ORIGINAL ARTICLE
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UDC: 616.12-008.331.1:616.379-008.64]:616-057
DOI: https://doi.org/10.2298/VSP260517059S

Work ability of employees with hypertension and diabetes mellitus: the role of working conditions and psychosocial risks

Radna sposobnost zaposlenih obolelih od hipertenzije i dijabetes melitusa: uloga uslova rada i psihosocijalnih rizika

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Abstract

Introduction/Aim. Arterial hypertension (HTN) and diabetes mellitus (DM) represent the most common chronic non-communicable diseases in the working population and are an important cause of reduced work ability. The aim of this study was to examine the impact of working conditions, psychosocial risks, and work organization on the work ability of employees with HTN and/or DM compared with employees without these chronic diseases. **Methods.** A cross-sectional study was conducted among 100 employed participants diagnosed with HTN and/or DM (cases group) and 100 employees without these diseases (control group) in two state-owned public sector companies in Niš, Serbia. The control group was frequency-matched to the cases group by sex, age group, company, and shift/night work schedule. Work ability was assessed using the Work Ability Index (WAI), stress level *via* the 10-item Perceived Stress Scale (PSS-10), and psychosocial factors using a questionnaire on job demands, autonomy, support, and satisfaction. Descriptive statistical methods, Pearson correlation, *t*-test, multiple linear regression, and logistic regression were applied. **Results.** The mean WAI score in the cases and control groups was 28.34 ± 3.18 and 41.76 ± 2.27, respectively, with a statistically significant difference (t = -34.32; $p < 0.001$; Cohen d = 4.85). Impaired work ability (WAI ≤ 27) was recorded in 44% of diagnosed cases, compared with 0% in the control group (χ^2 = 53.88; $p < 0.001$). The strongest correlates of WAI in the cases group were job autonomy (r = 0.549; $p < 0.001$) and supervisor support (r = 0.516; $p < 0.001$), whereas no psychosocial factor reached statistical significance in relation to WAI within the control group. Fear of job loss was reported by 86% of cases and 32% of controls (4.28 vs. 3.03; $p < 0.001$), and negatively correlated with WAI in the cases group (r = -0.317; p = 0.001). The regression model with organizational factors in the cases group explained 56.5% of the variance in WAI (F = 9.43; $p < 0.001$). In logistic regression, the diagnosis of HTN and/or DM independently increased the risk of impaired work ability [odds ratio (OR) = 156.36; 95% confidence interval (CI): 9.44–2,588.59; $p < 0.001$], with pronounced fear of job loss (OR = 3.62) and low autonomy (OR = 2.74) also identifying as independent predictors of impaired WAI. **Conclusion.** Work ability of employees with HTN and DM is significantly lower than that of healthy employees and is influenced by organizational workplace factors. Job autonomy, supervisor support, and job satisfaction are key protective factors, whereas fear of job loss has a negative impact. Comparison with the control group shows that the same psychosocial conditions do not affect work ability equally in healthy and diseased employees–their influence is considerably more pronounced in individuals with chronic illness. The results highlight the need for organizational interventions aimed at preserving work ability.

Keywords:
diabetes mellitus; hypertension; occupational medicine; surveys and questionnaires; work capacity evaluation.

Apstrakt

Uvod/Cilj. Arterijska hipertenzija (*arterial hypertension* – HTN) i dijabetes melitus (DM) predstavljaju najčešće hronične nezarazne bolesti u radno-aktivnoj populaciji i značajan su uzrok smanjenja radne sposobnosti. Cilj rada bio je da se ispita uticaj radnih uslova, psihosocijalnih rizika i organizacije rada na radnu sposobnost zaposlenih obolelih od HTN i/ili DM u poređenju sa zaposlenima koji ne boluju od ovih hroničnih bolesti. **Metode.** Sprovedena je studija preseka kod 100 zaposlenih ispitanika sa dijagnostikovanom HTN i/ili DM (grupa obolelih) i 100

