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Personality traits and the risk of coronary heart disease or stroke in women with diabetes – an epidemiological study based on the Women’s Health Initiative

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Abstract

OBJECTIVE: We studied the associations between personality traits and the risk of coronary heart disease (CHD) or stroke in women with diabetes.

METHODS: From the Women’s Health Initiative, 15029 women aged 50–79 years at enrollment and with self-reported treated diabetes at baseline or follow-up, were followed for a mean of 10 years. Personality traits measured from validated scales included hostility, optimism, ambivalence over emotional expressiveness, and negative emotional expressiveness. Multivariable Cox Proportional hazards regression models were used to examine associations between personality traits and the risk of adjudicated CHD (nonfatal myocardial infarction and CHD death) or stroke outcomes. Progressively adjusted regression approach was used in the multivariable models to adjust for demographics, depression, anthropometric variables, and lifestyle factors.

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Author Contributions:

J.M.J conceived and designed the study; acquired, managed, analyzed and interpreted data; drafted the manuscript and revised the manuscript; J.L. and M.H. conceived and designed the study; interpreted data; and critically reviewed and revised the manuscript; J.E.M., P.D., L.G., S.L. interpreted data and critically reviewed and revised the manuscript. J.M.J. and J.L. are the guarantors of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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RESULTS: A total of 1118 incident CHD and 710 incident stroke cases were observed. Women in the highest quartile of hostility had 22% [HR 1.22 (95% CI 1.01–1.48)] increased risk for CHD compared with women in the lowest quartile of hostility. P-values for trend were greater than 0.05. Stratified analysis by prevalent or incident diabetes showed that the highest quartile of hostility had 34% increased risk for CHD [HR 1.34 (95% CI 1.03–1.74)] among women with incident diabetes. Other personality traits were not significantly associated with stroke or CHD.

CONCLUSIONS: Hostility was associated with incidence of CHD among postmenopausal women with diabetes, especially among incident diabetes. These results provide a basis for targeted prevention programs for women with high level of hostility and diabetes.

Keywords

type 2 diabetes; coronary heart disease; stroke; personality traits; epidemiology

Introduction

As one of the most common chronic diseases, diabetes currently affects around 415 million people worldwide and will affect around 615 million people by 2040 ¹. In the US, more than 30 million people had diabetes in 2017 ² and type 2 diabetes constituted more than 90% of cases ¹. The main threats to the health and quality of life of people with diabetes are complications caused by the metabolic and vascular sequelae of diabetes ³. Cardiovascular disease (CVD) is one of the major diabetic complications and leading causes of mortality from diabetes ⁴.

In the general population, personality traits were reported to be related to the risks of CVD. Optimism is associated with reduced risk of CVD ^{5–8}. Hostility and negative affectivity are psychological risk factors for CVD ^{9–13}. Metabolic syndrome is an independent predictor of type 2 diabetes ¹⁴. One report showed that a combination of high level hostility and metabolic syndrome increased the risk of CVD by more than 4 fold in men compared to men with low hostility and metabolic syndrome ¹⁵. However, there is lack of study on the associations between personality traits and risk of CVD among people with type 2 diabetes.

Personality traits might be related to the occurrence of CVD in people with diabetes. Good glycemic control and adherence to diabetic treatment are important in the prevention of diabetic complications and personality traits are important factors in diabetic self-management and adherence to diabetic treatment ¹⁶. In people with diabetes, optimism is related to better diabetic control and fewer complications ¹⁷ while negative emotional states are related to poor metabolic control in people with diabetes ⁹. Ambivalent emotional expressiveness (AEE) could lead to distress due to emotional inhibition ¹⁸, and stress and emotional distress could lead to poor adherence to type 2 diabetic medications and to other common medications such as antihypertensive and cholesterol-lowering treatments ^{19, 20}.

In other studies, greater levels of hostility in people with type 2 diabetes raised susceptibility to stress-induced inflammation ²¹ while optimism was related to better immune defense ¹⁷. Personality traits might influence risk of CVD in people with diabetes through stress-related inflammatory pathways ²¹. Dysregulation of the neuroendocrine systems and increased

levels of stress-related hormones, such as cortisol were more often observed in individuals with greater levels of hostility²². The higher levels of cortisol can adversely affect blood pressure, blood glycemic control and other cardiovascular risk factors²³.

