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STRESS, VISUAL AND MUSCULOSKELETAL COMPLAINTS IN OPEN PLAN OFFICE STAFF

K. Vangelova and V. Stanchev

National Center of Public Health and Analyses, Sofia, Bulgaria

Summary. The aim of the study was to identify the main ergonomic and organizational risks contributing to stress, visual and musculoskeletal disorders in open plan office workers. A total of 73 subjects of mean age 28.3 ± 4.7 years were studied. Measurements of salivary cortisol and self-ratings for strain, fatigue, stress symptoms, visual and musculoskeletal complaints were performed. The work places were organized well, but the studied staff reported high work load and time pressure. The data showed higher cortisol levels during the workday under time pressure. High incidence of visual and musculoskeletal complaints mainly in the region of the back and the neck were found, associated with flickering and blinks on the screen monitors and overtime. Optimizing workplace organization could help reduce stress and health complaints of office staff.

Key words: *ergonomics, cortisol, fatigue, visual complaints, musculoskeletal complaints*

INTRODUCTION

Open plan offices are more common in the last decade because of their cost-effective design, possibility to accommodate more employees, possibilities for equal work space for all the employees, enhanced communication and collaboration. Today office workers spend most of their working hours at the computer. The main symptoms are visual discomfort, musculoskeletal disorders, and stress [3, 6, 12]. The ergonomic risks and work organization problems are considered to contribute to a higher level of stress at work, visual discomfort, musculoskeletal disorders [13], especially the overload, time pressure and tight deadlines in lack of personal resources to fulfill the duties [8]. Subjects, working in open plan office, are usually exposed to higher level of noise, and are

more likely to have problems with concentration and may be more prone to stress and physical exhaustion [7].

The secretion of the stress hormones is an objective and reliable indicator for stress [11], especially the concentration of cortisol in the saliva representing the free level of the hormone in the blood, showing a stable circadian rhythm with high morning values, decreasing during the day.

The aim of the study was to identify the main ergonomic and organizational risks contributing to stress, visual and musculoskeletal disorders in open office workers.

MATERIAL AND METHODS

The staff of open plan office, 73 subjects with mean age 28.3 ± 4.7 yrs and length of service 6.1 ± 3.4 yrs were studied. Informed consent was signed by all the subjects. The work was approved by the ethical committee of the National Center of Public Health and Analyses.

Work analysis, interview and chronometry of the basic workplaces were carried out. A questionnaire concerning the work place stressors was fulfilled.

The ergonomic study, based on observations, measurements and expert assessments, was aimed to follow the basic parameters of the work environment and workplace and work process organization. The static load of the musculoskeletal system and the risk in maintaining work posture were evaluated based on chronometric measurements of the time for maintaining an appropriate work posture, expert assessments and classification of work postures by type and characteristics, and analysis of some biomechanical parameters of the work posture (work angles of the joints, angles of bending and twisting of different parts of the body, etc.). A questionnaire for the self-ratings of the employees regarding their work posture and workplace (work surface, work chair, leg space) and unfavorable work activity factors has been applied.

The incidence and localization of musculoskeletal complaints was followed with the standardized Scandinavian questionnaire [4]. Questioning for visual complaints was carried, too. The Chrobach's a for the used scales was 0.72 and 0.68 for musculoskeletal and visual complaints, respectively.

The concentration of saliva cortisol was followed three times during the working day in 15 subjects. The cortisol samples were analyzed using a radioimmunoassay kit with within-assay coefficient of variation 4.8% and between-assay coefficient 7.2%. Strain and fatigue were self-rated on 9-point scales [2], ranging from very calm and relaxed to very high tension and pressure and from very fresh to very tired. The participants also were questioned for stress symptoms at the end of the workday [2] including a lot of work, feeling of tension, irritation, exhaustion, time pressure, difficulties in concentration (1 – not at all, 5 – to a large extent) and insufficient rests during the day (1 – definitely enough, 5 – far from enough). The Chrobach's α for the scales was 0.66.

Statistical analysis was performed with SPSS. Variation, correlation and regression analysis were used. Cortisol rates and ratings for strain, fatigue and stress symptoms were tested also for effect of work under time pressure.

RESULTS

Our results show that the main stressors of the investigated participants were work under time pressure (39.4 %), short deadlines (39.3%), unsatisfactory payment (35.21%), and noise (34.1 %).

Work places, situated in open plan offices, are adequate for workers demands and prolonged work with display. The work can be described as monotonous tasks under time pressure and low control. Repetitive movements are typical for developing documents, comparing the offers from different companies, data entry and similar activities. Phone calls and conversations with partners are carried out and decision making under pressure is needed.

