

Psychosocial Predictors of Hypertension in Men and Women

Susan Levenstein, MD; Margot W. Smith, DrPH; George A. Kaplan, PhD

Background: Psychosocial stressors have been shown to predict hypertension in several cohort studies; patterns of importance, sex differences, and interactions with standard risk factors have not been fully characterized.

Methods: Among 2357 adults in a population sample of Alameda County, California, free of hypertension in 1974, 637 reported in 1994 having ever used antihypertensive medication (27.9% of the men and 26.3% of the women). The effects of baseline psychosocial, behavioral, and sociodemographic factors on the incidence of treated hypertension were examined using multiple logistic regression.

Results: Low education, African American race, low occupational prestige, worry about job stability, feeling less than very good at one's job, social alienation, and depressive symptoms each had significant ($P < .05$) age-adjusted associations with incident hypertension. Associations were weakened by adjustment for body mass

index, alcohol consumption, smoking status, and leisure time physical activity, especially the associations of anxiety and depression, which persisted in women but not in men. In multivariate models, job insecurity (odds ratio, 1.6), unemployment (odds ratio, 2.7), and low self-reported job performance (odds ratio, 2.1) remained independent predictors of hypertension in men, whereas low-status work (odds ratio, 1.3) was an independent predictor of hypertension in women.

Conclusions: In the general population, low occupational status and performance and the threat or reality of unemployment increase the likelihood of developing hypertension, especially among men, independent of demographic and behavioral risk factors. Psychological distress and social alienation may also increase hypertension incidence, especially in women, chiefly through an association with health risk behaviors.

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LABORATORY STRESSORS and real-life difficulties such as job strain^{1,2} and job dissatisfaction³ can lead to elevations in blood pressure, and stress or distress have been reported in some⁴⁻⁷ but not all⁸ cohorts to predict the subsequent incidence of sustained hypertension. However, the relative importance of various types of psychosocial factors in the general population remains largely undefined; sex differences in patterns of predictors have been little studied; and interactions with standard hypertension risk factors have not been fully characterized.

The Alameda County Study, a longitudinal investigation of behavioral, social, psychological, and economic influences on health, provided the opportunity to examine the effects of a variety of psychosocial factors on the development of hypertension in men and women in the general population over many years of fol-

low-up. The breadth of the information available on these subjects also permitted evaluation of the confounding and mediating roles of most known sociodemographic and behavioral risk factors for hypertension.

RESULTS

Of the 2357 respondents to the 1974 survey who provided information regarding hypertension on the 1994 questionnaire, 637 (27.1%) reported having ever taken prescription medications for hypertension, 349 (26.3%) of 1326 women and 288 (27.9%) of 1031 men. All the psychosocial factors studied, except unemployment, were significant predictors of incident hypertension in age-adjusted analyses for the entire population. In sex-specific analyses, unemployment, worry about losing one's job, and feeling less than very good at doing one's job were predictors only in men; anxiety and depressive symp-

From the Human Population Laboratory, Berkeley, Calif (Drs Levenstein and Smith), and the Department of Epidemiology, University of Michigan, Ann Arbor (Dr Kaplan).

PARTICIPANTS AND METHODS

At its first survey in 1965, the Alameda County Study distributed 8038 questionnaires to a stratified random sample of the adult inhabitants of a single county in California and obtained completed questionnaires from 6928 individuals (3158 men and 3770 women). In 1974, 4864 of these panel members completed a similar second questionnaire (85% of located respondents), of whom 2730 (93% of located respondents, 79% of the subjects not known to be dead) completed a third questionnaire in 1994. Details of sampling and follow-up methods have been reported elsewhere.⁹

In the 1960s, hypertension was diagnosed in relatively few Americans,¹⁰ but by the early 1970s, the number of Americans receiving antihypertensive treatment had doubled,¹⁰ meaning that a higher proportion of what we would now consider the hypertensive population was receiving treatment. Because underdiagnosis is more widespread among minority groups,^{11,12} this shift could lead to artifactual associations of hypertension incidence between 1965 and 1974 with race or socioeconomic status. Hypertension incidence is therefore analyzed herein for the 1974-1994 period, when the problem of differential ascertainment is expected to be somewhat less severe.

