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LEADING ARTICLE

Risk of arterial hypertension and work-related stress in the population aged 25–64 years in Russia/Siberia (WHO — MONICA psychosocial program)

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Objective

To study how work-related stress affects the risk of arterial hypertension (AH) within a 16-year observation period in people aged 25–64 years in Novosibirsk, Siberia.

Materials and methods

We examined a random representative sample that consisted of people aged 25–64 years from a district in Novosibirsk in 1994 as a part of the III screening of the WHO-MONICA psychosocial program (men: n=657, mean age 44.3±0.4 years, response rate — 82.1 %; women: n=689, mean age 45.4±0.4 years, response rate — 72.5 %). The screening program included collecting socio-demographic data. The level of work-related stress was assessed with the Karasek scale. The period of prospective observation was 16 years. We used a chi-squared test (χ^2) to assess statistical significance in differences between groups. We used monofactorial and polyfactorial Cox regression model to assess relative risk (RR). We considered p≤0.05 to be statistically significant.

Results

High work-related stress levels were identified in 29.5 % of men and 31.6 % of women (χ^2= 2.574; υ=2 P=0.276). The level of work-related stress was higher in men who worked in a job that involved moderate manual labour compared with women (34.7 % in men vs 17.7 % in women; χ^2=7.755 df=2; p=0.021). At 16 years of observation RR of AH was higher in men (RR=1.4) than in women (RR=1.27). RR was higher in widowed men (RR=2.5), in women aged 25–44, 45–54, 55–64 years (RR=1.699, RR=2.427 and RR=2.694 respectively).

Conclusions

The level of work-related stress is similar in men and women. At the same time, at 16 years of observation RR of AH was higher in men compared with women.

Key words*: work-related stress, arterial hypertension, gender differences, relative risk.*

Conflict of interests: none declared.

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Introduction

The WHO defines "work-related stress" as being the response people may have when presented with work demands and pressures that are not matched to their knowledge and abilities and which challenge their ability to cope [1]. 28 % of working people in Europe (41 million people) are struggling with works-related stress [2]. Work-related stress is associated with cardiovascular disease (CVD) [3], musculoskeletal disorders (especially back pain) [4], anxiety depression [5], fatigue [6, 7], insomnia [8] and alcohol abuse [9]. It was suggested that more than 10 % of work-related disorders are associated with stress at workplace [10]. Finally, work-related stress leads to significant financial losses. For example, estimated total annual cost of stress in the EU is twenty billion dollars (EU-15). This figure is based on the costs to employers resulting from absenteeism, loss of productivity, health care costs and social welfare costs [11, 12].

Work-related stress was identified as an important independent risk factor for arterial hypertension (AH) [13, 14].

This study investigates the effect of work-related stress on the risk of arterial hypertension in men and women aged 25–64 years coming from different social groups in an open population in Novosibirsk, Russia, within a 16-year observation period.

Materials and methods

We examined a random representative sample that consisted of people aged 25–64 years from a district in Novosibirsk in 1994 as a part of the III screening of the WHO-MONICA psychosocial program (men: n=657, mean age 44.3±0.4 years, response rate — 82.1 %; women: n=689, mean age 45.4±0.4 years, response rate — 72.5 %).

The representative sample was formed according to the WHO-MONICA psychosocial program protocol requirements [15].

The screening program included the following parts:

1) Collecting socio-demographic data according to the standardized WHO-MONICA psychosocial program epidemiologic protocol that included ID, ad-

Table 1. **Distribution of the population aged 25–64 years by age groups (III screening program, 1994)**

Gender	Age groups								Total
	25–34 years		35–44 years		45–54 years		55–64 years		
	n	%	n	%	n	%	n	%	
Men	169	50.8	136	45.9	177	47.7	175	50.6	657
Women	164	49.2	160	54.1	194	52.3	171	49.4	689
Total	333	100	296	100	371	100	346	100	1346
χ^2=2.087 df=3; p=0.555									

Table 2. **Distribution of the population aged 25–64 years by marital status (III screening program, 1994)**

Gender	Marital status								Total
	Single (Never married)		Married		Divorced and not remarried		Widowed and not remarried		
	n	%	n	%	n	%	n	%	
Men	45	51.1	559	51.7	40	35.7	13	20	657
Women	43	48.9	522	48.3	72	64.3	52	80	689
Total	88	100	1081	100	112	100	65	100	1346
χ^2=33.113 df=3; p=0.0001									

Table 3. **Distribution of the population aged 25–64 years by level of educational attainment (III screening program, 1994)**

