

# Correlation between Cigarette Smoking and Blood Pressure and Pulse Pressure among Teachers Residing in Shiraz, Southern Iran

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## Abstracts:

**Background:** Hypertension (HTN) affects nearly 26% of the adult population worldwide. Assessment of factors which influence blood pressure is a major topic for public health. One of these preventable risk factors is smoking.

**Methods:** This cross-sectional study was conducted on 3115 (1842 [59.1%] females) teachers from Shiraz. The participants aged between 21 and 73 years. A questionnaire was used to collect data on several cardiovascular disease risk factors including smoking and blood pressure.

**Results:** The prevalence of smoking in our study group was 5.85%; 1.52% of the studied participants were ex-smokers. The prevalence of pre-HTN and HTN (JNC VII) was 42.6% and 18.2%, respectively. HTN was more prevalent among men and elderly people. Pre-HTN was more prevalent in smokers but HTN was more frequent in non-smokers. The mean range of systolic and diastolic HTN, and pulse pressure was greater in heavy smokers than those who smoked <20 packs year, although the difference was not statically significant.

**Conclusion:** The relation between the smoking status and blood pressure is not yet obvious. However, it seems that cessation or at least reduction in the amount of smoking would significantly decrease blood pressure.

**Keywords:** Tobacco Smoking; Pre-hypertension; Hypertension; Pulse Pressure

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## Introduction

Cardiovascular diseases are the leading cause of death in the developed countries and several developing nations such as Iran.<sup>1</sup> According to WHO reports, one of every three deaths (almost 17 million people a year) is caused by cardiovascular diseases. Hypertension (HTN) affects nearly 26% of the adult population worldwide.<sup>2</sup> It is an independent prognostic indicator for cardiovascular death and significantly associated with increased morbidity and mortality from renal insufficiency, cerebrovascular disease, congestive heart failure and myocardial infarction.<sup>3</sup> The prevention and management of HTN are major public health challenges for all developing and also developed countries. Maintaining a healthy weight, not smoking, engaging in regular exercise,

and maintaining a healthy diet have been shown to favorably influence cardiovascular risk factors such as HTN.<sup>4-6</sup> Over 50 years ago, Doll, *et al*, first showed that smoking can cause lung cancer.<sup>7</sup> Since then, numerous studies have demonstrated various ill effects of tobacco consumption on health especially through cardiovascular, neoplastic, and respiratory diseases. Several studies have described the effects of smoking on blood pressure and many reports have found that smoking reduces blood pressure. On the other hand, several other studies have shown that smoking increases blood pressure while some other studies failed to confirm any association between smoking and blood pressure (Table 1). The current study was conducted to determine the prevalence of HTN and the relations between smoking and blood pressure and pulse pressure among teachers residing in Shiraz, southern Iran.

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**Table 1:** Major studies on the association between smoking and blood pressure.

Reference	Place	Year	Population	Finding
<b>Fasting and Nilsen</b>	Norway	1995-1997	8950	Lower BP in S than NS
	Hong Kong china		3718 men	Lower BP in Chinese male smokers than NS
<b>Higgins and Kjelsberg</b>	Israeli	1967	10,000 working men	Lower BP in male smokers than NS and higher pulse rate
<b>Savdie</b>	Sydney, Australia	1975-1978	27,435 women and 34,088 men	Lower BP in S than NS
<b>Green</b>	Evans County USA	1977	2308	Lower BP in S than NS
<b>Gofin</b>	Israel	1982	2945	Lower BP in S in both adults
<b>Imamura</b>	Japan	1990-1993	7608 males	Lower BP in S than NS
<b>Benowitz</b>	San Francisco	1989	288 bus drivers	Lower BP in S than NS (serum cotinine)
<b>De Cesaris</b>	Italy	1992	20 S and 20 NS (case-control study)	Smoking causes an acute increase in BP
<b>Elliott and Simpson</b>	Britain	1980	Two groups with 85 subjects (case-control study)	S with more accelerated phase of HTN
<b>Dyer</b>	Chicago	1967-1973	39,665	Widened pulse pressure and pure systolic HTN in S than NS
<b>Aronow</b>	California	1970	-	Significant increase in peak SBP, DBP in S (nicotine level)
<b>Cryer</b>	Washington	1976	10	Higher BP in S than NS (epinephrine, norepinephrine )
<b>Lang</b>	Algiers district	1983	1098 men and 393 women	Not significant relation
<b>Simons</b>	Australia	1984	47,000	Not significant relation

