Occupational Stress among Welders in Bulgaria

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The main goal of this study is to assess salivary cortisol levels a mong Bulgarian welders. Totally 39 healthy volunteers working as welders have been investigated – 31 males and 8 females; age 37±9 yr. Two saliva samples were collected for each participant in specialized containers – Salivette (Sarstedt, Rommelsdorf, Germany). First sample (Cortisol 1) between 9 and 11am and second between (Cortisol 2) 15 – 17 pm. Cortisol reference values are 0,2-4,4 ng/ml. Increased cortisol levels above the reference range were found only in Cortisol 1. Mean Cortisol 1 salivary levels are $3,47 \pm 2,47$ ng/ml for all studied individuals with higher levels in males ($3,67 \pm 2,35$ ng/ml) than females ($2,71 \pm 2,95$ ng/ml). The present quantitative study evaluates the use of salivary cortisol concentration as a biomarker of stress among welders in Bulgaria.

Key words: salivary cortisol, occupational stress, welders

Introduction

Occupational stress is a major factor of the work environment which unmanaged can lead to serious health and personal issues. Working as a welder in a metallurgical company is a job that could attract a lot of stress. There could be different reasons for the presence of occupational stress. Noise, vibration, air pollutants, bad thermal comfort, non-ionizing radiation are affecting the employees every work day [8]. Conflicts at work, emotional demands, workload, time pressure are possible stressors. Static physical activities and forced work postures are part of the working process [4]. The combined effect of different stressors in the work environment could lead to poor work performance, acute and chronic health problems.

Occupational stress is associated with high levels of cortisol [5,6]. Cortisol, also known as "the stress hormone" is a steroid hormone produced by the adrenal glands. It has a circadian rhythm with highest levels in the morning that decline throughout the day and reach lowest point at night [1, 2, 3]. It is widely used in medical studies as an indicator for the stress response of the organism. The human body reacts to stressful situations with increase in cortisol secretion. Disturbances in cortisol secretion may

lead to fatigue, depression, obesity and immune dysfunction [6,7]. The aim of our study is to assess cortisol levels among healthy Bulgarian welders during their workday.

Materials and Methods

A total of 39 healthy volunteers (31 men and 8 women), with an average age of 37 ± 9 years were included in the study. Inclusion criteria for all participants was a minimum of one year's experience as a welder. Two saliva samples during one workday were collected for each participant in specialized containers – Salivette (Sarstedt, Rommelsdorf, Germany). First sample between 9 and 11am and second between 15-17 pm. All participants were instructed beforehand to abstain from eating, smoking, brushing their teeth or drinking any kind of liquid except water for at least 30 minutes before giving their samples. Each sample was assessed for cortisol levels. The concentration of cortisol in saliva was determined by the enzyme-linked immunosorbent assay (ELISA). Cortisol reference values are 0.2 – 4.4 ng/ml. MED CALC 16.4.3. was used for statistical analysis of the data.

Results and Discussion

Results from three of the participants were excluded due to corrupted samples or missing data. Increased cortisol levels above the reference range were found only in the first cortisol measurement (Cortisol 1). Based on the data from Cortisol 1, we constructed a new variable EV (extreme value) which indicates whether or not the cortisol value is normal or increased above the reference range. A value of 0 for the EV variable indicates that cortisol is normal and code 1 is for the opposite. Twelve employees (30.77%) showed increased cortisol levels above the reference values. Results for EV variable are shown in **Table 1.**

Table 1. Frequency analysis for EV variable.

Classification variable	EV
Sample size	39
EV = 1	12 (30.77%)
EV = 0	27 (69.23%)

Cortisol levels followed their normal direction of rise and fall during day. Highest values of the hormone were present in the Cortisol 1 and they declined throughout the end of the workday. The data from the descriptive statistics of salivary cortisol levels is shown in **Table 2**.

The following values were reported as mean ± SD (min-man): Cortisol 1 - 3.47 ± 2.47 ng / ml (0.50 - 8.48) and Cortisol 2 - 1.58 ± 1.01 ng/ml (0.3 - 4.3). A significant difference in the concentrations of cortisol in saliva was not found among sexes. A significant difference was found in the levels of cortisol in saliva between the first and the second samples ($p = 0.003$), with higher values being measured in the morning. A weak positive correlation was found between the levels of cortisol between the two saliva samples ($r = 0.38$).

Table 2. Descriptive statistics for cortisol levels

	N	Mean	95% CI	SD	Median	Minimum	Maximum	Normal Distr.
Age	39	36,872	33,633 to 40,110	9,9899	37,000	22,000	66,000	0,1285
Avg_Cortisol	39	2,885	2,224 to 3,546	2,0385	2,359	0,476	9,051	0,0008
Cortisol 1	38	3,472	2,657 to 4,287	2,4794	2,653	0,501	8,485	0,0522
Cortisol 2	36	1,586	1,241 to 1,930	1,0178	1,320	0,293	4,311	0,0054

Based on the obtained results, we construct a new classification variable AGD (age group dichotomy), which has a value of 0 for people with age$\leq$ 38 and 1 for people with age$>$ 38. Cross tabulation analysis of EV and AGD was performed. Results are shown in **Table 3.**

Table 3. Cross tabulation analysis of EV and AGD

	Classification EV		
Classification AGD	0 Cortisol 1 normal	1 Cortisol 1 Increased	
0 /age$\leq$38/	21 95,5% RT 77,8% CT 53,8% GT	1 4,5% RT 8,3% CT 2,6% GT	22
1 /age$>$38/	6 35,3% RT 22,2% CT 15,4% GT	11 64,7% RT 91,7% CT 28,2% GT	17
	27	12	39 (32 true and 7 wrong)

Table 3 shows that out of 39 classifications of welders by age group (with age$\leq$ 38 or age$>$ 38) and cortisol status (normal or increased above reference range) 32 are true and 7 are wrong. Based on the age classification (age$\leq$ 38 or age$>$ 38), it can be predicted whether a person will have abnormal or normal levels of cortisol from the first measurement.

Our data of salivary cortisol levels during welders work showed elevated values in twelve of thirty-nine participants in Cortisol 1. These results raise doubts about occupational stress in almost one-third of the study group (30.77%). A significant difference in salivary cortisol levels was not found among sexes. Older age in the studied group (age$>$ 38) is a risk factor for the development of occupational stress. Further research about the causes of stress among these employees is needed. All samples in Cortisol 2 showed values in the reference range.

Conclusion

Salivary cortisol levels of all participants showed normal dynamics throughout the workday. Cortisol levels had highest values in the morning and lowest in the end of the workday. The higher number of employees with increased cortisol levels in saliva from the morning sample is probably the result of the factors of the work environment. Further research is needed in order to clarify main work environment factors and their role for developing occupational stress among welders.

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