Original Article

Lifestyle Choices Influence the Susceptibility towards Essential Hypertension

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Abstract

Background: Despite provisions of anti-hypertensives and WHO measures, prevalence of hypertension is increasing worldwide, especially in low-& middle-income countries. This indicates a common issue, probably non-affordability of medicines and non-availability of proper health care facilities to larger section of population. This provided two important objectives to the study, first to investigate the basic health parameters of hypertensive and normotensive individuals and second to correlate their lifestyle choices with health parameters to understand the cause and effect.

Methods: The cross-sectional study was conducted through a consecutive sampling of 110 individuals, including hypertensive (n=60) and normotensive (n=50) individuals between January to September 2024 at Advanced Cardiac Centre, PGIMER. Data regarding participants lifestyle habits and biochemical parameters were collected using case record forms. Statistical analysis, including intergroup and intragroup comparisons, was performed using Chi-square test, unpaired t-test (Mann-Whitney test), descriptive analysis. A p-value <0.05 was considered statistically significant. Additionally, logistic regression analysis was conducted to evaluate the association between biochemical parameters and hypertension as predictive variables.

Results: A higher proportion of individuals with a sedentary lifestyle were observed in the hypertensive group. Further analysis of normotensive individuals with sedentary lifestyles revealed that 78.5% were vegetarians and only a small fraction reported with alcohol consumption. In contrast, hypertensives with a sedentary habit exhibited higher rates of non-vegetarian food intake (76.2%) and alcohol consumption (71.4%).

Conclusion: This study underscores lifestyle modifications as the primary strategy to improve the overall health parameters, to reduce the increasing prevalence of hypertension, as well as reduce drug dependence.

Keywords: Hypertension, lifestyle, biochemical parameters, blood pressure.

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Introduction

Hypertension increases the risk for cardiovascular diseases by keeping the blood pressure (BP) above the standard read of 120/80mm Hg. Essential/ Primary hypertension is more common, polygenic, and a complex condition where several factors like age, gender, stress, sedentary lifestyle, genetics, and epigenetics play an important role. Worldwide, the estimates for hypertensive individuals in the age group of 30-79 years is 1.28 billion, among which two-third belongs to low- and middle-income countries. Secondary hypertension is when BP elevates due to a known cause. It is less common, but present more among younger age group (18-40 years) and therefore, alarming [1-3]. Primary aldosteronism and renovascular hypertension are two representative examples of secondary hypertension. As per 2017 guidelines from the American College of Cardiology (ACC)/American Heart Association (AHA), BP measurement of 120/80mm Hg is the standard whereas stage 1 hypertension is when systolic blood pressure (SBP) is within 130-139 mm Hg, and stage 2, when SBP is above 140 mmHg. Although fluctuations in BP could be attributed to enormous lifestyle as well as heritable factors, former could have a strong effect regardless of genetic background. Studies on different populations report effective reduction in BP after incorporating healthy practices such as physical activity, non-westernized diet and proper sleep-wake cycle [4,5]. As per the European Society of Cardiology (ESC)/European Society of Hypertension (ESH), lifestyle changes must be considered as the primary line of treatment for hypertension in first 3-6 months, and the pharmacological treatment to be suggested only when uncontrolled BP persists despite lifestyle changes. Also, the lifestyle factors act independent of pharmacological treatment, as evident through DASH (Dietary Approaches to Stop Hypertension) diets, which are equally successful in the reduction of BP in patients with or without pharmacological treatment [1,6-7].

