Research Article

Biochemical changes among Saudi managers and employees of Dammam University exposed to work stress

Layla Abdull Mohsen Bashawri[1], Khaled Fikry Salama[2]

[1]Department of Clinical Laboratory Sciences, College of Applied Medical Sciences, University of Dammam, Dammam, Saudi Arabia.
[2]Environmental Health Department, College of Applied Medical Sciences, University Of Dammam, Dammam, Saudi Arabia.
Correspondence to: Khaled Fikry Salama, E-mail: ksalama@uod.edu.sa

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Abstract

Background: A psychological state that causes an individual to behave dysfunctionally at work is known as work stress, which occurs when persons fail to strike a balance between job demands and their abilities to cope with it early. Biochemical changes positively correlate with the level of global job strain and some of its components (interpersonal relations, work–home balance, managerial role, and organization climate).

Objective: To evaluate early biochemical and atherosclerotic changes among Saudi managers and employees exposed to work stresses during their administrative working conditions in the University of Dammam.

Material and Methods: Blood samples were taken from managerial staff and employees (men and women) in the University of Dammam. Biochemical indicators such as lipid profile and different inflammatory–immunological factors such as preindicators of atherosclerosis of work stress were measured using calibrated equipment.

Result: The results of this study revealed a significant association between managerial duties and job stress in both men and women and control group.This was evidenced in some biochemical parameters such as lipid profile and in different inflammatory and immunological factors. Some confounding factors such as working conditions, training, work planning conditions, and motivations also affected the results.

Conclusion: From this study, we can conclude that early biochemical indicators of atherosclerosis and different inflammatory–immunological factors should be considered, especially when work stress is expected to reach hazardous conditions. Training and motivation are also the main requirements for release and reduction of work stress.

KEY WORDS: Work stress, biochemical changes, atherosclerosis markers, job demands, Dammam University

Introduction

In today's world, job stress relates job features that create risks to the worker owing to excessive job demands, insufficient supplies to meet the workers needs, or the possibility of loss of the job. Consequently, work-related stress is a growing concern to workers, the business community, and society in developing countries such as Saudi Arabia.[1] Job stress can be defined as a job or working condition that pose threats to an employee. In other terms, job stress occurs as a result of a poor person–environment fit.[2] Extensive research has been conducted and various ideas have been proposed on stress. Stress is now considered as 'bad thing', leading to harmful biochemical and long-term effects. However, such effects have not been observed in positive situations.[3]

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Antibodies to oxidized low-density lipoprotein (oxLDL), heat shock protein (HSP)-65, high-sensitive C-reactive protein (hsCRP), anticardiolipin (aCL), and anti-b2-glycoprotein (GP)-I were considered to be inflammatory–immunological factors. In a broad study of this aspect, these factors were found to have a direct link in the pathogenesis of atherosclerosis (AS). Recent studies showed that early atherosclerotic changes positively correlated with the level of global job strain

and some of its components such as interpersonal relations, work–home balance, managerial role, and organization climate.[4,5]

Another study in an international tobacco company reported nearly 68% of work-related stress among its management staff.This estimate was based on those respondents who experienced symptoms of stress (scores 36%) on answering to the Personal Stress Inventory questionnaire, with no knowledge on the reliability/validity of the scores.[6]

In Saudi Arabia, the paid labor force nowadays includes women as an essential part, with their participation rates increasing sooner than those for men. Personal determinants such as age and sex, biological determinants, and behavioral determinants form the chief group of determinants that are found to be associated with cardiovascular morbidity and mortality. The main objective of this study is to evaluate early biochemical and atherosclerotic indicator changes in Saudi managers and employees exposed to work stress in the University of Dammam.

Materials and Methods

Healthy managers and employees (women/men) working in the University of Dammam and control workers were randomly selected. All were screened for the presence of individual risk factors (age, obesity, hypertension, diabetes, smoking, and low physical activity) and family risk factors for AS (obesity, hypertension, diabetes, heart attack, and stroke). All cases of morbidities and smoking history were excluded from the study.

An assessment was made of occupational stress/coping risk factors (the level of global stress and its components, i.e., particular stressors, training, motivation creativity, task work, promotion, fatigue resources, work load, interpersonal relations, work–home balance, leadership role, responsibility, everyday worries, recognition, organizational climate, and coping).

Serum levels of biochemical markers [total cholesterol, LDL, high density lipoprotein (HDL), triglycerides (TG), and glucose], and inflammatory–immunological markers (aCL, anti-β2-GPI, oxLDL, HSP, and hsCRP) were evaluated.

