

OBSERVATION

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## ARTERIAL HYPERTENSION IN WORKERS: PREVALENCE, AWARENESS, TREATMENT, CONTROL AND HEART CHANGES

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Hypertension prevalence, awareness of high blood pressure, its treatment and control were estimated in 1100 workers, between the ages 35 and 59. Hypertension was defined as blood pressure  $\geq 160/95$  mm Hg. The incidence of hypertensive heart disease was also investigated. All hypertensive persons were taken M-mode and 2-dimensional echocardiograms, electrocardiogram and chest X-ray. The criteria for both sexes were Casale's ECG for left ventricular hypertrophy and echocardiographic left ventricular mass index of 120 g/m or greater. The prevalence of hypertension was 14%. The percentage of persons who were aware of hypertension but did not receive treatment was 66%; 28% were treated but were not adequately controlled for high blood pressure. Only 6% of hypertensive workers received treatment and had high blood pressure under control. The prevalence of heart changes among the hypertensive workers as determined by echocardiographic standards was 67%, by electrocardiographic standards 19% and chest X-ray standards 29%. Systolic blood pressure was significantly related to ventricular mass ( $r=0.34$ ;  $0.26$ ) and voltage of R in a VL + S in V3 ( $r=0.28$ ;  $0.24$ ) in all hypertensive subjects, irrespective of treatment. Our study showed a high prevalence of hypertensive heart disease, 100% awareness of disorder and a low rate of treatment and control.

*Key terms:*

high blood pressure control, hypertension awareness, hypertensive heart disease, hypertension prevalence, hypertension treatment

**E**pidemiological studies indicate that approximately 15–20% of adults in the U.S.A. have blood pressure above 160/95 mm Hg (1–4). Hypertension is considered to be uncommon before the age of 20 (5). *Mimica and co-workers* (6) found that the prevalence of arterial hypertension in the adult population of Croatia was approximately 23%. Prospective studies have shown that untreated hypertension greatly increases the incidence of cardiac failure, coronary heart disease

with haemorrhagic and thrombotic stroke, renal failure, aortic dissection and death (7). In the U.S.A. more than half persons with hypertension are either not treated or are treated inadequately (8, 9). Preventing or reversing hypertensive complications by antihypertensive therapy is a major public concern. There is no doubt that control of severe hypertension is associated with reduction of stroke, congestive heart failure, renal failure and aortic dissection (7).

In this study, the prevalence of arterial hypertension according to the World Health Organization's classification of hypertension was evaluated in 1100 factory workers aged 35-59 years. In the subjects identified as hypertensive we examined hypertension awareness, treatment, control and potential consequent heart changes. Our aim was to learn more about the status of the cardiovascular system in workers that may serve as a baseline for any possible further study in this area. Also, by this study we collected valuable data that could serve for improvement of diagnostic and therapeutic measures in hypertensive subjects.

## METHODS

### *Population*

Between 1989 and 1990 1100 factory workers, aged between 35 and 59 years (mean and median = 47 yr, SD=6) were given a physical examination and had their medical histories taken. Out of 1100 workers 866 were men and 234 women, 906 were manual labour and 194 were administrative workers.

### *Blood pressure*

Blood pressure was measured by means of a mercury manometer on the upper arm after a five-minute rest, with the subject in the sitting position, using the first and fifth phases of Korotkoff's sounds (10). All subjects with hypertension were administered a specific questionnaire on hypertension awareness, duration of hypertension in years, regular use of antihypertensive medications, and adequate control of high pressure.

A person was considered hypertensive if one of the following conditions was met:

- diastolic pressure greater than or equal to 95 mm Hg,
- systolic pressure greater than or equal to 160 mm Hg,
- report about regular taking of an antihypertensive medication (regardless of the actual blood pressure measurement (11).

### *Electrocardiographic recording*

In all participants 12-lead electrocardiogram at rest was recorded in supine position. Casale's (12) ECG criteria for left ventricular hypertrophy were applied (R aVL + SV3 >35 mm in men and >25 mm in women age <40 years; TV  $\geq$ 0.0 mm, age >40 years R aVL+SV3 >22 mm in men and >12 mm in women, TV  $\geq$ 2.0 mm in men and women).

