Original Research

Wisconsin Rural Women's Health Study Psychological Factors and Blood Cholesterol Level: Difference between Normal and Overweight Rural Women

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ABSTRACT

OBJECTIVE

The aim of the present study is to investigate the effects of psychological factors on plasma lipid levels among rural women of central Wisconsin and to compare the effects of these variables among normal-weight and overweight women.

METHODS

Stratified sampling was used to select a random sample ($n=1500$) of farm and non-farm women aged 25 to 71 years from the Central Marshfield Epidemiologic Study Area. The baseline examination included measurements of blood pressure, skin folds, height, weight, and fasting blood lipids, glucose, and insulin. Framingham study questionnaires were employed to measure anger, anxiety, tension, and marital disagreement. The Spielberger Trait anger-reaction sub-scale was employed to assess proneness to anger.

RESULTS

Among normal-weight women, a positive association was found between anger-reaction scores and cholesterol ($b=0.008$), ratio ($b=0.014$), triglycerides ($b=0.02$), and LDL ($b=0.07$). The odds of elevated cholesterol were highest among women with high scores on the Spielberger anger-reaction scale ($OR=2.0$) and anger discussion scale ($OR=2.0$), while the odds were less among women with high scores on the anger-out scale ($OR=0.59$). However, among overweight women, we found only scores on the Framingham anger-discussion scale as an important factor to determine the plasma lipid levels.

CONCLUSION

Anger management may help to sever the link between psychological factors and CHD risk factors. Intervention intended to prevent cardiac events through the reduction of stress and modification of related psychological risk factors have successfully improved the CHD risk factors profile. Similar studies are needed to determine the efficacy of intervention for the primary prevention of CHD risk factors.

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INTRODUCTION

Approximately 102.3 million American adults have total blood cholesterol levels of 200 milligrams per deciliter (mg/dl) and higher, which is considered above desirable level.¹ Of these, about 41.3 million have levels of 240 mg/dl or higher, which is considered high risk. Studies have shown that hyperlipidemia with elevated levels of total cholesterol, low-density lipoprotein (LDL) cholesterol, and triglycerides; and low levels of high-density lipoprotein (HDL) cholesterol are important risk factors for coronary heart disease (CHD).²⁻⁵ Other major known risk factors for elevated plasma lipid levels are age, weight, blood pressure, diet, exercise, smoking and alcohol intake.⁶

Although links between elevated lipid levels and the risk factors listed above have been established in many studies, the combination of these risk factors do not account for the total variance in lipid levels.⁷⁻¹⁰ This problem has resulted in a broadening of the search for additional risk factors for hyperlipidemia, including psychological factors. A 1991 study reported by Dujovne and Kent examined the relationship of hostility-related variables and plasma lipid levels among men and women attending the Lipid, Atherosclerosis, Metabolic and LDL Apheresis Center at the University of Kansas Medical Center.¹¹ Overall, the results suggests that high levels of expressive hostility and cynical hostility are associated with elevated plasma lipid levels. Another study conducted in 1987 by Weidner and associates examined the association between type A behavior and hostility and CHD risk factors among 742 subjects participating in the Family Heart Study in Portland, Oregon.⁹ They found that persons scoring high on Type A behavior and hostility had elevated levels of total plasma cholesterol and LDL cholesterol. The findings were also replicated in a 1-year follow-up, suggesting that psychological factors have a detrimental effect on plasma lipids.

According to the rural Healthy People 2010 survey, mental health is one of the 10 leading health indicators.¹² Mental health was the fourth most often identified rural health priority. Psychological factors activate the sympathetic adrenal-medullary system and the pituitary adrenal-cortical system, resulting in elevated heart rate, blood pressure, catecholamines, and serum cholesterol.¹³⁻¹⁵ Stress induced catecholamine release is atherogenic when free fatty acids and other lipids are mobilized by these hormones in excess of metabolic requirements and then are taken up by the arterial wall or are converted to triglycerides. There have been numerous studies conducted to explain the damaging effect of psychological factors on high blood pressure,¹⁶⁻¹⁸ atherosclerosis,^{10, 19} and adverse lipid profiles.²⁰