Blood samples were taken for biochemical parameters and analyzed on the same day, according to routine laboratory procedures. Sera for immunological parameters were collected and stored according to international laboratory standards, and then tested in runs (up to 40 sera samples per day) to minimize day-to-day variations. The study group comprised 80 managers (40 men and 40 women), 130 employees (90 men and 40 women) selected from the University of Dammam, and the matched group comprised 60 control subjects (30 men and 30 women).

Work Stress Questionnaire

All the participants were investigated for the presence of individual (age, obesity, hypertension, diabetes, smoking, and low physical activity) and family (obesity, hypertension, diabetes, heart attack, and stroke) risk factors for AS.

Biochemical Indicators of Stress

Serum levels of biochemical (total cholesterol, LDL, HDL, TG, and glucose), and serological risk factors of AS (aCL, anti-β2-GPI, anti-oxLDL, anti-HSP, and anti-hsCRP antibodies) were evaluated.

Data Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) and Excel. Descriptive statistics and independent *t* test were used to analyze significance of the tested variables.

Result

Recent studies indicate that people facing high job strain are more reactive to behavioral tasks in general, than are subjects with low job strain. Some investigators have noted that there exists a relationship between job stress and an increase in cardiovascular risk factors.[9] Table 1 and Table 2 shows a significant association between levels of lipid profile such as cholesterol, TG, LDL, HDL, ($P < 0.05$) and between different inflammatory–immunological factors such as hsCRP, HSP, aCL IgM, anti-oxLDL, and anti-β2-GPI ($P < 0.01$) among men and women managers and employees in the University of Dammam. However, only blood glucose, aCL IgG, age, and BMI were not statistically significant.

AS is the major pathological process of some cardiovascular diseases such as coronary artery disease (CAD), ischemic stroke (IS), and peripheral arterial disease (PAD) as consequential secondary manifestations.[10]

Table 1: Comparison between the mean levels of biochemical markers of work stress among men and women managers in the University of Dammam

Variable	Men managers, *N* = 40, Mean ± SD	Women managers, *N* = 40, Mean ± SD	*P*
Age (years)	38 ± 6.6	37 ± 4.90	>0.05
BMI (kg/m^2)	27.6 ± 4.4	25.4 ± 8.4	>0.05
Glucose (mg/dL)	111 ± 42.3	109 ± 68.4	>0.05
Cholesterol (mg/dL)	209 ± 43.3	190 ± 48.2	<0.05
TG (mg/dL)	225 ± 120	171 ± 99.8	<0.05
HDL (mg/dL)	39 ± 10.6	47 ± 13.5	<0.05
LDL (mg/dL)	138 ± 32.3	119 ± 41.7	<0.01
hsCRP (mg/dL)	0.52 ± 0.24	0.35 ± 0.15	<0.01
aCL IgM (Ig Mu/mL)	0.26 ± 0.06	0.20 ± 0.03	<0.01
ACL IgG (Ig GU/mL)	0.18 ± 0.06	0.18 ± 0.07	>0.05
Anti-OLDL (mmol/L)	3.23 ± 88.7	2.31 ± 51.5	<0.01
Anti-β2-GPI (U/mL)	0.28 ± 008	0.24 ± 0.05	>0.05
Anti-HSP (ng/mL)	0.55 ± 0.14	0.45 ± 0.08	<0.05

Table 2: Comparison between the mean levels of biochemical markers of work stress among men and women employees in the University of Dammam

Variable	Men employees, *N* = 90, Mean ± SD	Women employees, *N* = 40, Mean ± SD	*P*
Age (years)	35 ± 6.00	38 ± 3.95	>0.05
BMI (kg/m^2)	28.6 ± 7.1	26.44 ± 0.56	>0.05
Glucose (mg/dL)	103 ± 42.4	90 ± 27.9	>0.05
Cholesterol (mg/dL)	184 ± 38.03	176 ± 23.60	>0.05
TG (mg/dL)	159 ± 84.9	88 ± 45.11	<0.05
HDL (mg/dL)	42.3 ± 11.46	61.2 ± 16.59	<0.05
LDL (mg/dL)	144 ± 38.4	105 ± 26.5	<0.05
hsCRP (mg/dL)	0.37 ± 0.18	0.22 ± 0.09	<0.01
aCL IgM (IgMU/mL)	0.24 ± 0.05	0.21 ± 0.06	<0.01
aCL IgG (IgGU/mL)	0.19 ± 0.04	0.18 ± 0.07	>0.05
Anti-OLDL (mmol/L)	4.28 ± 1.9	4.1 ± 0.8	<0.01
Anti-β2-GPI(U/mL)	0.28 ±. 07	0.25 ± 0.06	<0.05
Anti-HSP (ng/mL)	0.52 ± 0.15	0.45 ± 0.06	<0.01