S: Smokers; NS: Non-smokers; Ex-S: Ex-smokers; BP: Blood pressure

## Patients and Methods

This study was conducted in collaboration with the Ministry of Education, Shiraz branch, and Cardiovascular Research Center, Shiraz University of Medical Sciences. This cross-sectional study was conducted from February to December 2009 and comprised of 3115 teachers from Shiraz (1842 [59.1%] females) aged between 21 and 73 years. The mean age of women and men was 41.5 and

42.7 years, respectively. All eligible participants gave verbal informed consent to participate in this study. The participants were interviewed at Shiraz Healthy Heart House by nursing staff who had undergone comprehensive training in Cardiovascular Research Center of Shiraz University of Medical Sciences prior to initiation of the study. A questionnaire was used to collect data on demographic information, physical activity, tobacco use and any

**Table 2:** Smoking status in men and women

Smoking status	Women	Men	p value
Current smokers	1.5%	12.1%	<0.001
Ex-smokers	0.3%	3.2%	<0.001
Passive smokers	11%	3.6%	<0.001

**Table 3:** Age specific prevalence of blood pressure

Age	Systolic blood pressure			Diastolic blood pressure			
	BP	120-139	140-160	>160	80-89	90-99	>100
<40 years old		35.3%*	4.5%*	0.3%*	30.9%*	9.3%*	2.2%*
40-60 years old		43.2%¥	9.5%**	2.6%**	35%¥	13.4%**	5.7%**
>60 years old		34.8%	34.8%	30.4%	39.1%	26.1%	17.4%

\*P<0.05 when compared with who are 40-60 years old; \*\*P<0.05 when compared with the group who are older than 60 years old. ¥ P-value is not significant in these two groups.

kind of addiction, history of HTN or its treatment, diabetes mellitus, coronary artery disease, and dyslipidemia. A more detailed smoking history including number of cigarettes smoked per day and past history of smoking was also taken. Individuals who smoked one or more cigarettes per day were considered "current smokers," whereas those who had quit smoking for at least three months were considered "ex-smokers." Daily smokers were categorized into three groups: group 1, those with less than five pack year; group 2, 5–20 pack year; and group 3, smokers who had more than 20 pack year of smoking exposure.

Blood pressure (systolic and diastolic phase V of Korotkoff) was measured from the brachial artery according to JNC VII guidelines, using a standard mercury sphygmomanometer in the right arm in a sitting position, after at least 5 min of rest. It was repeated after 5 min and the second reading was used for analysis. The pulse pressure is defined as the systolic blood pressure (SBP) minus the diastolic blood pressure (DBP) and is normally between 40 and 49 mm Hg.<sup>27,28,30,31</sup>

To avoid any confounding effects of the treatment or behavior changes following the diagnosis of HTN, those patients who were aware of cardiovascular disease or HTN were excluded from the study. HTN was defined as a SBP $\geq$ 140 mm Hg or a DBP $\geq$ 90 mm Hg or being treated for HTN. Pre-HTN was defined as a SBP between 120 and 139 mm Hg or a DBP between 80 and 89 mm Hg in non-hypertensive participants.

Data were analyzed SPSS ver 15. Pearson  $\chi^2$  test was used to assess relationship between level of blood pressure and smoking status. A p value <0.05 was considered statistically significant.

## Results

The prevalence of smoking in our study population was 5.85%; 1.52% of the population were ex-smokers. Current smoking rates among men and women were 12.1% and 1.5%, respectively (Table 2). Smoking was more prevalent (10.4%) among those who had low level of education than those with high level of education (8.5%). Among the daily smokers, 85 (63%) consumed less than five pack year, 42 (31.3%) consumed between five and 20, and 7 (5.2 %) daily smokers had more than 20 pack year.

