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Work stress related lipid disorders and arterial hypertension in professional drivers – A cross-sectional study

Povezanost stresa na poslu sa lipidnim poremećajima i arterijskom hipertenzijom kod profesionalnih vozača – studija preseka

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Abstract

Background/Aim. Occupational stress is a term used to define ongoing stress that is related to the workplace. The study was conducted to determine association of occupational stress index (OSI) and its aspects with arterial hypertension and lipid disorders using data from a cross-sectional survey of male professional drivers. **Methods.** The cross-sectional study was performed in 439 professional drivers divided into groups (city- and intercity bus drivers, truck and taxi drivers). The OSI and OSI aspects (high demands, strictness, underload, extrinsic time pressure, noxious exposure, avoidance and conflict) were calculated using the standardized questionnaire. Determination of serum lipids, blood pressure (BP) and cardiovascular risk factors were done. **Results.** A significant difference in prevalence of diagnosed hypertension and dyslipidemia was found along with a difference in total OSI and OSI aspects among examined subgroups of drivers. A total OSI was highest in city, high in intercity bus drivers, and the lowest one in truck and taxi drivers (82.79 ± 3.5, 81.28 ± 3.7, 73.75 ± 3.5, 71.61 ± 4.4, respectively; $p < 0.01$). Similar pattern showed triglycerides (TG), total cholesterol (TC) and LDL cholesterol and BP, while HDL-cholesterol showed reverse order ($p < 0.01$). Logistic regression analyses with multiple OSI aspects adjusted for age and years of exposure showed associations of total OSI with arterial hypertension [OR 5.5; 95% CI (2.24–7.95)] and dyslipidemia [OR 1.43 95% CI (1.09–2.80)]. Underload was the most important OSI aspect associated with the arterial hypertension [OR 1.18; 95% CI (1.04–2.58)] and elevated LDL cholesterol [1.26; 95 CI (1.19–2.1)]. A total OSI had a significant association with elevated LDL cholesterol [2.64; 95% CI (1.19–7.7)], triglycerides [OR 3.27; 95% CI (1.20–5.1)] and low HDL cholesterol [OR 3.29; 95% CI (1.8–5.8)] ($p < 0.01$). **Conclusion.** The study provides the evidence for the significant association of total OSI and underload with lipid disorders and elevated blood pressure in professional drivers, which could be a possible link between job stress and coronary heart disease. Regular periodical examinations and workplace interventions aimed to decrease total OSI and underload are important aspects in primary prevention and additional reduction of cardiovascular risk.

Key words:
occupational exposure; stress, physiological; automobile driving; hypertension; dyslipidemias.

Apstrakt

Uvod/Cilj. Profesionalni stres predstavlja termin koji definiše stres koji je povezan sa radnim mestom. Studija preseka sprovedena kod profesionalnih vozača imala je za cilj da analizira povezanost indeksa profesionalnog stresa (OSI) i njegovih determinanti sa pojavom arterijske hipertenzije i lipidnim poremećajima. **Metode.** U studiji je analizirano 439 profesionalnih vozača podeljenih na grupe (vozači gradskih i međugradskih autobusa, kamiona i vozači taksija). Ukupan OSI i OSI determinante (visoki zahtevi, strogost, podopterećenje, vremenski pritisak, izloženost noksama, izloženost opasnostima i konfliktnost) određeni su pomoću standardizovanog upitnika. Određivanje serumskih lipida, krvnog pritiska i kardiovaskularnih faktora rizika izvršeno je prema protokolu istraživanja. **Rezultati.** Registrovana je značajna razlika u zastupljenosti hipertenzije, dislipidemije i vrednostima ukupnog OSI i njegovih determinanti u ispitivanim grupama vozača. Ukupan OSI bio je najveći kod vozača gradskih, visok kod međugradskih, manji kod vozača kamiona i najmanji kod vozača taksija (82,79 ± 3,5, 81,28 ± 3,7, 73,75 ± 3,5, 71,61 ± 4,4, redom; $p < 0,01$). Sličan nalaz postoji za trigliceride (TG), ukupni holesterol (TC) i LDL holesterol i krvni pritisak, dok je za HDL holesterol ova relacija bila obrnuta ($p < 0,01$). Logistička regresiona analiza sa multiplim OSI determinantama korigovana za starost i ek-