### *Echocardiographic measurements*

M-mode and 2-dimension echocardiograms were taken in all hypertensive subjects with the subject in the partial left decubitus position using a 2.25 MHz transducer and a Toshiba SSH-6 A echograph with a strip chart recorder on light-sensitive paper at 50 mm/s. For estimation the mean value of at least three consecutive cardiac cycles was used. Left ventricular measurements were made according to the recommendations of the European and American Society of Echocardiography and Penn convention (13, 14). The Penn convention measurements were used in an anatomically validated formula to calculate left ventricular (LV) mass (15, 16):

$$\text{LV mass (Penn)} = 1.04 [(IVS + \text{LVID} + \text{PWT})^3 - (\text{LVID})^3] - 13.6 \text{ g}$$

where

IVS = intraventricular septal thickness

VID = left ventricular dimensions

PWT = posterior wall thickness

The value of left ventricular mass was divided by body surface area to obtain left ventricular mass index. Left ventricular hypertrophy was diagnosed if LV mass exceeded 120 g/m<sup>2</sup> in both sexes (16).

### *Chest X-ray*

Chest X-ray was taken in all hypertensive persons. Specific X-ray appearance with an increase in convexity of the left ventricle with or without dilatation of the left ventricle was criterion for the diagnosis of hypertensive heart disease (17).

### *Statistical analysis*

Group data are presented as means and standard deviations. Statistical comparisons between groups were made by Student's t-test. The relationship between variables was assessed by Pearson's correlation. The significance level was set at P=0.05.



## RESULTS

The prevalence of arterial hypertension was 14%, or it was present in 151 out of 1100 workers. Table 1 shows that normotensive and hypertensive subjects were comparable by age. There were significant statistical differences between normotensive and hypertensive persons in the mean value of heart rate and body mass. The mean systolic blood pressure was  $176 \pm 22.00$  mm Hg, diastolic  $110 \pm 13.4$  mm Hg, and the mean duration of hypertension was  $6.3 \pm 5.7$  years. All hypertensive workers were aware of having hypertension. Only 28% (43 of 151) were treated but not adequately controlled, and only 6% (9 of 151) were treated and adequately controlled.

Table 1. Characteristics of normotensive and hypertensive subjects

Variable	Normotensive subjects n=949	Hypertensive subjects n=151
Age (yr)	$44.1 \pm 5.4$	$47.5 \pm 6.5$
Systolic blood pressure (mm Hg)	$136 \pm 14.8$	$175 \pm 22$
Diastolic blood pressure (mm Hg)	$86.7 \pm 10.8$	$110 \pm 13.4$
Heart rate (beats/min)	$82.4 \pm 11.9$	$85.5 \pm 14.6$
Body mass index (kg/m <sup>2</sup> )	$27.3 \pm 0.41$	$28.2 \pm 0.39$

The prevalence of left ventricular hypertrophy, as determined by the various echocardiographic reference standards (16, 18) is given in Table 2. The prevalence of hypertensive heart disease as determined by echocardiographic, ECG and X-ray standards was 67%, 19% and 24% respectively. Data in Table 3 show that there was a weak but significant correlation between systolic blood pressure and electrocardiographic LV hypertrophy and left ventricular mass per gramme both in treated and non-treated hypertensive subjects. There was a significant correlation between diastolic blood pressure and left ventricular mass per gramme. There was, however, no correlation between the duration of hypertension in years and either electrocardiographic or echocardiographic changes.

