physical job, %	15.0	16.1	14.1	14.9	16.2
Current smoker, %	19.4	26.0	20.2	15.2	12.8
Excessive alcohol consumption, %	24.4	26.5	25.4	22.9	19.8
Regular exercise, %	25.4	20.5	23.3	29.4	33.5
BMI, kg/m ² $\pm$ SD	22.5 $\pm$ 3.3	22.4 $\pm$ 3.3	22.5 $\pm$ 3.2	22.5 $\pm$ 3.3	22.7 $\pm$ 3.4
SBP, mm Hg $\pm$ SD	117.5 $\pm$ 17.5	115.9 $\pm$ 16.6	117.1 $\pm$ 17.3	118.6 $\pm$ 17.8	120.2 $\pm$ 18.7
DBP, mm Hg $\pm$ SD	73.1 $\pm$ 11.3	72.0 $\pm$ 11.0	73.0 $\pm$ 11.2	73.8 $\pm$ 11.3	74.3 $\pm$ 11.6
FBS, mg/dL $\pm$ SD	99.5 $\pm$ 15.7	98.5 $\pm$ 15.5	99.4 $\pm$ 15.2	100.0 $\pm$ 15.5	101.0 $\pm$ 18.0
HbA1c, % $\pm$ SD	5.1 $\pm$ 0.6	5.0 $\pm$ 0.6	5.1 $\pm$ 0.6	5.1 $\pm$ 0.6	5.2 $\pm$ 0.7
T-chol, mg/dL $\pm$ SD	202.0 $\pm$ 34.4	197.0 $\pm$ 34.3	200.9 $\pm$ 34.1	205.8 $\pm$ 34.5	207.5 $\pm$ 34.3
LDL-chol, mg/dL $\pm$ SD	116.1 $\pm$ 30.2	112.8 $\pm$ 30.3	115.5 $\pm$ 30.1	118.4 $\pm$ 30.2	119.9 $\pm$ 29.8
HDL-chol, mg/dL $\pm$ SD	62.0 $\pm$ 15.7	61.4 $\pm$ 15.6	61.7 $\pm$ 15.6	62.9 $\pm$ 15.9	62.7 $\pm$ 15.6
Triglyceride, mg/dL $\pm$ SD	101.99 $\pm$ 82.1	101.7 $\pm$ 84.3	102.5 $\pm$ 85.7	101.8 $\pm$ 76.2	101.3 $\pm$ 78.9
Hypertension, %	16.2	12.6	15.2	18.4	22.4
Diabetes mellitus, %	5.2	4.2	4.8	5.5	7.7
Dyslipidemia, %	35.6	32.1	34.9	38.2	39.7

BMI, body mass index; DBP, diastolic blood pressure; FBS, fasting blood sugar; HbA1c, hemoglobin A1c; HDL-chol, high-density lipoprotein cholesterol; LDL-chol, low-density lipoprotein cholesterol; SBP, systolic blood pressure; SD, standard deviation; T-chol, total cholesterol.

Excessive alcohol consumption was defined as consuming alcohol more than two drinks/day for male and one drink/day for female. Regular exercise was defined as exercising at least three times a week. Hypertension was defined as having history of hypertension or abnormality in 2005. Diabetes mellitus was defined as having history of diabetes mellitus or abnormality in 2005. Dyslipidemia was defined as having history of dyslipidemia or abnormality in 2005.

* All factors were significantly different by religiosity at the point of $P < .01$ except for triglyceride level which was not significant ($P = .82$).