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zaposlenih bez ovih bolesti (kontrolna grupa) u dve državne firme javnog sektora u Nišu, Srbija. Kontrolna grupa je usklađena sa grupom obolelih po polu, starosnoj kategoriji, firmi i smenskom/noćnom rasporedu rada. Radna sposobnost procenjivana je pomoću *Work Ability Index* (WAI), nivo stresa pomoću *10-item Perceived Stress Scale* (PSS-10), a psihosocijalni faktori putem upitnika o zahtevima posla, autonomiji, podršci i zadovoljstvu. Primenjene su deskriptivne statističke metode, Pearson-ova korelacija, *t*-test, višestruka linearna regresija i logistička regresija. **Rezultati.** Srednja vrednost skora WAI kod obolelih i kontrolne grupe bila je 28,34 ± 3,18 i 41,76 ± 2,27, redom, sa statistički značajnom razlikom (t = -34,32; $p < 0,001$; Cohen-ov d = -4,85). Narušena radna sposobnost (WAI ≤ 27) zabeležena je u 44% slučajeva u grupi obolelih u poređenju sa 0% slučajeva u kontrolnoj grupi (χ^2 = 53,88; $p < 0,001$). U grupi obolelih najjača povezanost sa WAI skorom utvrđena je za autonomiju na poslu (r = 0,549; $p < 0,001$) i podršku nadređenih (r = 0,516; $p < 0,001$), dok u kontrolnoj grupi ni jedan psihosocijalni faktor nije dostigao statističku značajnost u odnosu na WAI. Strah od gubitka posla bio je prisutan kod 86% ispitanika u grupi obolelih i 32% ispitanika u kontrolnoj grupi (4,28 vs. 3,03; $p < 0,001$), i u negativnoj korelaciji sa WAI u grupi obolelih (r = -0,317; p = 0,001). Regresionim modelom koji je uključivao organizacione faktore u grupi obolelih objašnjeno je 56,5% varijanse WAI skora (F = 9,43; $p < 0,001$). U logističkoj regresiji, dijagnoza HTN i/ili DM bila je nezavisno povezana sa rizikom od narušene radne sposobnosti [*odds ratio* (OR) = 156,36; 95% *confidence interval* (CI): 9,44–2 588,59; $p < 0,001$], dok su se izražen strah od gubitka posla (OR = 3,62) i niska autonomija (OR = 2,74) izdvojili kao nezavisni prediktori narušenog WAI. **Zaključak.** Radna sposobnost zaposlenih obolelih od HTN i DM značajno je niža u poređenju sa zdravim zaposlenima i uslovljena je organizacionim faktorima radne sredine. Autonomija na poslu, podrška nadređenih i zadovoljstvo poslom su ključni protektivni faktori, dok strah od gubitka posla deluje nepovoljno. Poređenje sa kontrolnom grupom pokazuje da isti psihosocijalni uslovi ne deluju jednako na radnu sposobnost zdravih i obolelih zaposlenih–njihov uticaj je znatno izraženiji kod osoba sa hroničnim oboljenjima. Rezultati naglašavaju potrebu za organizacionim intervencijama usmerenim na očuvanja radne sposobnosti.

Ključne reči:
dijabetes melitus; hipertenzija; medicina rada; ankete i upitnici; sposobnost, radna, ocena.

Introduction

Arterial hypertension (HTN) and diabetes mellitus (DM) are among the most common chronic non-communicable diseases in the working-age population and are important contributors to reduced work ability, increased sick leave, and premature exit from the workforce [1–4]. According to the World Health Organization – WHO, HTN affects approximately 1.28 billion adults globally [2], while DM prevalence among adults exceeds 10% [3]. In the Republic of Serbia, cardiovascular diseases remain the leading cause of mortality, while diabetes represents an increasing public health burden [5–7].

Work ability is defined as a dynamic relationship between the demands of the workplace and the individual capacities of the employee, including health status, functional abilities, and mental resources [8]. The Work Ability Index (WAI) is the most commonly used assessment tool in occupational medicine and is considered the standard instrument for assessing work ability [9].

In addition to medical determinants, numerous studies indicate that working conditions, particularly shift and night work, may influence blood pressure regulation, glucose metabolism, and overall cardiovascular risk [10–13]. Long-term disruption of the circadian rhythm has been associated with an increased risk of HTN, DM type 2, and metabolic disturbances, including metabolic syndrome [13–15].

Psychosocial risks at work, such as high work intensity, chronic stress, emotional exhaustion, and insufficient social support, may adversely affect employee health [16, 17]. According to the Karasek demand-control model, the combination of high job demands and low control over work defines "job strain", which has been associated with an increased risk of cardiovascular diseases [17, 18].

