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Occupation and Subclinical Carotid Artery Disease in Women: Are Clerical Workers at Greater Risk?

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The current study examined cardiovascular risk factors and carotid atherosclerosis in 362 women (ages 42–50 years) who were working in clerical, blue-collar, or white-collar jobs or who were not employed. Risk factors were measured premenopausally and ultrasound measures of carotid atherosclerosis were obtained approximately 11 years later. Clerical and blue-collar workers had more atherogenic profiles on physical, behavioral, and psychosocial risk factors when compared with white-collar and nonemployed women. Clerical workers had greater carotid intima–media thickness relative to all other groups and more focal plaque when compared with white-collar workers. Risk factors and workplace characteristics did not account for the greater carotid atherosclerosis observed in clerical workers. Further research is needed to investigate why clerical work may increase cardiovascular risk.

Key words: atherosclerosis, carotid arteries, occupation, risk factors, psychosocial, socioeconomic status

More than 2 decades ago, the Framingham Heart Study reported that women in clerical occupations were at higher risk for incident coronary heart disease (CHD; nearly 50% of the CHD cases in this study were angina) when compared with homemakers and women in other professions (Haynes & Feinleib, 1980). The occupation groups did not differ on traditional coronary risk factors, so these variables could not have explained the association between occupation and CHD. However, the tendency to suppress anger, to show infrequent job changes, and to have a nonsupportive boss predicted higher CHD risk within the clerical group. Several years later, a cross-sectional analysis from the Tecumseh Community Health Study (House, Strecher, Metzner, & Robbins, 1986) showed that women employed in clerical or sales occupations were about twice as likely to have CHD (myocardial infarction [MI] or angina) than were women in other occupations, after controlling for standard coronary risk factors. In contrast, a 20-year follow-up study of the Framingham cohort limited to MI and coronary death found no occupation-group differences among women (Eaker, Pinsky, & Castelli, 1992), suggesting that prior findings could have been consequential to the inclusion of angina. More recent studies in European samples have provided additional evidence that lower status occupations afford higher CHD risk for women, although none focused explicitly on the risk incurred by clerical workers (Marmot, Bosma, Hemingway, Brunner, & Stansfeld, 1997; Wamala, Mittleman, Horsten, Schenck-Gustafsson, & Orth-Gomér, 2000). Thus, preliminary evidence has suggested that women show an occupational gradient for CHD, with clerical workers at potentially high risk, but further research is needed.

A limitation of many previous studies of occupation and CHD is their inclusion of “soft” clinical outcomes (i.e., angina), which are poor indicators of severity of atherosclerosis, particularly in women (e.g., Wilcosky, Harris, & Weissfeld, 1987). In contrast, recent advances in scanning procedures allow for objective screening of atherosclerosis at presymptomatic stages. For example, previous research has shown that noninvasive B-mode ultrasound measures of carotid intima–media thickness (IMT) and plaque are associated with prevalent cardiovascular disease (e.g., Burke et al., 1995) and are prospectively linked with incident CHD and stroke (e.g., Chambless et al., 1997; O’Leary et al., 1999). However, to our knowledge, only a few previous studies have examined these types of indicators in relation to occupational status in women. A recent Swedish study (Rosvall et al., 2000) found a weak association between occupation and carotid IMT in middle-aged women, but identified a stronger inverse association with carotid stenosis (i.e., extent of plaque protruding into the lumen), which remained significant after adjustment for risk factors. Diez-Roux, Nieto,

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Tyroler, Crum, and Szklo (1995) found an inverse, gradient association between IMT and occupation class in female U.S. residents. However, the trend became nonsignificant and was essentially eliminated with adjustment for risk factors. A third study showed a small, inverse association between occupational class and subclinical disease, indicated by the level of aortic calcification, in Dutch women (van Rossum, van de Mheen, Witteman, Mackenbach, & Grobbee, 1999). Adjustment for risk factors had a negligible influence on the odds ratios, although the trend became nonsignificant because of small initial effect sizes. It is important to note that none of these previous studies focused explicitly on the level of subclinical atherosclerosis evident in clerical workers.

The primary goal of the current study was to examine the level of cardiovascular risk in clerical workers relative to nonemployed women and to those in other occupations in a relatively contemporary cohort of middle-aged women residing in the United States. We operationalized cardiovascular disease risk through assessments of physical, behavioral, psychosocial, and workplace risk factors measured at an initial visit, and through measures of B-mode ultrasound scans of IMT and plaque in the carotid arteries taken about 11 years later.

Research suggests that occupation is related to physical cardiovascular risk factors such as blood pressure or lipid levels (e.g., Leigh, 1991; Schnall et al., 1992) and to behavioral risk factors such as smoking or exercise (e.g., Marmot et al., 1991; Smith & Baghurst, 1991). In the current study, we examined occupation-group differences in physical and behavioral risk factors including blood pressure, lipid levels, fasting glucose, body mass index (BMI), exercise, smoking, and hormone replacement therapy (HRT) use. We also examined psychosocial variables thought to affect cardiovascular risk, including depression, social support, anger, and anxiety (for a review, see Rozanski, Blumenthal, & Kaplan, 1999). Finally, a substantial body of research has suggested that workplace characteristics are important in understanding the association between occupation and cardiovascular health (e.g., Hammar, Alfredsson, & Johnson, 1998; Marmot et al., 1997; Schrijvers, van de Mheen, Stronks, & Mackenbach, 1998). In the current study, we examined differences in job satisfaction, perceived use of skills, and supervisory support. In addition, we examined perceived job demands and job control. Jobs characterized by higher demand and lower control are thought to be associated with increased cardiovascular morbidity and mortality (i.e., Karasek, 1979; Theorell & Karasek, 1996), with control being the factor most consistently related to cardiovascular outcomes (for a review, see Schnall, Landisbergis, & Baker, 1994).