Table 2

Participants' characteristics according to religiosity by gender

Characteristics	Men				Women					
	Total (n = 18,947)	Not Religious at All (n = 4837)	Slightly Religious (n = 7644)	Somewhat Religious (n = 4712)	Religious (n = 1608)	Total (n = 18,018)	Not Religious at All (n = 3809)	Slightly Religious (n = 6484)	Somewhat Religious (n = 5449)	Religious (n = 2077)
Age, y ± SD	47.3 ± 11.9	42.8 ± 11.1	47.0 ± 11.1	50.3 ± 11.7	52.8 ± 12.6	46.5 ± 12.0	41.9 ± 10.5	44.7 ± 11.0	49.5 ± 11.9	52.1 ± 12.8
Married, %	82.6	75.6	83.8	86.8	86.0	60.0	53.9	58.4	63.9	65.3
Physical job, %	15.0	16.5	13.9	15.0	15.5	15.0	15.7	14.3	14.8	16.7
Current smoker, %	29.7	36.7	30.1	24.5	21.1	8.6	12.3	8.5	7.2	6.4
Excessive alcohol consumption, %	33.0	32.3	33.7	33.7	30.3	15.3	19.1	15.6	13.7	11.7
Regular exercise, %	26.1	20.2	23.3	29.0	33.3	24.8	20.9	23.4	29.7	33.8
BMI, kg/m ² ±SD	23.8 ± 3.0	23.6 ± 3.1	23.8 ± 3.0	23.9 ± 3.0	24.1 ± 3.1	21.1 ± 3.0	20.7 ± 2.9	20.9 ± 2.9	21.3 ± 3.0	21.6 ± 3.2
SBP, mm Hg± SD	122.2 ± 16.5	120.4 ± 15.6	122.2 ± 16.5	123.3 ± 16.8	124.6 ± 17.7	112.6 ± 17.1	110.0 ± 16.0	111.1 ± 16.3	114.5 ± 17.6	116.8 ± 18.7
DBP, mm Hg ± SD	76.4 ± 10.8	75.0 ± 10.4	76.4 ± 10.8	77.3 ± 10.9	77.8 ± 11.1	69.7 ± 10.7	68.2 ± 10.4	68.9 ± 10.3	70.8 ± 10.9	71.7 ± 11.3
FBS, mg/dL ± SD	103.8 ± 18.0	102.2 ± 17.9	103.7 ± 17.4	104.7 ± 17.7	106.1 ± 21.3	95.0 ± 11.1	93.7 ± 10.0	94.3 ± 10.0	95.9 ± 11.8	97.1 ± 13.7
HbA1c, % ± SD	5.2 ± 0.7	5.1 ± 0.7	5.1 ± 0.7	5.2 ± 0.7	5.3 ± 0.8	5.0 ± 0.5	4.9 ± 0.4	5.0 ± 0.4	5.1 ± 0.5	5.1 ± 0.6
T-choI, mg/dL ± SD	201.3 ± 33.4	198.5 ± 34.3	201.6 ± 33.4	203.0 ± 32.2	203.0 ± 32.6	202.8 ± 35.5	195.2 ± 33.6	200.0 ± 34.7	208.2 ± 36.2	211.0 ± 35.1
LDL-choI, mg/dL ± SD	119.6 ± 29.4	118.0 ± 30.0	120.0 ± 29.5	120.3 ± 28.7	120.4 ± 28.9	112.4 ± 30.7	106.2 ± 29.4	110.1 ± 30.0	116.7 ± 31.4	119.6 ± 30.5
HDL-choI, mg/dL ± SD	54.8 ± 13.0	54.6 ± 12.8	54.8 ± 13.0	55.1 ± 13.1	55.1 ± 13.4	69.6 ± 14.7	70.0 ± 14.7	69.8 ± 14.5	69.7 ± 14.9	68.6 ± 14.6
Triglyceride, mg/dL ± SD	128.7 ± 99.4	127.5 ± 99.2	128.9 ± 103.71	129.8 ± 92.6	126.9 ± 100.5	74.0 ± 44.0	68.8 ± 41.3	71.4 ± 41.1	77.7 ± 46.4	81.5 ± 48.2
Hypertension, %	21.2	16.2	20.8	24.4	28.0	11.0	8.0	8.5	13.1	18.0
Diabetes mellitus, %	7.8	6.1	7.4	8.9	11.6	2.4	1.8	1.8	2.6	4.7
Dyslipidemia, %	46.3	43.7	46.7	47.8	48.1	24.4	17.3	21.1	29.8	33.2

BMI, body mass index; DBP, diastolic blood pressure; FBS, fasting blood sugar; HbA1c, hemoglobin A1c; HDL-cholesterol, high-density lipoprotein cholesterol; LDL-cholesterol, low-density lipoprotein cholesterol; SBP, systolic blood pressure; SD, standard deviation; T-cholesterol, total cholesterol.