Table 3: Comparison between the mean levels of biochemical markers of work stress among men employees and control groups in the University of Dammam

Variable	Men employees, *N* = 90, Mean ± SD	Control men, *N* = 30, Mean ± SD	*P*
Age (years)	35 ± 6.00	35 ± 6.01	>0.05
BMI (kg/m^2)	28.6 ± 7.1	27.1 ± 5.07	>0.05
Glucose (mg/dL)	103 ± 42.4	91.7 ± 14.2	<0.05
Cholesterol (mg/dL)	184 ± 38.03	169 ± 36.9	<0.05
TG (mg/dL)	159 ± 84.9	135 ± 66.9	<0.05
HDL (mg/dL)	42.3 ± 11.46	42 ± 6.61	<0.05
LDL (mg/dL)	144 ± 38.4	112 ± 30.8	<0.05
hsCRP (mg/dL)	0.37 ± 0.18	0.35 ± 0.17	<0.01
aCL IgM (IgMU/mL)	0.24 ± 0.06	0.23 ± 0.05	>0.01
aCL IgG (IgGU/mL)	0.19 ± 0.07	0.18 ± 0.05	<0.05
Anti-OLDL (mmol/L)	4.28 ± 1.9	2.17 ± 0.9	<0.01
Anti-β2-GPI (U/mL)	0.28 ± 0.07	0.26 ± 0.10	<0.05
Anti-HSP (ng/mL)	0.52 ± 0.15	0.48 ± 0.01	<0.01

Antiphospholipid (aPL) antibodies comprising aCL and anti-β2-GPI have been reported to play an important role in the development and progression of AS and represent a non-traditional risk factor for cardiovascular diseases. In addition to being intrinsic components of the genesis of obesity, oxidative modifications to biomolecules and, in particular, to the oxLDL have been identified as a primary proatherogenic factor.[11]

Table 3 shows a significant association between levels of lipid profile such as cholesterol, TG, LDL, HDL ($P < 0.05$) and between different inflammatory–immunological factors as hsCRP, HSP, aCL IgG, anti-oxLDL, and anti-β2-GPI ($P < 0.01$) among men and women employees in the University of Dammam. However, only blood glucose, aCL IgM, age, and BMI were not statistically significant. Few studies have focused on the correlation between overtime, work, and cardiovascular disease.

Table 4: Comparison between the mean levels of biochemical markers of work stress among women employees and control groups in the University of Dammam

Variable	Women employees, *N* = 40, Mean ± SD	Control women, *N* = 30, Mean ± SD	*P*
Age (years)	38 ± 3.95	38 ± 4.9	>0.05
BMI (kg/m^2)	26.44 ± 0.56	26.4 ± 5.06	>0.05
Glucose (mg/dL)	90 ± 27.9	110 ± 23.7	>0.05
Cholesterol (mg/dL)	176 ± 23.60	181 ± 33.7	<0.05
TG (mg/dL)	88 ± 45.11	104 ± 50.5	<0.05
HDL (mg/dL)	61.2 ± 16.59	63 ± 17.9	<0.05
LDL (mg/dL)	105 ± 26.5	105 ± 22.4	<0.05
hsCRP (mg/dL)	0.22 ± 0.09	0.22 ± 0.08	<0.01
aCL IgM (IgMU/mL)	0.21 ± 0.06	0.22 ± 0.06	<0.01
aCL IgG (IgGU/mL)	0.18 ± 0.07	0.18 ± 0.06	<0.05
Anti-OLDL (mmol/L)	4.1 ± 0.8	2.8 ± 43.9	<0.01
Anti-β2-GPI (U/mL)	0.25 ± 0.06	0.25 ± 0.06	<0.05
Anti-HSP (ng/mL)	0.45 ± 0.06	0.49 ± 0.06	<0.01

Table 4 shows a significant association between levels of lipid profile such as cholesterol, TG, LDL, and HDL ($P < 0.05$) and between different inflammatory–immunological factors such as hsCRP, HSP, aCL IgG, anti-oxLDL, and anti-β2-GPI ($P < 0.01$) among men and women employees in the University of Dammam. However, only blood glucose, age, and BMI were not statistically significant.