Obesity is a known risk factor for elevated lipid levels.²¹ Obesity has also been suggested to have a negative impact on many psychological parameters, including depression.²²⁻²⁵ Studies have shown that overweight people have different behavioral and personality characteristics than normal-weight people. Obesity prevalence and incidence have reached

epidemic proportions in the United States.²⁶ A study conducted in 1974 by Segers and Mertens found that thin and normal-weight subjects exhibit little cardiovascular risk but present an increased psychological one characterized by anxiety, depression, and a tendency to agree or to disagree.²³ In this study, obese subjects had increased cardiovascular risk, but their psychological risk was not elevated. Therefore, it is important to consider the potential interaction of obesity and psychological variables in the development of elevated lipids.

Though numerous psychological measures have been tested for an etiological role in elevated plasma lipid levels, usually no more than one or two such measures have been incorporated in any single study. The aim of the present study is to investigate the effects of anger-related variables, tension, anxiety, self-esteem, marital disagreement, and marital satisfaction on plasma lipid levels among rural women of central Wisconsin and to compare the effects of these variables among overweight and normal-weight women.

METHODS

Participants for this study were recruited from the Marshfield Epidemiologic Study Area (MESA), a geographic area in rural central Wisconsin comprised of 14 zip codes and 50,000 residents.²⁷ Marshfield Clinic, Marshfield, Wisconsin, is an integrated regional health system with all major medical specialties and sub-specialties. Marshfield Clinic provides nearly all of the healthcare for the residents of the immediate service area. Inpatient events are also captured through a combined medical record with Saint Joseph's Hospital, which is also located in Marshfield.

The study was designed as a prospective cohort study with recruitment occurring between 1996 and 2001, with an allowance for an estimated 2% attrition per year. With a two-sided test (a type I error rate=0.05) and a relative risk of 2.0 in farm women versus non-farm women, the power was likely to vary from 44% for an outcome of 5 per 1,000 person years after 3 years, to 99% for any outcome exceeding 25 per 1,000 person years after 3 years. Stratified sampling was used to select a total sample size of 1,500 with the assumption that approximately 500 farm and 1,000 non-farm women would be included in the cohort. Consecutive random samples of 100 potential participants were drawn without replacement until the desired sample size was reached.

Following study approval by the Institutional Review Board, a letter introducing the study was mailed to the women identified to fit the study requirements. The mailing was followed-up by a telephone call by a research coordinator that explained the procedure of the study and invited the individual to the research site to participate in the cohort study. Before participation, all participants signed an informed consent document.

Self-administered questionnaires and appointment reminders were mailed to the participants. Questionnaires included items about personal health history, use of medications, symptoms of anxiety and depression, quality of life, social support, job control, socioeconomic status, reproductive history, smoking and alcohol intake, physical activity, and a detailed semi-quantitative food frequency questionnaire. At the appointment, the research coordinators reviewed the questionnaire with the participant. The health events reported on the questionnaire were further verified through the electronic medical record.

Height (cm) and weight (kilogram) were measured with participants clothed in an examination gown and undergarments. Waist, abdominal and hip circumferences were also measured. Reliability of all the measurements was assessed by repeating the measurements in 10% of the participants and the percentage agreement ranged from 98% to 100%. Body mass index (BMI) was calculated by dividing the weight in kilograms by the height in meters, squared. Each subject had a whole blood sample drawn by a trained phlebotomist after having fasted for at least 10 to 12 hours prior to the blood draw. The blood sample was later tested for lipids, glucose, insulin, TSH, cortisol, fibrinogen, factor VII and triglycerides.

Psychological measures

The Framingham Study, included a 300-item questionnaire, designed to assess the relationship of psychosocial factors to CHD.²⁸ Several of the questions were designed to measure the psychological status of study participants. The authors of this study developed 20 scales based on psychosocial stress. For this study, seven scales from the Framingham Study were used: tension, anxiety, anger symptoms, anger-in, anger-out, anger-discuss, and marital disagreement. The tension, anxiety, and anger scales reflect physiologic or behavioral responses by the individual to their environment. All scales were scored according to the Framingham Study guidelines.