Gender	Level of educational attainment								Total
	Tertiary education		Incomplete tertiary education, secondary specialized education		Secondary education		Incomplete secondary education, primary education		
	n	%	n	%	n	%	n	%	
Men	186	49.2	178	44.3	150	49.2	143	55.6	657
Women	192	50.8	224	55.7	155	50.8	114	44.4	685
Total	378	100	402	100	305	100	257	100	1342
χ^2=8.133 df=3; p=0.043									

Table 4. **Distribution of the population aged 25–64 years by professional status (III screening program, 1994)**

Gender	Professional status*																		Total
	SE		MLE		MAN		ITW		HMW		MMW		LMW		Students		Retired		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Men	28	84.8	55	55.6	65	50.8	84	42	144	88.9	167	63.3	21	17.1	9	81.8	84	34.7	657
Women	5	15.2	44	44.4	63	49.2	116	58	18	11.1	97	36.7	102	82.9	2	18.2	158	65.3	605
Total	33	100	99	100	128	100	200	100	162	100	264	100	123	100	11	100	242	100	1262
χ^2=238.16 df=8; p=0.001																			

Comment
* Professional status:
SE — senior executives
MLE — mid-level executives
MAN — managers
ITW — IT workers
HMW — Heavy manual workers
MMW — Moderate manual workers
LMW — Light manual workers

dress, full name, date of birth, registration date; gender — 1 — male, 2 — female. Distribution of the population by age groups is presented in *Table 1*.

Marital status (Table 2), level of educational attainment (Table 3) and professional status (Table 4) were also taken into consideration.

2) Testing using the psychosocial methods. In order to assess the level of work-related stress we used the Karasek scale [15]. The analyzed risk factor was assessed at baseline without registering its change over time. All methods were strictly standardized and met all WHO-MONICA psychosocial program requirements [15].

The collected data were analyzed in MONICA Data Center in Helsinki, Finland. Quality control was performed in MONICA Quality Control Centers: Dundee (Scotland), Prague (Czech Republic), Budapest (Hungary). All the collected data were approved [15].

All men and women with CVD (coronary artery disease, cerebrovascular disease, AH, myocardial infarction, diabetes) identified before or during the screening process were excluded from the study. The study eventually included 384 women and 190 men aged 25–64 years. The period of prospective observation was 16 years.

The primary endpoint of this study was new arterial hypertension identified during the observation period. We used the information from the results of annual physical exams, patient histories, hospital discharge papers, papers from the district health

Table 5. **Work-related stress in the population aged 25–64 years (III screening program, 1994)**

Age	25–34				35–44				45–54				55–64				25–64			
Gender	M		W		M		W		M		W		M		W		M		W	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Family stress																				
Low	28	17.8	22	17.5	25	16.4	22	18.2	32	26.4	30	20.4	38	27.1	20	14.8	123	21.6	94	17.8
Moderate	84	53.5	66	52.4	82	53.9	57	47.1	55	45.5	76	51.7	58	41.4	69	51.1	279	48.9	268	50.7
Severe	45	28.7	38	30.2	45	29.6	42	34.7	34	28.1	41	27.9	44	31.4	46	34.1	168	29.5	167	31.6
Total	157	100	126	100	152	100	121	100	121	100	147	100	140	100	135	100	570	100	529	100
	χ^2=0.076 υ= 2; p=0.963				χ^2=1.288 υ=2; p=0.525				χ^2=1.577 υ= 2; p=0.455				χ^2=6.495 υ=2; p=0.039				χ^2= 2.574 υ=2; p=0.276			

Table 6. **Work-related stress and marital status in the population aged 25–64 years (III screening program)**

Work-related stress	Marital status															
	Single (Never married)				Married				Divorced and not remarried				Widowed and not remarried;			
	M		W		M		W		M		W		M		ЖW	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Low	7	21.2	7	22.6	83	20.4	70	17.4	6	21.4	11	20.4	4	50	6	15
Moderate	14	42.4	16	51.6	197	48.4	206	51.1	14	50	27	50	2	25	19	47.5
Severe	12	36.4	8	25.8	127	31.2	127	31.5	8	28.6	16	29.6	2	25	15	37.5
Total	33	100	31	100	407	100	403	100	28	100	54	100	8	100	40	100
	χ^2=0.872 df=2; p=0.647				χ^2=1.286 df=2; p=0.526				χ^2=0.017 df=2; p=0.992				χ^2=4.986 df= 2; p=0.083			

Table 7. **Work-related stress and level of educational attainment in the population aged 25–64 years (III screening program)**

Work-related stress	Education level															
	Tertiary education				Incomplete tertiary education, secondary specialized education				Secondary education				Incomplete secondary education, primary education			
	M		W		M		W		M		W		M		W	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Low	27	19.4	24	16.6	25	19.4	28	17.1	22	22	31	24.8	26	24.1	10	11.1
Moderate	69	49.6	75	51.7	66	51.2	83	50.6	39	39	56	44.8	53	49.1	50	55.6
Severe	43	30.9	46	31.7	38	29.5	53	32.3	39	39	38	30.4	29	26.9	30	33.3
Total	139	100	145	100	129	100	164	100	100	100	125	100	108	100	90	100
	χ^2= 0.401 df=2; p=0.818				χ^2=0.407 df= 2; p=0.816				χ^2=1.828 df=2; p=0.401				χ^2=5.626 df= 2; p=0.06			

clinics, death reports, conversations with relative, and autopsy reports.