A Japanese study clearly demonstrated that long working hours were associated with an increased risk of acute myocardial infarction independent of other coronary risk factors. In another study, overtime work predicted increases in BMI and waist circumference over a 3-year follow-up. In our study population, the sedentary work style together with long working hours led to a higher coronary heart disease (CHD) risk, obesity, and abnormal lipid profiles.[12,13]

Cholesterol and TG were shown to be associated with lack of decision latitude but not with work demand, job strain, and the ratio of work demand to decision latitude. Null results were reported for job strain and serum cholesterol in the previous studies. Anti-oxLDL autoantibodies are related to the progression of AS. Children with healthy weights showing elevated anti-oxLDL autoantibody with even higher values than adults have been found in reports.[14]

Studies focusing on strain, workload, work-related stress, and so on are typically concerned with industrial or traditional service companies, especially those involved in mass service,

Table 5: Work stress confounding factors and response among men and women managers and employees in the University of Dammam

Variable	Men managers and employees (%)		Women managers and employees (%)	
	Yes	No	Yes	No
Training during employment[a]	45.0	66.4	25.0	33.6
Work motivation[a]	72.7	68.1	27.3	31.9
Creativity at work[a]	76.7	59.3	23.3	40.7
Task work organization[a]	73.0	62.7	27.0	37.3
Promotion at work[a]	51.7	63.9	18.3	36.1
Work schedule[a]	59.9	69.2	30.1	30.8
Work planning[a]	64.5	55.6	25.5	44.4
Work fatigue[a]	68.2	73.7	31.8	26.3
Work resources[a]	77.8	58.4	22.2	41.6

[a]Data of work stress confounding factors and response among men and women managers and employees in the University of Dammam scored mainly based on annual assessment.

and rarely knowledge-intensive companies. Results recorded in Table 5 indicated that work as an academic, which includes knowledge work, is perceived to offer a good and developing job, with working conditions characterized by a high level of influence, control, and flexibility. Recent studies point out that work-related stress is an increasing problem for knowledge workers, despite employee control and influence, and that knowledge work has characteristics that can cause frustration, work-related stress, and reduced performance.[2]

Discussion

AS, is a chronic process and involves a series of modifications in the arterial walls before the clinical endpoints set in. The modifications are endothelial damage, lipid infiltration, followed by intimal thickening, platelet adherence, smooth muscle cell proliferation, and plaque formation. The final change is plaque rupture, which leads to a clinical endpoint.[9] AS is the major pathological process of some cardiovascular diseases such as CAD, IS, and PAD as consequential secondary manifestations.[11]

The aPL comprising aCL and anti-β2-GPI have been reported to play an important role in the development and progression of AS and represent a nontraditional risk factor for cardiovascular diseases. In addition to being intrinsic components of the genesis of obesity, oxidative modifications to biomolecules and, in particular, to the oxLDL, have been identified as a primary proatherogenic factor.[10]

Few studies have focused on the correlation between overtime work and cardiovascular disease. A Japanese study clearly demonstrated that long working hours were associated with an increased risk of acute myocardial infarction independent of other coronary risk factors.[15,16]

It was not surprising that total cholesterol, TG, and LDL cholesterol increased with increasing age. However, the HDL cholesterol in women was unchanged or slightly increased with increasing age. This pattern was also observed in the general population. Body weight and height were measured using a standard procedure by trained assistants. There is an extensive literature that shows a close relationship between occupational stress and CHD. For the past few decades, many studies have shown that jobs or organizational roles associated with overload, excessive demands, and many responsibilities result in a high risk of adverse health outcomes, especially cardiovascular diseases.

A recent study demonstrated that some of the pathways linking psychosocial factors (job stress) and cardiovascular disease incidence are (1) elevation of physiological/hematochemical variables (e.g., blood pressure and serum lipid lipoprotein levels); (2) direct and indirect effects of adverse risk behaviors such as smoking, lack of physical exercise, poor diet and health-care habits; and(3) heightened emotional states such as anger, tension, and anxiety, implicated in cardiovascular disease development through neuroendocrine mediation.[17,18]

Numerous cohort studies and clinical trials have confirmed the association between a low HDL and an increased risk of CHD. The concentration of LDL correlates positively, whereas HDL correlates inversely to the development of coronary heart disease. We observed an increased concentration of total cholesterol, TGs, LDL cholesterol, and very LDL cholesterol but decreased concentration of HDL cholesterol in CHD patients when compared with the control subjects.[19–21]