- Tension Scale: Seven items that measure the frequency of occurrence of nervous symptoms.
- Anxiety Scale: Five items that encompass somatic expression of circulatory symptoms (giddiness, palpitation, etc.) of an anxiety state.
- Anger-symptoms Scale: Five items that reflect physiologic (headache, nervousness, etc.) reactions to anger.
- Anger-in Scale: Three items to determine if the reaction to anger is to internalize it.
- Anger-out Scale: Two items to determine if the reaction to anger is to take it out on others.
- Anger-discuss Scale: Two items to determine if the reaction to anger is to discuss it with a friend or relative.
- Marital Disagreement Scale: Eighteen items that reflect the frequency of disagreement over money matters, in-laws, children, housekeeping, sex, etc.

For each scale, scores ranged from 0 to 1, with 0 indicating the absence of stress and 1 indicating the complete presence of stress. As responses to the anxiety and tension scales were not distributed normally, ordinal variables were created for both of the scales, with four categories ranging from very low to high based on the frequency of responses in each category. Also, a binary variable (low, high) was created for the anger-symptoms, anger-in, anger-out, and anger-discussion scales.

Proneness to anger was assessed by the Spielberger Trait Anger Scale which is composed of two subscales, anger-temperament and anger-reaction.²⁹ For this study, only the anger-reaction subscale consisting of six items was used. Persons prone to anger reactions experience anger when frustrated, mistreated, or negatively evaluated by others. A continuous variable was created with scores ranging from 0 to 12. Also, a categorical variable was created with 3 categories:

- Low: Scores <2
- Moderate: Scores ranging from 2 to 4
- High: Scores ranging from 5 to 12.

Other factors included as potential, confounding variables were age, smoking status, level of education and BMI. For logistic regression analysis, age, smoking status and education, were divided into three categories.

- Age: 25 to 40, 41 to 50, or >50
- Smoking status: Never, past, and current smoker
- Level of education: Less than high school, high school, and college degree

A binary "overweight" variable was created with BMI ≥ 25 defined as "overweight" and BMI <25 defined as "normal-weight."

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Statistical analysis

Data was entered twice and verified prior to analysis. Statistical analysis was performed with the software application, Statistical Package for the Social Sciences [(SPSS), SPSS Inc., Chicago, IL], version 10.0. Multiple linear and multiple logistic regression were used in a cross-sectional analysis to examine the associations of psychological factors to plasma lipid levels. To assess the interaction of obesity, psychological factors and plasma lipid levels, a stratified analysis was used with the "overweight" variable as the split variable. A P -value <0.05 was considered to be statistically significant.

Data were analyzed in the following manner. For each psychological variable, multiple linear regression and multiple logistic regression analyses were performed in which age, ever smoked, currently employed, and education were statistically controlled and separate output was obtained for overweight and normal-weight women by taking the "overweight" variable as the split variable. We found age, currently employed, and education as confounding factors as

they were related to both the outcome and the effect variables. To adjust for the confounding, we entered all these factors into the model during analysis.

RESULTS

The study sample consisted of 1,500 women, residents of the MESA area, between the ages of 25 to 75. Ninety-nine percent (1,438/1,500) of the cohort was non-Hispanic Caucasian. The sample was divided into two weight categories: normal-weight (BMI <25) and overweight/obese (BMI ≥25). Table 1 documents the demographic and plasma lipid characteristics of the sample by weight categories.

There was a significant age difference between the normal-weight (mean age= 43.4 yrs) and the overweight cohort (mean age= 49.1 yrs). The number of normal-weight women (82.8%) currently employed by or working on a family or agricultural business, was significantly higher than overweight women not employed by non-family or agricultural business (77.3%). The level of education also differed significantly between the two cohorts with higher education in the normal-weight cohort than the overweight cohort. The plasma lipid measurements were significantly different between the two cohorts. The overweight cohort had higher levels of cholesterol, triglycerides and LDL cholesterol, and lower level of HDL cholesterol compared to normal-weight the cohort.

The scores from the psychological scales for both of the cohorts are presented in table 2. Both of the cohorts differed in anxiety and marital disagreement scores, while there was no difference in the anger and tension scores. Normal-weight women were found to have a high marital disagreement score and a low anxiety score as compared to overweight women.