The Siegrist effort-reward imbalance model emphasizes that stress arises when an employee perceives an imbalance between invested effort and received reward [19].

Social and occupational conditions, including job insecurity, are recognized determinants of employee health [20–22]. The contemporary biopsychosocial approach in occupational medicine emphasizes that work ability depends not only on medical status but also on psychological and social factors of the work environment [8, 20].

Despite the significance of chronic cardiometabolic diseases in the working-age population, studies specifically examining the interaction between psychosocial work factors, job insecurity, chronic disease, and work ability remain limited [20–22].

Furthermore, previous studies investigating work-related psychosocial risks have often lacked an adequate comparison group of healthy employees from the same work environment, making it difficult to distinguish disease-specific effects from those affecting employees more generally.

Therefore, the aim of this study was to assess the work ability of employees with HTN and DM and to examine the impact of working conditions and psychosocial factors on work ability. A particular strength of this study lies in the inclusion of a control group of employees without chronic diseases from the same work environment, enabling differentiation of the effects of psychosocial and organizational factors on work ability according to participants' health status.

Methods

Study design and participants

An analytical cross-sectional study was conducted among 100 employed individuals diagnosed with HTN and/or DM (cases group) in two public sector companies in Niš, Serbia. Concurrently, a control group comprising 100 employees without HTN and/or DM was recruited from the same two companies. Controls were frequency-matched to the cases group by sex (72% men, 28% women), age group (26–35, 36–45, 46–55, and 56–65 years), company (50 *per* company), and shift/night work schedule. Participants in both groups were recruited from the same two public-sector companies and represented comparable occupational categories, reducing the potential influence of workplace-related differences. Data were collected during regular periodic examinations at the Institute of Occupational Health Niš.

The study was approved by the Ethics Committee of the Institute of Occupational Health Niš (No. 2080, from August 29, 2025). The study was conducted in accordance with the principles of the Declaration of Helsinki. All participants provided written informed consent. Data were processed anonymously and confidentially.

Inclusion criteria for the cases group were as follows: diagnosed HTN and/or DM confirmed by medical documentation, active employment status, work tenure of at least 1 year, and voluntary written informed consent. Exclusion criteria were the following: severe acute illness, psychiatric disorders preventing questionnaire completion, and refusal to participate.

Inclusion criteria for the control group were: employment in one of the two public sector companies, work tenure of at least 1 year, age 18–65 years, absence of a diagnosis of HTN and/or DM confirmed by medical documentation, no use of antihypertensive or antidiabetic medication, and written informed consent. Exclusion criteria for the control group were: newly detected HTN and/or DM or borderline values (blood pressure > 130/85 mmHg or fasting glycemia > 6.1 mmol/L) during the periodic examination, other severe chronic non-communicable diseases (malignant disease, severe cardiovascular disease, chronic kidney disease, chronic pulmonary disease Global Initiative for Chronic Obstructive Lung Disease – GOLD stage II or higher), psychiatric disorders, pregnancy, and refusal to participate.

Participants were recruited using convenience sampling during regular periodic examinations.

Instruments

Work ability was assessed using the WAI [23], which encompasses seven dimensions: current work ability compared with lifetime best (0–10); work ability in relation to job demands (2–10); number of current diseases diagnosed by a physician (1–7); estimated work impairment due to diseases (1–6); sick leave taken during the past 12 months (1–5); self-prognosis of work ability over the next two years (1–7); and mental resources (1–4). The total WAI score ranges from 7 to 49, categorized as: poor (7–27), moderate (28–36), good (37–43), and excellent (44–49).

In this study, WAI was applied in the Serbian version. Cultural adaptation was performed using a standardized process that included forward translation, reconciliation of translated versions, independent back-translation, comparison with the original questionnaire, cognitive interviewing on a pilot sample of 20 employees to assess comprehensibility, and final linguistic review. Psychometric properties of the Serbian version were examined in the pooled sample (n = 200), including internal consistency (Cronbach $\alpha = 0.82$), test-retest reliability on a subsample of 30 participants over a 2-week interval (intraclass correlation coefficient – ICC = 0.89), and convergent validity with self-rated health and number of diagnoses. The obtained findings indicated satisfactory psychometric performance of the instrument in this study sample.