A secondary purpose of the current research was to further investigate if cardiovascular risk factors and workplace characteristics represent pathways through which occupation leads to differences in subclinical disease levels. In previous research, the degree to which measured risk factors accounted for any observed occupation gradient has varied, with some studies showing that risk factors and work characteristics essentially explained the trend (e.g., Diez-Roux et al., 1995; Marmot et al., 1997) and others identifying a significant, residual gradient after risk-factor adjustment (e.g., Rosvall et al., 2000; Wamala et al., 2000). Moreover, factors explaining possible excess risk in clerical workers, relative to other groups, have not been examined since the Framingham research (Haynes & Feinleib, 1980). Thus, we examined risk factors related to occupation grouping at baseline as possible mediators of the association between occupation and carotid atherosclerosis.

We predicted that women in clerical jobs would have greater carotid atherosclerosis (i.e., greater IMT and more focal plaque) relative to nonemployed women and to those employed in other professions. We predicted that women with lower status jobs—and particularly clerical workers—would have more atherogenic physical, behavioral, and psychosocial cardiovascular risk factor profiles relative to women in white-collar positions and nonemployed women and that they would report more stressful job circumstances (i.e., lower satisfaction, skills utilization, work support, and job control and higher job demands) relative to women with white-collar jobs. Finally, we predicted that differences in physical, behavioral, and psychosocial cardiovascular risk factors as well as workplace characteristics would help explain the occupation group differences in carotid IMT and plaque, but we anticipated that a residual gradient would remain.

Method

Participants

Between 1983 and 1985, 541 premenopausal women were recruited to participate in the Healthy Women Study (HWS), a prospective investigation of cardiovascular risk-factor changes associated with menopause. The University of Pittsburgh's Institutional Review Board has approved all aspects of the HWS protocol. Recruitment and baseline characteristics of the sample have been detailed in previous studies (Matthews, Kelsey, Meilahn, Kuller, & Wing, 1989). In brief, a recruitment letter was sent to randomly selected women within specific telephone area codes in Allegheny County, Pennsylvania, who were then screened by telephone according to the following eligibility criteria: age 42–50, menstrual bleeding within the last 3 months, no surgical menopause, diastolic blood pressure (DBP) < 100 mm Hg, no use of HRT, and no medications known to influence physical risk factors. Of the 2,405 women contacted by telephone, 89% (2,138) agreed to be screened for eligibility, 901 women were determined to be eligible, and 60% (541) of those eligible agreed to participate.

The current study reports baseline risk-factor data from women with occupation and carotid ultrasound data available ($N = 362$). We chose to analyze baseline risk-factor data because risk factors measured at an earlier time point are likely to be more powerful predictors of subclinical outcomes because they have had a longer time to operate. Notably, physical, behavioral, and psychosocial risk factors measured at baseline and at the visit chronologically closest to the carotid scan (i.e., 5 or 8 years postmenopausal) were moderately to highly correlated (i.e., from $r = .40$ for exercise to $r = .86$ for BMI). Furthermore, analyses examining occupation differences in risk factors measured closest in time to the carotid scan did not differ substantially from analyses based on baseline risk-factor data.[1] Women in this subsample were similar to women who participated in the 5th- or 8th-year postmenopausal examination but did not participate in the carotid evaluation ($n = 41$); however, they were significantly older and had lower BMIs at baseline (ps $< .05$). These trends did not differ systematically by occupation (ps for interactions all $> .05$). Among the eligible women (i.e., those who participated in the 5th- or 8th-year postmenopausal clinic exam), blue-collar workers tended to be less likely than other occupation groups to have ultrasound data, $\chi^2(3, 403) = 10.82$, $p < .05$.

[1] Analyses available from Linda C. Gallo on request.

Clinic Visits and Physical Risk Factors

Women were seen for a baseline clinic visit, and then began reporting their menstrual status through monthly postcards. Postmenopausal status was indicated by cessation of menses and/or use of HRT for 12 months, at which time participants attended the first of a series of follow-up visits. Occupation was assessed at baseline and at a 3-year follow-up. Not surprisingly, given the age of this sample, job categories appeared to be very stable between the baseline visit and the 3-year follow-up (contingency coefficient = .72).

Clinic visits included a fasting blood draw and measurements of height and blood pressure. Assays were conducted at a central laboratory that conforms to the standards of the Centers for Disease Control and the National Heart, Lung, and Blood Institute. Total serum cholesterol (Allain, Poon, Chan, Richmond, & Fu, 1974), triglycerides (Bucolo & David, 1973), and total high-density lipoprotein cholesterol (Warnick & Albers, 1978) were assayed, and low-density lipoprotein cholesterol was estimated using the Friedewald equation (Friedewald, Levy, & Fredrickson, 1972). Plasma glucose was measured using an enzymatic assay (Yellow Springs glucose analyzer, Yellow Springs Instruments, Yellow Springs, OH). Technicians certified by the Multiple Risk Factor Intervention Trial protocol (Dischinger & DuChene, 1986) measured blood pressure using the random zero-muddler method. Two blood pressures were taken, and systolic blood pressure (SBP) and DBP values represent the average of these measures. Pulse pressure was calculated as the difference between the mean SBP and DBP values.

Behavioral Risk Factors

Participants also completed a questionnaire that assessed smoking history, kilocalories expended in leisure-time physical activity during the previous week (Physical Activity Index; Paffenbarger, Wing, & Hyde, 1978), and average grams of alcohol consumed per day (calculated according to number and types of drinks). At postmenopausal visits, participants indicated whether they were using HRT or taking any other medications that would affect cardiovascular risk factors (i.e., digitalis, antihypertensive medications, lipid-lowering medications, insulin or related substances, and any other "heart medication"). Here, we report HRT and medication use from the clinic visit closest in time to the ultrasound scan (i.e., the fifth or eighth postmenopausal visit).