The prevalence of pre-HTN (SBP: 120–139 or DBP: 80–89 mm Hg) and HTN (SBP>139 or DBP>89 mm Hg) was 42.6% and 18.2%, respectively. The mean age of hypertensive subjects was 42.6 years; it was 41.9 in normal individuals. HTN was more prevalent among men and elderly people. The prevalence of pre-systolic HTN (SBP: 120–139 mm Hg) was 39.9%, grade 1 systolic HTN (SBP: 140–159 mm Hg) 7.8%, and grade 2 systolic HTN (SBP >160 mm Hg) was 1.9%. The prevalence for pre-diastolic HTN (DBP: 80–89 mm Hg) was 33.3%, grade 1 diastolic HTN (DBP: 90–99 mm Hg) 11.9%, and grade 2 diastolic HTN (DBP >100 mm Hg) was 4.4%.

The prevalence of high pulse pressure among hypertensive people in our studied population was 43.09%.

The population was categorized into three age groups of <40, 40–60, and >60 years. The prevalence of pre-HTN, systolic and diastolic HTN was higher in elderly people (Table 3).

While pre-HTN was more prevalent among smokers (26.1%) than non-smokers (21.1%), HTN was more frequent in non-smokers (Table 4). The

**Table 4:** Distribution of systolic and diastolic blood pressure and smoking status

Smoking status	Systolic blood pressure			Diastolic blood pressure		
	Systolic Pre-HTN	Grade 1 Systolic HTN	Grade 2 Systolic HTN	Diastolic Pre-HTN	Grade 1 Diastolic HTN	Grade 2 Diastolic HTN
Non-smoker	35.1%	12.7%	1.9%	33.3%	9%	4.5%
Smoker	40.3%	7%	1.5%	37.3%	11.9%	2.2%

**Table 5:** Pack year smoking and HTN

		Mean	Standard deviation	95% confidence interval for mean			
				Lower bound	Upper bound	Minimum	Maximum
Systolic HTN	<5 pack year	113.04	18.55	109.03	1117.04	70	168
	5-20 pack year	120.83	16.28	115.76	125.91	85	158
	>20 pack year	123.57	17.49	107.39	139.75	100	150
Diastolic HTN	<5 pack year	74.64	12.38	71.96	77.31	45	110
	5-20 pack year	78.62	10.05	75.49	81.75	60	108
	>20 pack year	75.14	11.18	64.80	85.49	60	90
Pulse pressure	<5 pack year	38.4	11.17	35.98	40.81	20	85
	5-20 pack year	42.21	11.51	38.62	45.80	20	68
	>20 pack year	48.42	9.16	39.94	56.90	39	60

prevalence of grade 1 HTN was 35% in smokers and 30.3% in non-smokers. Furthermore, grade 2 HTN was more frequent in non-smokers (4.9%) than smokers (2.2%).

There was a significant dose-effect relationship between the amount of smoking and blood pressure in some studies.<sup>8-10</sup> However, another research failed to confirm this association.<sup>11</sup> The mean systolic and diastolic blood pressure and pulse pressure were higher in heavy smokers than smokers with pack year smoking less than 20 (Table 5) although the difference was not statically significance. Heavy smokers had also higher variability in the above-said variables (Table 5).

## Discussion

Since 1971, several studies on the relation between smoking and blood pressure have been conducted and come into controversial results. This discrepancy in the reported results is mainly due existence of various confounding variables which influence the blood pressure but could not be controlled effectively during the study. In this study, we found that pre-HTN is more prevalent in smokers than non-smokers and that diastolic HTN (but not systolic HTN) is more prevalent in smokers than non-smokers (Table 4). Smokers with higher pack year smoking were more likely to have systolic HTN than occasional smokers with less than five pack year smoking. Despite lower prevalence

of systolic HTN in smokers, this observation may be attributed to low prevalence of heavy smokers in this population.