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spozicioni staž pokazala je povezanost ukupnog OSI sa hipertenzijom [OR 5,5; 95% CI (2,24–7,95)] i dislipidemijom [OR 1.43; 95% CI (1,09–2,80)]. Podopterećenje je najvažnija determinanta OSI udružena sa hipertenzijom [OR 1,18; 95% CI (1,04–2,58)] i povišenim LDL holesterolom [OR 1,26; 95% CI (1,19–2,1)]. Ukupni OSI pokazuje značajnu povezanost sa povišenim LDL holestrolom [OR 2,64; 95% CI (1,19–7.7)], hipertrigliceridemijom [OR 3,27; 95% CI (1,20–5,1)] i niskim HDL holesterolom [OR 3,29; 95% CI (1,8–5,8)] ($p < 0,01$). **Zaključak.** Studijom je ustanovljena značajna povezanost vrednosti ukupnog OSI i podopterećenja sa lipidnim poremećajima i povišenim krvnim pritiskom kod profesionalnih vozača, što može predstavljati vezu između profesionalnog stresa i koronarne bolesti srca. Redovno sprovođenje periodičnih pregleda i mera za redukciju ukupnog profresionalnog stresa i podopterećenja predstavlja značajan aspekt u primarnoj prevenciji koronarne bolesti i redukciji kardiovaskualrnog rizika.

Ključne reči:
profesionalna izloženost; stres, fiziološki; vozači automobila; hipertenzija; hiperlipidemija.

Introduction

Occupational stress is a term used to define ongoing stress that is related to the workplace. The stress may have to do with the responsibilities associated with the work itself, or be caused by conditions that are based on the corporate culture or personality conflicts. As with other forms of tension, occupational stress can affect both physical and emotional well being if not managed effectively.

Cardiovascular disease (CVD), and hypertension as one of its major components, is a major cause of morbidity and mortality in modern society [1]. The identification and modification of risk factors associated with cardiovascular disease is the main preventive approach. Work stress is currently not included in the American Heart Association list of established risk factors for CHD, but individual response to stress is acknowledged as a potential contributing factor [2]. The role of occupational stress in the etiology of CVD has recently received considerable attention. Occupation is a major socioeconomic factor that together with a prolonged exposure to stress at workplace may directly affect the autonomic nervous system and neuroendocrine activity contributing to the development of hypertension, lipid disorders and increased incidence of diabetes mellitus [3]. Stress at work has been linked with an increased risk of hypertension and coronary heart disease in retrospective and prospective studies [4, 5].

Although cross-sectional studies have linked work stress with lipid disorders, this association is not consistent [6, 7]. In line with this, mixed results for associations between occupational stressors and blood pressure are found in studies with casual blood pressure measurement [8].

Inconsistency of literature data related to occupational stress and prevalence of cardiovascular diseases implicated development of new tools for occupational stress assessment. Because occupational demands, threats, and conflicts – the most frequent stressors – cannot be identified by direct physical or biological measurement, theoretical concepts, and integrative models have been developed to delineate stressful job characteristics [9].

The occupational stress index *(*OSI) incorporates key aspects of the leading sociological work stress models: Job-Strain and Effort-Reward Imbalance that were developed from the perspective of cognitive ergonomics. Within the OSI the work environment is viewed as a whole, including task level issues, work schedule, physical, chemical and broader organizational factors, which all contribute to total burden [10]. The applications of specific OSI in subsets of professional drivers could be appropriate model for revealing connection between job stress and cardiovascular risk factors.

The study was conducted to determine the association of occupational stress index and its aspects with arterial hypertension and lipid disorders using data from a cross-sectional survey of male professional drivers.

Methods

The prospective cross sectional study was performed during 2008–2010 on a group of 439 working middle-aged male professional drivers (aged 35–60 years) who were divided into four occupational groups (94 city bus drivers, 100 intercity bus drivers, 123 truck drivers and 122 professional taxi drivers). Representativity of the sample size was calculated using data that Niš region worker-based populations is about 30,000. Minimal sample size of 439 ensures confidence level of 95% with 4.6% margin of error. Total number of 460 workers (200 bus drivers, 130 truck drivers and 130 taxi drivers) were randomly selected and invited to participate in the study. Recruitments were done during systematic preventive examinations which are standard work-related procedures organized in specialized dispensaries within the Institute of Occupational Health in Niš. The study was comprised of a standardized questionnaire about working conditions and occupational stressors as well as medical examination and medical record analysis.

The workers included in the study were permanently employed and spent more than 3 years in the current occupation. The workers with acute or chronic inflammatory diseases, immune and major systemic diseases, structural non-ischemic heart disease, history of myocardial infarction, myocardial revascularization procedures, cerebrovascular diseases, secondary hypertension, kidney, liver or other important chronic diseases, were excluded from the study.

