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Original

The Prevalence of Hypertension and Its Associated Risk Factors among Industrial Workers in Iran

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ABSTRACT

Background: Hypertension (HTN) is one of the most dangerous chronic diseases, and it is always considered one of the most common causes of mortality and disability all over the world. **Methods:** In this research, 3147 files of periodic examinations were studied. They were from various industries located in Iranian Kaveh Industrial Zone in 2018**.** The principal aim of this cross-sectional study was to elucidate the prevalence of HTN on a great number of people working in this industrial zone. The plan was to predict the exact effect of demographic factors, such as income, work experience, age, sex, BMI, etc. on blood pressure and, elucidate whether these variables make people vulnerable to HTN. **Results:** According to this research, around 5% of the subjects were hypertensive. Results showed that there was a significant relationship between HTN demographic characteristics ($p< 0.001$). Fisher test demonstrated a significant relationship between age and HTN ($p< 0.001$). The lowest percentage of accidents belongs to workers with 25-30 years of experience. Chi-square test showed no significant relationship between hypertension, and marital status and sex. Based on linear regression analysis, it was shown that the factors identified in this study, 23.3% predict HTN (r: 0.233). Moreover, BMI factor is the most important predictive variable (B=0.148) among the variables. **Conclusions:** Dramatic role of predictive factors and bringing out the new strategy to deal with HTN in the industrial workplace should be seriously considered. It will improve health level of workers as they spend a lot of time in factories.

Keywords: Health Level of Worker; Hypertension; Occupational Diseases

Introduction

Cardiovascular diseases are among the most common causes of death all over the world. From the vast number of chronic diseases, experts consider HTN a silent killer. This is because it generally has no observable symptoms. Therefore, the best way to protect individuals against its devastating impacts is awareness regarding HTN's risk factors. In addition to HTN, some studies found a positive correlation between pre-HTN symptoms and major cardiovascular diseases in the population. [1, 2] This indicates that detection of pre-HTN symptoms may have important clinical significance. In other words, experts should consider these signs borderline; in future studies, they should take them into account for efficient treatment in this step. This is because it reduces HTN induced morbidity and mortality in people at risk. It is estimated that 29% of adults will have

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HTN by the year 2025. [3] Oparil et al (2018) reported that HTN is the most critical metabolic risk factor and cause of mortality worldwide. [4] Studies in India, China, Thailand, Colombia, and Mexico show that age, smoking, BMI, high-fat diet, salt intake, little physical activity, literacy level, and alcohol consumption are additional risk factors. [4] In addition to people's habits and lifestyles, there is job stress in the workplace which has a synergistic effect on workers regarding HTN. [5] These environmental stressors include noise exposure, heat stress, and shift work. Kotokey and et al. (2011) reported the prevalence of HTN among Indian men and women was 26.8 and 27.6%, respectively. In the industrial population, it was 30%. [6] The authors also noted that the prevalence of HTN is higher in societies that are not economically and environmentally developed.

Health risks are significantly more prevalent in employees of small and medium-sized enterprises (SMEs) (<300 employees) than large-scale enterprises (≥1,000 employees). Furthermore, due to the various working hours, type of employment, and workplace, addressing health education and habits in work environment improves health behavior. [7] Large cohort studies, such as the Framingham Heart Study, have identified cholesterol as a modifiable risk factor, which can be treated with lifestyle change and pharmacological interventions. [8] Several clinical trials have demonstrated that treatment for dyslipidemia is effective because of preventing cardiovascular disease (CVD). [9, 10] Treatment of dyslipidemia can reduce CVD (cardiovascular disease) risk by nearly 30% over a 5-year period. [11] Metabolic risk indicator rates were markedly high and were increased significantly from the baseline over the 5-year follow-up of a cohort regarding copper-gold mining company workers. They were overweight and showed increased levels of cholesterol, blood pressure, and blood glucose. [12] Another study performed among workers from an opencast iron ore mine in South Goa showed the prevalence rates of diabetes, HTN, dyslipidemia, and polycythemia were 5.1, 8.3, 37.5, and 12.7%, respectively. [13] The level of arterial HTN is consistently associated with age, length of occupational experience, and body weight, and high prevalence of cardiovascular risk factors: They include alcohol consumption, cigarette smoking, family history, consumption of salty foods, and higher BMI among mining and milling workers. [14] In response to these challenges, all countries, as well as enterprises in Low and Low Middle Income Countries (LMIC), should consider appropriate interventions to protect and promote their workers' health. [15] For example, a study on male civil servants in Germany suggested that the prevalence and risk of cardiovascular disease were higher among office workers and policemen than firemen. [16, 17] A recent study conducted by Kakinuma *et al.* (2019) in Japan showed that men were at a lower risk, while women were at a higher risk of metabolic syndrome at nonmanufacturing companies than those at manufacturing companies. [18] The study by Kakinuma et al. (2019) revealed that there could be two possible reasons for the difference in risks regarding the two genders. One reason could be men and women have different positions within the same industry in Japan. [18] Smoking is a risk factor for coronary heart disease. In a meta-analysis of 54 studies, serum cholesterol levels were higher in smokers compared with nonsmokers in all but one study. This was while HDL cholesterol levels were on average 5.7% lower in smokers. [19] In the context of globalization, workers in LMIC face growing health and safety risks driven by industrialization and migration. [20] Workplace is considered an optimal setting for providing health services for adults in working age. This is because of the presence of natural social networks, the possibility of reaching a large population, and the time workers spend at their