Psychosocial Risk Factors and Workplace Characteristics

Finally, participants completed a battery of standardized self-report psychosocial measures at each visit. In the current report, we examine perceived social support, assessed via the Appraisal Support subscale (i.e., emotional support) of the well-validated Interpersonal Support Evaluation List (ISEL; Cohen, Mermelstein, Kamarck, & Hoberman, 1985); depression symptoms, as assessed through the well-validated Beck Depression Inventory (BDI; Beck & Beamesderfer, 1974); anxiety symptoms, evaluated through the Trait subscale of the widely used Spielberger State–Trait Anxiety Inventory (Spielberger, Sydeman, Owen, & Marsh, 1999); and trait anger as well as the tendency to suppress and express experienced anger, evaluated through two scales of the Spielberger State–Trait Anger Expression Inventory (i.e., Anger-In and Anger-Out; Spielberger et al., 1999). Internal consistencies for all psychosocial measures were adequate, ranging from $\alpha = .72$ (Anger-Out) to $\alpha = .86$ (Trait Anxiety).

Employed participants also completed a measure assessing their ambiguity about their job future, job satisfaction, and their opportunities to utilize skills. These scales were factor-analytically derived from an inventory developed by Caplan, Cobb, French, Harrison, and Pinneau (1980; Job Environment Inventory [JEI]) and modified for a study by Cottington, Matthews, Talbott, and Kuller (1986). Internal reliability for scales ranged from $\alpha = .66$ (Utilization of Skills) to $\alpha = .81$ (Job Satisfaction). Supervisory support was evaluated through a seven-item yes–no scale developed in the Framingham Heart Study (e.g., Haynes, Levine, Scotch, Feinleib, & Kannel, 1978), with $\alpha = .70$. Items indicating the components of "job strain" (i.e., control and demands) were completed via a mail survey approximately 3 years following enrollment. Job control was evaluated by summing three items assessing perceived control in what one's job involves and when and how these duties are performed ($\alpha = .75$). Job demand was assessed with a single item, " Overall, how demanding is your job?" for which participants responded on a 4-point scale (*not at all* to *very demanding*). Only 6 participants described their jobs as not at all demanding, and responses were therefore grouped into not at all or only slightly demanding ($n = 43$), moderately demanding ($n = 132$) or very demanding ($n = 135$).

Carotid Ultrasound

Beginning in 1993, the carotid ultrasound scan was added to the protocol for women returning for their 5th- or 8th-year postmenopause clinic visits. Carotid measurements were obtained using a scanner equipped with a 5-MHz array-imaging probe. A sonographer scanned the right and left common artery, carotid bulb, and the first 1.5 cm of the internal and external carotid arteries. Trained readers computed plaque scores and IMT measures. The readers measured the average IMT across 1-cm segments of the near and far walls of the distal common carotid artery, the far wall of the carotid bulb, and the internal carotid artery on both the right and left sides. An overall measure of IMT, in millimeters, was calculated by averaging measures from each location. We used a modified computerized reading program developed for the Cardiovascular Health Study (O'Leary et al., 1992).

Plaque scores were obtained from the images of the proximal common artery, distal common artery, carotid bulb, internal carotid artery, and external carotid artery. Plaque was defined as a discrete area of hyperechogenicity or a focal protrusion into the lumen of the vessel. For each location, readers assigned the following grades: 0 = no plaque; 1 = one small plaque < 30% of vessel diameter; 2 = one medium plaque 30% to 50% of the vessel diameter or multiple small plaques; 3 = one large plaque > 50% of the vessel diameter or multiple plaques with at least one medium plaque. Summary scores were computed across right and left carotid arteries for an overall measure of focal plaque. The distribution of plaque scores was extremely positively skewed. Forty-nine percent of the sample had a plaque score of 0, 24% had a score of 1, and 27% had a score of 2 or higher. Plaque score was therefore dichotomized, so that one group comprised women with scores of 0 or 1 ($n = 261$), and a second group comprised women with a plaque score of 2 or higher ($n = 96$). Because of subquality imaging of plaque that was not severe enough to compromise the IMT measures, 5 subjects had IMT data but no plaque scores.

To determine reproducibility of the IMT measures and the plaque index, 5 participants underwent two ultrasound examinations within 1 week. For each examination, two separate sonographers scanned the women and two readers scored each scan. Taking into account sonographer and reader variation, the intraclass correlation was .86 for IMT and .96 for the plaque index. In the current sample, the point-biserial correlation between IMT and plaque was $r = .60$ ($p < .01$). Carotid ultrasound measures were obtained an average of 10.7 years after the baseline ($SD = 1.20$), when the average age of the sample was 58.55 years ($SD = 2.02$). None of the women had clinically significant disease (i.e., disease that was affecting blood flow) at the time of the ultrasound.

Occupation Categories

Participants employed at baseline were assigned occupation codes through Hollingshead's (1975) Four Factor Index of Social Status, based on a comprehensive assessment of work history (Bromberger & Matthews, 1994). We used these codes to classify women according to blue-collar, white-collar, or clerical occupation categories. Blue-collar workers ($n =$

27) consisted of participants with Hollingshead Codes 1–4 (e.g., manual laborers, semiskilled or skilled manual workers, or domestic workers). White-collar workers ($n = 176$) included Hollingshead Codes 7–9 (e.g., business owners, higher executives, managers, professionals, technicians, and semiprofessionals). Finally, we created a discrete category, primarily Hollingshead Categories 5 and 6, which comprised participants whose primary duties were clerical or whose job titles were "secretary," "administrative assistant," or "clerical" ($n = 71$). Thirty-one women (primarily teachers, small-business owners, or managers) originally assigned to Category 6 did not have clerical jobs and were instead coded into the white-collar group. Eighty-eight women reported that they were not working at baseline, the majority of whom were homemakers (approximately 83%).