The overall participation rate was 95.4% and according to occupational groups there were 97% for bus drivers, 94.6% for truck drivers and 93.8% for taxi drivers. A total of 21 males did not finish examination (16 refused to participate, 3 did not signed informed consent, 2 did not return the questionnaire or did so with incomplete responses, and were excluded).

The research was conducted during working days where the ambulatory blood pressure readings and blood samplings were done.

The occupational stress index

The occupational stress index was calculated using the standardized questionnaire authorized by Belkić [11, 12]. The specific OSI questionnaire for professional drivers was used (Table 1). The questionnaire was anonymously self-rated by participants. If there were inconsistency of the data in questionnaire or weak compliance of participant to help in filling missed data the questionnaire was rejected.

The OSI model is arranged as a 2-dimensional matrix: levels of information transmission and the stressor aspects. The elements are summed into the OSI aspects that are then summed into the total OSI score, reflecting the overall burden from work stressors" [13]. The elements are equally weighted, scored from 0 to 2 (maximum), from absence to strongly present, with higher scores meaning higher level of burden. The elements are summed to yield aspects. The elements were summed by addition with equal weighting. In this study, information was accessible from "medical charts", worksite measurements and expert observations about night-shift work, number of work hours, vacation time, moonlighting, and exposure to physical and chemical toxins.

The OSI questionnaire was used in a cross sectional prevalence study design.

Table 1

The occupational stress index (Version 2003) [11, 12]

Aspects	Information Transmission Level			
	Input	Central decision making	Output/ Task performance	General
Underload	♦ Homogenous signals ♦ Low frequency of incoming signals communication ♦ Works alone-without a need for communication	♦ Decisions automatic from input	♦ Homogenous tasks ♦ Simple Tasks ♦ Nothing to do	♦ Fixed pay ♦ Inadequate pay ♦ No chances for upgrade ♦ Lack of recognition for work
High demand	♦ Several info. sources ♦ Heterogeneous information ♦ Heavy burden on visual system ♦ High frequency of incoming signals ♦ 3 sensory modalities ♦ Communication essentials	♦ Complex decisions ♦ Complicated decisions ♦ Decisions affect work of others ♦ Rapid decision-making	♦ Heterogeneous tasks ♦ Simultaneous task performance ♦ Complex tasks ♦ Rapid task performance	♦ Piece rate work ♦ Long work hours ♦ Holds 2+ jobs ♦ Lack of rest breaks ♦ Night shift/irregular work hours ♦ Lack of paid vacations
Strictness	♦ Strict requirements for signal detection	♦ Strict problem-solving strategy ♦ Strictly defined correct decision	♦ Work must meet a strictly defined standard	♦ Fixed body position ♦ Confined, windowless workspace ♦ Lack of autonomous workspace ♦ Limited in talking time off from work ♦ Low influence over: Schedule; Tasks; Policy; With whom one works
Extrinsic time pressure	♦ No control over speed of incoming signals	♦ Decisions cannot be postponed	♦ No control over rate of task performance	♦ Deadline pressure ♦ Speed-up
Aversiveness / Noxious exposures	♦ Glare ♦ Noise		•Isometric lifting •Vibration	♦ Heat ♦ Cold ♦ Noxious gases, fumes, dust
Avoidance / Symbolic aversiveness	♦ High level of attention (serious consequences of momentary lapse) ♦ Visually-disturbing scenes ♦ Exposed to emotionally disturbing occurrences	♦ Serious consequences of a wrong decision	♦ Hazardous task performance	♦ Work Accident ♦ Witnessed work accident ♦ Suicide occurrence ♦ Work-related litigation/Testifying in court ♦ Lack of emergency system functioning
Conflict / Uncertainty	♦ Signal/noise conflict ♦ Signal/signal conflict	♦ Missing information needed for decision ♦ Contradictory information ♦ Unexpected events ♦ Change of work plan	♦ Conflicting demands ♦ Task performance hampered by: Extrinsic problems ♦ Interruptions from people	♦ Emotionally-charged work atmosphere ♦ Lack of help with work-related difficulties ♦ Opposition to career advancement ♦ Violations of behavior norms/abuses of power ♦ No redress of grievance ♦ Threat of job loss ♦ Job lacks coherence

The use of this questionnaire requires a permission of the author, Dr. Karen Belkic (2003). It is available at http://www.workhealth.org/OSI/Index/Driver/OSI/Index.html

Determination of serum lipids and glycoregulation

Overnight fasting venous blood sample was taken between 8.00 and 9.00 am. After the serum was separated a total amount of cholesterol (TC), triglycerides (TG), high density hipoprotein (HDL) cholesterol and low density hipoprotein (LDL) cholesterol was determined. A total amount of cholesterol and TG was determined enzymatically by Bayer color test, on Technicon-Axon Bayer analyzer. HDL and LDL cholesterol were determined by direct enzyme colori-

metric essay without precipitation by Dade Behring reagens, on a Dimension Expand Dade Behring analyzer.