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work place. [21] LMIC often lacks evidence of effective health promotion, even when there is knowledge and interventions for developing healthy work place. [15] The status of non-communicable diseases among Iranian industrial workers has not been widely studied. This is because conducting such studies in these populations requires a lot of time and financial investment. In this industrial zone, approximately 40,000 people work in 700 industries. Medical examinations are performed annually by employers under the government law. This is an opportunity to monitor workers' health and conduct this study. Therefore, the aims of the present study are as follows:

1.To determine the prevalence of HTN among industrial workers of Kaveh Industrial Zone in Iran.

2.To investigate the correlation between HTN and occupational, economic, and social factors among industrial workers of the Saveh city in Iran.

Methods

The present study was performed by a retrospective, cross-sectional method. The samples included all the people whose information was recorded correctly, and had at least two years of work experience.

In this research, authors examined 3147 files regarding periodic examinations in 2018 from various industries. They included metal, aluminum, services, parts manufacturing, automobile manufacturing, and ceramic tiles located in Kaveh Industrial Zone. Then, the required information was extracted.

Inclusion criteria included more than two years of work experience, and exclusion criteria were incomplete information in the medical record. In this study, the dependent variable was blood pressure.

The occupational examination form for recording physical examination results included five pages and nine sections. They contained personal details, work history, assessment of occupational hazards; personal, family, and medical history; examinations, tests, para-clinical, referral results, and the doctor's decision about the health condition of personnel. The results recorded in the form of occupational examinations of employees were extracted and classified into three levels of normal blood pressure, pre-hypertension (pre-HTN), and HTN. Independent variables included demographic characteristics (age, sex, marital status, income, and level of education), job characteristics (type of occupation, type of industry, work experience), and medical information (BMI index, cholesterol, triglyceride, and smoking). Age was divided into three groups: under 30, 30 to 59, and over 60. Marital status was divided into two groups: married and single. Level of education included two groups: with no high school, and with high school or higher degree level. Work experience was categorized into 3 groups: under 20, 20 to 30 and over 30. Subjects' job was classified into five groups (metal, service, spare parts, automobile and ceramic), and income amount was divided into three groups.

Experts, then, analyzed data using SPSS 23.0. Two types of analysis were performed. First, univariate analysis was performed to determine the relationship between potential factors and blood pressure using. This was done through Chi-square and Fisher tests. Then, a multiple logistic regression test was performed for the variables which were significant in the univariate test ($p < 0.01$). In the multiple logistic regression test, the first group of each variable was selected as the reference group.

Results

Based on the results, researchers calculated the prevalence rate of HTN according to demographic, social, and economic variables. Figure 1 shows the diagrams of blood pressure rates. Figure 1a indicates that the highest prevalence rate of HTN belongs to people working in service industry (9.1%). It seems that among office, transport, manufacturing, and

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technical occupations, the frequency of people with high blood pressure is higher than those who are active in transport and transportation sector (8.7%) [Figure b]. Figure c demonstrates that the frequency of HTN in people with less than five years or between 5 and 10 years of experience is much higher than other groups (37.1%). The prevalence of HTN in the age group over 60 was higher than other age groups and was equal to 12.5% (Figure. 1d). Figure 1e shows that with increasing BMI, BP (blood pressure) rate increase as well. So, the highest rates of pre-HTN (25%) and HTN (10.7%) are related to body mass index of 30 and above. HTN was higher in smokers (7.3%) than in nonsmokers (Figure. 1g). Moreover, the rate of HTN (5.8%) and pre-HTN (17.8%) was higher in people with a lower level of education (Figure. 1f), and HTN (8.3%) and pre-HTN (22.5%) in people with low income were more than other groups (Figure. 1h).