Respondents were asked the following question in 1965 and 1974 regarding current "high blood pressure or hypertension": "Here is a list of medical conditions that usually last for some time. Have you had any of these conditions during the past 12 months?" In 1994, the wording was different: "... Have you ever had any of these conditions? Have you ever taken medicines prescribed for it?" Excluding subjects who had reported hypertension in 1965 or 1974, those who had ever taken prescribed antihypertensive medications by 1994 were considered to have incident hypertension.

Two potential psychological predictors of hypertension were examined in the 1974 questionnaire: the 18-item Alameda County Study depression scale¹³ and McCloskey and Schaar's 9-item scale measuring "anomy," the psychological equivalent of the sociological concept of anomie, social discontent, or alienation; a typical item is, "The trouble with the world today is that most people really don't believe in anything."¹⁴ Several work-related stressors were studied: current unemployment, worry about being able to keep one's present job, feeling only average or not very good at "the kind of work you usually do," and

having a low-status job (clerical, sales, or blue collar, as opposed to white collar, professional, or managerial). Education was recorded in years of schooling, and race/ethnicity was classified as white, African American, or other.

Nonpsychosocial hypertension risk factors assessed in 1974 were body mass index (calculated as weight in kilograms divided by the square of height in meters), smoking status, alcohol use in drinks per month, and leisure time physical activity rated on a scale of 0 to 16. Having had a "medical checkup" during the 2 years before the follow-up survey was also included in the adjustment variables to control for diagnostic bias related to health care access or use.

In a preliminary phase, univariate analyses were performed on a broad range of variables against hypertension incidence between 1965 and 1974 to generate hypotheses for testing in 1974-1994. This screened out a series of psychosocial factors that were not associated with hypertension during the earlier time period: difficulty relaxing, overall life or job dissatisfaction, lack of sleep, low per capita household income, subjective financial strain, household crowding, problems with dependent children, marital strain, and weak social connections.

Logistic regression analysis (SAS software package; SAS Institute, Cary, NC) was used to determine the associations of 1974 variables with development of hypertension by 1994, both in the entire study population and in men and women separately. The univariate age-adjusted association of each variable with incident hypertension was determined first. Psychosocial factors that were significantly associated in men, women, or the sample as a whole were then examined with adjustment for the set of behavioral risk factors. Finally, all individually associated variables were entered into a single multivariate model to determine the independence of the predictors in fully adjusted analyses.

Age, body mass index, physical activity, alcohol consumption, anomy, and depression were treated as continuous variables. Dummy variables were used for education (high school diploma, 9-11 years of schooling, and <9 years of schooling vs any college attendance), smoking (ex-smoker and <1-pack, 1-pack, and >1-pack-per-day smokers vs never-smokers), unemployment (unemployed and not in the labor force [including homemakers] vs currently employed), race (African American and other non-white vs white), and job status (low-status job and not in the labor force vs higher-status job).

toms were predictors only in women; and low education, African American race, and low occupational status were predictors in both sexes (**Table 1**).

Health risk behaviors and detection bias might have accounted in part for these associations, since high body mass index, smoking, low leisure time physical activity, and medical checkups were all associated with incident treated hypertension (**Table 1**). Adjustment for these factors reduced all the associations (**Table 2**), and only African American race, low-status job, and low job security remained significant predictors among the population as a whole. When adjusted analyses were performed in men and women separately, there was now no overlap between sexes: anomy, depression, and low-status work were significant predictors of hypertension only in women,

while job insecurity, unemployment, and subjectively inadequate job performance were significant predictors only in men (**Table 2**).

To determine whether the association of work-related stressors with hypertension was due to confounding by socioeconomic status, a series of models were built that included education in addition to health risk behaviors. All 3 stressors—worry about job insecurity (odds ratio [OR], 1.3; 95% confidence interval [CI], 1.0-1.7), having a low-status occupation (OR, 1.3; 95% CI, 1.0-1.7), and feeling less than very good at doing one's work (OR 1.4; 95% CI, 1.0-2.1)—remained significant predictors in these models.