The level of perceived stress was assessed using the 10-item Perceived Stress Scale (PSS-10) [24], which contains 10 items rated on a 5-point Likert scale (0–4). The total score ranges from 0 to 40, with categories of low (0–13), moderate (14–26), and high perceived stress (27–40).

The Serbian version of the PSS-10, previously validated in Serbian clinical and non-clinical samples [25], was applied in this study. In our sample, the Serbian version of the PSS-10 demonstrated satisfactory internal consistency (Cronbach $\alpha = 0.79$), with psychometric characteristics consistent with those reported in the Serbian validation study [25].

For non-validated self-report instruments used in this study, cultural adaptation procedures were conducted according to the standardized methodology for cross-cultural adaptation proposed by Beaton et al. [26], including forward and back translation, expert review, pilot testing, and linguistic and psychometric evaluation.

Psychosocial factors of the work environment were assessed using 10 items rated on a 1–5 scale, based on the demand-control model [27, 28], including job demands (work pace, intensity, sufficient time), control over work/autonomy (influence on work method and pace), social support (from colleagues and supervisors), fear of job loss, exhaustion after work, and job satisfaction. Items were derived from the Job Content Questionnaire (JCQ) [29] and culturally adapted for use in this study through forward/back translation and cognitive interviewing. In the pooled sample, Cronbach α coefficients for the subscales ranged from 0.71 to 0.83, indicating satisfactory internal consistency.

Statistical analysis

In this way, linguistic, semantic, and conceptual equivalence of the instruments was enhanced for use in the study population. However, except for the previously validated PSS-10, the applied instruments underwent only basic psychometric assessment and cultural adaptation, not full formal validation for the Serbian population. Therefore, the findings should be interpreted in light of these methodological considerations.

Associations between continuous variables were examined using Pearson's correlation coefficient, separately for the case and control groups. Differences in categorical variables were analyzed using the chi-square test or Fisher's exact test, where appropriate.

Multiple linear regression analysis was performed to identify independent predictors of the WAI. Logistic regression analysis was conducted with impaired work ability (WAI ≤ 27) as the dependent variable and diagnosis of HTN and/or DM, shift work, night work, fear of job loss, autonomy, sex, and age as independent predictors. Fear of job loss and autonomy were entered as dichotomized variables based on predefined cut-off values. Although frequency matching by age category was performed, the patients in the cases group remained significantly older, reflecting the naturally higher prevalence of cardiometabolic diseases among older employees. Therefore, age was additionally included as a covariate in regression analyses. Due to complete separation of the outcome in the control group (0 controls with WAI ≤ 27), the Haldane-Anscombe correction (+0.5) was applied when estimating odds ratios (ORs).

Statistical significance was set at $p < 0.05$. Effect size for between-group comparisons was calculated using Cohen *d*, with 0.2, 0.5, and 0.8 values interpreted as small, medium, and large effects, respectively. To control for multiple comparisons in correlation analyses, the Benjamini-Hochberg procedure (false discovery rate – FDR < 0.05) was applied. Prior to interpretation of the regression models, assumptions of linear regression were evaluated, including normality, linearity, homoscedasticity, and lack of problematic multicollinearity.

Multicollinearity was assessed using variance inflation factors (VIF) and tolerance values. All VIF values were below 6, and tolerance values exceeded 0.10, indicating no problematic multicollinearity among the predictors included in the regression model.

Results

The study included a total of 200 participants. Among them were 100 employees with HTN and/or DM (cases group) and 100 healthy controls (control group). The two groups were frequency-matched according to sex, age category, company, and shift/night work schedule. Despite frequency matching, participants with HTN and/or DM were significantly older than controls ($p < 0.001$), whereas work tenure did not differ significantly between the groups (Table 1).

Employees with HTN and/or DM had significantly lower work ability and significantly higher perceived stress than controls (Table 2). Impaired work ability (WAI ≤ 27) was observed exclusively in the cases group (44%), whereas none of the controls had impaired work ability ($p < 0.001$).