This study found that the majority of people with normal blood pressure in the automobile (27.2%) and metal industry (22.8%) are employed. Interestingly, people working in these two industries still have the highest percentage of high blood pressure (1.1% and 1.9%, respectively). Chi-square test showed significant results (P-value <0.05) (Table 1).

Education level can be considered an influential factor in the development of HTN. Results showed that the highest frequency was related to pre-HTN (12.3%) and HTN (4%) belonging to the diploma group and lower than the diploma. Chi-square test showed significant results (p-value <0.05) (Table 1).

With increasing BMI index, the frequency of HTN increased, and the results showed that the highest prevalence of pre-HTN (8.6%) and HTN (2.5%) belonged to the BMI group 25-29.9. The Chi square test showed significant results (p <0.05) (Table 1).

Of the 5% of the hypertensive group, 4.1% did not smoke, and 0.9% smoked. This is while Figure. 1g shows the prevalence of HTN in smokers at 7.3% and nonsmokers at 4.8%.

Examination of data on the three age groups revealed that with aging, the number of people with high blood pressure increases. This is while the number of people with normal blood pressure decreases.

The highest prevalence of pre-HTN (13.8%) and HTN (4.2%) is in the age group of 30-59. The results of fisher test showed significant results (p <0.05) (Table 1).

Among the four job categories: office, transport, manufacturing, and technical, the frequency of people with high blood pressure was higher than those in the production sector (3.1%).

The prevalence of pre-HTN and HTN in the middle-income group was 8.1% and 2.4%, respectively. Furthermore, the highest frequency in the normal blood pressure group belongs to the middle-income group. Chi-square test showed significant results (p <0.05) (Table 1).

Results suggested that the highest frequency of HTN was related to the employees with ten years or less work experience. Chi square test showed that the results were significant (p <0.05) (Table 1).

Table 2 shows the results of linear regression in which the effect of each independent parameter on blood pressure is shown. R^2 was equal to 0.233, which shows that the effect of variance of blood pressure on independent variables was 23.3%.

Among the independent variables, BMI (B = 0.14), education level (B = 0.11) and age (B = 0.054) had the greatest effect on increasing blood pressure as a dependent variable. Regression test showed that the results are significant (P-value <0.05).

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Table 1. The frequency of NBP, pre-HTN and HTN in the population, and the results of the relationship between potential factors and blood pressure condition making use of Chi-square or Fisher tests.

