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The influence of specific aspects of occupational stress on security guards' health and work ability: detailed extension of a previous study

Jovica Jovanović[1,3], Ivana Šarac[2], Jasmina Debeljak Martačić[2], Gordana Petrović Oggiano[2], Marta Despotović[2], Biljana Pokimica[2], and Blerim Cupi[1]

[1] *University of Niš Faculty of Medicine, Department of Occupational Health, Niš, Serbia*
[2] *University of Belgrade, Institute for Medical Research, National Institute of Republic of Serbia, Centre for Research Excellence in the Field of Nutrition and Metabolism, Belgrade, Serbia*
[3] *Institute of Occupational Medicine, Niš, Serbia*

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In our earlier study of security guards, we showed that higher occupational stress was associated with health impairments (metabolic syndrome, diabetes, hypertension, cardiovascular diseases) and work disability. The aim of this study was to further explore the association of specific occupational stressors with health impairments and work disability parameters in 399 Serbian male security guards (aged 25–65 years). Ridge linear regression analysis revealed that, after controlling for age, body mass index, and smoking status, professional stressors including high demands, strictness, conflict/uncertainty, threat avoidance and underload were significant positive predictors of fasting glucose, triglycerides, total and LDL cholesterol, blood pressure, heart rate, Framingham cardiovascular risk score, and temporary work disability. The security profession is in expansion worldwide, and more studies are needed to establish precise health risk predictors, since such data are generally lacking.

KEY WORDS: cardiovascular diseases; diabetes; hypertension; metabolic syndrome; occupational exposure; psychological stress; sick leave

Occupational stress is related to health impairments and temporary and permanent work disability (1–3), and some professions, such as security guards, entail higher stress than others (4). Security services involve a physical and emotional stress due to exposure to verbal and physical aggression and violence, and sometimes the use of physical force. Security guards are expected to behave responsibly, and carrying or using firearms greatly adds to the stress (5–10). Frequent incidents can lead to the development of burn-out and post-traumatic stress disorders (9–17). Some personality characteristics (e.g., impulsivity, aggressiveness), which are sometimes noted among security guards (18, 19), can predispose for enhanced response to psychological stress, escalation of conflict, and counterproductive problem-solving strategies (20, 21). In addition, these workers often work in unfavourable (too cold or too hot, noisy, dusty) working environments and conditions, such as confined workspaces, fixed body position and static effort, irregular and extended working hours, shift work, night work, and often. In addition, their jobs are often underpaid and insecure in terms of long-term contracts with all benefits (22–36). All these stressors place security guards in the category of jobs with a high level of occupational stress (4).

The number of security guards has grown substantially, as more and more private security services are engaged to protect people and property in many countries (37, 38), yet information about their health status and occupational stress is still limited.

Recently we have shown a surprisingly high prevalence of health impairments in 399 security guards (aged 25–65 years, mean age 45.6 years) in Serbia (4). Hyperglycaemia (77.2 %), dyslipidaemia (82.7 %), hypertension (69.9 %), metabolic syndrome (77.7 %), and diabetes (38.8 %) had much higher prevalence than in the general population or male workers in other professions in Serbia (39–42) or the world (43). More interestingly, this surprisingly high prevalence of health impairments was not related to obesity (as one could expect, considering the known association between these health impairments and adiposity), as most security guards (56.9 %) were not overweight or obese. The prevalence of overweight and obesity was 33.8 % and 9.3 %, respectively, and the mean body mass index (BMI) was 24.6 kg/m^2. This finding pointed to other contributing factors. We therefore assessed the levels of occupational

Corresponding author: Ivana Šarac, University of Belgrade, Institute for Medical Research, National Institute of Republic of Serbia, Centre for Research Excellence in the Field of Nutrition and Metabolism, Tadeuša Košćuška 1, 11158 Belgrade, Serbia, Email: *ivanasarac@yahoo.com*, ORCID: https://orcid.org/0000-0003-1439-9561

stressors at their workplaces and found significant positive associations between the total level of occupational stress [measured by the Occupational Stress Index (OSI) questionnaire (44)], and the prevalence of fasting hyperglycaemia, dyslipidaemia, hypertension, metabolic syndrome, diabetes, coronary heart disease, cerebrovascular insults, degenerative eye fundus changes, and temporary and permanent work disability. At the same time, the associations of occupational stress with health impairments and work disability were independent of the security guards' age, BMI, and smoking status.

In that study (4) we used the OSI questionnaire designed by Karen Belkić (44) to cover a broad range of occupational stressors, not always covered by some other occupational stress questionnaires (45, 46). Belkić's questionnaire groups occupational stressors in seven clusters, named "OSI aspects", and the sum of them represents the total OSI score. With our new study, presented here, we therefore wanted to look further into these specific OSI aspects and run additional statistical analyses to identify which specific stressors were associated with health and work disability risks, which could provide a the basis for timely implementation of preventive and corrective measures.

MATERIALS AND METHODS

The detailed study design and methods used have already been described in our previous paper (4) in which we analysed the influence of the total level of occupational stress on heath and work ability of security guards. As this study brings an extended statistical analysis of data collected in the previous study, we will limit this section to the most important information, and the reader may seek more details in our earlier report (4).

Study participants

The study included 399 male security guards, aged 25–65 years (mean age 45.6 years), who worked in a private security agency on the territory of South-Eastern Serbia at the time of the study (February to March 2016) and underwent mandatory regular check-ups at the Institute of Occupational Medicine Niš, Serbia. All the participants signed an informed written consent for participation. The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Institute of Occupational Health of Niš, Serbia.

Detailed characteristics of the study participants were described in Table 1 of our previous paper (4).

Participants' health status and work disability indicators

In short, the collected data included participants' age, work history (work position, total employment length and current employment length), smoking habits (active cigarette smoking at the moment of the examination, defined as at least one smoked cigarette per day), anthropometric data (body weight, height, BMI), fasting serum glucose and lipids [triglycerides, total cholesterol, low density lipoprotein (LDL) cholesterol, and high density lipoprotein (HDL) cholesterol], and blood pressure. Data also included the diagnoses of hypertension (47), hyperglycaemia (48), dyslipidaemia(49), metabolic syndrome (50), type 2 diabetes (48), angina pectoris, myocardial infarction, cerebrovascular insults (including ischaemic stroke, haemorrhagic stroke, and transient ischaemic attack), and degenerative changes in the eye fundus related to hypertension and/or diabetes. These data were used to calculate the Framingham risk score of each participant (51).