Analytic Approach

A series of one-way analyses of variance (ANOVAs) tested occupation-group differences in cardiovascular risk factors and workplace characteristics measured on a continuous scale, with Fisher's Least Significant Difference test for follow-up comparisons. Univariate outliers (i.e., at least ±4 *SD*s from the mean) were excluded on an analysis-specific basis. Variables with substantially skewed distributions (triglycerides, exercise, alcohol consumption, depression, emotional support) were analyzed using a logarithmic transformation. Transformations were reversed before presentation of means and standard deviations in tables. Chi-square analyses tested occupation-group differences for categorical cardiovascular risk factors and workplace characteristics. For all analyses, missing data were excluded on a pairwise basis.

The hypothesis that clerical workers would have greater IMTs when compared with other groups was tested in a hierarchical regression analysis (with age controlled at the first step). Occupation was dummy coded so that the three codes compared clerical workers with (a) nonemployed individuals, (b) blue-collar workers, and (c) white-collar workers. In each case, clerical was coded as 0, and the comparison group was coded as 1. The association between occupation and plaque was examined through a logistic regression analysis that modeled the probability of having a plaque score of 2 or higher. Consistent with the analyses for IMT, clerical workers represented the referent group.

Finally, hierarchical regression analyses tested the degree to which the cardiovascular risk factors and workplace characteristics related to occupation mediated observed group differences in carotid subclinical disease. We examined mediators in blocks so that separate analyses examined the contribution of all physical, behavioral, and psychosocial risk factors and workplace characteristics related to occupation. Consistent with Baron and Kenny (1986), mediation would be supported if the mediator block predicted the outcome in regression analysis and if the effect of occupation was substantially attenuated when the mediator block and occupation were entered simultaneously. Degree of mediation was evaluated by comparing the regression coefficients in the analysis that only included age and occupation with those from the analysis that included age, the mediator block, and occupation. A reduction in a regression coefficient for a contrast of at least 1.65 of its standard error considered evidence of mediation (e.g., Wills, McNamara, & Vaccaro, 1995).

Results

Sociodemographic Characteristics

Chi-square analyses examined occupation differences in sociodemographic characteristics. The sample was predominantly Caucasian (92%), but the occupation groups differed according to race, $\chi^2(9, N = 362) = 28.46$, $p < .01$. A relatively large proportion of blue-collar workers and a small proportion of white-collar workers reported non-Caucasian ethnicity. The occupation groups differed according to partner status and number of children, $\chi^2(3, N = 362) = 15.06$, $p < .01$, and $\chi^2(6, N = 362) = 14.43$, $p < .05$, respectively. Members of the nonemployed group were most likely and the blue-collar group were least likely to report living with partners. In addition, the blue-collar and nonemployed groups tended to have more children than the clerical or white-collar groups. The groups also differed according to family income, $\chi^2(9, N = 294) = 44.67$, $p < .01$, education, $\chi^2(9, N = 362) = 121.60$, $p < .01$, partners' education, $\chi^2(9, 279) = 58.86$, $p < .01$, and occupation, $\chi^2(9, 279) = 73.19$, $p < .01$, with clerical and blue-collar workers and their partners tending to fall into the lower socioeconomic strata.

Occupation and Physical, Behavioral, Psychosocial, and Workplace Characteristics

Table 1 summarizes the results of the analyses of the occupation-group differences on the physical, behavioral, and psychosocial cardiovascular risk factors. The groups differed significantly on BMI, with blue-collar and clerical workers showing significantly higher BMIs when compared with the white-collar participants. The groups differed marginally in fasting glucose and triglyceride levels ($p < .10$). No other occupation-group differences emerged for physical risk factors. Analyses examining occupation-group differences in behavioral risk factors revealed a difference for exercise, with clerical workers reporting less energy expenditure in leisure activity when compared with nonemployed and white-collar groups. A significant difference was also observed for HRT; white-collar and nonemployed women were more likely to report using HRT than were clerical or blue-collar workers. The occupation groups did not differ significantly in alcohol consumption, smoking history, or medication usage. Analyses for psychosocial risk factors showed that the groups differed significantly on a measure of Appraisal Support, with white-collar workers reporting significantly higher support when compared with the clerical or nonemployed groups. The groups also differed significantly on Trait Anger and marginally on Anger-Out. In both cases, blue-collar workers tended to have higher scores than did other groups. There were no other psychosocial risk factor differences among the groups.

The analyses for differences in workplace characteristics among the employed groups are summarized in Table 2. The groups did not differ in hours worked per week. Significant differences were observed on all three JEI subscales, with clerical and blue-collar workers reporting significantly higher job ambiguity, lower satisfaction, and less utilization of their skills when compared with white-collar workers. The groups reported differing levels of demand in their jobs; white-collar workers tended to describe their jobs as more demanding when compared with other groups. The groups did not differ on job control or perceived supervisory support.

Occupation and Subclinical Carotid Artery Disease

Occupation and IMT. As shown in Table 3, after adjusting for age, the occupation contrasts accounted for a significant amount of the variance in average IMT ($R^2 = .047$, $p < .001$). Clerical workers had significantly greater IMT when compared with each other group. As shown in Figure 1, average IMT for the groups were as follows: clerical workers, $M = 0.83$ mm ($SD = 0.14$);

Table 1
One-Way Analyses of Variance (ANOVAs) Examining Occupation-Group Differences on Physical, Behavioral, and Psychosocial Cardiovascular Risk Factors and Workplace Characteristics