Compared with controls, employees with HTN and/or DM reported significantly higher job autonomy, lower

Table 1

Basic demographic and occupational characteristics of participants

Variable	Cases (n = 100)	Controls (n = 100)	Test	*p*-value
Age, years	48.42 ± 8.59	43.39 ± 9.04	$t = 4.03$	< 0.001
Work tenure, years	21.80 ± 6.49	20.26 ± 9.53	$t = 1.34$	0.184
Gender				
male	72 (72)	72 (72)	$\chi^2 = 0.00$	1.000
Secondary education	80 (80)	84 (84)	$\chi^2 = 0.31$	0.581
Higher education	20 (20)	16 (16)	–	–
Shift work	74 (74)	74 (74)	$\chi^2 = 0.00$	1.000
Night work	66 (66)	65 (65)	$\chi^2 = 0.00$	1.000
Sick leave, 12 months	35 (35)	18 (18)	$\chi^2 = 6.57$	0.010
Arterial hypertension	40 (40)	0 (0)	–	–
Diabetes mellitus	30 (30)	0 (0)	–	–
Arterial hypertension + diabetes mellitus	30 (30)	0 (0)	–	–
Company 1/Company 2	50/50	50/50	–	–

n – number.

All values are given as numbers (percentages) or mean ± standard deviation.

Table 2

Work Ability Index (WAI) and perceived stress values

Parameter	Cases		Controls	
	mean ± SD	min–max	mean ± SD	min–max
WAI1: current work ability	7.18 ± 1.42	4–10	9.37 ± 0.76	7–10
WAI2: job demands	6.64 ± 1.54	4–9	8.56 ± 0.87	6–10
WAI3: number of diseases	3.26 ± 1.06	1–5	6.63 ± 0.64	5–7
WAI4: impairment due to diseases	2.80 ± 0.75	1–4	5.76 ± 0.50	4–6
WAI5: sick leave	2.22 ± 0.64	1–3	4.02 ± 0.80	2–5
WAI6: prognosis	3.76 ± 1.58	1–7	6.47 ± 0.84	4–7
WAI7: mental resources	2.50 ± 0.50	2–3	3.59 ± 0.55	2–4
WAI total	28.34 ± 3.18	23–37	41.76 ± 2.27	36–48
PSS-10 total	23.18 ± 1.90	20–26	20.01 ± 3.33	12–31

PSS-10 – 10-item Perceived Stress Scale; SD – standard deviation; min – minimum; max – maximum.

supervisor support, greater fear of job loss, and higher levels of exhaustion after work, whereas job satisfaction did not differ significantly between the groups. Within the cases group, fear of job loss and exhaustion after work were the most prominent psychosocial characteristics, whereas supervisor support showed the lowest ratings. In the control group, fear of job loss and exhaustion were reported less often, while overall job satisfaction and autonomy were comparable between the groups (Table 3).

No statistically significant difference in work ability was observed among participants with HTN alone, DM alone, and comorbidity, although employees with HTN tended to have the lowest WAI scores. Among employees with HTN and/or DM, shift work and night work were associated with significantly higher WAI scores (Table 4), whereas no significant associations were observed in the control group (data not shown).

Correlation analysis demonstrated that work ability in employees with HTN and/or DM was positively associated with job autonomy and supervisor support, whereas no significant associations between psychosocial factors and WAI were observed in the control group (Table 5).

Table 3

Comparative analysis of main outcomes and psychosocial factors

Variable	Cases	Controls	*t*-test	*p*-value	Cohen *d*
WAI total	28.34 ± 3.18	41.76 ± 2.27	-34.32	< 0.001	4.85
PSS-10 total	23.18 ± 1.90	20.01 ± 3.33	8.28	< 0.001	1.17
Autonomy (KP4)	3.28 ± 1.05	2.84 ± 1.08	2.92	0.004	0.41
Supervisor support (SP7)	2.50 ± 0.88	2.87 ± 1.01	-2.76	0.006	0.39
Fear of job loss (SZ8)	4.28 ± 0.70	3.03 ± 1.03	10.04	< 0.001	1.42
Exhaustion after work (ST9)	4.24 ± 0.77	2.77 ± 0.99	11.70	< 0.001	1.65
Job satisfaction (ST10)	2.88 ± 0.79	2.89 ± 1.09	-0.07	0.941	-0.01
Sick leave, 12 months	35 (35)	18 (18)	$\chi^2 = 6.57$	0.010	–
Impaired WAI, ≤ 27	44 (44)	0	$\chi^2 = 53.88$	< 0.001	–

WAI – Work Ability Index; PSS-10 – 10-item Perceived Stress Scale; KP4 – influence over work methods question 4 (job autonomy); SP7 – supervisor support question 7; SZ8 – fear of job loss question 8; ST9 – exhaustion after work question 9; ST10 – job satisfaction question 10.
All values are given as mean ± standard deviation or numbers (percentages).