For this study, the cutoff point for hypertriglyceridemia were TG ≥ 1.7 mmol/L, HDL cholesterol was as low as < 1.04 mmol/L in men or <1.3 mmol/L in women, and the cutoff point for hypercholesterolemia was TC ≥ 5.18 mmol/L and high LDL cholesterol as ≥ 3.37 mmol/L. The workers with history of specific treatment for lipid abnormality or one or more abnormal serum lipid concentrations were classified as dyslipidemic [14].

Blood pressure measurement and hypertension

Upon arrival subjects remained in resting (sitting) position for 5 min before starting measurement. Blood pressure was measured in the left upper arm by auscultation (sphygmomanometer and stethoscope, Becton Dickinson, USA) three times in accordance with the American Heart Association procedure and proposed average values [15]. Hypertension was defined according to WHO criteria: systolic blood pressure greater/equal 140 mmHg and/or diastolic blood pressure greater/equal 90 mmHg. Individuals were also considered hypertensive if they were currently taking antihypertensive therapy [16].

Consent and Data Security

All participants in this study were informed about the purpose and benefits of the project, research methods, potential risks or hazards of participation as well as the right to ask additional information at any time during the research procedure. They were further informed that their choice to participate was on voluntary basis, and that they were free to withdraw from the research project at any time. All phases, testing, and reports of the study were approved by the Institute for Occupational Safety and Health Internal Review Board. Written informed consent was obtained from all participants, and confidentiality was guaranteed for all participants.

Characteristics of the subjects are presented as mean ± SD. Differences between continuous and categorical variables were tested by ANOVA and χ^2-test, respectively. Post hoc multiple comparasion was done by the Tukey's test. Binary logistic regression was used to assess the association of the eight control measures (total OSI and seven OSI aspects) with arterial hypertension and distinctive lipid abnormalities, after controlling for the influence of age and years of exposure. All variables were entered together and enter logistic model were used. Presented data were obtained after the adjustment of odds ratio (OR) with the 95% confidence interval (CI 95%) and corresponding *p*-values. A *p*-value of < 0.05 was considered to be statistically significant. The multicollinearity of variables in logistic regression models is controlled by the examinees Tolerance and Variance Inflation Factor (VIF) for each variable. The value of VIF fewer than 10 were considered as acceptable. SPSS 16.0 software was used for statistical analyses.

Results

The basic characteristics of the examined groups of professional drivers are shown in Table 2. The examined groups were of the similar prevalence in smoking habit and positive family history of any types of atherosclerotic diseases. There were a significant difference in average age, years of service and professional exposition, prevalence of diagnosed hypertension and dyslipidemia. There was also a significant difference in OSI determinants as well as total OSI between occupational groups (ANOVA 218.4, $p < 0.001$) (Table 2).

Table 2

Baseline characteristics according to the worker group

Drivers	City bus driver	Intercity bus driver	Truck driver	Taxi driver	*p* – value by ANOVA or χ^2 test
Number	94	100	123	122	
Age (years), $\bar{x}$ ± SD	50.27 ± 10.1	47.63 ± 9.8	47.7 ± 8.8	42.98 ± 10.5	< 0.05
Years of service, $\bar{x}$ ± SD	26.11 ± 9.4	23.62 ± 9.2	14.08 ± 8.1	18.64 ± 10.0	< 0.001
Years of exposition, $\bar{x}$ ± SD	25.9 ± 9.2	23.2 ± 9.1	13.92 ± 8.1	18.35 ± 10.1	< 0.001
Smoker, n / %	34 / 36.1	47 / 47.0	58 / 47.1	64 / 52.4	NS
Family history of atherosclerotic disease, n / %	60 / 63.8	53 / 53.0	61 / 49.6	56 / 45.9	NS
HTA, n / %	93 / 98.9	94 / 94.0	68 /55.3	26 /21.3	< 0.001
Dyslipidemia, n / %	91 / 96.8	95 / 95.0	99 / 80.4	62 / 50.8	< 0.001
Occupational index determinants, $\bar{x}$ ± SD					
high demand	17.52 ± 1.5	23.38 ± 2.6	11.55 ± 0.9	17.89 ± 2.7	< 0.001
strictness	11.4 ± 1.0	12.69 ± 2.8	9.98 ± 0.5	16.45 ± 1.6	< 0.001
conflict / uncertainty	18.47 ± 1.1	15.93 ± 1.3	11.78 ± 1.9	15.71 ± 1.6	< 0.001
underload	11.87 ± 1.5	7.96 ± 1.3	15.11 ± 2.0	3.11 ± 0.8	< 0.001
avoidance / symbolic aversiveness	9.48 ± 1.0	10.31 ± 0.8	8.92 ± 1.3	7.83 ± 1.5	< 0.001
extrinsic time pressure	6.99 ± 0.8	6.04 ± 0.8	5.27 ± 0.4	6.55 ± 1.1	< 0.001
aversiveness / noxious exposures	7.0 ± 0.8	4.57 ± 0.5	11.15 ± 0.8	4.47 ± 0.5	< 0.001
OSI total, $\bar{x}$ ± SD	82.79 ± 3.5	81.28 ± 3.7	73.75 ± 3.5	71.61 ± 4.4	< 0.001