Risk factor	Nonemployed (n = 88)	Blue collar (n = 27)	Clerical (n = 71)	White collar (n = 176)	ANOVA or χ^2
Physical risk factors					
Age (years at carotid scan)					$F(3, 358) = 0.12$
M	58.44	58.62	58.60	58.57	
SD	1.76	2.53	1.74	2.18	
BMI (kg/m^2)					$F(3, 357) = 2.63$**
M	24.47_{ab}	25.82_{a}	25.20_{a}	23.95_{b}	
SD	4.14	5.01	4.93	3.59	
SBP (mm Hg)					$F(3, 358) = 0.85$
M	108.16	110.63	109.20	107.48	
SD	11.43	12.33	11.50	10.80	
DBP (mm Hg)					$F(3, 358) = 0.99$
M	72.58	74.00	72.03	71.48	
SD	8.10	8.49	7.67	7.77	
LDL-C (mg/dl)					$F(3, 357) = 0.57$
M	109.50	104.42	109.68	105.92	
SD	26.23	28.57	34.27	27.07	
HDL-C (mg/dl)					$F(3, 357) = 1.85$
M	60.19	56.47	58.22	61.76	
SD	12.73	13.55	14.18	14.41	
Triglycerides (mg/dl)[a]					$F(3, 353) = 1.99$*
M	79.14	93.70	84.64	72.05	
SD	34.75	62.34	51.39	30.08	
Fasting glucose (mg/dl)					$F(3, 355) = 2.18$*
M	87.91	88.81	84.47	85.93	
SD	10.81	10.75	9.78	9.40	
Behavioral risk factors					
Exercise (kilo-calories expended in past week during leisure activity)[a]					$F(3, 354) = 3.50$**
M	$1{,}463.36_{a}$	$1{,}556.04_{ab}$	979.59_{b}	$1{,}464.96_{a}$	
SD	1,200.04	1,600.14	907.88	1,256.06	
Alcohol consumption (grams per day)[a]					$F(3, 351) = 1.68$
M	8.49	7.20	7.95	8.76	
SD	9.35	11.84	8.59	9.91	
Ever smoked (%)	59.1	66.7	57.1	54.6	$\chi^2(3, N = 359) = 1.60$
Taking HRT at 5th or 8th year post follow-up (%)	60.9	40.7	38.8	51.4	$\chi^2(3, N = 354) = 8.53$**
Taking other medications at 5th or 8th year post follow-up (%)[b]	27.0	18.5	22.1	21.3	$\chi^2(3, N = 358) = 1.42$
Psychosocial risk factors					
ISEL Appraisal Support[a]					$F(3, 357) = 2.72$**
M	7.51_{a}	7.63_{ab}	7.39_{a}	8.15_{b}	
SD	2.39	2.06	2.52	1.97	
Beck Depression Inventory[a]					$F(3, 358) = 1.01$
M	4.97	4.48	4.51	4.00	
SD	5.10	4.57	4.91	4.07	
Spielberger Trait Anxiety					$F(3, 358) = 1.35$
M	17.90	18.44	18.18	17.07	
SD	5.16	6.60	5.17	4.49	
Spielberger Trait Anger					$F(3, 358) = 3.70$*
M	17.30_{a}	20.56_{b}	18.31_{a}	17.97_{a}	
SD	4.22	6.30	4.99	4.11	
Spielberger Anger-In					$F(3, 358) = 0.41$
M	14.50	15.33	15.01	14.94	
SD	3.14	5.31	4.28	4.15	
Spielberger Anger-Out					$F(3, 358) = 2.46$*
M	14.56	16.37	14.24	14.78	
SD	3.54	4.14	3.84	3.32	

Note. Means with common subscripts do not differ at $p < .05$ according to Fisher's Least Significant Difference test. BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; LDL-C = low density lipoprotein cholesterol; HDL-C = high-density lipoprotein cholesterol; HRT = hormone replacement therapy; ISEL = Interpersonal Support Evaluation List.
[a] Analysis based on log-transformed data. Means and standard deviations reflect nontransformed values. [b] Digitalis, antihypertensives, diuretics, diabetic medications, anticoagulants, lipid-lowering medications, or any other heart medications.
* $p < .10$. ** $p < .05$.

Table 2
One-Way Analyses of Variance (ANOVAs) Examining Occupation-Group Differences for Workplace Characteristics

Workplace characteristic	Blue collar (n = 27)	Clerical (n = 71)	White collar (n = 176)	ANOVA or χ^2
Average hours worked per week				$F(2, 274) = 1.95$
M	31.07	32.45	35.10	
SD	15.84	12.41	12.03	
Job Environment Inventory				
Job Ambiguity				$F(2, 269) = 11.55$***
M	11.46_b	10.96_b	9.42_a	
SD	3.61	2.50	2.75	
Job Satisfaction				$F(2, 259) = 5.54$**
M	12.52_b	13.40_b	14.22_a	
SD	2.71	2.82	2.59	
Utilization of Skill				$F(2, 266) = 21.51$***
M	10.42_a	11.86_b	13.71_c	
SD	3.23	3.03	2.71	
Framingham Boss Support				$F(2, 235) = 0.47$
M	0.74	0.77	0.73	
SD	0.28	0.30	0.30	
Job control				$F(2, 235) = 1.58$
M	6.74	6.54	7.09	
SD	2.72	2.35	1.91	
Job demand (%)				$\chi^2(4, N = 238) = 9.57$**
Not at all/slightly	21.7	24.6	11.3	
Moderately	43.5	44.6	40.0	
Very	34.8	30.8	48.7	

Note. Means with common subscripts do not differ at $p < .05$, according to the Fisher's Least Significant Difference test.
** $p < .05$. *** $p < .01$.

blue-collar workers, $M = 0.76$ mm ($SD = 0.09$); white-collar workers, $M = 0.76$ mm ($SD = 0.10$); nonemployed participants, $M = 0.77$ mm ($SD = 0.13$).

To ensure that the occupation effect was not solely a reflection of ethnicity or socioeconomic standing, we performed a second analysis in which participants' education and ethnicity (dummy coded with 0 = *Caucasian* and 1 = *non-Caucasian*) were statistically controlled. We did not control for income, because missing data would have resulted in a reduction in sample size to $N = 294$. Neither education ($\beta = -0.06$), nor ethnicity ($\beta = 0.05$) predicted IMT at the final model step. Consistent with the original analysis, blue-collar ($\beta = -0.16$), white-collar ($\beta = -.23$), and nonemployed ($\beta = -.18$) groups evidenced significantly lesser IMT when compared with the clerical workers.

