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Association of Stress and Depression with Regional Fat Distribution in Healthy Middle-Aged Men

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We examined whether the association of regional fat distribution with stress, defined in terms of vital exhaustion, and depression varies according to the total amount of body fat accumulation in healthy middle-aged men (n = 64). Regional fat distribution was measured using the waist-to-hip circumference ratio (WHR), and the total amount of body fat accumulation was measured using the body mass index (BMI). The results indicate that WHR in lean men was associated with characteristics contrary to those in moderately obese men. In lean men WHR tended to be associated with a high level of stress, while in moderately obese men an association was found with a low level of stress and a low level of depressive symptomatology. The present results support the suggestion that there is a difference between abdominal obesity at different degrees of generalized obesity, and they are likely to further our understanding about the differing risk for cardiovascular disorders posed by abdominal obesity in lean men compared to abdominal obesity in moderately obese men.

KEY WORDS: obesity; depression; middle-aged men; stress.

INTRODUCTION

The regional distribution of adipose tissue appears to be differentially related to metabolic and cardiovascular disease in obese subjects. Although

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a moderate excess of total body fat with a normal distribution may be relatively harmless, an accumulation of fat in the abdominal area is associated with increased incidence of coronary heart disease and non-insulin-dependent diabetes mellitus (for a review, see Bouchard *et al.,* 1993). Abdominal obesity, measured as the waist-to-hip circumference ratio (WHR), and generalized obesity measured as body mass index (BMI) also differ in their associations with cardiovascular risk factors, as well as with general health and socioeconomic variables. According to Lapidus *et al.* (1989) and Larsson *et al.* (1989), abdominal obesity is associated with elevated blood pressure, elevated plasma lipids and fibrinogen, poor perceived health, and a low social background and low level of education, while generalized obesity correlates with elevated blood pressure and plasma triglycerides, and with variables indicating good health and social adaptation, but not with high cholesterol.

Differences also exist in associations between these two measures of obesity and symptoms suggested to reflect psychosocial stress. Concerning abdominal obesity, associations with being frequently absent from work, with reporting psychosomatic and psychiatric disease including depressive periods, and with reporting of frequent use of antidepressive or anxiolytic drugs and stimulants have been found in middle-aged women (Lapidus *et al.,* 1989). Generalized obesity has, on the contrary, been associated with quite the opposite characteristics, namely, those of well-adapted individuals (Lapidus *et al.,* 1989). However, more recently Wing *et al.* (1991) reported that both abdominal and generalized obesity operate in the same direction in middle-aged women. These two measures of obesity were related to tension, anxiety, anger, pessimism, depression, and low self-esteem and low social support, but not to current perceived stress.

In the above studies abdominal and generalized obesity have been treated as separate entities. Abdominal and generalized obesity may, however, operate in mutual interaction. For example, Larsson *et al.* (1989) have demonstrated that associations between abdominal obesity and cardiovascular risk factors are different in lean than in obese men. This raises the possibility that there might also be differences in associations between abdominal obesity and psychosocial measures at different degrees of generalized obesity.

The present study was carried out to examine whether the association of abdominal obesity and psychological factors varies as a function of total amount of body fat accumulation. We focused on those psychological factors that, according to previous suggestions (Björntorp, 1991), are of importance in the distribution of fat to the abdominal area, namely, chronic stress, defined in the present study in terms of vital exhaustion, and depression. Furthermore, in previous studies the association of obesity and psychological factors has been examined in middle-aged women (Lapidus

et al., 1989; Wing *et al.,* 1991). The associations in women may, however, be different than in men (Bouchard *et al.,* 1993). Therefore, the present study was carried out with healthy middle-aged men.

METHOD

Subjects

The subjects were 101 middle-aged men who volunteered to participate in a research project aiming to examine the hypothetical associations between various behavioral and psychological characteristics, neuroendocrine responses, and insulin resistance syndrome in middle-aged men (Hautanen and Adlercreutz, 1993a, b). A letter about the study was sent to some big companies, trade unions, and sporting societies, and middle-aged men at the managerial level were invited to participate in the study. Potential participants were allowed to read a lay version of the research plan, which described the methods and the purpose of the study. The study protocol was approved by the local ethics committee.