Excessive alcohol consumption was defined as consuming alcohol more than two drinks/day for male and one drink/day for female. Regular exercise was defined as exercising at least three times a week. Hypertension was defined as having history of hypertension or abnormality in 2005. Diabetes mellitus was defined as having history of diabetes mellitus or abnormality in 2005. Dyslipidemia was defined as having history of dyslipidemia or abnormality in 2005.

Table 3

Cross-sectional relationship between religiosity and cardiovascular risk factors

Religiosity	Adjusted Odds Ratios (95% Confidence Interval)						
	Current Smoker [*]	Excessive Alcohol Consumption [*]	Regular Exercise [*]	Hypertension	Diabetes Mellitus	Dyslipidemia	Overweight/obesity [*]
Not religious at all	Reference						
Slightly religious	0.78 (0.73–0.84)	0.96 (0.91–1.03)	1.01 (0.95–1.09)	0.95 (0.87–1.04)	0.91 (0.80–1.05)	1.02 (0.96–1.09)	1.03 (0.96–1.10)
Somewhat religious	0.66 (0.61–0.71)	0.90 (0.84–0.97)	1.15 (1.07–1.24)	0.90 (0.82–0.99)	0.85 (0.73–0.98)	1.08 (1.01–1.15)	1.17 (1.08–1.26)
Religious	0.60 (0.53–0.67)	0.78 (0.70–0.85)	1.25 (1.14–1.37)	0.93 (0.83–1.05)	1.00 (0.84–1.20)	1.02 (0.93–1.12)	1.33 (1.20–1.47)

Excessive alcohol consumption was defined as consuming alcohol more than two drinks/day for male and one drink/day for female. Regular exercise was defined as exercising at least three times a week. Hypertension was defined as having history of hypertension or abnormality in 2005. Diabetes mellitus was defined as having history of diabetes mellitus or abnormality in 2005. Dyslipidemia was defined as having history of dyslipidemia or abnormality in 2005. Overweight/obesity was defined as those with body mass index was more than 25 kg/m² based on World Health Organization criteria.

Adjusted odds ratios: Models related to health habits were adjusted for age, gender, marital status, occupations, BMI, and other health habits except for outcome of interests. Models related to outcomes: hypertension, diabetes, dyslipidemia, and overweight/obesity were adjusted on age, gender, marital status, occupations, BMI, health habits, and relevant clinical risk factors (ie, hypertension, diabetes, and dyslipidemia); results in bold indicate statistically significant differences with a *P*-value less than 0.05.

* Indicates a statistical significance for the global *P*-value for each outcome.

Cross-sectional relationship between religiosity and cardiovascular risk factors by gender

Table 4

Religiosity	Adjusted Odds Ratios (95% Confidence Interval)									
	Current Smoker [*]		Excessive Alcohol Consumption [*]		Regular Exercise [*]		Hypertension		Diabetes Mellitus	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Not at all	Reference									
Slightly	0.80 (0.74–0.87)	0.73 (0.63–0.83)	1.00 (0.94–1.08)	0.87 (0.78–0.97)	1.01 (0.93–1.11)	1.01 (0.92–1.12)	1.04 (0.93–1.15)	0.80 (0.68–0.94)	0.95 (0.81–1.10)	0.81 (0.59–1.11)
Somewhat	0.65 (0.59–0.71)	0.69 (0.59–0.80)	0.95 (0.87–1.33)	0.82 (0.73–0.92)	1.18 (1.07–1.31)	1.15 (1.04–1.27)	0.98 (0.87–1.10)	0.76 (0.65–0.90)	0.90 (0.76–1.06)	1.04 (0.96–1.14)
Religious	0.58 (0.50–0.66)	0.64 (0.52–0.79)	0.78 (0.69–0.87)	0.72 (0.61–0.85)	1.29 (1.13–1.47)	1.25 (1.10–1.42)	0.95 (0.81–1.10)	0.83 (0.68–1.00)	0.97 (0.79–1.20)	0.98 (0.70–1.38)

Results in bold indicate statistically significant differences with a *P*-value less than 0.05.