HTA – arterial hypertension, OSI – occupational stress index.

Figures 1–4 show a boxplot presentation of serum lipids concentration. All the examined lipid parameters showed a significant difference among the examined groups of professional drivers. The value of serum lipids were the highest in bus drivers and the lowest in taxi drivers (Figures 1–4).

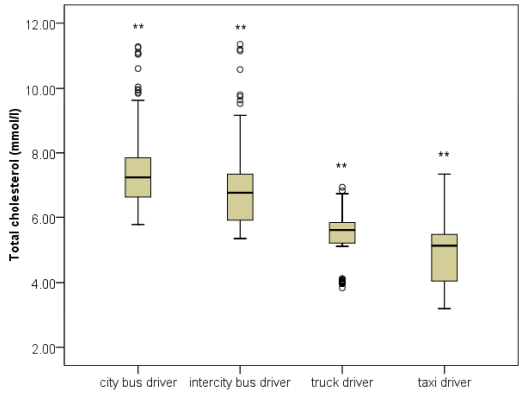

Fig. 1 – Total cholesterol concentration in the examined groups

ANOVA F = 145.9, *Post hoc* **$p < 0.01$ *vs* other groups; a box represents the interquartile range (IQR 25–75. percentiles) computed from Tukey's-hinges, central line represents median, values between 1.5–3 IQR's from the end of the box are labeled as outliers (o).

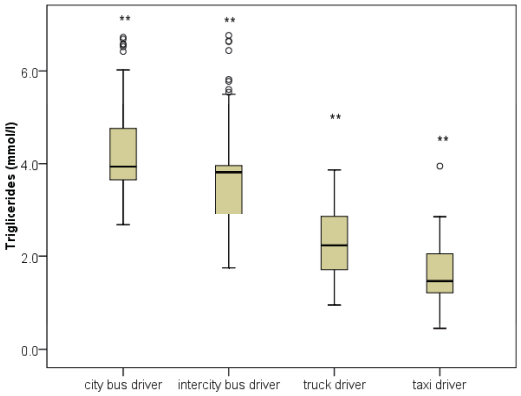

Fig. 2 – Triglyceride concentration in the examined groups

ANOVA F = 202.9,$p < 0.01$ *vs* other groups; a box represents the interquartile range (IQR 25–75. percentiles) computed from Tukey's hinges, central line represents median, values between 1.5–3 IQR's from the end of the box are labeled as outliers (o).**

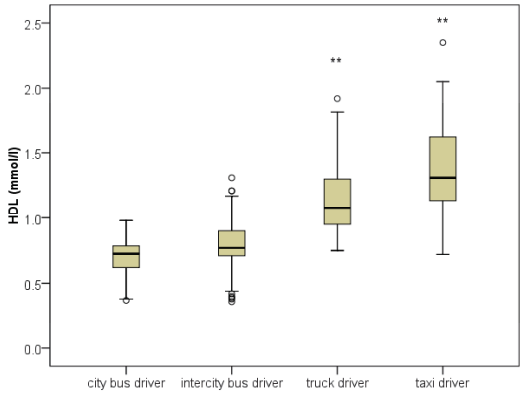

Fig. 3 – HDL cholesterol concentration in the examined groups

ANOVA F = 167.1,$p < 0.01$ *vs* other; a box represents the interquartile range (IQR 25–75. percentiles) computed from Tukey's hinges, central line represents median, values between 1.5–3 IQR's from the end of the box are labeled as outliers (o).**