Table 4

Work ability according to shift and night work schedule (cases group)

Group	WAI	*t*-test	*p*-value	Cohen *d*
Shift work (n = 74)	28.78 ± 3.25	2.41	0.018	0.58
Non-shift work (n = 26)	27.08 ± 2.61			
Night work (n = 66)	29.00 ± 3.19	3.01	0.003	0.65
Day work only (n = 34)	27.06 ± 2.77			

WAI – Work Ability Index; n – number.
All values are given as mean ± standard deviation.

Table 5

Pearson correlations of psychosocial factors with WAI

Factor	Cases		Controls	
	r	*p*	*r*	*p*
Autonomy (KP4)	0.549	< 0.001	-0.028	0.781
Supervisor support (SP7)	0.516	< 0.001	0.179	0.074
Job satisfaction (ST10)	0.376	< 0.001	-0.100	0.321
Fear of job loss (SZ8)	-0.317	0.001	0.115	0.254
Colleague support (SP6)	-0.217	0.030	-0.040	0.689
Sufficient time (ZP3)	0.195	0.052	0.021	0.837
Exhaustion (ST9)	-0.167	0.098	0.118	0.241
Strenuous work (ZP2)	-0.166	0.100	0.124	0.219
PSS-10 total	-0.054	0.596	-0.024	0.815
Age	-0.013	0.900	-0.045	0.660

WAI – Work Ability Index; KP4 – influence over work methods question 4 (job autonomy); SP7 – supervisor support question 7; ST10 – job satisfaction question 10; SZ8 – fear of job loss question 8; SP6 – coworker support question 6; ZP3 – sufficient time to complete work question 3; ST9 – exhaustion after work question 9; ZP2 – strenuous work question 2; PSS-10 – 10-item Perceived Stress Scale.
***Note*: Correction for multiple comparisons was performed using the Benjamini-Hochberg procedure [false discovery rate (FDR) < 0.05]. Only correlations surviving FDR correction were considered statistically significant.**

Table 6

Multiple linear regression analysis – predictors of WAI (cases group)

Predictor	B	SE	Beta	*t*-test	*p*-value
Autonomy (KP4)	1.565	0.413	0.515	3.790	< 0.001
Satisfaction (ST10)	1.763	0.497	0.441	3.550	< 0.001
Night work	2.924	1.085	0.438	2.694	0.009
Shift work	-3.029	1.211	-0.420	-2.501	0.014
Exhaustion (ST9)	0.972	0.465	0.235	2.091	0.040
Fear (SZ8)	-1.053	0.491	-0.231	-2.146	0.035
Colleague support (SP6)	1.049	0.441	0.228	2.377	0.020
Supervisor support (SP7)	0.526	0.409	0.146	1.287	0.202
Strenuous work (ZP2)	-0.850	0.585	-0.169	-1.452	0.150
PSS-10	0.148	0.159	0.089	0.934	0.353
Age	-0.075	0.040	-0.204	-1.890	0.062

WAI – Work Ability Index; SE – standard error; KP4 – influence over work methods question 4 (job autonomy); ST10 – job satisfaction question 10; ST9 – exhaustion after work question 9; SZ8 – fear of job loss question 8; SP6 – coworker support question 6; SP7 – supervisor support question 7; ZP2 – strenuous work question 2; PSS-10 – 10-item Perceived Stress Scale.
***Note*: R^2 = 0.565; adjusted R^2 = 0.505; F (11,88) = 9.43; p < 0.001.**

Table 7

Logistic regression – predictors of impaired work ability (WAI ≤ 27) in the pooled sample