Multiple linear regression analysis was carried out for the Framingham anger-symptoms scale and the marital disagreement scale scores and the anger-reaction subscale scores of Spielberger's Trait Anger Scale. Table 3 presents the β coefficients and P -values for the association between the plasma lipid measures and the psychological measures by weight categories. For normal-weight women, multiple linear regression analysis for the scores of the Framingham anger-symptoms scale revealed no significant association with plasma lipid measures. Analysis of Spielberger's anger-reaction subscale revealed significant positive associations between anger and cholesterol, ratio (total cholesterol/HDL cholesterol), triglycerides, and LDL measures. The marital disagreement score was found to have a significant negative association with the HDL measure. For overweight women, none of the psychological measures were found to have a significant effect on the plasma lipid measures.

Table 1. Demographics and plasma lipid characteristics of the Rural Women's Health Study Cohort and comparison among normal-weight and overweight women.

	Entire cohort % or Mean, 95% CI (n = 1500)	Normal-weight women % or Mean, 95% CI (n = 494)	Overweight women % or Mean, 95 % CI (n = 1006)	χ^2 or t-test
Mean age (years)	47.2	43.4	49.1	t = -8.47 **
Currently employed	79.1%	82.8%	77.3%	χ^2 = 5.97 *
Occupation – Homemaker	58.4%	60.9%	57.2%	χ^2 = 1.88
Marital status – Married	89.1%	90.1%	88.6 %	χ^2 = 0.77
Education				
< High school or high school	70.7%	63.4%	74.4%	χ^2 = 19.34**
College degree	29.3%	36.6%	25.6%	
Smoking status (ever smoked)	34.7%	36.0%	34.0%	χ^2 = 0.60
	197	186.6	202.3	
Blood cholesterol level (mg/dl)	(194.4, 198.3)	(183.0, 190.6)	(199.9, 204.4)	t = -7.96 **
HDL level	53.6	58.5	51.1	
	(52.8, 54.3)	(57.3, 59.8)	(50.4, 52.1)	t = 9.84 **
LDL level	123.4	114	128.1	
	(121.7, 125.1)	(111.4, 116.9)	(125.3, 131.1)	t = -8.02 **
Triglycerides level	102.3	75.9	117.9	
	(99.4, 105.6,)	(73.5, 79.8)	(114.4, 121.5)	t = -14.70**
Ratio – Total cholesterol/ HDL level	3.8	3.2	4.0	
	(3.7, 3.8)	(3.3, 3.3)	(4.0, 4.1)	t = -14.27**

* $P < 0.05$

** $P < 0.0001$

Table 2. Psychological characteristics of the Rural Women's Health Study Cohort and comparison among overweight and normal-weight women.

Psychological variables	Entire cohort	Normal-weight women	Overweight women	t-test or Mann-Whitney test
	Mean, 95% CI or Median, Range (n = 1500)	Mean, 95% CI or Median, Range (n = 494)	Mean, 95% CI or Median, Range (n = 1006)	
Anger-reaction ^a	3.6 (3.6, 3.8)	3.7 (3.5, 3.9)	3.6 (3.5, 3.7)	t = -.566
Anger-symptoms ^b	0.3 (0.3, 0.3)	0.3 (0.3, 0.3)	0.3 (0.3, 0.3)	t = -.577
Marital disagreement ^b	0.2 (0.2, 0.2)	0.2 (0.2, 0.2)	0.2 (0.2, 0.2)	*t = 2.067
Anxiety ^b	Median = 0.2 Range = 1.0	Median = 0.0 Range = 1.0	Median = 0.2 Range = 1.0	**Mann-Whitney Z = -4.133
Tension ^b	Median = 0.3 Range = 1.0	Median = 0.3 Range = 1.0	Median = 0.3 Range = 1.0	
				Mann-Whitney Z = -.361

^a Scores range from 0 to 12, with a higher score representing a greater level of anger.

^b Scores range from 0 to 1; 0 indicates the absence of stress, and 1 indicates the complete presence of stress.

*P <0.05

**P <0.0001

Table 3. Results of multiple linear regression relating psychological factors to plasma lipids and lipoproteins (β coefficient, P-value). Significant results are presented in bold.