This study aims to investigate the association between personality traits and risk of developing CVD in postmenopausal women with diabetes based on a prospective cohort study in the US -Women's Health Initiative (WHI). The personality traits that we investigated include: optimism, ambivalence over emotional expressiveness (AEE), negative emotional expressiveness (NEE), and hostility. CVD is measured by the incidence of coronary heart disease (CHD) or stroke over follow-up. Our study hypotheses were: The personality traits: optimism, AEE, NEE, and hostility are associated with the incidence of CVD in women with diabetes.

Methods

Study population

This study was based on the Women's Health Initiative (WHI) which is a large-scale longitudinal epidemiological study designed to investigate the major causes of morbidity and mortality in postmenopausal women²⁴. Detailed information on the study are described elsewhere^{25–29}. In summary, 161,808 women aged 50 to 79 years were recruited from 40 clinical centers throughout the United States between 1993 and 1998. The WHI includes both clinical trials (CT) and observational study (OS) components. Participants in the OS included 93,676 women who were screened for the CT but were ineligible, unwilling to participate in the clinical trial, or were recruited through a direct invitation for the OS. When WHI study ended in 2005, WHI Extension Studies (Extension study 1 was from year 2005 to 2010, Extension study 2 was from year 2010 to 2020) continued follow-up of all women who consented. The study was approved by Institutional Review Boards at all 40 clinical centers and at the coordinating center. All participants provided written informed consent.

Diabetes cohort

From the WHI cohort, we selected study participants who had prevalent diabetes or who were diagnosed with diabetes, i.e., incident diabetes, during the WHI follow-up and Extension Study 1. A participant was considered to have prevalent diabetes if she reported that she had ever been treated with diabetes with pills or shots, was diagnosed after age 30 and had not been hospitalized for coma. Self-reported diabetes was assessed and found to be a valid indicator of diagnosed diabetes^{30, 31}. The criteria for incident diabetes during follow-up was not having prevalent diabetes at the baseline and reported being treated for diabetes (pills or insulin shots) during the follow-up.

From the WHI cohort, we selected 6837 women with prevalent diabetes at baseline and 16241 women with incident diabetes during the WHI follow-up. Among the 6837 women with prevalent diabetes at baseline, we excluded 1850 women who had CVD at baseline and 668 women who had cancer (except non-melanoma skin cancer) at baseline, and 31 women without follow-up information. After the exclusions, 4288 women with prevalent diabetes entered the final study cohort. Among the 16241 women with incident diabetes during the

WHI follow-up, we excluded 1285 women with cancer (except non-melanoma skin cancer) at baseline, 925 women who had any cancer except non melanoma skin cancer before the diagnosis of diabetes during the follow-up, 2802 women who had CVD at baseline, 442 who had CVD before the diagnosis of diabetes during follow-up, and 46 women who had the date of end of follow-up before the date of diabetes diagnosis. After the exclusions, there were 10741 women with incident diabetes during follow-up who entered the final study cohort. Thus in total, there were 15029 with diabetes in our study cohort.

Exposure variables:

In this study, optimism, Ambivalence over Emotional Expressiveness (AEE), Negative Emotional Expressiveness (NEE), and hostility were constructed WHI variables that were selected for the measurement of personality traits at the baseline of WHI:

Optimism: Optimism was measured by the revised version of the Life Orientation Test ³² which included six questions: 1. In unclear times, I usually expect the best; 2. If something can go wrong for me, it will; 3. I'm always hopeful about my future; 4. I hardly ever expect things to go my way; 5. I rarely count on good things happening to me; 6. Overall, I expect more good things to happen to me than bad. Answers to each of these questions were coded from 1=strongly disagree to 5=strongly agree. The answers were reverse recoded for questions 2, 4 and 5 and a summed score found. Possible total scores ranged from 6–30 with higher scores representing greater optimism.

Ambivalence over Emotional Expressiveness (AEE): AEE was measured based on a three-item subscale of the Ambivalent Over Emotional Expression Questionnaire ³³. Questions included were: 1. After I express anger at someone, it bothers me for a long time; 2. I try to suppress my anger, but I would like other people to know how I feel; 3. I worry that if I express negative emotions such as fear and anger, other people will not approve of me. The response values ranged from 1="Strongly Disagree" to 5="Strongly Agree". The total summary score was based on the average response values of the three questions and ranged from 1 to 5. A higher score indicated greater ambivalence in expressing negative emotions.