Our results are in accordance with the previous reports. The concentration of LDL correlates positively, whereas HDL correlates inversely to the development of coronary heart disease. Our work has revealed a significant increase in hsCRP and lipid profile in the blood circulation of patients with CHD. A significant decrease in the levels of HDL was observed in CHD patients. The concentration of hsCRP (inflammatory marker) is increased in CHD subjects. Therefore, we suggest the use of these biomarkers as a diagnostic tool for CHD patients.[22,23]

Therefore, this confirms the participation of anti-oxLDL antibodies; however, the effect of their increase or decrease on chronic diseases such as obesity and AS requires additional investigation. Nevertheless, in accordance with the results of our study, it is possible that an elevated level of anti-oxLDL autoantibodies acts as an early marker of cardiovascular risk in obese adolescents.[24]

This fact that direct correlation of anti-oxLDL autoantibodies level and increasing BMI reveals an existence of a possible interaction between biochemical and anthropometric parameters.

More recent study demonstrated that serum concentrations of HSP-27 IgG antibodies were significantly higher in patients with chest pain, compared with the healthy control subjects. These results indicate that increases in antibody concentrations are not directly associated with the acute coronary event or related to myocardial necrosis, although they may be associated with the underlying atherogenic process.[25]

AS is considered to be a disease whose pathogenesis includes inflammatory and immunological mechanisms, including autoimmune reaction against HSPs.[1–4] HSPs are produced by cells of the arterial wall to protect the cells against any damage in response to stress or injury, such as infection, mechanical stress, oxidative stress, and cytokine stimulation. Accumulating evidence has demonstrated that higher anti-HSP-60, HSP-65, and HS-P70 antibodies were associated with the development and severity of AS.[26–28]

There is increasing evidence that inflammation plays an important role in pathogenesis of atherosclerosis and its complications. Many studies have shown that CRP acts as an independent risk factor for atherosclerotic vascular disease. It has also been shown that hsCRP is not only a marker of generalized inflammation but also directly and actively involves in atherogenesis.[29]

The elevated hsCRP concentration significantly correlates with age and is associated with metabolic disorders such as dyslipidemia. In atherosclerotic plaques, CRP is found to bind to the LDL particle, which leads to activation of the complement; thus, CRP acts as a proinflammatory marker and contributes to atherogenesis. It may also elevate ischemic tissue damage via complement-dependent mechanism and tissue factor production by macrophages.[29]

The aCL antibodies are a heterogeneous family of auto-antibodies directed against protein–phospholipid complexes. Research has shown that elevated level of aCL contributes to increased thrombotic risk by mechanisms such as platelet damage, interference with antithrombin III activity, and inhibition of prekallikrein or protein C activation by thrombomodulin.[30,31]

Changes in the concentration of plasma lipids often observed in CHD patients certainly play a role in the development of vascular disease. Cholesterol has been cornered as the primary factor in the development of AS, whereas HDL is considered as one of the most important protective factors against AS. The protective function of HDL is because of to its active involvement in the reverse transport of cholesterol.[18,32,33]

Antibodies to oxLDL and HSP-65, hsCRP, anticardiolipin, and anti-2 GPI antibodies were considered to be inflammatory–immunological factors. In the broad study of this aspect, these factors were found to have a direct link in the pathogenesis of AS. Surprisingly, our results revealed that early atherosclerotic changes negatively correlated with the level of global job strain and some of its components.[18,33]

The hsCRP has a prognostic value in patients with acute coronary syndromes; however, its basic role is in the primary prevention setting. The hsCRP has been found to have roles both as a marker of low-grade chronic systemic inflammation and of direct involvement in AS.[22]

Many other risk factors involved in inflammation and autoimmunity (several autoantibodies and their respective autoantigens) have been found as possible factors in the development and progression of AS such as oxLDL and anti-oxLDL; β2-GPI and anti-β2-GPI; and HSP, and anti-HSP autoantibody systems.[33,34]

Conclusion

In conclusion, in this evaluation of atherosclerosis biochemical indicators, especially hsCRP, proved to be the strongest and the most significant predictor of the risk of future cardiovascular events. Thus, these data raise the possibility that the addition of AS biochemical indicators and hsCRP to standard lipid screening will generate an improved method for identifying persons at high risk for future of cardiovascular events, and a method of identifying managers and employees at risk for cardiovascular events in the University of Dammam.

Reducing high job strain in the companies and different educational instauration should involve a comprehensive approach to job stress interventions. For example, training can be provided for workers to improve their knowledge, skills, and resources. Besides increasing coping skills through various stress management strategies, training provides opportunities for workers to learn new skills and develop their own special abilities in their field of work.

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