Occupation and plaque. Occupation did not significantly predict plaque score after controlling for age (Adjusted $R^2 = .02$, $p > .10$). However, white-collar participants had a significantly lower likelihood of showing a plaque score of 2 or higher when compared with clerical participants (odds ratio = 0.49, 95% confidence interval range = 0.27, 0.90). The proportion of women with plaque scores ≥ 2 were 37.1%, 30.8%, 27%, and 22.9% for clerical, blue-collar, nonemployed, and white-collar workers, respectively. Because the overall occupation effect was not significant, we did not perform mediation analyses for plaque.

Mediation Analyses for Occupation and Carotid IMT

Preliminary analyses revealed that the psychosocial mediator block was not significantly associated with IMT ($R^2 = .007$, $p > .10$). Thus, mediation analyses were conducted only for physical and behavioral risk factors and workplace characteristics.

Control for physical risk factors. Although SBP was not related to occupation, we controlled for this variable because it is a strong predictor of IMT and because there was a trend toward an occupation-group difference. Thus, the following risk factors were included in the physical risk factor mediation block: SBP, BMI, glucose, and triglycerides (log-transformed). As shown in Table 3, the physical risk factors accounted for a significant amount of variance in IMT ($R^2 = .074$, $p < .001$). SBP and triglycerides represented independent predictors of IMT in the final model ($p < .01$). However, occupation continued to account for a significant amount of the variance in IMT after controlling for these variables ($R^2 = .045$, $p < .001$), and the coefficients for the occupation-group contrasts were nearly equivalent to those in the original model.

Control for behavioral risk factors. Next, we examined the degree to which behavioral risk factors accounted for the occupation differences in IMT. We controlled for smoking despite the lack of statistical difference among the groups, because it is a strong predictor of IMT and because an occupation-group trend in smoking emerged. Thus, smoking history, exercise, and HRT were entered in the mediator block. Results from this analysis are displayed in Table 3. The behavioral risk factors accounted for a significant amount of variance in IMT ($R^2 = .032$, $p < .005$), but only smoking status and exercise (log-transformed) were independent predictors. Neither the occupation effect nor the coefficients

Table 3
Regression of Average Carotid Intima–Media Thickness on Occupation, With Adjustment for Age and Cardiovascular Risk Factors Related to Occupation

Step and variable entered	*B*	*SE B*	β	R^2	*F* test
Model 1: Adjusted for age ($N = 362$)					
1. Age (years at time of carotid scan)	.007	.003	.12	.015	$F(1, 360) = 5.50$**
2. Occupation[a]				.047	$F(1, 357) = 5.93$**
Clerical versus not employed	−.055	.018	−.20***		
Clerical versus blue collar	−.066	.026	−.15**		
Clerical versus white collar	−.066	.016	−.28***		
Model 2: Adjusted for age and physical risk factors ($N = 354$)					
1. Age (years at time of carotid scan)	.005	.003	.09	.012	$F(1, 354) = 4.16$**
2. Physical risk factors[b]				.074	$F(5, 349) = 7.11$***
3. Occupation[a]				.045	$F(3, 346) = 5.99$***
Clerical versus not employed	−.056	.018	−.21***		
Clerical versus blue collar	−.079	.025	−.18***		
Clerical versus white collar	−.059	0.15	−.26***		
Model 3: Adjusted for age and behavioral risk factors ($N = 346$)					
1. Age (years at time of carotid scan)	.009	.003	.15	.023	$F(1, 345) = 8.13$***
2. Behavioral risk factors[c]				.032	$F(2, 342) = 3.83$***
3. Occupation[a]				.040	$F(3, 339) = 4.97$***
Clerical versus not employed	−.053	.019	−.20***		
Clerical versus blue collar	−.064	.027	−.14**		
Clerical versus white collar	−.064	.017	−.27***		

[a] Clerical = 0; not employed, blue collar, or white collar = 1. [b] Systolic blood pressure, body mass index, trigylcerides (log-transformed), and fasting glucose. [c] Smoking history (ever or never smoked), exercise (log-transformed), hormone replacement therapy.
** $p < .05$. *** $p < .01$.

for the occupation-group contrasts were attenuated to levels suggesting mediation.

Control for workplace characteristics. Finally, we examined the degree to which workplace characteristics related to occupation explained the greater IMT in clerical workers compared with white-collar and blue-collar workers. To ensure an accurate comparison of regression coefficients, we first repeated the analysis of the association between occupation and IMT with employed participants who had complete workplace characteristic data ($N = 230$). The results from this analysis were similar to the analysis of

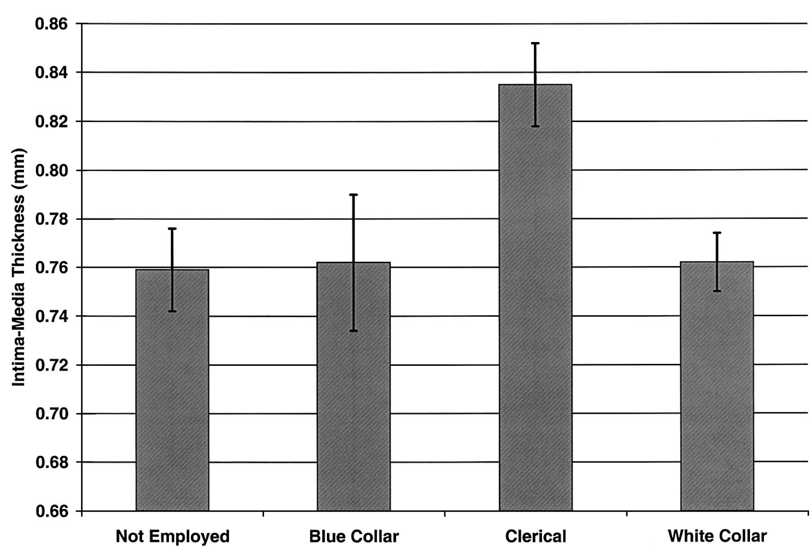

Figure 1. Average carotid intima–media thickness in millimeters (adjusted for age) for each occupation group.