Negative Emotional Expressiveness: (NEE): The measurement of NEE was based on 4 items of the Emotional Expressiveness Questionnaire ³³ and the following questions were used: 1. When I am angry, people around me usually know; 2. People can tell from my facial expressions how I am feeling; 3. I always express disappointment when things don't go as I'd like them to; 4. If someone makes me angry in a public place, I will "cause a scene". The response values for each question ranged from 1="Strongly Disagree" to 5="Strongly Agree." Average response values of the four questions were used as the total score where a higher score represents greater tendency in expressing negative emotions.

Hostility: The measurement of hostility was based on the cynicism subscale of the Cook and Medley instrument ³⁴. The following thirteen questions were asked: 1. I have often had to take orders from someone who did not know as much as I did; 2. I think a great many people make a lot of their bad luck in order to gain the sympathy and help from others; 3. It

takes a lot of argument to convince most people of the truth; 4. I think most people would lie to get ahead; 5. Most people are honest mainly through fear of being caught; 6. Most people will use somewhat unfair means to gain profit or an advantage rather than to lose it; 7. No one cares much what happens to you; 8. It is safer to trust nobody; 9. Most people make friends because friends are likely to be useful to them; 10. Most people inwardly do not like putting themselves out to help other people; 11. I have often met people who were supposed to be experts who were no better than I; 12. People often demand more respect for their own rights than they are willing to allow for others; 13. A large number of people are guilty of bad sexual behavior. The response values were 0="False", 1="True" to each of the above questions. The sum of response values of all thirteen questions were used as the total score where a higher score represents greater hostility.

Outcome variables:

The primary outcome was first occurrence of coronary heart disease (CHD) or stroke during follow-up. CHD was defined as first occurrence of clinical myocardial infarction (MI), definite silent MI or a death due to definite CHD or possible CHD. Stroke was defined as the first occurrence of stroke or a death due to cerebrovascular event. Information on the cardiovascular outcomes were adjudicated by physicians following standard diagnostic standards for the WHI CT and OS components through 2010³⁵. From 2010, cardiovascular outcomes were adjudicated for the subset that included all former hormone trial participants and all African American and Hispanic participants, and self-reported for other participants.

Potential confounders:

The following potential confounders were considered: baseline information on age, race/ethnicity (American Indian or Alaska Native, Asian or Pacific Islander, Black or African-American, Hispanic/Latino, non-Hispanic white, or other), educational level (high school or less, some college/technical training, college or some post-college, and master or higher), different study cohorts (participation in OS or CTs, and different treatment assignments for all three CTs), hypertension (never, currently untreated, currently treated), high cholesterol requiring pills ever (no, yes), atrial fibrillation (for the analysis of stroke), family history of MI (for the analysis of CHD) or stroke (for the analysis of stroke). Prior hormone therapy (never, E alone, E+P, E alone ever and E+P ever). Depressive symptoms were categorized into none, mild, or moderate based on previously established cut-points of 0.009 and 0.06³⁶. Additional covariates included physical activity (<5, 5-<10, 10-<20, 20-<30, 30+ metabolic equivalent task values (METs) per week), smoking habit (never, former, current), alcohol consumption (non-drinker, past drinker, current and <1 drink per week, current and 1-7 drinks/week, current and ≥7 drinks/week, current and <1 drink per month), body mass index (BMI), waist-to-hip ratio (WHR), and healthy eating index (HEI)-2005 score (quartile). HEI-2005 was a measure of diet quality that assesses conformance to the 2005 dietary guidelines for Americans³⁷.

Follow-up:

The study participants were followed from the first time of interview if she already had diabetes, or from the date when she first reported diabetes during WHI follow-up, until the

first occurrence of CHD or stroke, date of death, or February 28, 2017 whichever occurred first.

Statistical analyses:

We performed both descriptive and inferential statistical analyses. Each personality trait exposure variable was categorized into quartiles. The baseline characteristics of exposure variables were described by mean and standard deviation (SD) for continuous variables and by number and percentage for categorical variables. Chi-square tests were applied to test differences for categorical variables and ANOVA was used to test differences for continuous variables.