	Framingham anger symptoms		Speilberger's anger reaction subscale		Framingham marital disagreement scale	
	Normal-weight	Overweight	Normal-weight	Overweight	Normal-weight	Overweight
Cholesterol	-0.025 (0.60)	-0.004 (0.91)	0.008 (0.02)	0.004 (0.09)	0.031 (0.58)	0.031 (0.46)
HDL	-0.370 (0.15)	0.240 (0.25)	0.021 (0.24)	0.001 (0.88)	-0.610 (0.04)	0.100 (0.64)
Ratio	0.069 (0.36)	-0.066 (0.34)	0.014 (0.01)	0.003 (0.41)	0.150 (0.08)	0.0009 (0.90)
Triglycerides	0.220 (0.08)	-0.040 (0.69)	0.020 (0.02)	0.0007 (0.08)	0.270 (0.08)	-0.006 (0.96)
LDL	-0.140 (0.73)	-0.100 (0.74)	0.074 (0.01)	0.019 (0.33)	0.630 (0.18)	0.070 (0.84)

Adjusted for age, smoking status, employment, and level of education.

Multiple logistic regression analysis was carried out for anxiety, tension, anger-symptoms, anger-in, anger-out, anger-discuss, and anger-reaction scales. Among normal-weight people, the odds of elevated cholesterol were higher among women with high scores on the Speilberger's anger-reaction subscale (OR=2.0, 95% CI= 1.08, 3.7), and anger discussion scale (OR=2.0, 95% CI= 1.09, 3.9), while the odds were less among women with high scores on the Framingham anger-out scale (OR= 0.59, 95% CI= 0.3, 0.9). The odds of low HDL were high among women with moderate anxiety compared to low anxiety (OR= 2.6, 95% CI= 1.1, 6.1) and high levels of anger-out compared to low levels of anger-out (OR= 2.66, 95% CI = 1.1, 6.4), while the odds were less among the women with high levels of anger-discussion (OR= 0.29, 95% CI= 0.1, 0.7). The odds of elevated LDL levels were less among the women with higher levels of anger-discussion (OR= 0.62, 95% CI= 0.4, 0.9). For overweight women, only anger-discussion was found to have a significant effect on the plasma lipid levels. The odds of elevated triglycerides (OR= 0.6, 95% CI= 0.4, 0.9), elevated

ratio (OR= 0.62, 95% CI= 0.3, 0.9), and low HDL (OR= 0.63, 95% CI= 0.4, 0.9) were lower among women with higher levels of anger-discussion compared to women with lower levels of anger-discussion.

DISCUSSION

This study supports the hypothesis that psychological factors play a different role among normal-weight and overweight subjects. The study findings suggest a strong association between trait anger-reaction and elevated plasma lipid levels among normal-weight women. However, a significant association among overweight women was not found. Among normal-weight women, we observed a negative correlation between scores on the Framingham anger-out and anger-discussion scales, and plasma lipid levels. While among overweight-women, only the Framingham anger-discussion was found to be an important factor in determining plasma lipid levels. No evidence was found that feeling anxious or tense predicted plasma lipid levels in both of the cohorts.

The study findings confirm those of the Framingham study in showing an association of anger-out with cholesterol levels. In the Framingham study,²⁸ the authors found that lower scores on the anger-out variables was associated with elevated cholesterol levels among women aged 45 to 65 years. Previous cohort studies have also reported that scores on the Framingham anger-out scale are inversely related to CHD risk factors. Among white collar men aged 45 to 64 years, Haynes, Feinleib, & Kannel³⁰ observed that lower Framingham anger-out scores were related to significantly increased risk of CHD in multivariate analysis. More recently, in the Caerphilly study of 2,890 men aged 49 to 65 years, investigators detected an increased risk of ischemic heart disease among low scorers on the Framingham anger-out scale.³¹

Several limitations of this study are worth noting. First, our results were based on a single evaluation of psychosocial factors. Because levels of anxiety and tension are not necessarily static in individuals, the lack of association between symptoms of anxiety, tension, and plasma lipid levels may reflect a lack of stability in the psychological symptoms of the participants. It would be potentially fruitful to complete a longitudinal study to evaluate patterns of psychological factors over time based on repeated symptom assessment and to explore its association with plasma lipid levels. A second potential limitation is that the anger questions were framed in the context of what happens when someone is really angry or annoyed. No account was taken to the frequency or duration of anger episodes or to the level of anger being experienced. Also, small numbers of measures were available for all the scales. For example, anger-discuss and anger-out were measured with only two items. Furthermore, this study includes only non-Hispanic white (99%) women. This limitation reduces the generalizability of findings to other ethnic samples, as well as to male cohorts.