In all-inclusive multivariate analyses (**Table 3**), African American race, job insecurity, and low-status work

Table 1. Predictors of Incident Treated Hypertension in the Alameda County Study*

Risk Factor	N	All Subjects	Women	Men
Female sex	1326	0.9 (0.8-1.1)
Age, per year	2357	1.03 (1.02-1.04)	1.03 (1.01-1.04)	1.03 (1.01-1.04)
Medical checkup <2 y before follow-up	1817	1.8 (1.4-2.3)	1.6 (1.1-2.2)	2.2 (1.5-3.2)
Body mass index, per point	2345	1.14 (1.10-1.17)	1.14 (1.09-1.18)	1.17 (1.11-1.23)
Never smoked	960	1.0		
Ex-smoker	569	0.9 (0.7-1.1)	0.7 (0.5-1.0)	1.0 (0.7-1.4)
Smokes <1 pack/d	232	0.9 (0.7-1.3)	1.0 (0.6-1.5)	0.9 (0.5-1.7)
Smokes 2 packs/d	308	1.5 (1.1-2.0)	1.7 (1.2-2.4)	1.3 (0.9-2.1)
Smokes >1 pack/d	271	1.4 (1.0-1.8)	1.2 (0.8-1.8)	1.6 (1.0-2.4)
Leisure time physical activity, per point	2357	0.94 (0.91-0.97)	0.90 (0.87-0.94)	0.98 (0.94-1.02)
Alcoholic drinks/mo, per drink	2352	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.01)
Attended college	1224	1.0		
<9 y of schooling	140	1.0 (0.7-1.5)	1.7 (1.0-3.0)	0.6 (0.3-1.1)
9-11 y of schooling	269	1.4 (1.1-1.9)	1.9 (1.3-2.8)	1.0 (0.6-1.6)
High school diploma only	718	1.4 (1.2-1.8)	1.6 (1.2-2.1)	1.3 (0.9-2.0)
White	1982	1.0		
African American	152	1.7 (1.2-2.4)	1.7 (1.1-2.7)	1.8 (1.0-3.0)
Other ethnicity	223	0.9 (0.7-1.3)	0.9 (0.6-1.3)	0.9 (0.7-1.3)
White collar, managerial, or professional job	624	1.0		
Clerical, sales, or blue collar worker	709	1.5 (1.2-1.8)	1.4 (1.1-1.9)	1.5 (1.1-2.0)
Not in labor force	945	0.8 (0.7-1.0)	0.9 (0.7-1.1)	0.6 (0.3-1.1)
Not worried about keeping job	849	1.0		
Worried about keeping job	409	1.4 (1.1-1.7)	1.1 (0.8-1.7)	1.5 (1.1-2.0)
Not in labor force	945	0.8 (0.7-1.0)	0.9 (0.7-1.2)	0.6 (0.3-1.1)
Very good or excellent at doing job	1182	1.0		
Average or not good at doing job	139	1.5 (1.0-2.1)	1.3 (0.8-2.0)	2.1 (1.1-3.8)
Not in labor force	945	0.8 (0.7-1.0)	0.9 (0.7-1.1)	0.6 (0.3-1.1)
Employed	1273	1.0		
Unemployed	79	1.5 (0.9-2.4)	1.0 (0.5-2.0)	2.3 (1.1-4.8)
Not in labor force	945	0.8 (0.7-1.0)	0.9 (0.7-1.1)	0.6 (0.3-1.1)
Anomy score, per point	2346	1.07 (1.03-1.11)	1.11 (1.05-1.17)	1.03 (0.97-1.09)
Depression score, per point	2354	1.04 (1.00-1.08)	1.08 (1.03-1.13)	0.98 (0.92-1.04)

*Risk factors were assessed in 1974; hypertension was reported in 1994 by 637 of 2357 subjects. Data are given as age-adjusted univariate odds ratios (95% confidence intervals).

were retained in the all-subject model. When the model was limited to women, low-status work was the only independent psychosocial predictor of hypertension; in men, job insecurity, unemployment, inadequate job performance, and African American race were independent predictors (Table 3). Age, body mass index, smoking status, and medical care remained associated with hypertension in both sexes, whereas lack of exercise was associated only in women.

Repetition of the major analyses using hypertension rather than antihypertensive medication as the end point produced similar results (data not shown).