Predictor	OR	95% CI	*p*-value
Group, cases vs. controls	156.36*	9.44–2,588.59	< 0.001
Shift work, yes	1.12	0.56–2.22	0.746
Night work, yes	0.98	0.49–1.96	0.953
Fear of job loss, SZ8 ≥ 4	3.62	1.45–9.04	0.006
Low autonomy, KP4 < 3	2.74	1.18–6.36	0.019
Gender, male	1.32	0.67–2.58	0.420
Age *per* year	1.03	0.99–1.08	0.124

WAI – Work Ability Index; OR – odds ratio; CI – confidence interval; SZ8 – fear of job loss question 8; KP4 – influence over work methods question 4 (job autonomy).
***Note*: *Haldane-Anscombe correction (+0.5) applied due to the empty cell (0 controls with WAI ≤ 27). Other OR values were calculated directly from the logistic model.**

Multiple linear regression identified job autonomy, job satisfaction, and night work as significant independent predictors of work ability among employees with HTN and/or DM. The model explained 56.5% of the variance in WAI and was statistically significant (Table 6), whereas the corresponding model in the control group was not statistically significant (data not shown).

Logistic regression performed on the pooled sample identified HTN and/or DM diagnosis as the strongest independent predictor of impaired work ability. Pronounced fear of job loss and low job autonomy were also independently associated with impaired WAI, whereas shift work, night work, sex, and age were not significant predictors (Table 7).

Sick leave during the previous 12 months was more frequent among employees with HTN and/or DM than among controls. Although participants with comorbid HTN and/or DM had the highest frequency of sick leave, differences between diagnostic subgroups were not statistically significant. Disability commission referral was recorded only among employees with HTN and/or DM.

Discussion

The central finding of this study is the important role of organizational and psychosocial work-related factors in shaping work ability among employees with HTN and DM. By including a control group of employees without HTN and DM from the same companies, with comparable proportions of shift and night work and matched sex and age categories, this study enabled a clearer differentiation between the effects of chronic cardiometabolic diseases themselves and the effects of psychosocial and organizational workplace conditions. In the cases group, job autonomy and supervisor support demonstrated the strongest positive associations with WAI, whereas these associations did not reach statistical significance in the control group. These findings are consistent with the Karasek demand-control model, according to which greater job control may have a protective role in employee health and functioning [27, 28]. The psychosocial dimensions assessed in this study were derived from the JCQ [29]. Together, these findings suggest that employees with chronic cardiometabolic diseases may be more sensitive to

psychosocial workplace conditions than their healthy colleagues.

An important methodological consideration relates to the structure of the WAI itself, which incorporates components directly associated with health status, including physician-diagnosed diseases and functional limitations. Consequently, part of the observed difference between cases and controls may reflect instrument characteristics rather than actual differences in functional work ability.

The mean WAI in the cases group (28.34) corresponded to moderate work ability, whereas the control group mean (41.76) fell within the good work ability category. The difference of approximately 13 points was substantial and statistically significant. Previous research has shown that chronic health conditions and both individual and work-related factors are important determinants of work ability [30, 31]. The magnitude of the difference identified in our study may partly reflect differences in occupational context, disease burden, lifestyle habits, and work organization. Nevertheless, the findings support the view that chronic cardiometabolic diseases substantially affect employees' functional work ability.

Multiple regression analysis explained 56.5% of the variance in WAI in the cases group, indicating a relatively strong contribution of psychosocial and organizational factors to work ability among employees with HTN and/or DM. By contrast, the same model applied to the control group explained only a small proportion of variance and was not statistically significant. In the cases group, job autonomy, job satisfaction, and night work emerged as the strongest independent predictors of WAI. Similarly, logistic regression analysis showed that, independent of disease status, pronounced fear of job loss and low autonomy were associated with impaired work ability. Taken together, these findings indicate that psychosocial workplace factors may not affect all employees equally, but rather exert a more pronounced influence among workers with chronic cardiometabolic diseases.

Pronounced fear of job loss, registered in 86% of cases and 32% of controls, represents an important finding of this study. Previous research suggests that subjective job insecurity is an important psychosocial stressor associated with adverse mental and physical health outcomes [32, 33]. The elevated prevalence of fear of job loss even in the control group may reflect broader labor-market conditions. However, its negative association with WAI was observed only among employees with HTN and/or DM, suggesting that workers with chronic disease may be particularly vulnerable to the detrimental effects of occupational insecurity.