the full sample, as shown in Table 4. The occupation block accounted for a significant amount of the variance in IMT after controlling for age ($R^2 = .067$, $p < .001$), and the blue-collar and white-collar groups evidenced lesser IMT when compared with the clerical group. The following workplace characteristics were related to occupation and were included in the mediator block for the adjusted model: job satisfaction, ambiguity, demand (two dummy codes, with *not at all* or *slightly demanding* compared with *moderately demanding* and with *very demanding*), and utilization of skills. The workplace characteristics accounted for 7.6% of the variance in IMT ($p < .005$), and job demand was the only independent predictor in the final model step. Individuals with moderately or very demanding jobs evidenced lesser IMT when compared with individuals who described their jobs as slightly or not demanding. The occupation contrasts also continued to account for a significant amount of variance in IMT, and neither the blue-collar nor the white-collar versus clerical contrast was attenuated to a level suggesting mediation.

Discussion

Consistent with previous research, including clinical (e.g., Marmot et al., 1997; Wamala et al., 2000) and subclinical (Diez-Roux et al., 1995; van Rossum et al., 1999) outcomes, these results from a sample of middle-aged women residing in the United States showed that occupation was related to level of cardiovascular risk. Women with clerical and blue-collar occupations tended to have higher levels of physical, behavioral, and psychosocial cardiovascular risk factors when compared with women having white-collar professions and with women who were not employed. Further, women with clerical occupations evidenced more carotid atherosclerosis (i.e., greater IMT and more focal plaque) when compared with other groups, according to ultrasound measures taken approximately 11 years later. Thus, the current study lends additional credence to the hypothesis that clerical work may be associated with higher cardiovascular risk for women when compared with other types of occupations (c.f. Haynes & Feinleib, 1980). To our knowledge, this study is the first to examine clerical occupation explicitly in relation to a subclinical disease outcome, and it is among the first to examine occupation and subclinical disease in women.

Does Occupation Relate to Cardiovascular Risk Factor and Workplace Profiles?

Consistent with previous research (e.g., Blane et al., 1996; Pekkanen, Tumilehto, Uutela, Vertianinen, & Nissinen, 1995), we found that lower status occupation groups (i.e., blue collar and clerical) had more atherogenic physical and behavioral cardiovascular risk profiles on measures of BMI, triglycerides, and exercise. Analyses for psychosocial cardiovascular risk factors showed that the occupation groups differed on measures of perceived social support, trait anger, and the tendency to outwardly express anger, with clerical workers having the lowest levels of support and blue-collar workers having the highest anger scores. The occupation groups also differed significantly in terms of a variety of workplace characteristics that have been associated with cardiovascular risk in previous research (e.g., Hammar et al., 1998; Marmot et al., 1997; Wamala et al., 2000; see also review by Schnall et al., 1994). Overall, white-collar workers described their jobs more positively when compared with blue-collar and clerical workers. Thus, women with higher prestige jobs may be protected from negative health outcomes through healthier cardiovascular risk profiles.

Does Occupation Predict Subclinical Carotid Artery Disease?

Women employed in clerical jobs had greater IMT, assessed approximately 11 years after baseline, when compared with all other groups. Women in clerical jobs were also more likely to have higher plaque scores when compared with the white-collar group. Importantly, IMT has been prospectively linked with increased risk of stroke and MI (Chambless et al., 1997; O'Leary et al.,

Table 4
Regression of Average Intima–Media Thickness on Occupation for Employed Groups Only, With and Without Adjustment for Workplace Characteristics Related to Occupation

Step and variable entered	*B*	*SE B*	β	R^2	*F* test
Model 1: Adjusted for age only ($N = 230$)					
1. Age (years at time of carotid scan)	.006	.004	.11	.011	$F(1, 229) = 2.60$
2. Occupation[a]				.067	$F(2, 227) = 8.20$***
Clerical versus blue collar	−.059	.029	−.15*		
Clerical versus white collar	−.068	.018	−.28***		
Model 2: Adjusted for age and job characteristics ($N = 230$)					
1. Age (years at time of carotid scan)	.006	.004	.11	.011	$F(1, 229) = 2.60$
2. Workplace characteristics[b]				.076	$F(5, 224) = 3.73$***
3. Occupation[a]				.055	$F(2, 204) = 7.14$***
Clerical versus blue collar	−.046	.028	−.11*		
Clerical versus white collar	−.066	.018	−.27***		

[a] Clerical = 0; blue collar or white collar = 1. [b] Job Ambiguity, Job Satisfaction, Utilization of Skill, Job Demand (dummy coded).
* $p < .10$. *** $p < .01$.

1999), suggesting that women in clerical jobs could be at greater vulnerability for future clinical cardiovascular disease. It is important to note, however, that the variance accounted for by the occupation effect was relatively low (i.e., 4.7% for IMT and 2% for plaque), although interestingly, occupation accounted for almost 7% of the variance in IMT when only employed participants were considered. Moreover, relative to standard physical risk factors, including SBP, which only accounted for 7% of the variance, or to behavioral risk factors, including smoking, which accounted for only 3% of the variance, the occupation contrasts represent a similar contribution to explaining the total variance in IMT. The finding that blue-collar workers had more atherogenic profiles at baseline but did not manifest greater IMT seems paradoxical and, as discussed below, limitations of the sample may have impeded our ability to assess the level of risk in the blue-collar workers. Nevertheless, the finding of higher risk in clerical workers than in blue-collar workers is consistent with previous research (Haynes & Feinleib, 1980).

Do Cardiovascular Risk Factors and Workplace Characteristics Contribute to the Association Between Occupation and IMT?