Data on duration of temporary work disability (related to one of the diagnosed chronic diseases mentioned above) during the preceding year (in days) were obtained from medical records and data on applications for permanent work disability status (related to the diagnosed conditions mentioned above) from relevant work disability medical commissions.

Unfortunately, we did not collect waist circumference data for anthropometric measurements, as this measurement does not make part of regular check-ups, which is why the metabolic syndrome in this study was diagnosed based on four of the five criteria defined by the American Heart Association/National Heart, Lung, and Blood Institute (50), i.e., on fasting glucose, triglycerides, HDL cholesterol, and

Table 1 Specific OSI aspect scores among security guards and their contribution to total OSI score

	Mean	SD	Median	Min	Max	% Total OSI score	Max score points	% Max score
High demands	16.1	10.0	19.5	0.0	32.0	20.7	40 points	40.2
Strictness	14.9	4.5	14.0	6.5	22.5	19.1	24 points	61.9
Conflict/uncertainty	12.6	6.7	10.0	5.0	26.0	16.3	30 points	42.2
Underload	12.3	8.1	9.5	0.0	22.0	15.8	22 points	55.8
Threat avoidance	9.0	4.9	9.5	0.5	17.0	11.6	20 points	44.8
Noxious exposures	8.5	4.3	10.0	0.0	14.0	10.9	14 points	60.6
Extrinsic time pressure	4.4	2.5	3.5	1.0	9.5	5.6	10 points	43.6
Total OSI score	77.7	10.7	81.3	52.5	97.0	100.0	160 points	48.6

OSI – Occupational Stress Index (44)

blood pressure measurements, whereas waist circumference (abdominal obesity) is missing. Had waist circumference been measured, the number of participants with the metabolic syndrome would probably have been even greater than 77.7 %.

Occupational stress index (OSI) questionnaire- specific aspects

The OSI questionnaire by Belkić (44), analyses the presence and intensity of specific stressors at the workplace, grouped in into seven clusters (OSI aspects) described below. Their sum gives the total OSI score (maximum 160 points).

The aspect *high demands* (maximum 40 points) includes the following items: receiving information from several sources at the same time, receiving heterogeneous information, high frequency of incoming signals, visual observation and heavy burden on visual system, receiving three or more different sensory stimuli at the same time, necessity of communication at work, making complicated, complex and rapid decisions, or decisions which affect the work of the others, performing rapid, simultaneous, heterogeneous and complex tasks, salary based the task performance, holding two or more jobs, long working hours, shift and night work, irregular working hours, lack of rest-breaks, and lack of paid vacations.

The aspect *strictness* (maximum 24 points) involves the following items: strict demand for detecting signals, performing tasks according to strictly defined standards, fixed position during work, performing work in a confined, window-less workplace, lack of the autonomous workplace, limitations in taking time-off from work, limited influence on decision making over schedule, tasks, policy, and with whom one works.

The aspect *conflict/uncertainty* (maximum 30 points) includes the following items: vague difference between different incoming signals (e.g., signal-signal conflicts, and signal-noise conflicts), obtaining contradictory information, the lack of essential information needed for decision making, conflicting demands, work without sense, confrontation with unexpected events that require the change of the previous work plan, the lack of essential information, tasks performance often hampered by extrinsic problems or interruptions from other people, an emotionally charged atmosphere burdened with interpersonal conflicts, a lack of support and assistance from colleagues, hurdles in career advancement imposed by others, fixed-term employment or a threat of layoffs, violations of behaviour norms and rules of conduct, abuses of power, and inability to complain.

The aspect *underload* (maximum 22 points) includes the following items: receiving homogeneous signals, low frequency of incoming signals, working alone without the need for communication with other people, making decisions automatically, performing the same and simple tasks, monotonous work or having nothing to do, fixed salary regardless of the work invested, insufficiency of salaries for the living needs of worker and his family, the inability to progress in career, and the lack of recognition for work.

The aspect *threat avoidance* (maximum 20 points) includes the following items: avoidance of hazards with high level of attention and constant readiness to avoid possible serious consequences, the pressure that wrong decisions can have serious (potentially fatal) consequences, hazardous task performance, the presence of visually and auditory disturbing scenes and events, high level of emotionally-disturbing events, experiencing work accidents and witnessing work accidents, witnessing suicide occurrence at work, work- related litigations and testifying in court, and lack of functioning emergency systems.

The aspect *noxious exposures* (maximum 14 points) includes the following items: exposure to blinding light, flash, noise, vibrations, temperature extremes, toxic gases, fumes, dust, and load lifting.

The aspect *extrinsic time pressure* (maximum 10 points) includes the following items: no control over speed of incoming signals, lack of ability to delay decisions, fixed speed of task- execution, the need of speeding up the work, and the existence of deadlines.

[For detailed description of the specific OSI aspects and the scoring system, see the reference (44)].

Statistical analysis

The data were processed by statistical software SPSS 26.0 (SPSS Inc., Chicago, IL, USA), STATGRAPHICS Centurion 18.1.06 (StatPoint Technologies, Inc.,The Plains, VA, USA), and R 4.0.3 for Windows (The R Foundation for Statistical Computing, Vienna, Austria).

Descriptive data were presented as means with standard deviations (*SD*) or medians with ranges (min–max) for continuous/discrete variables, then as the number of participants (*N*) and percentages per category (%) for categorical variables.

The association between continuous/discrete variables was tested with the Spearman's rank correlation coefficient (r_s), and the association between continuous/discrete and dichotomous categorical variables with the non-parametric Mann-Whitney *U* test. Penalized ridge linear regression was applied to overcome the issue of multicolinearity in multiple linear regressions [tested by the variance inflation factor (VIF)] (52) using the STATGRAPHICS Centurion 18.1.06 and statistical packages "ridge" (53) and "lmridge" (54) in R 4.0.3. Variables were centred and standardised during ridge-penalised regression. Ridge parameter was chosen automatically using the method of Cule and De Iorio (55, 56), and 10-fold cross-validation was performed. All tests were two-tailed. The statistical significance was established at $p<0.05$, but in case of multiple comparisons, the Bonferroni correction for statistical significance was

also applied (57). The Bonferroni corrected/adjusted *p* value was calculated by dividing the original α-value (0.05) by the number of multiple comparisons (i.e., hypotheses tested) in the performed analyses (57).