An important finding of this study is that employees with HTN and/or DM working night shifts demonstrated significantly higher WAI compared with those working only day shifts, whereas no such difference was observed in the control group. This finding may be explained by the healthy worker effect, according to which workers with better health status and preserved functional capacity are more likely to remain in more demanding jobs and shift schedules [34]. The absence of a similar gradient in the control group further supports the interpretation that this selection effect may be more evident among employees with chronic disease.

No statistically significant association was observed between the total PSS-10 score and work ability in either group, despite substantially higher perceived stress among cases. One possible explanation may relate to the relatively low variability of stress values within the cases group, whereas in the control group the generally high WAI values may have limited the observable association, potentially reflecting a ceiling effect of good work ability [35]. In this context, specific psychosocial workplace characteristics may represent more sensitive indicators of work-related functioning than general measures of perceived stress.

Participants with isolated HTN demonstrated somewhat lower WAI compared with those with DM or comorbidity, although all diagnostic subgroups had considerably lower WAI compared with controls. Given the borderline statistical significance and the lack of detailed data on disease severity and disease control, differences between diagnostic subgroups should be interpreted cautiously. Cardiovascular disease and DM have also been associated with early exit from paid employment, with work-related factors contributing to this relationship [36].

The findings of this study highlight the importance of organizational and psychosocial dimensions of work ability among employees with chronic diseases. By introducing a control group, it was demonstrated that the difference between diseased and healthy employees is not solely a consequence of medical status, but also reflects the interaction between chronic diseases and psychosocial work conditions. Workplace interventions aimed at strengthening job autonomy, improving supervisor support, and reducing psychosocial risks may contribute to preserving work ability among employees with chronic non-communicable diseases. Previous evidence suggests that organizational interventions combined with workplace health-promotion programs may improve employee work ability [37].

Limitations of the study

Several limitations should be acknowledged. First, the cross-sectional design does not allow causal inference regarding the observed associations. Second, frequency matching rather than individual matching resulted in a residual age difference between groups, although age was statistically controlled in regression analyses. Third, all participants were recruited from public sector companies, which may limit the generalizability of findings to other occupational settings. Another limitation is that the study did not include detailed clinical indicators of disease severity or quality of disease control, such as blood pressure values, glycosylated haemoglobin levels, disease duration, treatment adherence, or the presence of chronic complications. Consequently, the observed associations between HTN and/or DM and work ability should be interpreted at the level of disease presence rather than according to the severity or

level of clinical control of these conditions. Another limitation concerns the psychometric properties of some instruments used in this study. Although cultural adaptation procedures and basic psychometric indicators were assessed, full formal validation of all instruments for the Serbian working population has not yet been established. Therefore, the findings should be interpreted in light of these methodological considerations.

The very wide confidence interval for the OR of HTN and/or DM diagnosis in logistic regression reflects statistical imprecision caused by complete separation of the outcome (0 controls with WAI $\leq$ 27). Although the obtained OR was high, this result should not be interpreted as indicating severe clinical disease, since the majority of participants had medically controlled HTN and/or DM and remained occupationally active. The inflated estimate primarily reflects statistical separation rather than disease severity.

Future studies should employ longitudinal designs and include larger and more heterogeneous occupational samples to provide additional insight into the long-term impact of psychosocial and organizational factors on work ability among individuals with chronic diseases.

The inclusion of a control group represents an important methodological strength of this study, allowing a more precise understanding of the interaction between health status and psychosocial workplace factors.

Conclusion

Work ability of employees with arterial hypertension and diabetes mellitus is significantly lower than in employees without these chronic diseases and is determined by organizational and psychosocial factors of the work environment. Work autonomy, supervisor support, and job satisfaction represent key protective factors, while job insecurity has a negative effect—and one that is specifically more pronounced in diseased than in healthy employees. The obtained results indicate the need for improving work organization and reducing psychosocial risks in the work environment, with targeted monitoring of employees with chronic non-communicable diseases. An integrated approach encompassing medical supervision, health promotion, and organizational changes in the workplace can contribute to extending the working life and reducing the risk of losing work ability in the working-age population.

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Received on May 17, 2026
Revised on July 29, 2026
Revised on August 10, 2026
Accepted on August 19, 2026
Online First October 2026