In the inferential analysis, COX proportional hazards models were used to evaluate the associations (hazard ratios and 95% confidence intervals) between each of the exposures and the occurrence of CHD or stroke, respectively. The survival time was defined as the duration from the start of the follow-up to the end of follow-up as described above.

By using a progressively-adjusted regression method, multivariable proportional hazard models were adjusted for potential confounders. The first model adjusted for age, ethnicity, education, family income, family history of MI for the outcome of CHD, family history of stroke for the outcome of stroke, hypertension, high cholesterol requiring pills ever, and study cohort (CT or OS and different assignments for CTs). The second model additionally adjusted for depressive symptoms. The third model additionally adjusted for major modifiable lifestyle factors including BMI, waist-to-hip ratio, dietary quality, physical activity, smoking history, and alcohol consumption. Trend analysis were performed by entering the main exposure variables as continuous variables in the models. We further performed stratified analysis by prevalent or incident diabetes, as well as insulin treatment within the subgroups with prevalent diabetes or incident diabetes. Interaction between prevalent or incident diabetes and exposures, as well as the interaction between insulin treatment and exposures within subgroup with incident diabetes were performed. In the supplementary analyses, we tested the correlation between hostility score and time from menopause. We also test interaction between prior hormone use, VMS (hot flash or night sweats) symptom or prior hysterectomy and the hostility were conducted.

Results

The 15029 participants in our study were followed for a mean of 10 years with SD 5.5. A total of 1118 incident CHD and 710 incident stroke cases were observed. Table 1 shows the baseline characteristics of the study cohort by the quartile of hostility. Compared with the lowest quartile group, the highest quartile group was younger at the baseline ($p<0.001$), more likely to be black women ($p<0.0001$), current smokers ($p<0.0001$), past drinkers ($p<0.0001$), have lower level of education ($p<0.0001$), higher BMI ($p<0.0001$), lower HEI-2005 score ($p<0.0001$), and lower total energy expenditure from recreational physical activity (MET-hours/week) ($p<0.0001$). The highest quartile group had more hypertension ($p<0.0001$), more cholesterol treated requiring pills ever ($p<0.05$), more had never prior hormone therapy ($p<0.001$) than the lowest quartile group. The incidence rate of CHD was 687.84/100000 person-years, 780.68/100000 person-years, 710.09/100000 person-years,

890.97/100000 person-years in the first, second, third and fourth quartile of hostility in women with diabetes, respectively.

Table 2 shows the results from the hazard proportional regression models for the incidence of CHD. Women in the highest quartile of hostility had 24% [HR 1.24 (95% CI 1.03–1.49)] increased risk of CHD compared with women in the lowest quartile in model 1 which adjusted for age, race/ethnicity, education, family history of diabetes, family history of MI, hypertension, high cholesterol requiring pills ever, and different study cohorts. Similar results [HR 1.25 (95% CI 1.03–1.51)] were found in model 2 which adjusted further for depressive symptoms (plus model 1 variables) and model 3 [HR 1.22 (95% CI 1.01–1.48)] which additionally adjusted for life style factors such as BMI, WHR, smoking, alcohol intake, physical activity and quality of diet (plus model 1 and model 2 variables). P-values for trend were greater than 0.05. We did not find any statistically significant associations between optimism, Ambivalence over Emotional Expressiveness (AEE), Negative Emotional Expressiveness (NEE) and the risk of CHD.

Table 3 presents the results from the hazard proportional regression models for the incidence of stroke. No statistically significant associations between optimism, AEE, NEE or hostility and the incidence of stroke were found in different models. P-values for trend analysis were greater than 0.05.