Table 2 Prevalence of left ventricular hypertrophy by echocardiographic criteria in hypertensive subjects (n=151)

Criterion	Hypertensive subjects n (%)
Left ventricular mass $\geq 120$ g/m <sup>2</sup>	101 (67)
Left ventricular internal dimension $\geq 55$ mm	52 (35)
Left atrial internal dimension $\geq 40$ mm	8 (5)
Posterior wall thickness $\geq 12$ mm	32 (21)
Intraventricular septal thickness $\geq 12$ mm	58 (39)

Table 3 The relationship between mean systolic blood pressure, diastolic blood pressure or duration of hypertension and ECG hypertrophy and left ventricular mass per gramme in treated and non-treated hypertensive subjects

	ECG LV Hypertrophy	LV Mass
<b>Non-treated subjects (n=99)</b>		
Systolic pressure (182 $\pm$ 22.0 mm Hg)	0.28*	0.34*
Diastolic pressure (115 $\pm$ 11.4 mm Hg)	0.18	0.29*
Duration of hypertension (6.8 $\pm$ 5.7 yrs)	0.15	0.03
<b>Treated subjects (n=52)</b>		
Systolic pressure (169 $\pm$ 19.1 mm Hg)	0.24*	0.26*
Diastolic pressure (108 $\pm$ 13.1 mm Hg)	0.17	0.23*
Duration of hypertension (6.1 $\pm$ 5.4 yrs)	0.11	0.02

\*Statistically significant difference at  $P \leq 0.05$ ; LV = left ventricular

## DISCUSSION

The prevalence of arterial hypertension according to the data of the World Health Organization is 18% (11). Jouve and co-workers stated that 22% of administrative



workers in Marseilles, aged  $53.8 \pm 5.0$  years were hypertensive (19). According to *Mimica and co-workers* (6) the prevalence of arterial hypertension in adult population aged 35-54 years with heart changes was 23%, and without heart changes 18%. *Marinković* (20) reported the prevalence of arterial hypertension in adult population to be between 10% and 25%. In our study the prevalence of arterial hypertension was generally within the range determined previously by other authors. Our population was younger than that of *Jouve and co-workers* (19). Our sample was also more homogenous than that of *Mimica and co-workers* (6) whose population came from different parts of Croatia.

The variability of blood pressure is a well known phenomenon and it depends on the mode of measurement, place of measurement as well as on the person performing measurement (21). The percentage of hypertension awareness in our study was 100% because blood pressure measurement was part of yearly systematic examinations for all workers. According to the report of the *Joint National Committee* (22) the percentage of unaware hypertensive population was 26%, that of the population on medications 54%, without medication 18%, of the population aware, uncontrolled and on medication 22%, of that aware, uncontrolled and with no medication 18%, and of the population that was aware, controlled and on medication 34%. The percentage of persons with hypertension, who were treated and controlled was lower in our study than in the final report of the *Joint National Committee* and *Clark's* study (22, 23). *Clark* (23) found that between 1976 and 1980 36% of persons with hypertension were unaware of their hypertension, 10% were aware but not treated, 33% were treated but not controlled, and only 11% were treated and controlled. Awareness and control of hypertension improved from 1982 to 1984, the number of subjects who were unaware decreased to 34% and that of the treated and controlled increased from 11 to 32% (hypertension was defined as 140/90 mm Hg).

The major reason for inadequate treatment and control of hypertension in our subjects was poor adherence to treatment. Poor communication between the physician and the patient may be the single most important impediment to effective adherence to treatment. Physicians fail to convey interest in controlling the patient's blood pressure, do not educate subjects about the importance of blood pressure treatment and control, do not measure blood pressure at each visit or examination and do not tell subjects his/her blood pressure reading at each examination. Physicians likewise do not inform subjects of the mutual responsibility in achieving blood pressure control. Persons with hypertension do not accept the commitment to achieve blood pressure control, to follow non-pharmacological recommendation such as weight control, salt intake and alcohol abuse. The cost of antihypertensive therapy and office visit was irrelevant as far as inadequate control of blood pressure in our subjects was concerned.