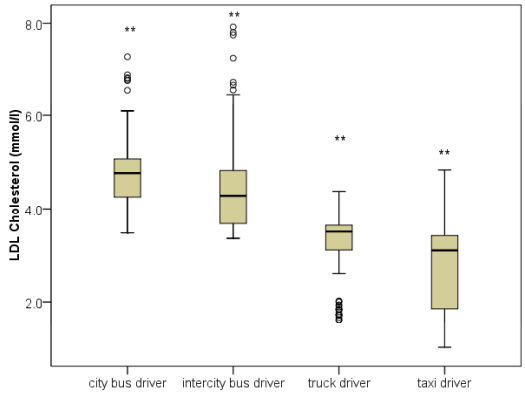

Fig. 4 – LDL cholesterol concentration in the examined groups

ANOVA F = 134.5,$p < 0.01$ *vs* other groups; a box represents the interquartile range (IQR 25–75. percentiles) computed from Tukey's hinges, central line represents median, values between 1.5–3 IQR's from the end of the box are labeled as outliers (o).**

The values of systolic and diastolic BP significantly varied among the examined professional drivers groups. They were significantly higher in city and intercity bus drivers compared to truck and taxi drivers (Figure 5).

The results in Tables 3 and 4 are based on binary logistic regression analyses with multiple OSI aspects entered together adjusted for age and years of exposure. Underload was the most important OSI aspect associated with arterial hypertension (OR 1.18). There were also significant associations between total OSI with arterial hypertension (OR 5.59). The logistic analysis did not show a signifficant association of OSI aspects and total OSI with dyslipidemia after adjusting for age and years of exposure (Table 3).

Table 3

Associations of occupational stress index (OSI) aspects and a total OSI with arterial hypertension and dyslipidemia in professional drivers

Occupational stress index aspects	Arterial hypertension	Dyslipidemia of any type
	Odds ratios (95% CI)	Odds ratios (95% CI)
High demand	0.62 (0.27–1.41)	0.67 (0.01–1.9)
Strictness	0.81 (0.38–1.69)	0.78 (0.01–1.3)
Conflict / Uncertainty	0.91 (0.38–2.14)	0.74 (0.01–1.9)
Under-load	1.18 (1.04–2.58)**	1.01 (0.02–1.8)
Avoidance / Symbolic aversiveness	1.16 (0.43–3.09)	0.84 (0.01–1.1)
Extrinsic time pressure	1.91 (0.60–6.0)	1.20 (0.02–2.4)
Aversiveness / Noxious exposures	0.44 (0.17–1.12)	0.55 (0.01–1.6)
OSI total	5.598 (2.24–7.95)**	1.43 (1.09–2.80)*

Dependent variables: arterial hypertension, binary logistic regression, enter models adjusted for age and years of exposure, CI – confidence intervals; *$p < 0.05$, **$p < 0.01$

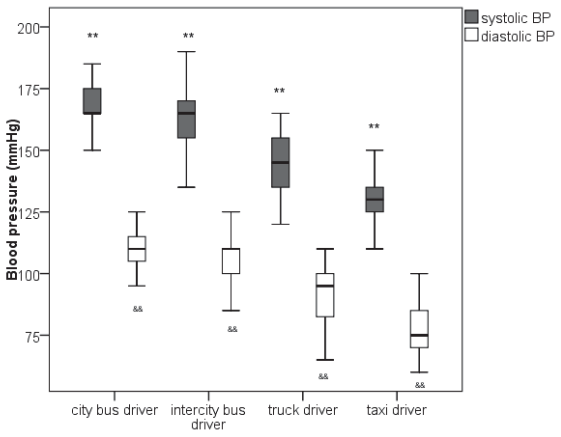

Fig. 5 – Systolic and diastolic blood pressure (BP) values in the examined groups

ANOVA F = 266.3 for systolic BP and ANOVA F = 236.1 for diastolic BP,$p < 0.01$ *vs* other systolic values; $p < 0.01$ *vs* other diastolic values; a box represents the interquartile range (IQR 25-75. percentiles) computed from Tukey's hinges, central line represents median, values between 1.5–3 IQR's from the end of the box are labeled as outliers (o).**

In all the participants including those on lipid-lowering medications underload showed a significant association with elevated concentration of LDL cholesterol, while other occupational stress index aspects did not show any significant association. A total OSI has significant positive association with hypertriglyceridemia, elevated LDL cholesterol and low HDL cholesterol concentration (Table 4).

sional drivers. This could be in part explained by a difference in average age and duration of exposure at current job but also in a significant difference in evaluated OSI aspects and total OSI (Table 2).