The interactions between prevalent or incident diabetes and the exposure variables were tested and did not show any significant interaction. The score (mean and SD) on each of the personality traits for women with prevalent diabetes or incident diabetes were shown in supplementary table 1. The mean score of optimism in women with incident diabetes were significantly higher compare with women with prevalent diabetes. The mean score of hostility in women with incident diabetes were significantly lower compare with women with prevalent diabetes. There were no significant difference in the AEE and NEE mean scores. No statistically significant associations between personality traits and incidence of CHD or stroke were found in women with prevalent diabetes. Among women with incident diabetes, significant associations between hostility and CHD were found in model 1 [HR 1.34 95% CI 1.04–1.74], model 2 [HR 1.35 (95% CI 1.04–1.76)] and model 3 [HR 1.34 (95% CI 1.03–1.74)] (supplementary table 2). To exclude possible reverse causality, we further assessed the relationship between hostility and CHD by excluding the first year's follow-up. The highest quartile of hostility was related to increased risk of CHD in model 3 [HR 1.38, 95% CI (1.04–1.82)]. Within subgroups with incident diabetes, we performed a statistical test on interactions between insulin treatment and exposure variables and did not find significant interactions. Furthermore, we conducted stratified analyses by treatment with insulin in women with incident diabetes or prevalent diabetes. No significant associations between the hostility and the risk of CHD were observed in any of the stratified analyses. We did the similar stratified analyses for stroke by prevalent diabetes and incident diabetes and also additionally stratified by the treatment of insulin or not. We did not find any significant associations between personality traits and the risk of stroke in the stratified analyses. In our supplementary analyses, there were no statistical difference in the time from menopause by quartile of hostility. There were no significant correlation between time from menopause and the hostility traits. Interactions test between prior hormone use, VMS

symptom, or prior hysterectomy did not reveal any significant interactions. Since age and time from menopause are highly correlated, we additionally adjusted for VMS symptom and prior hysterectomy and the association hostility and the risk of CHD remained same.

Discussion

In this large-scale epidemiological study, we observed significant associations between high levels of hostility and the risk of coronary heart disease among women with diabetes. This finding was specific to women with incident, and not prevalent, diabetes. We did not find significant associations between optimism, AEE, NEE and the risk of CHD or stroke among women with diabetes.

To our knowledge, our study is the first prospective cohort study to investigate the associations between personality traits and the risk of CHD and stroke among women with diabetes. There have been studies on personality traits and risk of CHD in the general population without special focus on people with diabetes. A study based on WHI participants showed that the highest quartile of optimism was related to decreased incidence of CHD and total mortality compared to the lowest quartile³⁸. The association between hostility and incidence of CHD was not statistically significant.

The potential mechanisms behind the observed associations between high levels of hostility and the risk of CHD are complex. Links could be through stress-related inflammatory pathways [15] or health-behavioral pathways¹⁶. The higher level of hostility could increase individual's susceptibility to stress-induced higher cortisol levels²² and inflammation [15]. Cardiovascular disease is an inflammatory condition. Increased inflammatory markers, such as interleukin-6 (IL-6) level, are associated with risk of CVD^{39, 40}. In laboratory-based experimental stress testing of 140 participants with type 2 diabetes, participants with higher hostility scores had higher levels of IL-6⁴¹. Behaviorally, these personality traits affect self-management and adherence to the diabetic treatment and control program which includes regular blood glucose test, regular physical exercise, healthy diet and medication, and management of hypertension and dyslipidemia¹⁶. Good glycemic control is vital for the prevention of diabetic complications. Hostility was shown to be related to poorer glycemic control among people with type 2 diabetes¹⁶. In a 6 months follow-up study of 412 individuals (205 women) with type 2 diabetes from China, people who had high levels of negative affectivity and social inhibition had poor adherence to diabetic medication⁴². In our stratified analysis by prevalent or incident diabetes, we found significant associations between higher level of hostility and the risk of CHD only among women with incident diabetes. The biological mechanism behind the relationship is not fully understood. One possible explanation could be due to the fact that the personality traits were measured before or after diabetes diagnosis. Among the subgroup with incident diabetes, hostility was measured before diabetes diagnosis. Women with higher level of hostility may be less likely to engage in healthy behaviors such as attending regular medical check-up and adhering to the medical treatment. Thus, they might have had long period impaired glucose hemostasis which could synergize with the higher levels of hostility traits to increase the individual's susceptibility to CHD⁹⁻¹³. Among the subgroup with prevalent diabetes, the personality traits were measured after they were already diagnosed with diabetes and under the

treatment of diabetes. Thus, the risk of CHD may be more related to prior diabetes control and treatment other than post-diabetes hostility.