During the annual physical exams we performed standardized blood pressure measurements on the right hand using mercury sphygmomanometers (we registered the first phase of Korotkoff sounds as systolic arterial pressure and the fifth phase as the diastolic blood pressure and then analyzed the mean). We considered patients to have arterial hypertension if systolic blood pressure was 140 mmHg or higher and/or diastolic blood pressure was 90 mmHg and higher in those individuals who did not receive hypotensive therapy. Hypertension group also included men with normal blood pressure readings if they were taking hypotensive therapy during the exam or stopped taking it less then two weeks prior.

We identified 229 new cases of AH in women and 46 cases in men over the observation period.

The statistical analysis was performed using the SPSS Version 11.5 [16]. We used a chi-squared test (χ^2) to assess statistical significance in differences between groups [17]. We used monofactorial and polyfactorial Cox regression model to assess relative risk (RR) and confidence intervals (CI) [18]. We considered $p \leqslant 0.05$ to be statistically significant.

Results

We identified high work-related stress levels in 29.5% of men and 31.6% of women (χ^2= 2.574; υ=2, p=0.276). We identified higher levels of stress in men (31.4%) and women (34.1%) of older age group of 55–64 years (χ^2=6.495 υ=2; p=0.039) (Table 5).

We identified no differences in work-related stress in men and women depending on marital status (Table 6).

Similarly, we identified no differences in work-related stress in men and women depending on the level of educational attainment (Table 7).

Table 8 presents compared level of work-related stress depending on professional level. We identified higher stress levels in men who worked in a job that involved manual labour compared with women of this

Table 8. **Work-related stress and professional status in the population aged 25–64 years (III screening program)**

WRS	Professional status*																									
	SE				MLE				MAN				ITW				HMW				MMW				LMW			
	M		W		M		W		M		W		M		W		M		W		M		W		M		W	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
L	3	12.5	2	50	10	22.7	8	22.9	10	23.8	19	43.2	13	19.7	27	31	21	19.6	2	22.2	26	22	27	34.2	4	28.6	23	28.8
M	10	41.7	1	25	26	59.1	18	51.4	20	47.6	19	43.2	30	45.5	46	52.9	53	49.5	4	44.4	51	43.2	38	48.1	7	50	39	48.8
S	11	45.8	1	25	8	18.2	9	25.7	12	28.6	6	13.6	23	34.8	14	16.1	33	30.8	3	33.3	41	34.7	14	17.7	3	21.4	18	22.5
Total	24	100	4	100	44	100	35	100	42	100	44	100	66	100	87	100	107	100	9	100	118	100	79	100	14	100	80	100
	χ^2=3.129 df= 2; p= 0.19				χ^2= 0.72 df= 2; p= 0.698				χ^2= 4.775 df=2; p= 0.092				χ^2=7.721 df=2; p=0.021				χ^2=0.089 df= 2; p= 0.957				χ^2=7.755 df=2; p= 0.021				χ^2= 0.01 df= 2; p= 0.995			

Comment: * WRS — work-related stress
L — low
M — moderate
S — severe
SE — senior executives
MLE — mid-level executives
MAN — managers
ITW — IT workers
HMW — heavy manual workers
MMW — moderate manual workers
LMW — light manual workers

Table 9. **Work-related stress and relative risk of arterial hypertension in the open population aged 25–64 years (monofactorial Cox regression model)**

Observation period	Gender	Men				Women			
16 years	Age group	p	RR	95% CI		p	RR	95% CI	
				Lower bound	Upper bound			Lower bound	Upper bound
	25–64	0.05	1.4	1.021	5.491	0.034	1.276	1.018	1.6

Table 10. **Work-related stress and relative risk of arterial hypertension in the open population aged 25–64 years over 16-years observation period (multifactorial Cox regression model)**