COMMENT

In these analyses of a longitudinally followed population sample, several measures of life stress predicted the incidence of treated hypertension during the subsequent 20 years, especially in men. The patterns of psychosocial predictors were different in the 2 sexes, with work-related stressors being more prominent in men and subjective psychological distress being more prominent in women. In multivariate models with all potential hypertension risk factors, including education and ethnicity (the only important risk factors missing from the Alameda County Study are salt intake and family history),

several work-related stressors proved to be independent predictors of hypertension.

Two measures of subjective distress, depression and social alienation, were significantly associated with incident hypertension in age-adjusted univariate analyses. When behavioral risk factors were taken into account, these associations remained significant only in women, however, and subjective distress dropped entirely out of the fully adjusted multivariate models.

These results are consistent with prospective associations between psychosocial factors and hypertension reported by previous investigators. In the Normative Aging Study, there was a significant negative association between emotional stability and the incidence of hypertension in a male population, controlling for baseline blood pressure, education, and alcohol consumption.⁴ Adjustment was not made for the ethnic and behavioral factors, which accounted for most of the association of psychological distress with hypertension in our data.

Analyses from the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study found anxiety and depression to predict later incidence of hypertension and especially of prescription treatment for hypertension.⁵ This association persisted in African Americans and older whites after adjustment for education, cigarette smoking, body mass index, alcohol use,

Table 2. Psychosocial Predictors of Incident Treated Hypertension in the Alameda County Study, Adjusted for Nonpsychosocial Risk Factors*

Risk Factor	All Subjects	Women	Men
Attended college	1.0		
<9 y of schooling	0.8 (0.9-1.2)	1.2 (0.7-2.1)	0.5 (0.2-0.9)
9-11 y of schooling	1.2 (0.9-1.7)	1.4 (0.9-2.1)	1.0 (0.6-1.7)
High school diploma only	1.3 (1.1-1.6)	1.4 (1.1-1.9)	1.2 (0.9-1.7)
White	1.0		
African American	1.5 (1.0-2.1)	1.4 (0.9-2.3)	1.6 (0.9-2.8)
Other ethnicity	0.9 (0.6-1.3)	0.9 (0.6-1.3)	0.9 (0.6-1.3)
White collar, managerial, or professional job	1.0		
Clerical, sales, or blue collar worker	1.5 (1.2-1.8)	1.5 (1.1-2.0)	1.2 (0.9-1.6)
Not in labor force	0.8 (0.6-1.1)	1.0 (0.7-1.3)	0.6 (0.3-1.2)
Not worried about keeping job	1.0		
Worried about keeping job	1.3 (1.0-1.6)	1.0 (0.7-1.5)	1.5 (1.1-2.1)
Not in labor force	0.9 (0.7-1.1)	1.0 (0.7-1.3)	0.7 (0.3-1.3)
Very good or excellent at doing job	1.0		
Average or not good at doing job	1.4 (0.9-2.0)	1.1 (0.7-1.8)	2.0 (1.1-3.8)
Not in labor force	0.9 (0.7-1.1)	1.0 (0.7-1.3)	0.6 (0.3-1.2)
Employed	1.0		
Unemployed	1.5 (0.9-2.4)	0.9 (0.4-1.8)	2.3 (1.0-5.1)
Not in labor force	0.9 (0.7-1.1)	1.0 (0.7-1.3)	0.6 (0.3-1.2)
Anomy score, per point	1.03 (0.99-1.08)	1.05 (1.01-1.09)	1.02 (0.95-1.07)
Depression score, per point	1.00 (0.96-1.05)	1.03 (1.00-1.08)	0.95 (0.89-1.02)

*Risk factors were assessed in 1974; hypertension was reported in 1994. Data are given as odds ratios (95% confidence interval) adjusted for age, body mass index, medical checkups, alcohol consumption, smoking status, and leisure time physical activity.

and baseline systolic blood pressure; leisure time physical activity was not associated with hypertension in this population.

Anxiety was predictive of hypertension over an 18- to 20-year period in the Framingham Study, but only in middle-aged men, with no association in women or older men.⁶ The association persisted after adjustment for smoking and for initial systolic blood pressure; education, alcohol use, relative weight, and glucose tolerance were not associated with incident hypertension in this population, and physical activity was not examined.