In additional analyses, we examined the extent to which physical, behavioral, and psychosocial variables documented as cardiovascular risk factors in other research and related to occupation in the current sample explained the finding of more carotid atherosclerosis in women with clerical jobs. The variance accounted for in IMT by occupation was reduced only minimally with statistical control for physical and behavioral risk factors (i.e., from 4.7% to 4.5% and 4.0%, for physical and behavioral factors, respectively), and none of the contrasts comparing clerical workers with other groups was reduced to a level suggesting mediation. Psychosocial risk factors accounted for very little variance in IMT and therefore could not have explained the occupation effect. Thus, consistent with some previous research (e.g., Rosvall et al., 2000; van Rossum et al., 1999; Wamala et al., 2000), known cardiovascular risk factors did not account for the association between occupation and subclinical atherosclerosis or for the excess risk associated with clerical work specifically.

In analyses that included only employed participants, statistical adjustment for workplace characteristics also reduced the variance explained by the occupation effect very little, from 6.7% to 5.5%, and the parameters comparing clerical with blue-collar and white-collar workers were not substantially attenuated. In contrast to previous research showing job control to be an important factor in explaining occupation differences in cardiovascular morbidity and mortality (e.g., for a review, see Schnall et al., 1994), this variable did not predict IMT in the current sample nor was it significantly associated with our occupation categories. Instead, we found that job demand predicted IMT, so that individuals with more demanding jobs evidenced less carotid atherosclerosis, even with occupation in the model. Because we did not assess the job strain parameters using the well-established Karasek (1985; Karasek et al., 1998) measure, and because only one item was used to assess job demand, these findings await substantiation in future research. Notably, our demand item simply asked "How demanding is your job?" whereas the Karasek measure of job demand includes items focusing on workload and time demands (i.e., deadlines, output, the need to work quickly). Given that in the current analyses white-collar workers reported the highest demand but had the lowest subclinical disease, it is conceivable that the item captured the tendency to perceive one's job as stimulating or challenging rather than stressful.

Limitations

Several limitations of the current research should be considered in interpreting these findings. First, the HWS sample includes women who were initially healthier and better educated when compared with the general population (Matthews et al., 1989). In particular, these trends may have impeded our ability to adequately evaluate risk associated with blue-collar occupation. The blue-collar group was quite small and probably did not provide a full representation of occupations held by women in the population. Blue-collar women in our sample were typically employed in service jobs (e.g., sewing assistant, home health aide, house cleaner) as opposed to labor or manufacturing jobs. In addition, a greater number of participants who reported blue-collar work at baseline as compared with other occupation categories did not undergo the IMT scan, which may have further impeded our ability to assess their risk. Furthermore, the sample was primarily non-Hispanic Caucasian, preventing an examination of ethnic differences and possibly limiting the generalizability of the findings. Additional limitations relate to the fact that the study did not include a standardized measure of job demand and control, such as the Karasek Job Content Questionnaire (Karasek et al., 1998). Moreover, job demand was evaluated using only a single item. The results regarding job demand and control should therefore be viewed as tentative, and additional research using more comprehensive measures is recommended.

Summary and Future Research Directions

By examining a subclinical outcome within a contemporary cohort, we found that women employed in clerical occupations had more carotid atherosclerosis when compared with women who were not employed or who were employed in other occupations. Thus, as suggested 2 decades ago by research from the Framingham study (Haynes & Feinleib, 1980), clerical workers may be at higher cardiovascular risk than other groups. Women with lower status occupations (i.e., clerical and blue-collar workers) also had more atherogenic cardiovascular risk profiles at baseline, providing additional evidence for an occupational gradient in cardiovascular risk for women. In addition, clerical workers evidenced higher levels of subclinical disease in this study and of clinical disease in the Framingham (Haynes & Feinleib, 1980) and Tecumseh (House et al., 1986) studies when compared with blue-collar workers. This suggests that the observed results do not simply reflect socioeconomic differences but that something distinct about clerical work or clerical workers places them at higher risk. Nonetheless, even taking into account diverse risk factors and work characteristics, we were unable to explain the excess subclinical disease risk observed in clerical workers. Our results suggest several directions for further investigation.

Clerical workers reported very low levels of leisure-time physical activity when compared with other women, including blue-collar workers. Although differences in exercise did not explain the excess risk associated with having a clerical occupation, clerical work itself may also be associated with lower levels of physical activity when compared with other types of work. Thus, in combination with leisure activity, the energy expenditure of clerical workers may be even further reduced. Moreover, a recent study found that women employed in sedentary occupations had a more atherogenic lipid profile when compared with women in active occupations (Wilbur, Naftzger-Kang, Miller, Chandler, & Montgomery, 1999). Thus, future studies might focus on physical activity across work and leisure.

Clerical workers also tended to report less job control when compared with other groups, and, like blue-collar workers, they described their jobs in relatively negative terms. Further, some evidence suggests that low job control may be the most salient characteristic of the job-strain model and may be particularly relevant to women working in low-status occupations (Bosma et al., 1997; Bosma, Peter, Siegrist, & Marmot, 1998). Thus, as noted above, additional research with well-validated measures of job strain is warranted. Further, some researchers have suggested that the job-strain model may not provide a comprehensive explanation for the occupational gradient in women. For example, Wamala et al. (2000) noted the need to consider other negative aspects of the work environment, such as gender discrimination. Future research might also consider factors such as exposure to sexual harassment, workplace accommodation of familial responsibilities, pay inequity, and the distribution of gender across job titles within a company. Although these factors could affect men's work satisfaction, they may be particularly important to women.

In aggregate, our results and those from the Framingham (Haynes & Feinleib, 1980) and Tecumseh (House et al., 1986) studies have suggested a continued focus on clerical work and cardiovascular risk in women. Women's presence in the labor force will assuredly continue to increase over the next decades, and clerical work is likely to remain a common role for working women for some time. Research that identifies the factors that could place clerical workers at higher risk is therefore needed to identify targets for prevention and intervention efforts.

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