Demographic characteristic		HTN status								
		NBP			Pre HTN			HTN		
		frequency	%	Cumulative%	frequency	%	Cumulative %	frequency	%	Cumulative %
Industry	Metal	714	22.8%		170	5.4%		59	1.9%	
	Service	87	2.8%		33	1.1%		12	0.4%	
	Spare	554	17.7%	78.7%	112	3.6%	16.3%	27	0.9%	5.1%
	Automobile	869	27.7%		88	2.8%		35	1.1%	
	Ceramic	244	7.8%		107	3.4%		26	0.8%	
	chi-square test					144.557				
	P					0.000				
Levels of education	≤High School	1661	52.9%	78.6%	387	12.3%	16.2%	126	4%	5.1%
	>High School or more	807	25.7%		123	3.9%		33	1.1%	
	chi-square test					22.41				
	P					0.000				
Marital status	single	313	10%	78.7%	52	1.7%	16.3%	20	0.6%	5%
	married	2155	68.7%		458	14.6%		139	4.4%	
	chi-square test					2.441				
	P					0295				
Sex	male	2431	77.5%	78.7%	504	16.1%	16.3%	158	5%	5.03%
	female	37	1.2%		6	0.2%		1	0.03%	
	chi-square test					1.043				
	P					0.592				
BMI(kg/m^2)	<18.5	39	1.2%	78.1%	2	0.1%	16.2%	0	0%	5%
	18.5-24.9	1084	34%		127	4%		35	1.1%	
	25-29.9	1062	33.9%		271	8.6%		77	2.5%	
	30-39.9	283	9%		110	3.5%		47	1.5%	
	chi-square test					128.09				
	P					0.000				
Smoking	yes	277	8.8%	78.6%	68	2.2%	16.3%	27	0.9%	5.1%
	no	2191	69.8%		442	14.1%		132	4.1%	
	chi-square test					6.005				
	P					0.050				
Income	≤150 $	366	11.7%		119	3.8%		44	1.4%	
	150-250 $	1576	50.2%	78.7%	253	8.1%	16.3%	74	2.4%	5.2%
	>250	526	16.8%		138	4.4%		41	1.3%	
	chi-square test					56.410				
	P					0.000				
Work experience	<5 years	900	28.7%		175	5.6%		59	1.9%	
	5-10 years	898	26.8%		156	5%		59	1.9%	
	10-15 years	370	11.8%	76.9%	105	3.3%	16.2%	15	0.5%	5.2%
	15-20 years	251	8%		60	1.9%		18	0.6%	
	> 20 years	49	1.6%		14	0.4%		8	0.3%	
	chi-square test					25.175				
	P					0.001				
Age	< 30 years	514	16.4%		77	2.5%		26	0.8%	
	30-59 years	1948	62.1%	78.7%	432	13.8%	16.3%	132	4.2%	5.03%
	≥ 60	6	0.2%		1	0.03%		1	0.03%	
	Fisher test					11727				
	P					0.015				
Job	Production	1779	56.5%		318	10.1%		96	3.1%	
	Transportation	58	2%	78.5%	36	1.1%	16.1%	9	0.3%	5.1%
	Technician	188	6%		120	3.8%		22	0.7%	
	Official	443	14 %		36	1.1%		32	1%	
	chi-square test					175.091				
	P					0.000				

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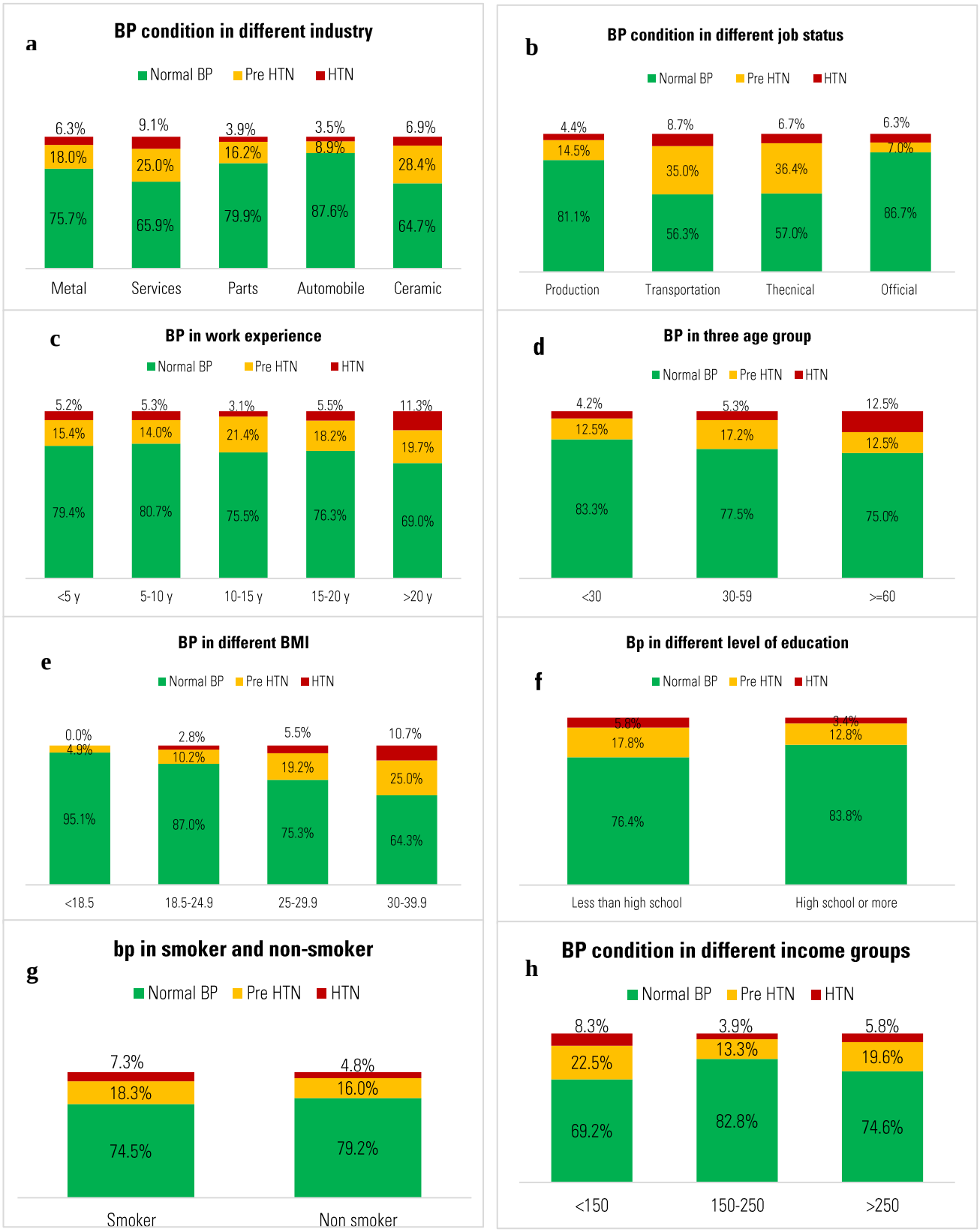