The psychosocial stressors most predictive of hypertension in the Alameda County Study were low-status work, unemployment, and concern about possible job loss. Those associations were robust enough to persist after adjustment for a broad range of behavioral and sociodemographic risk factors. Job strain, the combination of high demands at work with low decision latitude or control, has been associated with higher ambulatory blood pressure in both cross-sectional and prospective studies,^{1,2,15,16} as have other work-related stress indicators in some³ but not all¹⁷ studies. Blood pressure elevation in the unemployed population has been reported to be related to suppressed anger¹⁸; in at least one study,¹⁹ however, the threat of layoff was not associated with elevated blood pressure despite subjects' reporting considerable distress.

Differential distribution of behavioral risk factors accounted for much of the association between psychosocial factors and incident hypertension in the present analyses. In particular, a higher incidence of hypertension in subjects with low education or with high levels of social alienation or depressive symptoms was largely related to smoking, obesity, and a sedentary lifestyle, and disappeared entirely when a full set of sociodemographic fac-

tors were taken into consideration as well. The excess hypertensive risk related to psychological distress is thus chiefly mediated by increases in health risk behaviors in distressed individuals or due to confounding by low socioeconomic status and African American race.

Not all of the hypertension-promoting effect of life stress could be explained by behavioral and sociodemographic factors, however, leaving a role for psychophysiological pathways related to cardiovascular reactivity, such as persistent sympathetic activation,^{2,20} breath holding,²¹ and stimulation of the hypothalamic-pituitary-adrenal axis.²²

Psychosocial stressors, especially job-related stressors, predicted hypertension more strongly in men than in women in these data as in those of other investigators,⁶ despite a similar overall incidence of hypertension by sex; only 1 work-related stressor, having a low-status job, was a more important predictor in women than in men. Indicators of subjective distress and low educational attainment, on the other hand, were more predictive of hypertension in women than in men. The greater impact of stress on the development of hypertension in men compared with women may be related to sex differences in cardiovascular stress reactivity.^{23,24} It may also be conjectured that the threat or reality of unemployment could be particularly devastating for men, for psychological and/or practical reasons.

There have been hints in the literature of such differential risk factor patterns, ie, men appearing more sensitive to work-related threats to their autonomy, and women to difficulties in relationships with family and friends.²⁵ The association between job strain and raised ambulatory blood pressure has been found chiefly in men,² although job strain was associated with gestational hypertension in one study.¹⁶

Table 3. Predictors of Incident Treated Hypertension in the Alameda County Study: All-Inclusive Multivariate Model*

Risk Factor	All Subjects	Women	Men
Female sex	1.2 (0.9-1.5)
Age, per year	1.03 (1.02-1.04)	1.03 (1.01-1.04)	1.03 (1.01-1.04)
Medical checkup <2 y before follow-up	1.9 (1.5-2.4)	1.6 (1.1-2.3)	2.3 (1.5-3.4)
Body mass index, per point	1.15 (1.11-1.19)	1.12 (1.08-1.17)	1.18 (1.11-1.25)
Never smoked	1.0		
Ex-smoker	0.9 (0.7-1.2)	0.7 (0.5-1.0)	1.2 (0.8-1.7)
Smokes <1 pack/d	1.0 (0.7-1.4)	1.0 (0.7-1.6)	1.0 (0.5-1.8)
Smokes 1 pack/d	1.7 (1.2-2.3)	1.8 (1.2-2.6)	1.7 (1.0-2.8)
Smokes >1 pack/d	1.4 (1.0-2.0)	1.1 (0.7-1.8)	1.9 (1.2-3.1)
Leisure time physical activity, per point	0.95 (0.92-0.98)	0.92 (0.88-0.96)	0.98 (0.94-1.03)
Alcoholic drinks/mo, per drink	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.01)
Attended college	1.0		
<9 y of schooling	0.6 (0.4-1.0)	1.0 (0.5-1.9)	0.3 (0.1-0.7)
9-11 y of schooling	1.0 (0.7-1.4)	1.2 (0.8-1.9)	0.7 (0.4-1.3)
High school diploma only	1.2 (0.9-1.5)	1.3 (0.9-1.8)	1.1 (0.7-1.6)
White	1.0		
African American	1.6 (1.1-2.3)	1.4 (0.8-2.3)	2.1 (1.1-3.9)
Other ethnicity	0.9 (0.6-1.3)	0.9 (0.5-1.4)	1.0 (0.6-1.7)
Not in labor force	0.9 (0.7-1.2)	0.9 (0.7-1.2)	0.6 (0.3-1.3)
White collar, managerial, or professional job	1.0		
Clerical, sales, or blue collar worker	1.2 (1.0-1.6)	1.3 (1.0-1.9)	1.2 (0.8-1.6)
Not worried about keeping job	1.0		
Worried about keeping job	1.3 (1.0-1.7)	1.0 (0.7-1.5)	1.6 (1.1-2.2)
Very good or excellent at doing job	1.0		
Average or not good at doing job	1.3 (0.9-2.0)	1.0 (0.6-1.7)	2.1 (1.0-4.2)
Employed	1.0		
Unemployed	1.3 (0.8-2.3)	0.8 (0.4-1.7)	2.7 (1.1-6.5)
Anomy score, per point	1.02 (0.97-1.07)	1.01 (0.95-1.08)	1.01 (0.93-1.08)
Depression score, per point	0.99 (0.95-1.04)	1.03 (0.97-1.09)	0.94 (0.87-1.02)