Of the 101 men, 64 were eligible for the present study. Twenty-five had either borderline (140/90 to 160/95) or definite (more than 160/95) hypertension according to previously published criteria (Hypertension Detection and Follow-up Program Cooperative Group, 1979). The diagnosis was based on the medical history and/or blood pressures measured during the physical examination. One subject had diabetes and four subjects suffered from coronary heart disease. Of the remaining 71 subjects, those reporting ethanol use of more than 400 g/week ($n = 5$) were excluded. Finally, two subjects were excluded because of incomplete psychological data. Thus, this study includes 64 healthy 30- to 55-year-old men (mean ± SD, 44.5 ± 5.4 years). They were receiving no medication and had no history or clinical evidence of liver, kidney, gastrointestinal, endocrine, or coronary heart disease, as determined by clinical examination and by laboratory analyses, which included blood cell counts, serum chemistry profiles, urinalyses, and electrocardiograms.

Measures

Abdominal and Generalized Obesity

The waist-to-hip circumference ratio (WHR), a measure of abdominal obesity, was determined as follows: The smallest girth between the rib cage and the iliac crest and the largest girth between the waist and thigh were

defined as the circumference of waist and the circumference of hip, respectively. The body mass index (BMI), a measure of generalized obesity, is the ratio of weight to height squared (kg/m^2). All measurements were conducted with the participant in underwear and without shoes.

Lifestyle and Socioeconomic Factors

Smoking was assessed as current smoking status (nonsmoking = 0, smoking = 1), and alcohol consumption as the amount of beer, wine, and hard liquor consumed separately per week, which was converted into grams of absolute alcohol. Physical activity was measured with a scale ranging from no regular physical activity (1) to strenuous physical activity (4). The scale for measuring educational level ranged from primary school (1) to university level (7).

Psychological Variables

Vital Exhaustion. The subjects were administered the Form B of the Maastricht Questionnaire (MQ; Appels, 1989) as a measure of Vital Exhaustion (VE). The 21 questions constituting the MQ were transformed for the present study into statements with response ranges from totally disagree (1) to totally agree (5). Development of the original Form B of the MQ, as well as its reliability and criterion validity, is described in detail by Appels (1989) and Appels *et al.* (1993).

Usually, VE has been treated as an unidimensional concept (e.g., Appels, 1989). The correlation matrix of the 21 items, however, indicate that in the present study more than one dimension could be obtained. Thus, we conducted a principal-factor analysis for the MQ items and rotated the factors against the VARIMAX criterion. Three factors were revealed with an eigenvalue above 1, the three-factor solution explaining 77.1% of the total variance. The factors were named according to the statements with highest loadings as follows: *Demoralization* ("I feel I want to give-up trying," "I sometimes feel that my body is like a battery that is losing its power," "I want to be dead at times," "I feel dejected," "I feel like crying sometimes"; *Hopelessness* ["I feel fine" (coded reversely), "I believe that I have come to a dead end," "I feel weak all over," "I have experienced a feeling of hopelessness recently"); and *Fatigue* ("I have an increasing difficulty in concentrating on a single subject for long," "I have a feeling I haven't been accomplishing much lately," "I wake up repeatedly during the night," "I often feel tired," "It takes more time for me to grasp a difficult problem than it did a year ago"). Reliability of the MQ was measured with the

General Coefficient of Reliability (Tarkkonen, 1987), which is a method designed for multidimensional constructs. Reliabilities for the total score and for the Demoralization, Hopelessness, and Fatigue subscales were .91, .91, .88, and .91, respectively.

Depression. A shortened version of the Depressive Behavior Survey Schedule (DBSS) by Cautela (1979) was administered to the subjects. The shortened version consisted of 28 items in which the subjects were requested to respond how often they felt a described way. In the present study the scale ranged from almost-never (1) to almost-always (5).

The original version of the DBSS consisted of 43 items. The purpose for shortening the schedule was based on practical reasons: The prevalence of depressive disorders appears to be relatively low in a normal population, thus the distribution of depressive symptomatology in a sample of healthy individuals is expected to be skewed. To anticipate the potentially skewed distribution in the present group of healthy middle-aged men, items reflecting the most extreme form of depression (e.g., "I feel like killing myself," "I wish I were dead," "I am going to panic," "I want to hurt other people") were excluded from the original version resulting in a shortened version consisting of 28 items.