Comparison of ECG, chest X-ray and echocardiographic criteria shows the superior sensitivity of echocardiography in the determination of left ventricular hypertrophy (24-26). Left ventricular hypertrophy detected in about 5% of hypertensive subjects by electrocardiography and in 50% by the criteria of *Casale* (12) appeared to provide improved accuracy in the ECG determination of left ventricular hypertrophy. *Šmalcelj and co-workers* (27) found the prevalence of

left ventricular hypertrophy by echocardiographic criteria in 63% of hypertensive subjects. Similarly, our subjects had mild, moderate, severe and malignant hypertension. The important result of our analysis is the association between systolic blood pressure, left ventricular mass and electrocardiographic left ventricular hypertrophy. The correlation was not significantly greater in persons who received no treatment than in those who were treated. In some other studies, correlation between the blood pressure value and the degree of left ventricular hypertrophy was not found (17, 28). Our results appear to be in concordance with the reports by *Burke and co-workers* (29) and *Levy and co-workers* (30) that left ventricular mass increases the elevation of the systolic blood pressure. We failed to find correlation between the duration of hypertension and left ventricular hypertrophy. Accordingly, we could not support *Weber's* (26) finding that left ventricular hypertrophy was associated with long-lasting hypertension, but we confirmed the finding by *Šmalcelj and co-workers* (27) that left ventricular hypertrophy was not associated with the duration of hypertension.

Summarizing the results of our study, in the working population that consisted predominantly of physical workers, 14% of men and women between the ages 35 and 59 years needed treatment for high blood pressure. Hypertensive persons showed 100% hypertension awareness, a high prevalence of hypertensive heart disease (up to 67%, depending on the diagnostic method) and a very low percentage of those who were treated and controlled for hypertension. Better control of hypertension requires vigilance and mutual commitment by both physician and patient.

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*Sažetak*

**PREVALENCIJA ARTERIJSKE HIPERTENZIJE U RADNIKA:  
SVJESNOST, LIJEČENJE, PRIMJERENO PRAĆENJE I PROMJENE  
NA SRCU**

Istraživali smo prevalenciju arterijske hipertenzije, definirane prema kriterijima Svjetske zdravstvene organizacije (krvni tlak 160/95 mm Hg), svjesnost o povišenom krvnom tlaku i primjereno praćenje povišenoga krvnoga tlaka. Ispitivanje je provedeno u skupini od 1100 radnika u dobi od 35 do 59 godina jedne tvornice strojeva i kartonaže. Incidencija promjena na srcu istraživana je M-mođeom i dvodimenzionalnom ehokardiografijom, elektrokardiografijom i rendgenskim snimanjem srca. Za dijagnozu hipertrofije lijeve klijetke upotrijebili smo Casaleove EKG kriterije i ehokardiografski indeks mase lijeve klijetke ( $120 \text{ g/m}^2$ ) u oba spola. Prevalencija arterijske hipertenzije bila je 14%. Postotak neliječenih bolesnika svjesnih hipertenzije bio je 66%. Postotak liječenih bolesnika bez primjereno usklađenog krvnog tlaka bio je 28%. Postotak bolesnika s primjereno usklađenim krvnim tlakom bio je samo 6%. Ehokardiografske promjene na srcu nađene su u 67% hipertenzivnih radnika, radiološke promjene nađene su u 24%, a elektrokardiografske u 19% hipertenzivnih osoba. U svih hipertenzivnih osoba, i liječenih i neliječenih, sistolički krvni tlak bio je značajno povezan s masom lijeve klijetke ( $r = 0,34; 0,26$ ) i elektrokardiografskim naponom R u aVL + S u V3 ( $r = 0,28; 0,24$ ). Dijastolički krvni tlak bio je značajno povezan s masom lijeve klijetke. Hipertrofija lijeve klijetke nije bila povezana s trajanjem hipertenzije. U hipertenzivnih radnika opažen je visoki postotak hipertenzivne kardiomiopatije i u 100% slučajeva bili su svjesni svoje hipertenzije. Međutim, nizak postotak (34%) hipertenzivnih radnika bio je liječen, a u vrlo niskom postotku (6%) povišeni krvni tlak bio je praćen na odgovarajući način. Dobiveni podaci upućuju na to da je potrebno temeljito poboljšati praćenje povišenog krvnog tlaka u hipertenzivnih osoba. Za bolje liječenje hipertenzije potrebna je uzajamna suradnja liječnika i bolesnika.

*Ključne riječi:*

hipertenzija – liječenje, hipertenzija – prevalencija, hipertenzija – uvjerenost o, povišeni krvni tlak – praćenje, srčane promjene

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