RESULTS

Specific OSI aspect scores, their contribution to total OSI score, and correlations between them

Specific aspect scores and their contribution to total OSI score are shown in Table 1.

As we have already shown in our previous paper (4), the mean total OSI score equalled approximately one half of the maximum possible score (48.6 %). The following aspects accounted for the highest contributions to total score: high demands, strictness, conflict/uncertainty, and underload (Table 1).

Although the aspects noxious exposures, extrinsic time pressure, and threat avoidance did not significantly contribute to the total OSI scores, their scores were quite high in relation to their maximum score. This suggests that the impact of these aspects of occupational stressors should not be neglected, as they were reasonably represented. For all specific OSI aspects, mean scores were in the range of about 40–60 % of their maximum points.

Table 2 shows the correlations between specific aspect scores and the total OSI score. Total OSI score was positively associated with high demands, strictness, conflict/uncertainty, and extrinsic time pressure (p<0.001) and negatively associated with the underload and noxious exposures (p<0.001). Although the association between total OSI score and threat avoidance was statistically significant, this association was weak (r_s=-0.145, p=0.004) and diminished after applying the Bonferroni correction for multiple comparisons. All pairwise associations between the aspects high demands, strictness, conflict/uncertainty, and extrinsic time pressure were positive (p<0.001), while their associations with the aspects underload, threat avoidance, and noxious exposures were negative (p<0.001). All pairwise associations between the aspects underload, threat avoidance, and noxious exposures were positive (p<0.001). Apart from the association between total OSI score and threat avoidance, all associations remained statistically significant after applying the Bonferroni correction.

Correlations between specific occupational stressors (specific OSI aspect scores) and indicators of health status and temporary and permanent work disability among security guards

Spearman's rank correlation analysis revealed that OSI aspects high demands, strictness, conflict/uncertainty, and extrinsic time pressure positively correlated with all health risk and work disability indicators, except HDL cholesterol

Table 2 Inter-correlations between total OSI score and specific OSI aspects

	Total OSI score		**High demands**		**Strictness**		**Conflict / uncertainty**		**Underload**		**Threat avoidance**		**Noxious exposures**		**Extrinsic time pressure**	
	r_s	p	r_s	p	r_s	p	r_s	p	r_s	p	r_s	p	r_s	p	r_s	p
Total OSI score	-	-	0.824	**<0.001***	0.874	**<0.001***	0.594	**<0.001***	-0.643	**<0.001***	-0.145	**0.004**	-0.238	**<0.001***	0.701	**<0.001***
High demands	0.824	**<0.001***	-	-	0.875	**<0.001***	0.389	**<0.001***	-0.905	**<0.001***	-0.212	**<0.001***	-0.483	**<0.001***	0.748	**<0.001***
Strictness	0.874	**<0.001***	0.875	**<0.001***	-	-	0.551	**<0.001***	-0.802	**<0.001***	-0.275	**<0.001***	-0.430	**<0.001***	0.738	**<0.001***
Conflict / uncertainty	0.594	**<0.001***	0.389	**<0.001***	0.551	**<0.001***	-	-	-0.360	**<0.001***	-0.676	**<0.001***	-0.399	**<0.001***	0.528	**<0.001***
Underload	-0.643	**<0.001***	-0.905	**<0.001***	-0.802	**<0.001***	-0.360	**<0.001***	-	-	0.285	**<0.001***	0.561	**<0.001***	-0.725	**<0.001***
Threat avoidance	-0.145	**0.004**	-0.212	**<0.001***	-0.275	**<0.001***	-0.676	**<0.001***	0.285	**<0.001***	-	-	0.697	**<0.001***	-0.415	**<0.001***
Noxious exposures	-0.238	**<0.001***	-0.483	**<0.001***	-0.430	**<0.001***	-0.399	**<0.001***	0.561	**<0.001***	0.697	**<0.001***	-	-	-0.495	**<0.001***
Extrinsic time pressure	0.701	**<0.001***	0.748	**<0.001***	0.738	**<0.001***	0.528	**<0.001***	-0.725	**<0.001***	-0.415	**<0.001***	-0.495	**<0.001***	-	-

* remained significant after the Bonferroni corrections for multiple comparisons (p<0.0001). OSI=Occupational Stress Index (44); p=statistical significance of correlations; r_s=Spearman's rank correlation coefficients

(r_s ranging from 0.420 to 0.581, $p<0.001$ for all analyses). As expected, all pairwise associations between these OSI aspects and HDL cholesterol were negative, (r_s ranging from -0.415 to -0.550, $p<0.001$ for all analyses).

The Mann-Whitney *U* test confirmed the positive associations of those OSI aspects with all health impairments ($p<0.012$ for all analyses, Table 3).

Surprisingly, aspects noxious exposures, underload, and threat avoidance were negatively associated with all of the health risk and work disability indicators (the only significant positive correlations were found for HDL cholesterol). However, these negative correlations were weaker than the above-mentioned positive correlations for the aspects high demands, strictness, conflict/uncertainty, and extrinsic time pressure (r_s ranging from -0.160 to -0.380, $p<0.001$ for almost all analyses; data not shown). Another surprise was that these aspects also had negative associations with diabetes, angina pectoris, myocardial infarction, cerebrovascular insults, degenerative eye fundus changes, and permanent work disability (Table 3).

The Bonferroni correction for multiple comparisons (which established statistical significance at $p<0.00071$) did not alter the statistical significance for most of the correlations, except for the associations of high demands and extrinsic time pressure with hyperglycaemia and hypertension; extrinsic time pressure with dyslipidaemia and metabolic syndrome; threat avoidance with cholesterol, Framingham risk score, angina pectoris, myocardial infarction, cerebrovascular insults, and permanent work disability; and the association of noxious exposures with HDL cholesterol.

Ridge linear regression for associations between specific OSI aspects and indicators of health status and temporary work disability among security guards

In order to confirm the significance of the influence of specific occupational stressors on health and work disability parameters and to verify the independence of that influence, we ran additional multiple linear regressions. As already reported in our previous paper (4), age, BMI, and smoking highly correlated with all of the analysed indicators of health risks and work disability in security guards. In order to assess the independent impact of specific occupational stressors on health status and work disability in the current study, we therefore had to include these three variables as "control" variables in all regression models. Additionally, all specific OSI aspects were included as potential predictors. As we previously pointed out, specific OSI aspects significantly correlated with each other, which raised the issue of multicolinearity in the regression analyses (the highest VIF was 23.5, mean VIF 10.2) and required the implementation of penalised models, that is, ridge linear regression (52).The selection of ridge penalty parameter was automatic, as described by Cule and De Iorio (55, 56). With these penalty parameters applied, all VIFs in the models were reduced to 3.3 or less (mean VIF 1.5). The maximum ridge penalty was 0.179 (penalty for the heart rate model). Additionally, in order to assess the contribution of specific OSI aspects to the variability of dependent variables (using the adjusted R^2), we made supplementary models which included only age, BMI, and smoking status as predictors. The ridge parameters for those models without OSI aspects were set to be the same as for the full model (with all OSI aspects included).The results of ridge linear regression analyses are shown in Table 4.