It has been shown that smoking would raise blood pressure and heart rate through its acute vasoconstriction effect.<sup>12,13</sup> Different research groups have reported the effect of smoking on blood pressure: Some showed that there is no association between smoking and blood pressure;<sup>14-17</sup> some reported that blood pressure of smokers was lower than that of non-smokers;<sup>8,9,18-20</sup> and some believed that smoking would raise blood pressure.<sup>12,13,21,22</sup> To support these relations, several theories have been proposed some of which have been evaluated in laboratory. Aronow, *et al*, demonstrated the positive effect of smoking on blood pressure and also analyzed the level of nicotine in cigarettes so there was a significant increase in systolic and diastolic blood pressure as well as pulse rate after smoking either high- or low-nicotine cigarette in comparison with smoking nicotine free cigarette.<sup>12</sup> Smoking releases the sympathetic neurotransmitters norepinephrine and epinephrine; it associates with hemodynamic and metabolic changes which are mediated through adrenergic mechanisms.<sup>13,23</sup> Association of chronic smoking with decreased blood pressure is interesting in some epidemiologic studies; this suggests the existence of substances other than nicotine in cigarette smoke which would have an opposite, hypotensive action.<sup>12,17</sup> Borzelleca

and Dominiak found a new substance, one of the nicotine metabolites, named cotinine that relaxes vascular smooth muscles and dilates blood vessels *in vitro*.<sup>19,24,25</sup> The observed negative relation between smoking and blood pressure would probably attribute to these nicotine metabolites. The physiologic effects of such substances in smoke are not still well understood, thus assessment of the effects of nicotine and its metabolites would be beneficial.

Some epidemiologic studies like this one reported a relation between smoking and blood pressure. De Cesaris reported that each cigarette induces a similar and statistically significant acute increase in both blood pressure and heart rate which lasts for a long time and could be detected in 24-hour ambulatory blood pressure monitoring.<sup>26</sup>

On the other hand, there are some studies that showed a negative relation between smoking and blood pressure; they suggested that smoking would decrease blood pressure. In Nilsen's study, occasional smokers had lower blood pressure than never smokers; there were no difference between daily smokers who smoked more than one pack year compared to never smokers. This may suggest that the observed lower blood pressure among smokers is a transient phenomenon.<sup>18</sup> Goldbourt, *et al*, reported that current smokers had lower weight, and systolic and diastolic blood pressure but had a higher pulse rate. These findings confirmed a number of previous studies but no physiologic rule was proposed.<sup>20</sup> Green, *et al*, reported a causal relationship between chronic smoking and reduced blood pressure. The results showed a pattern of increased blood pressure among non-smokers and ex-smokers than among smokers.<sup>11</sup> Many research groups have reported that no association exists between smoking habits and blood pressure.<sup>14-17</sup>

Pulse pressure appears to be a better predictive factor than the systolic or diastolic blood pressure alone. An increase in pulse pressure places greater stress on arteries and left ventricle, resulting in increased fracture rate in the elastic components of the vessel wall and ventricular hypertrophy. The vascular intima becomes prone to damage, thereby increasing the risk of atherosclerosis and thrombosis and heart failure.<sup>27,28</sup> In this study, the mean value for pulse pressure was higher in smokers with a history of more than 20 pack year smoking—a higher pulse pressure was observed in smokers than non-smokers. Association between cigarette smoking and a wide pulse pressure may reflect either an increased peripheral resistance in smokers or presence of aortic atherosclerosis and arterial inelasticity, as smoking is a risk factor for atherosclerosis.<sup>29</sup>

There was a significant dose-effect relationship between the amount of smoking and blood pres-

sure in some studies.<sup>8-10</sup> Other researchers such as Green and Brischetto, *et al*, failed to confirm this finding. In our study, smokers with a past history of higher pack year were more likely to have systolic HTN than occasional smokers who smoked lesser than five pack year. Goldbourt and Medalie demonstrated a negative dose-dependent association between cigarette smoking and both systolic blood pressure and diastolic blood pressure. Their results were the same even after they adjusted the results for weight, skinfold and cholesterol.<sup>10</sup>

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