*Risk factors were assessed in 1974; hypertension was reported in 1994. Data are given as odds ratios (95% confidence intervals).

Because of the limitations of the Alameda County Study data set, these analyses addressed only treated hypertension, not measured blood pressure, as an end point. An attempt was made to correct for the inability to include undiagnosed blood pressure elevations by controlling for recourse to medical care ("checkups") during the period before the follow-up survey. Hypertension diagnosis and awareness also significantly increased during the period of this study, due in large part to the efforts of the National High Blood Pressure Education Program,²⁶ and diagnostic criteria evolved. Reassuringly, it can be estimated that by 1994 more than 80% of Americans with blood pressure of 165/90 mm Hg or higher on random screens reported having received treatment at some time.¹¹ One review of studies of blood pressure and stressor exposure found associations to be, if anything, stronger in the studies based on objective blood pressure measurements than in those based on self-report,²⁷ suggesting that using the end point of self-reported hypertension treatment does not induce bias in favor of associations (perhaps because subjects with high cardiovascular reactivity may be overdiagnosed in screening situations). Caution is suggested by the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study, however, which examined both end points: anxiety and depression were slightly more strongly associated with treated hypertension than with the combined end point of elevated measured blood pressure and antihypertensive treatment.⁵

Selective memory by patients and differences in physicians' decision to treat according to psychosocial char-

acteristics could also have had an unmeasured effect on our results.

Differential access to medical care is of great importance in socioeconomic patterns of hypertensive disease in the United States. In this study of psychosocial predictors of hypertension we were able to control to some extent for access to care. Various reasons underlying undertreatment, including lack of insurance coverage (reported by 5.4% of Alameda County Study subjects in 1974), act indirectly through the final common pathway of poor access to health care.

It should be noted that the present analyses are of necessity limited to the association of psychosocial factors with hypertension incidence. These factors might actually have an impact on the pathologic factors related to hypertension above and beyond affecting the onset of the condition, due to associations with adherence to therapy—especially when more expensive drugs are prescribed.

Censoring is potentially an important issue in a lengthy follow-up study such as this one, where a single questionnaire after 20 years is used for case ascertainment. Because many of the subjects with the most severe incident hypertension will have died from complications such as coronary heart disease or stroke, we are to some extent studying a population of survivors. The rates of incident hypertension reported in these analyses are therefore likely to underestimate the true incidence rates. There is no obvious reason, however, to expect differential death rates in hypertensive persons

according to psychosocial characteristics, so this limitation should introduce no systematic bias.

In conclusion, psychosocial stressors at baseline increase the 20-year risk of developing hypertension in the general population, particularly in men. An association of hypertension with global distress (social alienation and depression) is found only in women, and is largely accounted for by patterns of health risk behaviors. Work-related stressors (in women, low-status job; in men, concerns about job performance and the threat or reality of unemployment) predict incident hypertension independent of a wide range of potential behavioral and socio-demographic risk factors.

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Corresponding author: Susan Levenstein, MD, Via del Tempio 1A, 00186 Rome, Italy (e-mail: slevenstein@compuserve.com).

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