The ridge-penalised linear regression analyses (Table 4) with adjustments for age, BMI, and smoking status showed that most OSI aspects (except noxious exposures and extrinsic time pressure) were significant positive predictors for all of the examined health risk parameters, including fasting glucose, triglycerides, total and LDL cholesterol, systolic and diastolic blood pressure, heart rate, Framingham risk score, and the number of lost working days due to sick leave. Only for HDL cholesterol were these associations negative. Furthermore, noxious exposures were negatively associated with total cholesterol levels ($p=0.044$), but this association became insignificant after applying the correction for multiple comparisons.

The linear regression models with ridge penalization explained 50.1–78.1 % of the variance in the examined parameters (adjusted R^2), and were statistically significant ($p<0.001$ for all the tests). Only for HDL cholesterol was the adjusted R^2 lower (28.5 %). After the Bonferroni correction for multiple comparisons, the vast majority of the significant predictions remained (Table 4).

Since the maximum ridge penalty of the Cule and De Iorio method (55, 56) was 0.179 (for heart rate), we ran additional sensitivity analysis with 0.180 ridge penalty applied for all models (equal ridge penalty for all dependent variables). The maximal VIF was now 1.0, and mean VIF was 0.9, and even better model stability was achieved. The results were pretty much the same, with the same significance of regression coefficients of OSI aspects. The only difference was that the associations of age with serum glucose and lipid levels became significant, whereas the positive association of extrinsic time pressure with total cholesterol became marginally significant ($p=0.048$, but insignificant after applying the Bonferroni correction), and the association of noxious exposures and total cholesterol became insignificant. These models explained 50.0–72.1 % of the variance in the examined parameters and were again statistically significant ($p<0.001$), whereas the adjusted R^2 was lower only for HDL cholesterol (27.8 %) (data not shown).

To examine independent associations of specific OSI aspects with specific health conditions and permanent work disability would call for ridge logistic regression, but the analysis would not be reliable due to the small sample size, large number of predictors included, and very small (or very high) frequencies of certain conditions (58, 59).

Table 3 Association of specific OSI aspects scores with health impairments and permanent work disability [Mann-Whitney *U* test for significant differences (*p*) in specific OSI scores between security guards with and without specific health impairment or permanent work disability]

Health impairment/work disability presence:		N (%)	Specific OSI aspects scores													
			High demands		Strictness		Conflict / uncertainty		Underload		Threat avoidance		Noxious exposures		Extrinsic time pressure	
			Median (Min-Max)	p	Median (Min-Max)	p	Median (Min-Max)	p	Median (Min-Max)	p	Median (Min-Max)	p	Median (Min-Max)	p	Median (Min-Max)	p
Hyperglycaemia	yes	308 (77.2)	19.5 (0.0 - 32.0)	**0.003**	14.5 (7.0 - 22.5)	**<0.001***	10.5 (5.0 - 26.0)	**<0.001***	9.8 (0.0 - 22.0)	0.134	10.0 (0.5 - 16.5)	0.321	10.0 (0.0 - 14.0)	0.305	3.5 (1.0 - 9.5)	**0.011**
	no	91 (22.8)	19.0 (0.0 - 30.0)		12.5 (6.5 - 22.0)		8.5 (5.0 - 24.0)		9.5 (0.5 - 21.0)		7.0 (0.5 - 17.0)		9.5 (0.0 - 13.5)		3.0 (1.0 - 9.5)	
Dyslipidaemia	yes	330 (82.7)	19.8 (0.0 - 32.0)	**<0.001***	14.5 (7.0 - 22.5)	**<0.001***	10.0 (5.0 - 26.0)	**<0.001***	9.5 (0.0 - 22.0)	0.539	10.0 (0.5 - 16.5)	0.162	10.0 (0.0 - 14.0)	0.287	3.5 (1.0 - 9.5)	**0.002**
	no	69 (17.3)	5.5 (0.5 - 28.8)		10.5 (6.5 - 22.0)		8.5 (5.5 - 24.0)		19.0 (0.5 - 21.0)		6.5 (1.0 - 17.0)		10.0 (0.0 - 13.5)		3.0 (1.0 - 9.5)	
Hypertension	yes	270 (69.9)	19.8 (0.0 - 32.0)	**0.002**	14.5 (7.0 - 22.5)	**<0.001***	10.5 (5.0 - 26.0)	**<0.001***	9.5 (0.0 - 22.0)	0.217	9.5 (0.5 - 16.5)	0.215	10.0 (0.0 - 14.0)	0.952	3.5 (1.0 - 9.5)	**0.001**
	no	120 (30.1)	14.9 (0.0 - 30.0)		13.3 (6.5 - 22.0)		8.5 (5.0 - 24.0)		11.0 (0.5 - 21.0)		9.3 (0.5 - 17.0)		10.0 (0.0 - 13.5)		3.0 (1.0 - 9.5)	
Metabolic syndrome	yes	306 (76.7)	19.8 (0.0 - 32.0)	**<0.001***	14.5 (7.0 - 22.5)	**<0.001***	10.5 (5.0 - 26.0)	**<0.001***	9.5 (0.0 - 22.0)	0.661	9.5 (0.5 - 16.5)	0.344	10.0 (0.0 - 14.0)	0.414	3.5 (1.0 - 9.5)	**0.003**
	no	93 (23.3)	14.9 (0.0 - 30.0)		13.3 (6.5 - 22.0)		8.5 (5.0 - 24.0)		11.0 (0.5 - 21.0)		9.3 (0.5 - 17.0)		10.0 (0.0 - 13.5)		3.0 (1.0 - 9.5)	
Diabetes type	yes	155 (38.8)	25.5 (0.5 - 32.0)	**<0.001***	20.0 (7.5 - 22.5)	**<0.001***	21.0 (5.5 - 26.0)	**<0.001***	4.0 (0.0 - 22.0)	**<0.001***	5.0 (0.5 - 16.5)	**<0.001***	3.0 (0.0 - 14.0)	**<0.001***	7.0 (1.0 - 9.5)	**<0.001***
	no	244 (61.2)	10.1 (0.0 - 30.0)		13.0 (6.5 - 22.5)		9.0 (5.0 - 24.5)		19.0 (0.5 - 22.0)		10.5 (0.5 - 17.0)		10.0 (0.0 - 13.5)		3.0 (1.0 - 9.5)	
Angina pectoris	yes	27 (6.8)	28.5 (9.5 - 31.5)	**<0.001***	21.0 (11.5 - 2.5)	**<0.001***	24.0 (5.0 - 26.0)	**<0.001***	3.0 (0.5 - 21.0)	**<0.001***	5.0 (0.5 - 15.0)	**0.003**	2.5 (0.5 - 13.0)	**<0.001***	8.0 (2.0 - 9.5)	**<0.001***
	no	372 (93.2)	11.0 (0.0 - 32.0)		14.0 (6.5 - 22.5)		9.5 (5.0 - 26.0)		14.5 (0.0 - 22.0)		9.5 (0.5 - 17.0)		10.0 (0.0 - 14.0)		3.5 (1.0 - 9.5)	
Myocardial infarction	yes	25 (6.3)	29.0 (9.0 - 31.5)	**<0.001***	20.0 (11.5 - 2.5)	**<0.001***	24.0 (6.5 - 26.0)	**<0.001***	2.5 (0.0 - 21.0)	**<0.001***	4.5 (0.5 - 16.0)	**0.002**	2.0 (0.0 - 13.0)	**<0.001***	8.5 (2.0 - 9.5)	**<0.001***
	no	374 (93.7)	11.0 (0.0 - 32.0)		14.0 (6.5 - 22.5)		9.5 (5.0 - 26.0)		14.3 (0.5 - 22.0)		9.5 (0.5 - 17.0)		10.0 (0.0 - 14.0)		3.5 (1.0 - 9.5)	