According to the Serbian National Registry of Cardiovascular Diseases in 2007 the family history for CAD was presented in 53.8%, smoking 43.9%, dyslipidemia 47.3% and hypertension in 70.8% of population in the district of Niš [17]. Comparing the obtained values we can assume relatively similar prevalence in this study population, but also very unbalanced prevalence among different drivers groups (Table 2). To test the hypothesis that occupational stress has impact on development of arterial hypertension and lipid abnormalities we determined serum lipid concentrations and blood pressure. Taking into account that age and greater lifetime exposure to stressful work environment (for example, job strain) have synergistic effects on cardiovascular diseases [18] we made logisitic regression analysis adjusted for age and exposure.

According to the stress-disequilibrium theory, job stress and particularly low workplace control could lead to chronic disease risk through deregulation processes occurring at several linked levels of cardiac and endocrine system mechanisms [19]. Several plausible mechanisms have been suggested through which long-term work stress may have an impact on the risk of CHD. They include prolonged overactivation and dysregulation of the autonomic nervous system and the hypothalamuspituitary-adrenal (HPA) cortex axis. The COR-

Table 4

Association of occupational stress index aspects and a total occupational stress index (OSI) with lipid disorders

	Low HDL-L	High TC	High TG	High LDL-C
Occupational stress index aspects	Odds ratios (95% CI)	Odds ratios (95% CI)	Odds ratios (95% CI)	Odds ratios (95% CI)
High demand	0.76 (0.44–1.32)	0.63 (0.03–11.5)	0.77 (0.15–3.87)	0.89 (0.26–2.95)
Strictness	0.78 (0.52–1.18)	0.83 (0.04–10.8)	0.84 (0.17–4.08)	0.76 (0.23–2.46)
Conflict / Uncertainty	0.90 (0.50–1.59)	0.61 (0.03–11.0)	0.78 (0.15–3.97)	1.24 (0.37–4.16)
Underl-load	1.10 (0.67–1.79)	1.09 (0.06–2.96)	0.98 (0.2014.85)	1.26 (1.19–2.1)*
Avoidance / Symbolic aversiveness	0.92 (0.46–1.84)	0.85 (0.04–5.6)	0.97 (0.19–4.95)	1.02 (0.29–3.53)
Extrinsic time pressure	1.05 (0.40–2.75)	1.01 (0.05–9.1)	1.12 (0.20–5.06)	1.58 (0.43–5.78)
Aversiveness / Noxious exposures	0.63 (0.33–1.22)	0.41 (0.02–7.8)	0.70 (0.13–3.7)	0.61 (0.17–2.14)
OSI total	3.29 (1.8–5.8)**	4.48 (0.24–12.8)	3.27 (1.20–5.1)**	2.64 (1.19–7.7)**

TC – total cholesterol; TG – triglycerides; HDL – high density hipoprotein; LDL – low density hipoprotein; *$p < 0.05$; **$p < 0.01$; Binary logistic regression models, Odds ratios adjusted for age and years of exposure; CI – confidence intervals.

Discussion

In this cross-sectional study on occupational stressors, hypertension and lipid disorders in professional drivers, the intensity of occupational stressors and their association with serum lipids and blood pressure were examined after controlling for age and years of exposure at current job.

A high prevalence of the examined cardiovascular risk factors (family history of atherosclerotic disease, smoking, presence of arterial hypertension and dyslipidemia) was found in professional drivers. Some of these risk factors (arterial hypertension and dyslipidemia) showed a significant difference in prevalence among different groups of profes-

DIS study [20] demonstrated that some of the pathways linking psychosocial factors (job stress) and cardiovascular disease incidence are: elevation of physiological/hematochemical variables (e.g., blood pressure and serum lipid lipoprotein levels); direct and indirect effects of adverse risk behaviors such as smoking, lack of physical exercise, and poor diet and health care habits; and heightened emotional states, such as anger, tension, and anxiety, implicated in cardiovascular disease development through neuroendocrine mediation [21].

The nature of work has changed over the past two decades, moving towards a 24-hour society with increasing demand for goods and services to be provided around the clock. Consequently, workplace exposures, such as psycho-

social stress, shift-work and long working hours, have been reported to be associated with increased risk of cardiovascular disease (CVD). Chronic stimulation of the HPA axis by depression frequently results in hypercortisolemia, blunted HPA activity, and diminished feedback control, as evidenced by nonsuppression of cortisol secretion following dexamethasone suppression. When present, hypercortisolemia is associated with suppression of growth and sex hormones [22].