Excessive alcohol consumption was defined as consuming alcohol more than two drinks/day for male and one drink/day for female. Regular exercise was defined as exercising at least three times a week. Hypertension was defined as having history of hypertension or abnormality in 2005. Diabetes mellitus was defined as having history of diabetes mellitus or abnormality in 2005. Dyslipidemia was defined as having history of dyslipidemia or abnormality in 2005. Overweight/obesity was defined as those with body mass index was more than 25 kg/m² based on World Health Organization criteria.

Adjusted odds ratios: models related to health habits were adjusted for age, gender, marital status, occupations, body mass index, and other health habits except for outcome of interests. Models related to outcomes; hypertension, diabetes, dyslipidemia, and overweight/obesity were adjusted on age, gender, marital status, occupations, body mass index, health habits, and relevant clinical risk factors (ie, hypertension, diabetes and dyslipidemia).

* Indicates a statistical significance for the global *P*-value for each outcome.

Table 5

Comparison of baseline characteristics between those who did not attend follow-up and those who attended at least one follow-up

Characteristics	Sample Who Attended Atleast One Follow-up (n = 29,215)	Sample Without Follow-up (n = 7750)	P-value
Religiosity, % religious	10.2	9.7	<.01
Age, y $\pm$ SD	47.6 $\pm$ 11.8	44.4 $\pm$ 12.0	<.01
Female, %	48.3	50.4	<.01
Married, %	72.6	68.0	<.01
Physical job, %	14.5	16.8	<.01
Current smoker, %	18.6	22.6	<.01
Excessive alcohol consumption, %	24.4	24.1	.55
Regular exercise, %	26.2	22.5	<.01
BMI, kg/m ² , $\pm$ SD	22.5 $\pm$ 3.3	22.4 $\pm$ 3.4	.49
SBP, mm Hg $\pm$ SD	117.9 $\pm$ 17.5	116.3 $\pm$ 17.3	<.01
DBP, mm Hg $\pm$ SD	73.4 $\pm$ 11.3	72.2 $\pm$ 11.2	<.01
FBS, mg/dL $\pm$ SD	99.6 $\pm$ 15.4	99.1 $\pm$ 16.5	<.01
HbA1c, % $\pm$ SD	5.1 $\pm$ 0.6	5.1 $\pm$ 0.6	<.01
Total cholesterol, mg/dL $\pm$ SD	202.6 $\pm$ 34.3	199.9 $\pm$ 34.8	<.01
LDL-cho, mg/dL $\pm$ SD	116.5 $\pm$ 30.2	114.8 $\pm$ 30.6	<.01
HDL-cho, mg/dL $\pm$ SD	62.2 $\pm$ 15.8	61.5 $\pm$ 15.4	<.01
Triglyceride, mg/dL $\pm$ SD	101.6 $\pm$ 78.5	103.7 $\pm$ 94.7	<.05
Hypertension, %	16.9	13.7	<.01
Diabetes mellitus, %	5.2	5.0	.53
Dyslipidemia, %	36.1	33.9	<.01

BMI, body mass index; DBP, diastolic blood pressure; FBS, fasting blood sugar; HbA1c, hemoglobin A1c; HDL-cho, high-density lipoprotein cholesterol; LDL-cho, low-density lipoprotein cholesterol; SBP, systolic blood pressure; SD, standard deviation; T-cho, total cholesterol.

Excessive alcohol consumption was defined as consuming alcohol more than two drinks/day for male and one drink/day for female. Regular exercise was defined as exercising at least three times a week. Hypertension was defined as having history of hypertension or abnormality in 2005. Diabetes mellitus was defined as having history of diabetes mellitus or abnormality in 2005. Dyslipidemia was defined as having history of dyslipidemia or abnormality in 2005.