Table 3 continued

Health impairment/work disability presence:		N (%)	High demands Median (Min-Max)	p	Strictness Median (Min-Max)	p	Conflict / uncertainty Median (Min-Max)	p	Underload Median (Min-Max)	p	Threat avoidance Median (Min-Max)	p	Noxious exposures Median (Min-Max)	p	Extrinsic time pressure Median (Min-Max)	p
Cerebrovascular insults	yes	26 (6.5)	29.3 (8.3 - 32.0)	**<0.001***	20.5 (12.5 - 2.5)	**<0.001***	24.0 (5.0 - 26.0)	**<0.001***	2.8 (0.0 - 20.5)	**<0.001***	4.8 (0.5 - 16.5)	**0.002**	2.3 (0.0 - 12.5)	**<0.001***	8.3 (2.5 - 9.5)	**<0.001***
	no	373 (93.5)	11.0 (0.0 - 31.5)		14.0 (6.5 - 22.5)		9.5 (5.0 - 26.0)		14.5 (0.5 - 22.0)		9.5 (0.5 - 17.0)		10.0 (0.0 - 14.0)		3.5 (1.0 - 9.5)	
Eye-fundus changes	yes	41 (10.3)	28.0 (2.5 - 32.0)	**<0.001***	21.0 (9.0 - 22.5)	**<0.001***	24.5 (6.5 - 26.0)	**<0.001***	3.0 (0.0 - 21.5)	**<0.001***	3.5 (0.5 - 15.0)	**<0.001***	2.0 (0.0 - 13.0)	**<0.001***	8.0 (2.5 - 9.5)	**<0.001***
	no	358 (89.7)	11.0 (0.0 - 31.5)		14.0 (6.5 - 22.5)		9.5 (5.0 - 26.0)		15.0 (0.5 - 22.0)		10.0 (0.5 - 17.0)		10.0 (0.0 - 14.0)		3.0 (1.0 - 9.5)	
Permanent work disability	yes	26 (6.5)	28.9 (9.5 - 32.0)	**<0.001***	20.8 (13.5 - 2.5)	**<0.001***	24.0 (6.5 - 26.0)	**<0.001***	3.0 (0.0 - 21.0)	**<0.001***	5.0 (0.5 - 16.5)	**0.004**	2.5 (0.0 - 12.5)	**<0.001***	8.3 (2.5 - 9.5)	**<0.001***
	no	373 (93.5)	11.0 (0.0 - 31.5)		14.0 (6.5 - 22.5)		9.5 (5.0 - 26.0)		14.5 (0.5 - 22.0)		9.5 (0.5 - 17.0)		10.0 (0.0 - 14.0)		3.5 (1.0 - 9.5)	

* remained significant after the Bonferroni corrections for multiple comparisons ($p<0.00071$); *N*=number of subjects; OSI=Occupational Stress Index (44); *p*=statistical significance of difference; *SD*=standard deviation

DISCUSSION

To our knowledge, this is the first study to examine the impact of specific professional stressors on health status and working ability in security guards. It has singled out OSI aspects high demands, conflict/uncertainty, threat avoidance, strictness, and underload as the most influential stressors on fasting glucose, triglycerides, total, LDL and HDL cholesterol, systolic and diastolic blood pressure, heart rate, Framingham risk score, and temporary work disability after correcting for age, BMI, and smoking, while the aspects noxious exposures and extrinsic time pressure did not show significant influence.

High demands, strictness, conflict/uncertainty, and underload contributed the most to the overall level of stress in security guards, while the contribution of threat avoidance, noxious exposures, and extrinsic time pressure was lower. However, it is very important to note that the OSI questionnaire (44) itself has the scoring system that reflects unequal contribution of each aspect, which needs to be taken into account. All individual aspect scores were in the range of 40–60 % of the maximum score for respective aspects, while the total OSI score was about half (~50 %) the maximum (4).

Unfortunately, since the OSI questionnaire by Belkić has been only been used in the population of Serbian and Swedish workers so far (1–3, 38, 39, 44–46), we cannot directly compare our data with the data on the levels of specific occupational stressors in security guards in other countries, which would be very interesting to see. However, we could compare them with the data obtained with the same questionnaire for other professions in Serbia, such as professional drivers (40–42), bank employees (41), and electronic (41) and metal industry (41) workers, as presented in Table 5. We also could not compare our findings on the relationships of specific occupational stressors with health impairments and work disability among security guards, as, to the best of our knowledge, no other studies of this kind have yet been published.