Since the items in the shortened version covered different elements of depression, a factor analysis (principal-factor method with VARIMAX rotation) was computed. Six factors were revealed with an eigenvalue above 1. In the two endmost factors there was only one significant loading on both, making the factors difficult to interpret. Thus, a four-factor solution was adopted which explained 76.5% of the total variance. The factors were named according to the statements with the highest loadings as follows: *Dysphoria* ("Nobody cares about me," "Things appear hopeless," "I am sad," "I feel I can't cope with life," "I feel lonely"); *Anergia* ("I have trouble concentrating," "I have trouble making up my mind," "I feed tired without any reason," "I feel inadequate," "I am afraid to stick up for my rights"), *Anhedonia* ("I don't feel like going out," "I don't enjoy being with people," "I don't seem to enjoy anything," "I tend to be pessimistic"), and *Insomnia* ("I don't sleep through the night," "I have trouble falling asleep," "I feel tired without any reason"). Reliabilities as estimated by the General Coefficient of Reliability (Tarkkonen, 1987) for the total score and for the Dysphoria, Anergia, Anhedonia and Insomnia subscales were .95, .94, .94, .94, and .89, respectively.

Procedure

The study was carried out over 3 consecutive days at the Helsinki University Hospital. The anthropometric measurements were conducted in

connection with the medical examinations. Psychological testing was carried out at noon of the second examination day. The testing included a general interview evaluating the subject's current life situation and self-administered questionnaire covering several psychological coronary risk factors. The subjects completed the questionnaires at home and returned them, when they came to the medical examination in the morning of the third examination day. The procedure has been described in detail previously (Hautanen and Adlercreutz, 1993a, b).

Statistical Analyses

All the examined variables were normally distributed based on Shapiro and Wilk's W statistics. Associations of WHR and BMI with total scores and with different components of VE and Depression were examined using Pearson product moment correlations. Univariate analysis of variance was used to examine the effect of WHR and BMI on VE and Depression after dividing subjects into two groups (based on median splits) for both of these measures.

To examine whether the association of WHR with VE and Depression differs at different degrees of BMI, Pearson correlations were computed separately for the following two groups: for the group with BMI above (>24.38) and for the group with BMI below (≤24.38) the median. Furthermore, the relative contribution of the psychological factors to WHR in the groups with BMI above and below the median was examined through forward stepwise multiple regression analysis with WHR as the dependent variable. Only variables that significantly ($p < .05$) contributed to the R^2 were considered independent determinants of WHR.

It has been previously shown that age, socioeconomic factors, such as level of education, and lifestyle factors, such as smoking, alcohol consumption, and physical activity, significantly contribute to the variance of WHR and BMI (Björntorp, 1991; Lapidus *et al.*, 1989; Larsson *et al.*, 1989). Therefore, WHR and BMI were adjusted for their effect by using partial correlations, method of covariance, or residuals (forward stepwise multiple regressions) in analyses. In correlation and variance analyses, WHR and BMI were also adjusted for their effect on each other.

RESULTS

Basic characteristics of the study group are shown in Table I. Thirty-nine percent of the subjects were smokers, 33% reported strenuous physical

Table I. Characteristics of the Study Group

	Mean	SD	Range
Height (cm)	178.0	5.6	168–197
Weight (kg)	80.2	11.4	60–113
Body mass index (kg/m^2)	25.8	3.1	20.0–34.3
Waist circumference (cm)	89.4	9.2	71–115
Hip circumference (cm)	96.8	5.1	86–110
Waist-to-hip ratio	.92	.07	.78–1.12
Alcohol (g/week)	148.0	86.0	–400

Table II. Correlation of Waist-to-Hip Ratio (WHR) and Body Mass Index (BMI) with Vital Exhaustion and Depression

	WHR	WHR[a]	WHR[b]	BMI	BMI[a]	BMI[b]
Vital Exhaustion						
Total score	.00	–.04	–.03	.03	.05	.03
Demoralization	.13	.07	.16	.11	.02	.11
Hopelessness	.09	.11	.12	.03	–.07	.09
Fatigue	–.23	–.22	–.32**	–.12	.10	–.16
Depression						
Total score	–.17	–.09	–.17	–.16	–.03	–.14
Dysphoria	.05	–.02	.11	.09	.07	.13
Anergia	–.22	–.03	–.23	–.25*	–.13	–.24
Anhedonia	–.23	–.11	–.28*	–.21	–.05	–.25*
Insomnia	.05	.02	.09	.06	.02	.09

[a]Controlling WHR and BMI for their effect on each other.
[b]Controlling WHR and BMI for age, educational level, smoking, alcohol consumption, and physical activity
*$p < .05$.
**$p < .01$.

activity, and 11% were physically inactive. Furthermore 3.1% of the subjects had a primary school and 3.1% a secondary school level of education, 7.8% had graduated from a high school, 6.3% from a trade school, and 42.2% had graduated from a college and 37.5% from a university.