Table 6

Longitudinal association between religiosity and cardiovascular risk factors

Religiosity	Adjusted Odds Ratios (95% Confidence Interval)						
	Current Smoker *	Excessive Alcohol Consumption *	Regular Exercise *	Hypertension	Diabetes Mellitus *	Dyslipidemia	Overweight/obesity
Not religious at all (n = 6647)	Reference						
Slightly religious (n = 11,162)	0.88 (0.78–0.99)	0.98 (0.91–1.06)	0.99 (0.94–1.06)	1.05 (0.98–1.13)	0.80 (0.75–0.87)	1.02 (0.94–1.11)	0.98 (0.91–1.06)
Somewhat religious (n = 8198)	0.75 (0.65–0.87)	1.01 (0.93–1.10)	1.07 (1.01–1.14)	0.96 (0.89–1.04)	0.71 (0.66–0.77)	1.02 (0.93–1.11)	0.99 (0.91–1.08)
Religious (n = 2942)	0.88 (0.71–1.08)	0.87 (0.77–0.98)	1.06 (0.98–1.16)	0.94 (0.85–1.05)	0.64 (0.57–0.71)	0.95 (0.84–1.07)	0.99 (0.89–1.11)

Results in bold indicate statistically significant differences with a *P*-value less than 0.05.

Only significant interactions with gender were observed in regular exercise and dyslipidemia.

Interaction terms between religiosity and other measurements (gender, age, marital status, and occupation) were examined in all analyses. Significant interactions with gender were observed in regular exercise and dyslipidemia, those with age in smoking, excessive alcohol consumption, and regular exercise, those with marital status in hypertension and dyslipidemia, and those with occupation in smoking, excessive alcohol consumption, regular exercise, hypertension, diabetes, and dyslipidemia.

Excessive alcohol consumption was defined as consuming alcohol more than two drinks/day for male and one drink/day for female. Regular exercise was defined as exercising at least three times a week. Hypertension was defined as having history of hypertension or abnormality in 2005. Diabetes mellitus was defined as having history of diabetes mellitus or abnormality in 2005. Dyslipidemia was defined as having history of dyslipidemia or abnormality in 2005. Overweight/obesity was defined as those with body mass index was more than 25 kg/m² based on World Health Organization criteria.

Adjusted odds ratios: models related to health habits were adjusted for age, gender, marital status, occupation, and health habits at baseline and time variable. Models related to outcomes: hypertension, diabetes, dyslipidemia, and overweight/obesity were adjusted for age, gender, occupation, health habits, relevant clinical risk factors (ie hypertension, diabetes, and dyslipidemia), and body mass index at baseline and time variable.

* Indicates a statistical significance for the global *P*-value for each outcome.

Table 7

Longitudinal association between religiosity and cardiovascular biomarkers

Religiosity	Adjusted β -Coefficients (95% Confidence Interval)							
	SBP	DBP	FBS	HbA1c	T-chol	LDL-chol*	HDL-chol	TG
Not religious at all	Reference							
Slightly religious	-0.16 (-0.44-0.12)	-0.07 (-0.24-0.11)	0.04 (-0.21-0.29)	-0.01 (-0.02-0.01)	0.53 (-0.03-1.09)	0.62 (0.13-1.11)	-0.07 (-0.28-0.13)	-0.28 (-1.66-1.11)
Somewhat religious	-0.05 (-0.35-0.25)	0.01 (-0.18-0.20)	0.18 (-0.09-0.45)	-0.01 (-0.02-0.01)	0.41 (-0.20-1.02)	0.28 (-0.25-0.81)	-0.07 (-0.29-0.15)	1.08 (-0.42-2.58)
Religious	-0.13 (-0.53-0.27)	-0.16 (-0.42-0.09)	-0.21 (-0.57-0.15)	0.00 (-0.02-0.01)	-0.26 (-1.07-0.56)	0.10 (-0.62-0.81)	-0.27 (-0.57-0.29)	-0.51 (-2.52-1.50)

BMI, body mass index; DBP, diastolic blood pressure; FBS, fasting blood sugar; HbA1c, hemoglobin A1c; HDL-chol, high-density lipoprotein cholesterol; LDL-chol, low-density lipoprotein cholesterol; SBP, systolic blood pressure; T-chol, total cholesterol.

Results in bold indicate statistically significant differences with a *P*-value less than 0.05

Analyses were adjusted for age, gender, occupation, health habits, BMI, and time variable. For analyses related to SBP and DBP, models were also adjusted for baseline blood pressure; for FBS and HbA1c, analyses were also adjusted for baseline diabetes related measures; and for the lipid outcomes, models were also adjusted for the respective baseline lipid level.

* Indicates a statistical significance for the global *P*-value for each outcome