Below we shall analyse the specific OSI aspects in terms of their occurrence among security guards and of their influence on development of the examined health impairments and work disability.

High demands

The high demands aspect indicates high burden of work and obligations, including difficult, complicated, and demanding tasks. It also includes shift and night work, extended working hours, lack of breaks, lack or insufficient length of annual leaves, and holding multiple jobs. In other words, it represents "work-overload" and "over-responsibility".

Probably the most significant within this aspect is the stress from shift and overnight work, common for security services (22–28). Many agree to work (night) shifts to

increase their incomes. However, each individual has its own circadian rhythm and an internal biological clock (60, 61). Working (night) shifts disturbs these rhythms (including hormonal secretion of cortisol, catecholamines, melatonin, growth hormone, leptin, ghrelin) (62–65) differently between individuals (60–62), and daytime sleep cannot replace the night time sleep, because it is shorter and more disturbed (64, 65). Shift work, night work, and chronic sleep deprivation are associated with a higher risk of obesity (particularly abdominal obesity), disrupted glucose metabolism, dyslipidaemia, metabolic syndrome, diabetes, cardiovascular disease (including hypertension, atherosclerosis, coronary heart disease, and stroke), cancer risk, mental problems, and injuries (46, 64–72). Furthermore, shift and night work lead to bad lifestyle habits, such as increased cigarette smoking and alcohol consumption, reduced physical activity, and inadequate diet (irregular meals, night eating, consumption of the so called "junk food", eating disorders), higher total caloric intake and decreased energy expenditure due to metabolic slowdown (64, 65, 71–75). Working in shifts also reduces social contacts and participation in social events (as they mostly take place during daytime), leading to social isolation and more frequent marital, sexual, and fertility issues, often reported by security guards working in shifts (22, 28).

However, there are studies that claim the opposite. For example, a Teheran study (35) showed that security guards who worked rotating shifts had lower scores in the Osipow job stress questionnaire, than guards working fixed shifts. Similar was reported for Brazilian security guards (36).

Working long hours and overtime is also common among security guards (28–34) and adds to the burnout syndrome, health impairments, injuries, and absenteeism (76, 77). Similar to shift work, it also affects family and social life and other activities that could relieve stress (including sports and other physical activities) (30, 31, 34, 77–79). Long working hours and lack of recovery time have been shown to contribute to obesity, dyslipidaemia, metabolic syndrome, diabetes, cardiovascular disease, injuries, and absenteeism (75, 80–83).

Even though Serbia has strict regulations on maximum working hours a day or a week, overtime, night shifts, shift rotations, and day and week rests (84), many security agencies ignore them, pushing their staff to work overtime, long night shifts, without enough rest in between (38).

Strictness

The strictness aspect implies strict rules and procedures, standards, and limited autonomy ("low decision latitude") and influence on time-tables, choice of co-workers, and policies ("low job control"). It also implies workplace spatial limitations and fixed body position (29).

Epidemiological studies show that low decision latitude and/or low job control are associated with diabetes, dyslipidaemia, cardiovascular disease, and long sick-leave (2, 42, 85–92).

Confined, cramped workplaces, fixed body position, lack of movement, and physical inactivity increase sensitivity to stress, while moderate physical activity diminishes response to psychological stressors by decreasing plasma catecholamines and cortisol and by increasing the sensitivity of β2-adrenergic receptors, which lowers the heart rate and blood pressure (93). Furthermore, lack of movement and physical inactivity predisposes to obesity, insulin resistance, dyslipidaemia, and metabolic syndrome, all of which directly increase the cardiovascular risk (94, 95).

Conflicts/uncertainty

The conflicts/uncertainty aspect is pronounced among security guards, as their job is to deal with conflict situations (often including verbal and physical aggression), in which even their and other peoples' lives may be at risk. Such stressful situations often have long-lasting consequences, and sometimes result in post-traumatic stress disorder, depending on the guard's personality traits, training, and social support (10–15). This type of stress is even more pronounced in guards who carry firearms (5–9, 31). Fortunately, most guards have never fired a single shot on duty (5). However, those who were involved in a shooting incident may suffer from severe traumatic consequences (5–12, 31).

In addition, certain personality traits such as aggression, impulsivity, and the lack of training and workplace support can facilitate negative outcomes in conflict situations (16–21, 31).

Any job may involve a negative working atmosphere full of interpersonal conflicts, bullying, mobbing, and threat of job loss, but this may be even more pronounced in security services (7, 11, 12, 20, 21, 30, 31). All this increases tension at work and a lowers job satisfaction.

Many studies have shown that conflicts at work can be associated with higher risk of metabolic syndrome, diabetes, cardiovascular and cerebrovascular insults, and prolonged sick leave (41, 42, 91, 96–99).

Economic transition in Serbia seems to further increase the level of professional stress among these workers (38). High unemployment rate in the country certainly plays into the hand of employers, who can impose minimum salaries, avoid paying health and pension insurance or even declaring security staff on payrolls, and denying them free weekdays, vacation, and sick leave (100–102). It was found that the perceived stress arising from the fear of a job loss and unemployment is a risk factor for the development cardiovascular disease (46, 91,102–104).

Underload

The underload aspect involves monotonous, automatic, repetitive, and simple tasks, rare signals, and no company.

Table 4 Ridge (penalised) linear regression models for assessing independent impact of specific OSI aspects on health and temporary work disability indicators (with adjustment for age, BMI, smoking status, and influence of other OSI aspects)