Figure 1. The prevalence rate of NBP, pre-HTN and HTN in subjects at the time of this study as bar chart to compare them in term of variables. Industry (a), job (b), work experience (c), age (d), BMI (e), smoking (f), level of education (g) and income (h). The data showed the highest prevalence of HTN was in people who work in service industries and who were engaged in transportation units. Furthermore, BP was more prevalent in subjects who have more than 20 years' work experience and everybody who was over 60 years old. As it was expected, having BMI over 30 and being smoker were another effective factors to rise the number of pre-HTN and HTN cases.

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Table 2. Linear regression results for the impact of job and demographic parameters on NBP, pre-HTN and HTN

Predictors	B	Std. Error	Beta	t	Sig.
(Constant)	1.240	.138		9.016	.000
Education	-.118	.023	-.100	-5.108	.000
BMI	.148	.013	.195	11.116	.000
Smoking	-.025	.015	-.029	-1.678	.093
Industry	-.005	.005	-.016	-.875	.382
Age	.054	.027	.041	1.997	.046
Job Type	.024	.006	.085	4.108	.000
Work experience	.010	.010	.019	.996	.319
Income	-.023	.018	-.026	-1.261	.207
Marital status	.000	.031	.000	-.011	.991
Sex	-.048	.081	-.010	-.595	.552
R=0.233		R^2= 0.54		Adjusted R Square = 0.051	

Discussion

When it comes to talking about workers engaging in industrial workplaces, demographic and socio-economic factors have key roles in dealing with this chronic disease. In the present study, results showed that the prevalence of HTN could be different in people who work in various industries. It relies on the participants' demographic conditions. Due to the rise of obesity around the world, a great body of evidence documented the main factors of HTN, including age, gender, smoking, exercise, family history, dietary habits, and BMI [22, 23]. BMI is one of the most important determinants of BP in the studied population. Nearly 10% of obese people suffered from HTN. As indicated in Figure 1, the prevalence of HTN significantly increased with an increase in BMI. Although many indicators predict hypertension such as waist circumference (WC), waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR), the importance of body mass index (BMI) is still controversial. Some researchers reported that BMI has a high correlation with hypertension [24, 25]. Landi *et al.* (2018) stated that the average systolic and diastolic blood pressure increased significantly and linearly based on BMI [26] Accordingly, obesity, which is usually determined by BMI, is one the principal risk factors for HTN [27, 28]. Although there are concerns about BMI [29, 30], finding stressed the highest prevalence of HTN in participants who are obese. Furthermore, the additional analysis implied the importance of BMI as an indicator to predict the prevalence rate of HTN. Consistent with Sullivan et al. (2015) [31], this research suggested that overweight and obesity *per se* may lead to the development of HTN and play a central role in its pathogenesis. It was demonstrated the ideal health metrics, such as normal BMI, was correlated with lower prevalence and incidence of both cardiovascular and non-cardiovascular diseases. [32] Hence, some researchers believe that BMI should be recommended as a simple and effective predictor of HTN in public health strategies. [33, 34]