Self-ratings of the employees showed minimal complaints of the workplace ergonomics and work posture and no complaints related to the work in open plan office. The data show that only 15% of the employees have problems with display positioning, while 84% enjoy enough space on their work place. The same percent (84%) work in good work posture with support for hands. The greater part of employees is satisfied with lighting conditions in offices. Despite the good quality of the monitors, 12% of the study participants complain from flickering screen and 33% from blinks on the screen of the monitor.

The self-ratings show high rates of visual discomfort. At the end of the working day 70% of the employees report visual fatigue and 30% report itching, reddening and tearing. A high frequency of musculoskeletal complaints was also reported. Only 23% of the inquired subjects had no musculoskeletal complaints, 14% had one complaint, 10% – two complaints and 53% – three or more musculoskeletal complaints. The percentage of the employees with musculoskeletal complaints in the region of the neck was the highest (60%), followed by complaints in the region of the back (56%) and low-back (51%). The number of visual complaints correlated with the number of musculoskeletal complaints ($r = 0.59$ $p = 0.000$). Additionally, there was an association between eye fatigue complaints and musculoskeletal complaints in the region of the neck ($r = 0.32$, $p = 0.005$).

Salivary cortisol values followed the circadian rhythm up to noon time (high values in the morning, decreasing at noon time) (Fig. 1), but remained nearly the same towards the end of the workday. Significantly higher cortisol values were found in the middle of the workday ($F_{(1,14)} = 5.274$, $p = 0.038$) and within a trend in the end of the workday ($F_{(1,14)}$) = 4,074, $P = 0.063$) with the group rating to work under high time pressure in comparison to the ones rating moderate time pressure. Both the ratings for strain and fatigue increased with the advance of work time. No significant differences between the two groups concerning self-reported strain were found, while fatigue was significantly higher in the group rating high time pressure.

The self-ratings indicated that the investigated individuals felt tense, irritated and had problems with concentration at the end of the workday, more expressed in the group rating high time pressure (Table 1). The studied subjects considered that the workload was high and the time for work breaks insufficient, so they worked often under time pressure. The self-ratings for insufficient time for work breaks and a lot of

work were associated significantly with cortisol values at the end of the workday (r = 0.48, p = 0.05 and r = 0.81, p = 0.000, respectively) and the feeling of tension at the end of the workday (r = 0.74, p = 0.001 and r = 0.55, p = 0.023, respectively). The difficulties in concentration correlated significantly with the feeling of irritation (r = 0.60, p = 0.011), associated also with cortisol values in the middle and the end of the workday (r = 0.52, p = 0.032 and r = 0.64, p = 0.006). Cortisol values in the middle and the end of the workday were related with time pressure (r = 0.57, p = 0.017 and r = 0.65, p = 0.004, respectively), and levels at the end of the day - with the feeling of tension (r = 0.68, p = 0.003).

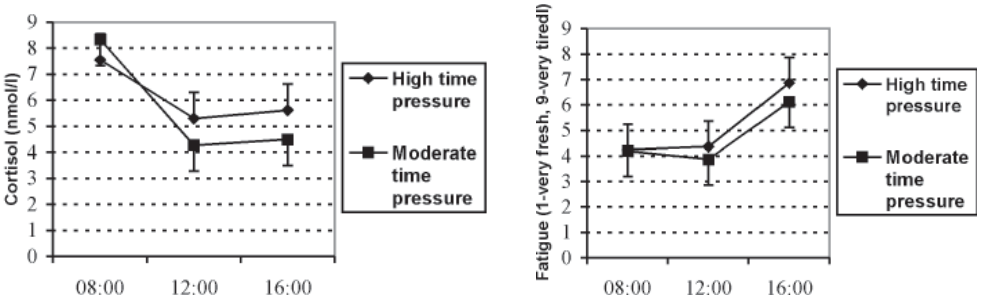


Fig.1. The effect of time pressure on salivary cortisol rates and fatigue ratings during work in open office staff

Table 1. Stress symptoms at the end of the workday in open plan office staff rating high and moderate time pressure

Indices (max score)	High time pressure ratings	Moderate time pressure ratings
Tense (1 = not at all, 5 = to a large extent)	3.53 ± 0.53	3.12 ± 0.89
Irritated (1 = not at all, 5 = to a large extent)	3.00 ± 0.54	2.75 ± 0.88
Exhausted (1 = not at all, 5 = to a large extent)	2.75 ± 0.46	2.37 ±0.49
Time pressure (1=not at all, 5 = to a large extent)	3,76 ± 0.74**	2.87 ± 0.81
Problems with concentration (1 = not at all, 5 = to a large extent)	3.00 ± 0.92	2.62 ± 0.91
High workload (1 = not at all, 5 = to a large extent)	4.01 ± 0.60*	3.37 ±0.74
Insufficient time for work breaks (1 = not at all, 5 = to a large extent)	4.12 ± 0.99***	2.25 ±0.77