A meta-analysis of articles published from 1980 to 1998 concerning negative emotions and heart disease concluded that evidence related to the relationship of distress-induced atherosclerosis and endothelial dysfunction strongly supports the role of psychological factors in the development of CHD risk factors.³² Anger management may help to sever the link between this negative emotion and CHD risk factors. Intervention intended to prevent cardiac events through the reduction of stress and modification of related psychological risk factors are promising and efficacious.³³ Interventions such as type A behavior counseling, cardiac rehabilitation, exercise training, anger/anxiety reduction, and meditation, have successfully forestalled the recurrence of cardiac events,^{34,35} and have improved CHD risk factor profiles and overall quality of life.³⁶ Similar studies are needed to determine the efficacy of intervention for the primary prevention of CHD risk factors.

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REFERENCES

1. Center for Disease Control and Prevention. Cholesterol fact sheet. 2002. Available at <http://www.cdc.gov/omh/AMH/factsheets/cardio.htm>. Accessed January 2, 2004.
2. Gillium RF. Coronary heart disease in black populations. I. Mortality and morbidity. *Am Heart J* 1984;104:839-851.
3. Gillium RF, Grant CT. Coronary heart disease in black populations. II. Risk factors. *Am. Heart. J* 1984;104:852-860.
4. Singh, B. Mehta JL. Management of dyslipidemia in the primary prevention of coronary heart disease. *Curr Opin Cardiol* 2002;17:503-511.
5. Koba S, Hirano T, Sakaue T, Takeuchi H, Adachi M, Katagiri T. An increased number of very-low-density lipoprotein particles is strongly associated with coronary heart disease in Japanese man, independently of intermediate -density-lipoprotein or low-density-lipoprotein. *Coron Artery Dis* 2002;13:255-262.
6. American Heart Association. Cholesterol. 2002. Available at <http://www.americanheart.org/presenter.jhtml?identifier=448>. Accessed January 2, 2004.
7. Suarez E, Bates M, Harralson T. The relation of hostility to lipids and lipoproteins in women: evidence for the role of antagonistic hostility. *Ann Behav Med* 1998;20:59-63.
8. Johnson E, Collier P, Nazzaro P, Gilbert D. Psychological and physiological predictors of lipids in black males. *J Behav Med* 1992;15:285-298.
9. Weidner G, Sexton G, McLellarn R, Connor S, Matarazzo J. The role of Type A behavior and hostility in an elevation of plasma lipids in adult women and men. *Psychosom Med* 1987;49:136-145.
10. Dembroski T, MacDougall J, Williams R, Haney T, Blumenthal J. Components of Type A, hostility, and anger-in: relationship to angiographic findings. *Psychosom Med* 1985;47:219-233.
11. Dujovne VF, Houston B. Hostility-related variables and plasma lipid levels. *J Behav Med* 1991;14:555-565.
12. Gamn L, Stone S, Pittman S. Rural health and mental disorders—a rural challenge. In: Gamm L, Hutchison L, Dabney B, Dorsey A, eds. *Rural Healthy People 2010: A companion Document to Healthy People 2010*, College Station, TX: The Texas A&M University System Health Science Center; 2003;1:165-186.
13. Krantz DS, Manuck SB. Acute psychological reactivity and risk of cardiovascular disease: a review and methodological critique. *Psychol Bull* 1984;96:435-464.
14. Adams DO. Molecular biology of macrophage activation: a pathway whereby psychosocial actors can potentially affect health. *Psychosom Med* 1994;56:316-327.
15. Haft J. Cardiovascular injury induced by sympathetic catecholamines. *Progress in Cardiovascular Disease* 1974;XVII(1):73-85.
16. Markovitz J, Matthews K, Kannel W, Cobb J, D'Agostino R. Psychological predictors of hypertension in the Framingham study: is there tension I hypertension? *JAMA* 1993;270:2439-2443.
17. Porter L, Stone A, Schwartz J. Anger expression and ambulatory blood pressure: a comparison of state and trait measures. *Psychosom Med* 1999;61:454-463.