Our study has the following strengths: it has a large study sample of women with diabetes, long follow-up period, detailed information on personality traits and potential confounding factors such as diet, physical activity, smoking and alcohol consumption, and adjudicated information on the study outcomes (i.e. CVD). Our study has some limitations. First, information on the exposures and potential confounding factors were collected at baseline, changes of personality variables during follow-up were not examined and may have resulted in some misclassification and biased the results towards the null. Second, our study was based on postmenopausal women with diabetes in the US and this might limit the generalizability of our results. Third, diabetes diagnoses were self-reported and incident diabetes were all treated diabetes. However, the validity of self-reported diabetes is high according to validation studies in the WHI when comparing self-report with a gold standard based on medical record review and with medication inventories^{30, 31}. We cannot generalize our results to diabetes treated with only diet and life style modification. Fourth, this study investigated four personality traits and the risk of CHD or stroke. Several stratified analysis by subgroups of women were performed. Thus, multiple comparisons might be a concern and the play of chance could not be completely ruled out in the statistical analyses.

Conclusion

A higher level of hostility was associated with increased risk of coronary heart disease in our study of postmenopausal women with diabetes. However, additional research is needed to confirm this association. This study adds to the literature documenting the association between hostility and the risk of CHD among postmenopausal women with diabetes. Our results could provide a basis for health professionals to design and test a targeted prevention program for women with high hostility. As personality traits are not prone to change, the purpose of such an intervention is not to change personality but to direct intervention efforts toward women identified as at risk for adverse outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements:

A short list of WHI investigators can be found in the supplementary data.

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Table 1.

Baseline characteristics of the study cohort by quartiles of hostility trait

	Hostility							
	Q1		Q2		Q3		Q4	
	n	Mean (SD) or (%)	n	Mean (SD) or (%)	n	Mean (SD) or (%)	n	Mean (SD) or (%)
Age at baseline (years)	2410	68.1 (7.6)	2797	67.9 (7.6)	3661	67.4 (7.7)	2478	66.8 (7.8)
Ethnicity								
American Indian or Alaskan Native	7	(0.3)	17	(0.6)	16	(0.4)	32	(1.3)
Asian or Pacific Islander	114	(4.7)	92	(3.3)	123	(3.4)	83	(3.3)
Black or African-American	248	(10.3)	365	(13.0)	666	(18.2)	620	(25.0)
Hispanic/Latino	109	(4.5)	134	(4.8)	201	(5.5)	224	(9.0)
White (not of Hispanic origin)	1896	(78.7)	2157	(77.1)	2606	(71.2)	1474	(59.5)
Other	36	(1.5)	32	(1.1)	49	(1.3)	45	(1.8)
Educational levels								
higher diploma or less	520	(21.6)	661	(23.6)	955	(26.1)	884	(35.7)
some college or technical training	907	(37.6)	1096	(39.2)	1597	(43.6)	1000	(40.4)
college graduate or some post-college	533	(22.1)	578	(20.7)	643	(17.6)	365	(14.7)
master degree or higher	450	(18.7)	462	(16.5)	466	(12.7)	229	(9.2)
BMI (kg/m ²)	2389	30.8 (6.3)	2782	31.1 (6.4)	3638	31.7 (6.6)	2468	32.6 (6.7)
Waist/Hip Ratio (WHR)	2398	0.9 (0.1)	2787	0.9 (0.1)	3643	0.9 (0.1)	2473	0.9 (0.1)
Total energy expend from recreational phys activity (MET-hours/week)	2407	10.6 (12.3)	2795	9.9 (12.0)	3659	9.4 (11.6)	2475	9.0 (11.9)
TOTAL HEI-2005 SCORE	2410	67.9 (10.6)	2796	67.4 (10.8)	3661	66.3 (10.7)	2478	64.8 (11.1)
Smoking habit								
Never Smoked	1258	(52.2)	1485	(53.1)	1906	(52.1)	1317	(53.1)
Past Smoker	996	(41.3)	1117	(39.9)	1491	(40.7)	948	(38.3)
Current Smoker	156	(6.5)	195	(7.0)	264	(7.2)	213	(8.6)
Alcohol consumption								
Non drinker	303	(12.6)	337	(12.0)	505	(13.8)	451	(18.2)