The economic status of people is another factor in determining blood pressure. Workers' income was considered an indicator of their economic status. Participants who received lower and higher income have a higher rate of HTN as oppose to middle ones. In contrast, the result of a study conducted in Vietnam demonstrated that men in the low economic group had a significantly lower risk for HTN than those in other income groups. [35] The Vietnamese study stated that high rate of hypertension among richer men may reflect their adoption of western lifestyles such as high-fat diets, less physical activity, higher alcohol consumption, and job stress. Moreover, they reported that women in the low- and middle-income groups showed a significantly higher risk than those in the high-income group. [35] As for income, this study's data support the assumption that its effect on blood pressure is modified by lifestyle and dietary factors such as malnutrition. [36]

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Data extracted in this research confirmed the result of Samal *et al.'s study* (2007). They imply that a low level of education was significantly associated with HTN. A higher rate of HTN in participants with low level of education is almost expected. This is because of their little awareness of the increased risk of HTN, its potential consequences and even their insufficient knowledge regarding nonmedical treatment. [37] Although there is evidence that minimizes the impact of awareness on HTN, [38] it might be reasonable that educational level markedly influences the knowledge of people about HTN. An example of risk factor can be stroke. So, there is a strong need for employing a high level of education to reduce the risk for HTN and other diseases. [39-42] Because of the importance of education for health among men and women, experts should emphasize the level of education. In other words, better education leads to healthier lifestyle (e.g. drinking, physical activity, lower rates of smoking) and more access to health care services. [43]

Using mercury sphygmomanometer, authors showed that the highest prevalence of HTN belonged to the third age group (over 60). This was consistent with previous studies. [44, 45] The second age group included the highest number of pre-HTN cases compared to the rest of the groups. Blood pressure is an established cause of vascular disease. [46] It was proven that age is more associated with cardiovascular disease mortality than other causes. [43] The risk of HTN increases as people get older. It could be related to the low physical activity and age-related factors.

The workers' BP, in this study, was different in various industries. In fact, the industry determines their BP. The highest rate of HTN was reported in people working in a company involved in services to other factories. Because the majority of participants in Service Company work in the office, they had little physical activity and a low stressful environment, compared with the ones in other industries.

The previous study conducted in Iran showed a higher prevalence of cardiovascular risk factors such as hypertension in women. [44, 47] The findings of this study, however, indicated that the prevalence of HTN is higher in men than in women in Iran. Ebrahimi et al. (2010) reported a non-significant prevalence of hypertension among young men, while the prevalence of hypertension was markedly higher in older (>45-year-old) women. [48]

Generally, there is a significant relationship between blood pressure condition and a number of variables like age, work experience, education level, job, income, and BMI. Besides, the results of linear regression showed most of these variables could predict HTN in people during their working period. Thus, it highly suggests these variables be considered when authorities hire employees for industrial companies. Factors, for example, hiring people without finishing high school or staying in work for more than 20 years in some jobs common in developing countries) will make them really vulnerable to get HTN and even other kinds of chronic diseases. This would have negative economic and psychosocial effects on healthcare systems and the community and families.

However, there were two major limitations for this study. First, the population included only factories in Kaveh industrial zone in Markazi Province. Further studies should be conducted on all Iranian industrial populations to accurately capture the evolution of HTN in Iranian industries. Second, researchers did not gather data on serum lipid levels or other relevant metabolic laboratory results. Therefore, the contribution of these factors to the prevalence of HTN could not be analyzed. Because Iran is a big country with plenty of various manufacturers, the authors hope to conduct another study in order to further understand this phenomenon.

Conclusions

The result of present study emphasizes the important role of predictive factors and developing efficient approaches to deal with HTN in industrial

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workplace. This improves health level in people who usually spend a long time in factories. Furthermore, the more individuals know about today's chronic disease risk factors, the better they will be able to control or prevent future chronic disease epidemics.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgement

This paper was the result of research project approved by the Research Council of Saveh University of Medical Sciences (Ethics code: IR.SAVEHUMS.REC.1398.013). All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

Author contributions

The authors confirm contribution to the paper as follows: study conception, design, analysis and interpretation of results: MF; data collection: AHB; draft manuscript preparation: AHB and MP.

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