WHR and BMI were significantly correlated ($r = .78, p < .001$). Age, educational level, and alcohol consumption were unrelated to WHR and BMI, while current smoking showed a significant association to both variables ($r = .32, p < .01$, and $r = .25, p < .05$, for WHR and BMI, respectively). Physical activity was significantly related to WHR ($r = -.32, p < .01$), but unrelated to BMI.

Total scores of VE and Depression were significantly correlated ($r = .75, p < .001$). The following correlations between the components of these two measures were significant: the Demoralization component of VE with the Dysphoria component of depression ($r = .61, p < .001$), the Hopelessness component of VE with the Dysphoria ($r = .47, p < .001$) and Anergia ($r = .25, p < .05$) components of depression, and the Fatigue component of VE with the Anergia ($r = .47, p < .001$), Anhedonia ($r = .44, p < .001$), and Insomnia ($r = .26, p < .05$) components of depression.

Association of WHR and BMI With VE and Depression

Table II shows the Pearson correlation coefficients of WHR and BMI with VE and Depression. WHR was unrelated to the used psychological measures and remained unrelated after adjusting for BMI. BMI was significantly associated with a low level of the Anergia component of depression, but after adjusting for WHR, the association became nonsignificant.

Furthermore, when adjusting WHR and BMI for age, educational level, and lifestyle, significant associations were revealed between a low level of the Fatigue component of VE and WHR and between a low level of the Anhedonia component of depression and both WHR and BMI (Table II).

The effect of WHR and BMI on VE and Depression was examined using univariate analysis of variance, after dividing subjects into two groups (based on median splits) for both of these measures. The only significant finding was that, of the components of VE, a higher level of Demoralization characterized subjects with WHR above the median ($M \pm SD$, $.25 \pm .56$) compared to subjects with WHR below the median [$M \pm SD$, $-.25 \pm 1.14$; $F(1, 62) = 4.8, p < .03$]. This result remained statistically significant after the adjustments for BMI [$F(1, 61) = 4.2, p < .046$] and for age, educational level, and lifestyle [$F(1, 56) = 5.7, p < .02$].

Associations Between WHR and VE and Depression at Different Degrees of BMI

In subjects with BMI above the median, WHR was unrelated to total VE scores but was correlated significantly with a low total score of depressive symptomatology (Table III). The association remained significant after the adjustment for age, educational level, and lifestyle factors. The forward stepwise multiple regression analysis replicated this result: The program chose total score of depression only [$R^2 = .15$, $F(1, 31) = 5.6$, $p < .01$; R^2 (after controlling for age, education, and lifestyle by using

Table III. Correlation of Waist-to-Hip Ratio (WHR) with Vital Exhaustion and Depression in Individuals with a Body Mass Index (BMI) Above (n = 33) and Below (n = 31) the Median

	BMI			
	Above median		Below median	
	WHR	WHR[a]	WHR	WHR[a]
Vital Exhaustion				
Total score	−.19	−.22	.14	.10
Demoralization	.09	.12	.19	.35*
Hopelessness	.08	.18	.01	−.06
Fatigue	−.50**	−.63***	.10	−.03
Depression				
Total score	−.39*	−.39*	−.01	.00
Dysphoria	.05	.08	−.01	.15
Anergia	−.39*	−.41*	.05	−.02
Anhedonia	−.26	−.30	−.06	−.13
Insomnia	−.09	.01	−.01	−.04

[a]Controlling WHR for age, educational level, smoking, alcohol consumption, and physical activity.
*$p < .05$.
**$p < .01$.
***$p < .001$.

residual method) = .14, $F(1, 30) = 4.7$, $p < .04$]. With regard to components of VE and depression, a low level of the Fatigue component of VE and a low level of depression's Anergia component were significantly correlated with WHR (Table IV). When adjusting WHR for age, education, and lifestyle, the associations remained unaltered. However, in the forward stepwise multiple regression analysis, the Fatigue component of VE was selected and no other variables [$R^2 = .25$, $F(1, 31) = 10.3$, $p < .003$; R^2 (after controlling for age, education, and lifestyle) = .35, $F(1, 30) = 15.9$, $p < .0004$].

In subjects with BMI below the median, WHR was unrelated to total scores and to components of VE and depression (Table IV). After adjusting WHR for age, education, and lifestyle, the correlation between WHR and a high level of the Demoralization component of VE became significant. The forward stepwise multiple regression analysis replicated this result: The program selected the Demoralization component of VE and no other variables [R^2 (after controlling for age, education, and lifestyle) = .13, $F(1, 29) = 4.2$, $p < .05$].