Gender / Reference group	Risk group	Men				Women			
		p	RR	95% CI		p	RR	95% CI	
				Lower bound	Upper bound			Lower bound	Upper bound
No stress	Work-related stress	0.3	1.5	0.5	3.9	0.021	1.166	0.917	1.482
Married	Single (Never married)	0.09	2.4	0.5	11	0.568	1.163	0.692	1.955
	Divorced and not remarried	0.1	1.7	0.06	9	0.134	1.581	0.868	2.880
	Widowed and not remarried	0.01	2.5	1.4	14	0.647	1.176	0.587	2.357
Higher education	Tertiary/Secondary specialized education	0.8	1.1	0.3	4.2	0.106	1.319	0.943	1.844
	Secondary education	0.7	0.7	0.1	3.9	0.780	1.056	0.718	1.554
	Incomplete secondary/Primary education	0.5	0.6	0.1	2.5	0.062	1.543	0.979	2.433
MAN. and ITW	Job type	0.8	1.4	0.04	15	0.998	1.002	0.239	4.202
24–34 years	35–44 years	0.08	1.4	0.9	13	0.003	1.699	1.204	2.399
	45–54 years	0.2	1.7	0.02	3.4	0.0001	2.472	1.737	3.518
	55–64 years	0.1	1.9	0.01	4	0.0001	2.694	1.556	4.666

Comment: MAN — managers, ITW — IT workers.

group (34.7% in men vs 17.7% in women; χ^2=7.755 df=2; p=0.021).

Monofactorial regression analysis showed increased AH risk over the 16-year observation period in individuals who had work-related stress (men: RR=1.4; CI 1.021–5.491; p<0.05; women: RR=1.27; CI 1.018–1.6; p<0.034) (Table 9).

Multifactorial modeling that included social parameters and age showed that RR of AH in women who had work-related stress was 1.166 (CI 0.917–1.482; p<0.021) and RR in men was 1.5 (CI 0.5–3.9; p>0.05). In the groups that differed in marital status RR was the highest in the widowed men — 2.5 (CI 1.4–14; p<0.01). No statistically significant differences in AH RR were identified in men and women who had different levels of educational attainment and professional statuses. The comparison of 25–34 age group with the other three age groups showed that the AH RR in women who had work-related stress was 1.699 in the 35–44 age group (CI 1.204–2.399; p<0.003); 2.472 in the 45–54 age group (CI 1.737–3.518; p<0.0001) and 2.694 in the 55–64 age group (CI 1.556–4.666; p<0.0001). We didn't identify any statistically significant differences in the RR of AH in men of different age groups who had work-related stress (Table 10).

Discussion

Multiple factors are associated with the development of CVD and especially AH, including genetic, biological and psychosocial factors. It is well known that working conditions, age and gender can cause the development of AH. Furthermore, some data suggest that the effect of work-related stress on AH development differed between men and women, indicating that it contributed to a different extent depending on gender [19].

In the investigated population of working-age individuals (25–64 years) work-related stress was quite prevalent — almost ⅓ of men and women struggled with high levels of stress at the workplace. Men and women in the older age group (55–64 years) experienced more work-related stress. The level of work-related stress was higher in men who worked in a job that involved moderate manual labour compared with women, which means that "blue collars" are subjected to higher levels of stress compared with "white collars" [13].

Over the 16-year observation period the RR of AH in individuals with work-related stress was noted to be slightly higher in men (1.4) then in women (1.27). After marital status, level of educational attainment, professional status and age were included in the Cox-regression model along with work-related stress, AH risk increased in women (RR=1.6), widowed men (RR=2.5), and in women of all age groups (35–44 years: RR=1.69; 45–54 years: RR=2.47; 55–64 years: RR= 2.64).

Our study was similar to Wiernik et al. 2013 [20] cohort study that included 122 816 individuals (84 994 men). This study identified that work-related stress was a potential risk factor for AH development in women with low professional status. Besides, stress associated with marital life and low socioeconomic status was also investigated as a potential risk factor for AH. Moreover, work-related stress was identified as an independent risk factor for arterial hypertension [13, 20].

Conclusions

1. High work-related stress levels were identified in 29.5 % of men and 31.6 % of women (χ^2= 2.574; υ=2 P;=0.276). We identified higher levels of stress in men (31.4 %) and women (34.1 %) of older age group of 55–64 years (χ^2=6.495 υ=2; p=0.039).

2. The level of work-related stress was higher in men who worked in a job that involved moderate manual labour compared with women (34.7 % in men vs 17.7 % in women; χ^2=7.755 df=2; p=0.021). We identified no differences in work-related stress in men and women depending on the level of educational attainment.

3. Monofactorial regression analysis showed that AH RR in individuals with work-related stress was slightly higher in men (1.4) then in women (1.27) over the 16-year observation period.

4. Multifactorial modeling showed a rise in the RR of AH in several groups: in women who had work-related stress (RR=1.166); in the widowed men (RR=2.5) and in women of the 35–44 age group (RR=1.699), of the 45–54 age group (RR=2.472) and of the 55–64 age group (RR=2.694).

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