	Hostility							
	Q1		Q2		Q3		Q4	
	n	Mean (SD) or (%)	n	Mean (SD) or (%)	n	Mean (SD) or (%)	n	Mean (SD) or (%)
Past drinker	580	(24.1)	734	(26.2)	970	(26.5)	786	(31.7)
<1 drink per month	385	(16.0)	431	(15.4)	605	(16.5)	339	(13.7)
<1 drink per week	475	(19.7)	581	(20.8)	780	(21.3)	456	(18.4)
1 to <7 drinks per week	492	(20.4)	515	(18.4)	589	(16.1)	346	(14.0)
7+ drinks per week	175	(7.3)	199	(7.1)	212	(5.8)	100	(4.0)
High cholesterol requiring pills ever								
No	1972	(81.8)	2291	(81.9)	2963	(80.9)	1979	(79.9)
Yes	438	(18.2)	506	(18.1)	698	(19.1)	499	(20.1)
Hypertension								
Never hypertensive	1441	(59.8)	1600	(57.2)	2066	(56.4)	1376	(55.5)
Untreated hypertensive	899	(37.3)	1088	(38.9)	1473	(40.2)	1002	(40.4)
Treated hypertensive	70	(2.9)	109	(3.9)	122	(3.3)	100	(4.0)
Relative had stroke								
No	1132	(47.0)	1301	(46.5)	1628	(44.5)	1125	(45.4)
Yes	1278	(53.0)	1496	(53.5)	2033	(55.5)	1353	(54.6)
Relative had MI								
No	1349	(44.8)	1140	(44.2)	2039	(45.1)	1365	(47.4)
Yes	1659	(55.2)	1438	(55.8)	2479	(54.9)	1515	(52.6)
Depressive symptoms								
None	2024	(84.0)	2147	(76.8)	2640	(72.1)	1512	(61.0)
Mild	264	(11.0)	367	(13.1)	528	(14.4)	411	(16.6)
Moderate	122	(5.1)	283	(10.1)	493	(13.5)	555	(22.4)
Systolic blood pressure								
<=120	745	(30.9)	748	(26.8)	987	(27.0)	650	(26.3)
120 – 140	1067	(44.3)	1288	(46.1)	1707	(46.7)	1119	(45.2)

	Hostility							
	Q1		Q2		Q3		Q4	
	n	Mean (SD) or (%)	n	Mean (SD) or (%)	n	Mean (SD) or (%)	n	Mean (SD) or (%)
>140	597	(24.8)	760	(27.2)	964	(26.4)	705	(28.5)
Diastolic blood pressure								
<90	2198	(91.2)	2567	(91.8)	3345	(91.4)	2247	(90.8)
>=90	211	(8.8)	229	(8.2)	313	(8.6)	227	(9.2)
Prior hormone therapy								
never	1060	(44.8)	1315	(47.9)	1813	(50.3)	1323	(54.2)
E alone	697	(29.4)	815	(29.7)	1079	(29.9)	703	(28.8)
E+P	471	(19.9)	499	(18.2)	550	(15.3)	323	(13.2)
E alone ever or E+P ever	140	(5.9)	117	(4.3)	164	(4.5)	91	(3.7)

Table 2: Association (HR 95% CI) between personality traits and CHD in women with diabetes.

		Model ^a	Model ^b	Model ^c
	Cases	HR (95% CI)	HR (95% CI)	HR (95% CI)
Optimism				
1	157	Reference	Reference	Reference
2	145	1.04 (0.87–1.24)	1.04 (0.87–1.25)	1.06 (0.89–1.28)
3	214	0.96 (0.82–1.13)	0.96 (0.82–1.14)	0.98 (0.83–1.16)
4	129	0.94 (0.78–1.13)	0.94 (0.78–1.14)	0.96 (0.79–1.17)
p-value for trend		0.42	0.37	0.53
Ambivalence over Emotional Expressiveness (AEE)				
1	160	Reference	Reference	Reference
2	207	1.05 (0.89–1.23)	1.05 (0.90–1.23)	1.05 (0.89–1.23)
3	115	1.01 (0.84–1.22)	1.01 (0.84–1.23)	1.04 (0.86–1.25)
4	163	1.03 (0.86–1.23)	1.03 (0.86–1.23)	1.03 (0.86–1.23)
p-value for trend		0.88	0.89	0.85
Negative Emotional Expressiveness (NEE)				
1	151	Reference	Reference	Reference
2	171	0.95 (0.80–1.13)	0.95 (0.80–1.13)	0.95 (0.80–1.13)
3	189	0.94 (0.80–1.11)	0.94 (0.80–1.11)	0.93 (0.79–1.11)
4	134	1.07 (0.89–1.29)	1.07 (0.89–1.28)	1.06 (0.88–1.28)
p-value for trend		0.57	0.59	0.70
Hostility				
1	122	Reference	Reference	Reference
2	143	1.10 (0.92–1.33)	1.11 (0.92–1.33)	1.11 (0.93–1.34)
3	225	1.00 (0.83–1.19)	1.00 (0.84–1.19)	0.99 (0.83–1.19)
4	155	1.24 (1.03–1.49)	1.25 (1.03–1.51)	1.22 (1.01–1.48)
p-value for trend		0.08	0.08	0.13