Altered adrenocortical function and increased cortisol output can influence hepatic lipoprotein metabolism and insulin sensitivity in target organs. Low concentrations of HDL cholesterol, increased LDL cholesterol and triglycerides have been linked with high basal secretion of cortisol [23]. In the presented study, professional drivers with the highest OSI score have significantly higher serum lipids concentrations (TC, LDL cholesterol and TG) and lower HDL cholesterol than drivers with lower score (Figures 1–4). Binary logisitc regression adjusted for age and duration of job exposure showed that a total OSI has a significant association with dyslipidemia of any type (OR 1.43) (Table 3) and with specific lipid abnormalities such as low HDL cholesterol, high LDL cholesterol and hipertriglyceridemia in the examined professional drivers (Table 4). Underload was the most important OSI aspects associated with specific lipid abnormalities in professional drivers. In all the participants including those on lipid-lowering medications underload showed a significant positive association with elevated LDL cholesterol (Table 4). The obtained results indicate importance of a total OSI and some of its aspects especially underload score, for the development of cardiovascular disease in professional drivers, through lipid abnormalities and hypertension connected with the endothelia function and inflammation [24].

It is unclear whether the development of risk seen in some trials is due in part to the direct effects of chronic stress on insulin resistance, resting blood pressure, and lipoprotein metabolism, or the effects of some specific aspects of occupational stress which is supported by Whitehall II and other studies [25]. Work-related risk factors include both physical and psychosocial elements. It is showed that individuals who suffered more "job strain," i.e. those who were under pressure to work hard or quickly but who had less control over that pressure, had a greater risk of cardiovascular disease. The results based on the job strain model which we used in this study showed that high demands and low control were associated with elevated blood pressure and cardiovascular diseases. Interventions that increase decision-making latitude or diminished psychological demands (e.g., by reducing time pressure) resulted in favorable changes in mediators relevant to the cardiovascular system, such as blood pressure and lipid profile [26].

Binary logistic regression analyses with multiple OSI aspects entered together adjusted for age and years of exposure showed a significant importance of a total OSI for the development of elevated blood pressure. A few-fold increased association of arterial hypertension with total OSI was seen (OR 5.594). Underload (homogenous and simple job tasks, working alone without any communication, automatic decision from input, inadequate pay and no promotion prospects) was the most important OSI aspect associated with the increased blood pressure and hypertension (OR 1.18). Other OSI aspects did not show a significant association with elevated BP (Table 3).

A large body of evidence supports the link between job strain and cardiovascular disease. Ambulatory blood pressure levels have been shown to increase in work situations with high job strain, either directly or through behavior modification and highly contribute to the development of cardiovascular disease [26, 27]. Similar study on occupational stressors and hypertension in transit operators indicate to significant effects of working stressors on hypertension [8].

Strengths and weaknesses of the study

Strengths of the study are reflected in careful assembly of the sample (representative workers` population, high response rate, valid sample size and application of defined exclusion criteria). Assessment of the exposure variable was done using validated occupational specific questionnaire which was anonymous self-rated with control for missing values. Outcome variable were set by explicit diagnostic criteria and medical records organized by professional health workers at worksite clinic. There were also adjustments for age and years of exposure. We were able to test for a potential dose–response relationship between job stressors and levels of blood pressure and lipid parameters.

Potential limitations and potential biases in the present study need to be considered. There are several potential confounders whose data were not available in regression analysis. Obesity/body mass index, socioeconomic level/education and dietary habits were not assessed although they could have impact on distinctive OSI aspect and total OSI association with clinical output (systolic and diastolic BP, serum lipids concentrations). Our study sample does not allow for testing of the association between untreated hypertension and stressors since the majority of hypertensives in our sample were treated.

Much of the occupational exposure data, especially from the longitudinal studies, were gathered from full-time working persons with some degree of occupational stability. The exclusion of temporary workers, such in this study, a group likely to be exposed to job strain, could attenuate risk estimates. Also the cross-sectional design of the study must be accounted for causal inferences and possible confounders. Hence, a predictive role of work stress index aspects was determined by assessment of the potential predictors and its association with disease outcomes of interest. Although the study was conducted with one occupation only, it examined methodological issues that are important to consider for other occupational groups as well. However, the results might not be generalizable in detail to other occupations.

Conclusion

The study provides an evidence for the significant association of occupational stress with lipid disorders and elevated blood pressure in professional drivers, which could be a possible link between job stress and coronary heart disease.

A total OSI and underload as one of its aspects, showing the lack of social communication, simple task prepraration and underestimation of working results, showed the strongest association in this occupational group.

Regular periodical examinations and workplace interventions aimed to decrease a total OSI and underload, are important aspects in primary prevention and additional reduction of cardiovascular risk.

Conflict of interest

The authors declare that they have no conflict of interest.

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