Predictors (independent variables)	Dependent (predicted) variables																			
	Glucose		Triglycerides		Total cholesterol		LDL cholesterol		HDL cholesterol		Systolic BP		Diastolic BP		Heart Rate		Framingham risk score		Lost working days	
	β	p	β	p	β	p	β	p	β	p	β	p	β	p	β	p	β	p	β	p
Model including only age, BMI and smoking status																				
Age	0.199	**<0.001***	0.223	**<0.001***	0.286	**<0.001***	0.296	**<0.001***	-0.179	<0.001*	0.150	**<0.001***	0.079	**0.012**	0.130	**<0.001***	0.553	**<0.001***	0.158	**<0.001***
BMI	0.597	**<0.001***	0.647	**<0.001***	0.627	**<0.001***	0.576	**<0.001***	-0.368	<0.001*	0.637	**<0.001***	0.608	**<0.001***	0.557	**<0.001***	0.402	**<0.001***	0.572	**<0.001***
Smoking status	0.205	**<0.001***	0.149	**<0.001***	0.183	**<0.001***	0.195	**<0.001***	-0.132	<0.001*	0.149	**<0.001***	0.121	**<0.001***	0.196	**<0.001***	0.195	**<0.001***	5.465	**<0.001***
Ridge parameter †	0.116		0.091		0.061		0.063		0.157		0.122		0.158		0.179		0.064		0.159	
Ridge model adjusted R^2	0.533		0.597		0.625		0.572		0.241		0.535		0.456		0.445		0.754		0.473	
Overall ridge model p- value	**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***	
Model including age, BMI, smoking status and all OSI aspects together																				
Age	0.048	0.136	0.055	0.078	0.051	0.100	0.059	0.089	-0.082	0.051	-0.003	0.914	-0.039	0.229	0.008	0.801	0.446	**<0.001***	0.040	0.218
BMI	0.477	**<0.001***	0.510	**<0.001***	0.463	**<0.001***	0.418	**<0.001***	-0.296	**<0.001***	0.511	**<0.001***	0.502	**<0.001***	0.461	**<0.001***	0.316	**<0.001***	0.468	**<0.001***
Smoking status	0.302	**<0.001***	0.243	**<0.001***	0.307	**<0.001***	0.333	**<0.001***	-0.226	**<0.001***	0.239	**<0.001***	0.198	**<0.001***	0.283	**<0.001***	0.362	**<0.001***	0.253	**<0.001***
High demands	0.123	**<0.001***	0.140	**<0.001***	0.209	**<0.001***	0.205	**<0.001***	-0.071	**0.040**	0.112	**<0.001***	0.078	**0.005**	0.088	**<0.001***	0.093	**0.004**	0.075	**0.006**
Strictness	0.275	**<0.001***	0.269	**<0.001***	0.272	**<0.001***	0.289	**<0.001***	-0.244	**<0.001***	0.266	**<0.001***	0.256	**<0.001***	0.246	**<0.001***	0.218	**<0.001***	0.225	**<0.001***
Conflict / uncertainty	0.190	**<0.001***	0.228	**<0.001***	0.283	**<0.001***	0.272	**<0.001***	-0.119	**0.005**	0.218	**<0.001***	0.189	**<0.001***	0.162	**<0.001***	0.149	**<0.001***	0.170	**<0.001***
Underload	0.275	**<0.001***	0.294	**<0.001***	0.318	**<0.001***	0.318	**<0.001***	-0.204	**<0.001***	0.267	**<0.001***	0.247	**<0.001***	0.222	**<0.001***	0.224	**<0.001***	0.226	**<0.001***
Threat avoidance	0.177	**<0.001***	0.166	**<0.001***	0.203	**<0.001***	0.237	**<0.001***	-0.210	**<0.001***	0.169	**<0.001***	0.161	**<0.001***	0.182	**<0.001***	0.158	**<0.001***	0.146	**<0.001***
Noxious exposures	-0.024	0.496	-0.050	0.180	-0.085	**0.044**	-0.066	0.153	-0.036	0.406	-0.033	0.347	-0.017	0.598	0.005	0.863	-0.023	0.527	-0.012	0.693
Extrinsic time pressure	0.029	0.448	0.020	0.607	0.020	0.646	0.031	0.518	-0.028	0.535	0.024	0.511	0.019	0.590	0.038	0.241	-0.008	0.838	0.053	0.130
Ridge parameter ‡	0.116		0.091		0.061		0.063		0.157		0.122		0.158		0.179		0.064		0.159	
Ridge model adjusted R^2	0.597		0.669		0.726		0.666		0.285		0.604		0.514		0.501		0.781		0.524	
Overall ridge model p- value	**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***		**<0.001***	

* remained significant after the Bonferroni corrections for multiple comparisons (p<0.00071). †ridge parameter set to be equal with the ridge parameter of full model below (which also includes all OSI aspects). ‡ridge parameter automatically calculated using the method of Cule and De Iorio (55, 56). *β* (beta) – standardised linear regression coefficients after ridge- penalisation; BMI – body mass index; HDL – high density lipoprotein; LDL – low density lipoprotein; OSI – Occupational Stress Index; *p* – statistical significance of regression coefficients; R^2 – coefficient of determination

It also involves small salaries, no acknowledgment, and no career advancement. It is quite common in private security services (e.g., a night watchman in a store) and can cause dissatisfaction over time (29, 34–37). Furthermore, monotony and understimulation lead to drowsiness, tiredness, diminished arousal and reduced activation of the hypothalamic-pituitary-adrenal (HPA) and the sympathetic-adrenal-medullary (SAM) axis (105, 106). However, some studies indicate that boring, understimulating, poorly rewarding jobs cause distress, increase HPA and SAM activity (100–107), and can be associated with insulin resistance, dyslipidaemia, diabetes, and cardiovascular disease (40–42, 107).

In light of the latter studies, we decided to look deeper into our initial findings of negative association of this aspect with health impairments and work disability, as we have also found a negative association of this aspect with some other, more potent stress aspects. Indeed, after controlling for age, BMI, smoking status, and other OSI aspects (in regression analyses), this aspect turned out to be a significant positive predictor of health risks and temporary work disability.

Threat avoidance

Perhaps the most difficult to explain is the initially found negative association between the threat avoidance aspect and health and work disability indicators. This aspect includes danger control and avoidance, execution of dangerous tasks, and experience of disturbing events, all of which is expected in security services (6–10). Since high-risk jobs are associated with a strong acute activation of the HPA and SAM axes, they are expected to positively correlate with health risk indicators.

However, not all security guards are involved in high-risk jobs, and many of them seldom experience stressful events or are under constant pressure to avoid potential threats (e.g., a night watchman in a store or a plant) (23, 28, 34–36). In line with this, the threat avoidance aspect in this study was associated negatively with other potent stressful aspects, and positively with underload and noxious exposures (indicating understimulation and probably outdoor working conditions), and after adjustment for age, BMI, smoking status, and other OSI aspects (in regression analyses), this aspect proved to be a significant positive predictor of health risks and temporary work disability.

Noxious exposures

The noxious exposures aspect includes exposure to physical, chemical, and biological hazards, including climate and microclimate extremes. Workers exposed to noise, air pollution, and temperature extremes are at higher risk of developing arterial hypertension, dyslipidaemia, diabetes, coronary heart disease, and stroke (41, 42, 87, 108–110).