DISCUSSION

We examined whether there are differences in associations between abdominal obesity (measured in terms of WHR) and stress and depression at different degrees of generalized obesity (measured in terms of BMI) and found that the pattern of associations varies according to the total amount of body fat. However, the present results not only revealed differences in associations with WHR at different degrees of generalized obesity, but suggested that increased WHR in moderately obese men is associated with characteristics contrary to those in lean men: A low level of stress and a low level of depressive symptomatology were related to increased abdominal obesity in moderately obese men, while in lean men an association was found between WHR and a high level of stress. The associations in moderately obese men were not explained by age, educational level, smoking, alcohol consumption, or physical activity, while in lean men the association became significant only after adjustment for these factors.

It has been shown previously that lean men with a high WHR have a higher risk for cardiovascular disease compared to men with generalized obesity (Lapidus *et al.,* 1984; Larsson *et al.,* 1984). Furthermore, it has been shown that vital exhaustion, which is suggested to be a response to chronic stress (Appels, 1989), is a risk indicator for myocardial infarction in middle-aged men (Appels, 1989). Therefore, the present findings, that a high level of vital exhaustion characterizes lean men, and a low level of vital exhaustion as well as a low level of depression characterizes moderately obese men with a preponderance of abdominal fat accumulation, may further our understanding on the differing risk for coronary heart disease posed by abdominal obesity in lean men compared to abdominal obesity in moderately obese men.

However, not all aspects of vital exhaustion or depression were significant in the associations we found. Of the components of vital exhaustion, *not experiencing fatigue* and, of the components of depression, *not feeling anergia* were related to increased WHR in moderately obese men. In forward stepwise multivariate regressions, only the Fatigue component of vital exhaustion remained significant. The significant correlation of Fatigue with Anergia ($rr = .47$, $p < .001$) may explain in part why this particular component of depression did not add to the amount of variance explained in WHR. In lean men, only the Demoralization component of vital exhaustion was significantly associated with increased WHR. This result remained the same in multivariate regressions.

Previous studies have shown that as far as cardiovascular risk factors and social background are concerned, increased WHR in lean men is associated with different variables than in obese men (Larsson *et al.,* 1989).

In lean men, but not in moderately obese men, an association has been found for increased smoking and fibrinogen and poorer social status, while in moderately obese men, but not in lean men, an association has been found for high serum cholesterol and diastolic blood pressure. The results of this study add evidence concerning the differing role of WHR in lean than in obese men also with regard to those psychological factors that reflect stress and depression. Consequently, the present results further support the proposition (Larsson *et al.*, 1989) that there is probably a fundamental difference between abdominal obesity at different degrees of generalized obesity.

It has, however, been emphasized that it is important to separate a quantitative obesity factor from an adipose tissue distribution factor in analyses of the impact of moderate obesity on health (Lapidus *et al.*, 1989). In the present study, a simplified conclusion would have been drawn by utilizing abdominal and generalized obesity as separate entities only: Abdominal obesity, irrespective of the degree of generalized obesity, and generalized obesity, irrespective of the degree of abdominal obesity, were unrelated to stress and depression. Regarding stress, the results are, however, in line with the findings of Wing *et al.* (1991) in middle-aged women. Nevertheless, the treatment of abdominal and generalized as separate entities should not be neglected in psychological studies.

The mechanisms that explain the tendency for a higher stress response in lean men with abdominal obesity remain speculative at present. The hypothesis promoted by Björntorp (1991) may explain the observed association. Stressful stimuli and ensuing hypothalamic arousal may cause neuroendocrine dysregulation, which, if chronic, may result in an accumulation of fat into the abdominal area. This may in turn lead to insulin resistance and dyslipidemia characteristics of abdominal obesity. Our previous results on the association between a high level of stress, measured in terms of vital exhaustion, and increased serum insulin and c-peptide concentrations and insulin/glucose ratio in this particular group of healthy middle-aged men (Räikkönen *et al.*, 1994) are also consistent with that idea.

With regard to the association of abdominal obesity with a low stress response and a low level of depressive symptomatology in moderately obese men, it can be suggested that social adaptation, defined in terms of the low prevalence of psychiatric disease including depressive periods, that is shown to characterize moderately obese individuals (Lapidus *et al.*, 1989) may regulate the course of these associations.

The following limitations may be suggested to affect the generalization from the findings: The present study involved a selected group of healthy middle-aged men at the managerial level who volunteered to participate in the study. However, they expressed varying degrees of stress,

depression, WHR, and BMI, these variables showing normal distributions. Thus, there is no reason to presume that the found associations would reflect any possible biases of selection.

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