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^a adjusted for age at baseline, race/ethnicity (American Indian or Alaska Native, Asian or Pacific Islander, Black or African-American, Hispanic/Latino, non-Hispanic white, and other), education (high school or less, some college/technical training, college or some post-college, and master or higher), family history of MI (no, yes), hypertension never, currently untreated, currently treated, high cholesterol requiring pills ever (no, yes), and different study cohorts (participation in OS or CTs, and different treatment assignments for all three CTs), prior hormone use

^b Further adjusted for depressive symptoms,

^c further adjusted for BMI, WHR, smoking (never, former, current), alcohol intake (non-drinker, past drinker, current and <7 drinks/week), physical activity (<5, 5-<10, 10-<20, 20-<30, 30+ Metabolic equivalent (METs)/week), and quality of diet (quartile)

Table 3: Association (HR 95% CI) between personality traits and stroke in women with diabetes.

		Model ^a	Model ^b	Model ^c
	Cases	HR (95% CI)	HR (95% CI)	HR (95% CI)
Optimism				
1	157	Reference	Reference	Reference
2	145	1.04 (0.83–1.30)	1.04 (0.83–1.30)	1.10 (0.87–1.38)
3	214	0.92 (0.75–1.13)	0.92 (0.75–1.13)	0.97 (0.79–1.20)
4	129	0.84 (0.67–1.07)	0.84 (0.66–1.07)	0.90 (0.70–1.14)
P-value for trend		0.10	0.09	0.23
Ambivalence over Emotional Expressiveness (AEE)				
1	160	Reference	Reference	Reference
2	207	0.93 (0.76–1.14)	0.93 (0.76–1.14)	0.92 (0.75–1.13)
3	115	1.01 (0.80–1.28)	1.01 (0.80–1.28)	1.02 (0.81–1.30)
4	163	1.14 (0.92–1.42)	1.15 (0.92–1.42)	1.12 (0.90–1.40)
p-value for trend		0.13	0.13	0.17
Negative Emotional Expressiveness (NEE)				
1	151	Reference	Reference	Reference
2	171	0.95 (0.77–1.18)	0.95 (0.77–1.18)	0.99 (0.80–1.23)
3	189	0.90 (0.73–1.10)	0.89 (0.73–1.10)	0.91 (0.74–1.13)
4	134	0.99 (0.79–1.24)	0.99 (0.79–1.24)	1.02 (0.81–1.29)
p-value for trend		0.71	0.71	0.89
Hostility				
1	122	Reference	Reference	Reference
2	143	0.97 (0.77–1.24)	0.97 (0.77–1.24)	0.97 (0.76–1.23)
3	225	1.13 (0.91–1.41)	1.13 (0.91–1.41)	1.13 (0.91–1.42)
4	155	1.18 (0.92–1.49)	1.18 (0.92–1.50)	1.14 (0.89–1.45)
p-value for trend		0.11	0.12	0.20

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^a adjusted for age at baseline, race/ethnicity (American Indian or Alaska Native, Asian or Pacific Islander, Black or African-American, Hispanic/Latino, non-Hispanic white, and other), education (high school or less, some college/technical training, college or some post-college, and master or higher), family history of stroke (no, yes), hypertension never, currently untreated, currently treated, high cholesterol requiring pills ever (no, yes), and different study cohorts (participation in OS or CTs, and different treatment assignments for all three CTs), atrial fibrillation, prior hormone use

^b further adjusted for depressive symptoms,

^c further adjusted for BMI, WHR, smoking (never, former, current), alcohol intake (non-drinker, past drinker, current and <7 drinks/week, current and 7 drinks/week), physical activity (<5, 5-<10, 10-<20, 20-<30, 30+ Metabolic equivalent (METs)/week), and quality of diet (quartile)