18. Goldberg E, Comstock G, Graves C. Psychological factors and blood pressure. *Psychol Med* 1980;10:243-255.
19. Matthews KA, Owen JF, Kuller LH, Sutton-Tyrell K, Jansen-McWilliams L. Are hostility and anxiety associated with carotid atherosclerosis in health post-menopausal women? *Psychosom Med* 1998;60:633-638.
20. Engebreston TO, Stoney CM. Anger expression and lipid concentrations. *Int J Behav Med* 1995;2:281-298.
21. American Heart Association. Risk factors of coronary heart disease. 2002. Available at <http://www.americanheart.org/presenter.jhtml?identifier=235>. Accessed January 2, 2004.
22. Jacobs S, Wagner M. Obese and nonobese individuals: behavioral and personality characteristics. *Addictive Behavior* 1984;9:223-226.
23. Segers M, Mertens C. Psychological and bioclinical CHD risk factors. Quantitative differences between obese, normal and thin subjects. *J Psychosom Res* 1974;18:403-411.
24. Crisp AH, McGuinness B. Jolly Fat: relation between obesity and psychoneurosis in general population. *BMJ* 1975;1:7-9.
25. Johnson S, Swenson WM, Gastineau CF. Personality characteristics in obesity: relation of MMPI profile and age of onset of obesity to success in weight reduction. *Am J Clin Nutr* 1976;626-632.
26. Center for Disease Control and Prevention. Overweight and obesity. 2003. Available at <http://www.cdc.gov/nccdphp/dnpa/obesity/index.htm>. Accessed January 2, 2004.
27. McCarty C, Chyou P, Ziegelbauer L, Kempf D, McCarty D, Gunderson P, Reding D. A comparison of cardiovascular disease risk factors in farm and non-farm residents: the Wisconsin Rural Women's Health study. *Wis Med J* 2002;101:34-39.
28. Haynes S, Levine S, Scotch N, Feinleib M, Kannel W. The relationship of psychological factors to coronary heart disease in the Framingham study. I Methods and risk factors. *Am J Epidemiol* 1978;107:362-383.
29. Spielberger CD, Jacobs G, Russel S, Crane RS. Assessment of anger: the State-Trait Anger Scale. In: Butcher JN, Spielberger CD, eds. *Advances in personality assessment*. Hillsdale, NJ: Lawrence Erlbaum Associates. 1983;2:161-189.
30. Haynes SG, Feinleib M, Kannel WB. The relationship of psychological factors to coronary heart disease in the Framingham study. III. Eight-year incidence of coronary heart disease. *Am J Epidemiol* 1980; 111:37-58.
31. Gallacher JE, Yarnell JW, Sweetnam PM, Elwood PC, Standfeld SA. Anger and incident heart disease in the Caerphilly study. *Psychosom Med* 1999;61:446-453.
32. Kubzansky L, Kawachi I. Going to the heart of the matter: do negative emotions cause coronary heart disease? *J Psychom Res* 2000;48:323-337.
33. Smith TW, Ruiz JM. Psychological influences on the development and course of coronary heart disease: current status and implications for research and practice. *J Consult Clin Psychol* 2002;70:548-568.
34. Cossette S, Frasura-Smith N, Lesperance, F. Clinical implications of a reduction in psychological distress on cardiac prognosis in patients participating in a psychosocial intervention program. *Psychosom Med* 2001;63:257-266.
35. Tacon AM, McComb J, Caldera Y, Randolph P. Mindfulness meditation, anxiety reduction, and heart disease. A pilot study. *Fam Community Health* 2003;26:25-33.
36. Lavie CJ, Milani RV. Effects of cardiac rehabilitation and exercise training programs on coronary patients with high levels of hostility. *Mayo Clinic Proc* 1999;74:959-966.