In this study, however, we have initially found significant negative associations between this aspect and health impairments and work disability, which were only partly lost after the Bonferroni correction for multiple comparisons. One possible explanation is that the noxious exposures aspect involves security work in an isolated working space (e.g., in a guard house) or outdoors, which is often associated with underload. In agreement with this, the noxious exposures aspect in our study was in a positive correlation with underload and threat avoidance and in a negative correlation with more stressful aspects. After the correction for age, BMI, smoking, and other OSI aspects in linear regression, the association between noxious exposures and nearly all health and disability parameters became insignificant.

Extrinsic time pressure

The extrinsic time pressure aspect involves pressure to make quick decisions, act quickly, and meet deadlines and has been reported in some security services (30) but in some not (34). This kind of psychological pressure is associated with the acute and chronic activation of the HPA and SAM axes (111), exhaustion, hypertension, dyslipidaemia, diabetes, acute myocardial infarction, sudden cardiac death, stroke, and work absenteeism (2, 41, 46, 112, 113).

At first, we too found positive correlations between this aspect score and all health and work disability parameters, and they were only partly lost after the Bonferroni correction for multiple comparisons but became insignificant after adjustment for age, BMI, smoking status, and other OSI aspects in linear ridge regression analysis. It turns out that in our study sample extrinsic time pressure is not a significant independent risk factor for the development of health impairments and work disability. In fact, the contribution of this aspect to overall stress was the lowest.

Strengths and limitations

We have already discussed some of the strengths and limitations of our overall findings in the earlier paper (4). The strengths include the use of a validated questionnaire (which includes specific aspects of stress not addressed by some other questionnaires) (1, 44–46), a large number of collected data, a large sample, and controlling for possible confounding factors (gender, age, BMI, and smoking status) (114).

In this study some of the weaknesses remain, such as the lack of data on waist and hip circumferences, total caloric intake, physical activity, and use of medicaments, while we sought to resolve the others (the presence of multiple comparisons, the presence of multicolinearity in linear regressions, and inability to perform logistic regressions for dichotomous variables). The effect of multiple comparisons was addressed with the Bonferroni correction (57), which confirmed the statistical significance for nearly all established correlations. The effect of

Table 5 Comparison of specific OSI aspect scores and total OSI score between security guards and other professions in Serbia

	Security guards compared with other professions (reference)			
	Professional drivers (40–42)	**Banking workers (41)**	**Electronic industry workers (41)**	**Metal industry workers (41)**
High demands	≈	↓	↑	↑
Strictness	≈	↓	↑	≈
Conflict/uncertainty	≈	↓	↑	↑
Underload	↑	↑	↓	↓
Threat avoidance	≈	↑	↑	↓
Noxious exposures	≈	↑	↓	↓
Extrinsic time pressure	↓	↓	↑	↑
Total OSI score	≈	≈	↑	≈

↑–higher in security guards; ↓ –lower in security guards, ≈ –similar; OSI – Occupational Stress Index

multicolinearity in linear regressions (tested by VIF) was addressed with the ridge-penalised linear regression with automatically selected ridge parameters (55, 56), and it also did not significantly alter the findings compared to simple, non-penalised linear regression (data not shown). Moreover, when all ridge parameters were set to be equal (0.180) for all regression models, the results were quite the same. Maximal VIF was 1.0, mean VIF was 0.9, and the issue of multicolinearity was greatly solved. Ridge regression also solved the possible impact of unequal contribution of different aspects in the OSI questionnaire, since all predictor variables had to be standardised for ridge regression, and the effect of maximum possible score was lost.

Finally, one important weakness of our study is the inability to perform logistic regressions to see the effect of specific OSI aspects on occurrence of individual health conditions and permanent work disability, because of very low (or very high) frequencies (i.e. prevalence) of some of the health conditions in the present study sample (58, 59). However, ridge linear regressions covered a half of the examined health conditions (e.g., hyperglycaemia, dyslipidaemia, hypertension, metabolic syndrome and diabetes), and additional logistic regressions were not necessary for these conditions.

The significance of this work is high, because more and more people are engaged as security guards everywhere in the world, not only in Serbia, and private security industry is now considered as one of the world's fastest growing professions (37, 38). The surprisingly high prevalence of health impairments among security guards in our study calls for further, broader and more detailed investigation of health risks involved in this profession, especially in view of the general lack of such data, save for a few rare studies of security guards' health status (26, 115–117). It is very important to identify occupational stressors which most impair health and working ability in security guards, in order to tailor and implement specific preventive and corrective measures to reduce stress (1). These measures may include adequate professional orientation, selection, training, improvements to working conditions and work organization, stricter implementation of labour regulations (control of overtime and shift work, day and week rests), coping techniques, healthy lifestyles, and regular medical check-ups (118).

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Conflicts of interest

None to declare.

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Utjecaj specifičnih aspekata profesionalnoga stresa na zdravlje i radnu sposobnost zaštitara: detaljno proširenje prethodne studije

U našem ranijem istraživanju zaštitara osoba i imovine pokazali smo da je povećan profesionalni stres povezan s rizikom od metaboličkoga sindroma, dijabetesa, hipertenzije, kardiovaskularnih bolesti i s radnom nesposobnošću. Cilj ovoga istraživanja bio je daljnje istraživanje povezanosti između specifičnih stresora na radu i parametara oštećenja zdravlja i radne nesposobnosti u 399 srbijanskih zaštitara u dobi od 25 do 65 godina. Linearna regresijska analiza Ridge otkrila je da su profesionalni stresori, uključujući visoke zahtjeve, strogost, sukob/neizvjesnost, izbjegavanje prijetnji i podopterećenost, nakon kontrole dobi, indeksa tjelesne mase i pušačkoga statusa, bili značajni pozitivni prediktori glukoze natašte, triglicerida, ukupnoga i LDL kolesterola, krvnoga tlaka, pulsa, Framinghamske procjene kardiovaskularnoga rizika i privremene radne nesposobnosti. Budući da je zaštitarska profesija u ekspanziji diljem svijeta, potrebno je provesti više istraživanja kako bi se uspostavili precizni prediktori zdravstvenoga rizika, jer takvi podatci uglavnom nedostaju.

KLJUČNE RIJEČI: kardiovaskularne bolesti; bolovanje; dijabetes; hipertenzija; metabolički sindrom; profesionalna izloženost; psihološki stres