(* F(1,15) = 5.645, p = 0.032; ** F(1,15) = 7.243, p = 0.021; *** F(1,15) = 8.799, p = 0.01

The data of the stepwise regression model show that the self-ratings for insufficient time for work breaks are associated with cortisol secretion (Table 2), and determine 32.2% of the secretion of the hormone in the midday and 37.1 % at the end of the work day together with exhaustion. Predictors of visual complaints are the blinks and flickering of the screen of the monitor and overtime work. The overtime

was due to insufficient time to complete the work in the frame of the workday, i.e. a lot of work. The number of musculoskeletal complaints was associated with the ratings of blinks on the screen of the monitor, insufficient work space and flickering of the screen. Predictors for the pain in the region of neck and shoulders are the number of visual complaints and ratings for uncomfortable working posture in a highly significant model (p = 0.006).

Table 2. Stepwise multiple regression analysis for cortisol values, number of visual and musculoskeletal complaints and pain in the neck/shoulders and back as independent variables.

Variables		**β**	**t**	**p**
Dependent	***Predictor***			
1. Cortisol –midday values	Insufficient time for work breaks	0.606	2.850	0.013
r^2 for the model = 32.20 %, F = 8.124, p = 0.013				
2. Cortisol – values at the end of the workday	Insufficient time for work breaks Exhaustion	0.762 0.334	5.393 2.363	0.000 0.000
r^2 for the model = 70.40 %, F =18.834 , p = 0.000				
3. Number of visual complaints	Blinks on the monitors Flickering monitor Overtime work	0.262 0.346 0.253	2.429 3.239 2.371	0.018 0.002 0.021
r2 for the model = 25.70 %, F = 8.954 , p = 0.000				
4. Number of musculoskeletal complaints	Blinks on the monitors Insufficient work space Flickering monitor	0.419 0.290 0.265	4.108 2.889 2.611	0.000 0.005 0.011
r^2 for the model = 31.20 %, F = 11.452, p = 0.000				
5. Pains in the neck and shoulders	Visual complaints	0.688	3.518	0.004
	Uncomfortable working posture	0.522	2.670	0.02
r^2 for the model = 49.70 %, F = 7.913, p = 0.006				

DISCUSSION

Our findings show high rate of visual and musculoskeletal complaints in rather young staff. The prevalence of musculoskeletal disorders and prolonged musculoskeletal sickness absence varies widely among working population, and even among office workers carrying out similar occupational tasks [1]. Despite the good quality of the monitors and work place organization, the visual complaints were related mainly to the flickering, blinks on the screen of the monitor and overtime. Unexpectedly, the musculoskeletal complaints were related to flickering and blinks of the monitors, too. In case of impossibility to adjust the parameters of the workplace, the employees perhaps work in non-ergonomic postures, as they try to find a good vision angle in which the blinks are less and the picture on the monitor is of better quality. It is well

known that the injuries of the musculoskeletal system have a multifactorial etiology [5]. The complaints in the region of the back are linked mainly to work posture, non-ergonomic work organization, inadequate duration and problems in organization of the work tasks [13], while the ones in the region of the neck – with non-ergonomic work posture, the presence of uncorrected refractional abnormalities, and strain [9]. Prolonged musculoskeletal sickness absence was found to be more frequent in groups with greater time pressure at work, lower job control and more adverse beliefs about the work-relatedness of musculoskeletal disorders [1].

Cortisol levels and fatigue were higher under time pressure. The data of Schell et al. [10] found cortisol to be predictor of musculoskeletal pain in the region of the neck, shoulders and back of men, working in the media. Our earlier data [14] also showed a relation between cortisol levels and musculoskeletal complaints in aging group of sound engineers in radio production, but the findings were not confirmed in the present study.

In conclusion, our data showed higher cortisol levels during the workday under time pressure, predicted by insufficient time for work breaks. The self-ratings of the employees showed symptoms of strain and fatigue (irritation, exhaustion, lack of concentration, etc.). High rate of visual and musculoskeletal complaints in a relatively young age group were found to be associated with flickering and blinks of the screen monitors and overtime. Periodic control of state of vision and adequate optical correction is needed. Optimizing workplace organization could help reduce stress and health complaints in office staff.

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Corresponding author:
Katia Vangelova
National Center of Public Health and Analyses
15 Akad. Ivan Geshov Blvd.
Bg – 1431 Sofia
+35928056224
e-mail: k.vangelova@ncpha.government.bg