As per meta-analysis, individuals with less physical activity bear a 6% lower risk of hypertension in comparison to individuals with a sedentary lifestyle. Recommended physical activity in patients with pharmacological treatment led to the withdrawal of anti-hypertensive drugs. The remarkable benefits have also been observed in patients with resistant hypertension who incorporated physical exercise in their routines [8]. Smoking is another well-known habit as well a risk factor for increasing hypertension. Besides other toxic chemicals present in cigarettes, Nicotine is a known adrenergic agonist, which impacts both systemic and local catecholamine release. Also, smoking elevates oxidative stress and impairs cardiac remodelling, bioavailability of nitric oxide, endothelial function, and arterial flexibility. As per one of the Iranian studies, when the impact of cigarette smoke on BP was investigated among elementary school children, the outcome depicts increased systolic and diastolic BP among exposed group in comparison to non-exposed group. Regardless of public awareness about the risks of smoking, millions of individuals continue to smoke worldwide. Hence, alternate strategies are suggested by physicians to enhance smoking cessation, such as nicotine replacement therapy and behaviour modification [9-12]. Third risk factor is high body fat mass commonly known as overweight [13-15]. The World Health Organization recommended Body-mass index (BMI) of 18.5-24.9kg/m^2 as normal, 25-25.9kg/m^2 as overweight and above 30kg/m^2 as obese. Study on individuals from India (Gujrat) reported a positive association of high BMI among males and females with the occurrence of hypertension [16]. Several epidemiological studies from different populations have also repeatedly reported an increased risk of hypertension due to alcohol consumption. As per some studies, reduction in alcohol consumption among heavy drinkers significantly reduced the systolic and diastolic BP, but the exact mechanism remains elusive [17-20]. Additionally, stress due to any reason, including disturbed sleep, is another factor known to influence sympathetic and adrenergic activation. As per psychological counsellors, the relaxation techniques should be incorporated into practices for better sleep and stress management [21-23]. Considering the above-mentioned information, the primary objective of the study was to examine if any difference occurs between hypertensive and normotensive individuals with respect to lifestyle choices. The second objective was to investigate how specific lifestyle choices, such as physical activity, dietary habits, alcohol and smoking consumption, and sleep patterns, influence

the risk of developing essential hypertension. Both objectives together direct us towards potential targets for preventive strategies and improved management of essential hypertension.

The current study is unique as it offers a dual approach to assess the comprehensive correlation of lifestyle choices as well as biochemical profiles with respect to essential hypertension within a target group. As per available literature almost negligible data was found on this correlation from Indian studies.

Materials and Methods

Recruitment and Diagnosis

As per the JNC report 8, hypertension was diagnosed if the individual had systolic and diastolic BP above 130/80mm Hg with or without anti-hypertensive treatment. The baseline BP was recorded using an electronic apparatus and validated by a sphygmomanometer, when seated with straight posture on a chair comfortably, with both feet on the ground. All the consecutive patients diagnosed with essential hypertension (hypertensive, n=60) and healthy individuals (normotensive, n=50) were recruited using consecutive sampling method, from the Advanced Cardiac Centre, PGIMER, Chandigarh, between January-September, 2024. All the participants were conversant with the study, and provided written informed consent. All the patients, either newly diagnosed or visiting for follow-up, within the age range of 20-65 years were recruited, whereas individuals with secondary hypertension and pregnant women were excluded. Expert phlebotomist collected 2-3ml blood sample from each participant for biochemical analysis such as lipid profile (HDL-C, LDL-C, Total Cholesterol, Triglycerides), Total Protein, Urea, Uric Acid, Creatinine, Sodium, Potassium, Chloride and CRP. The Institutional Ethics Committee of PGIMER, Chandigarh (IEC-12/2023-2968), and Panjab University, Chandigarh (240822-II-160) provided the ethical approval to the study.

Assessment of Lifestyle factors

Hypertension was divided into four stages: Pre-hypertensive stage [SBP 120-139mm Hg, diastolic blood pressure (DBP) 80-89mm Hg] Stage1 (SBP 140-159mm Hg and DBP 90-99mm Hg), Stage2 (SBP>160mm Hg and DBP>100mm Hg) and Stage3 (SBP ≥180 or DBP ≥110mm Hg). The structured questionnaires in the Case record form of each participant documented various parameters (age, gender, height, weight) including lifestyle choices [consumption of alcohol and cigarette smoking (each with rough quantification), sedentary or active occupation/lifestyle, additional physical activity, dietary history (portion of meals, junk, fried or healthy food), and sleep-wake patterns].

For analytical purpose cigarette smoking was marked as present smoker, former smoker or never smoker, whereas alcohol consumption was classified as present drinkers, former drinkers and never drinkers. BMI was measured as per WHO recommendations and physical activity was determined as sedentary (if occupation with no physical work and complete absence of walk/exercise) or active (if occupation with physical work or regular walk/exercise assessed in minutes). The sleep patterns were identified as per quality and quantity of sleep (as told by participant), whereas dietary patterns were measured as Vegetarian/non-vegetarian, and consumption of junk food (with less nutrition, high calories). Analysis for junk food was excluded later, as most of the participants in this study were non-frequent consumers.

Statistical analysis

The association of BP with lifestyle choices was analysed using the Chi-square test and with other clinical evaluation of biochemical parameters by the unpaired t-test (Mann-Whitney test) and descriptive statistical analysis. Logistic regression was used to analyze the rate of change in susceptibility towards hypertension due to particular biochemical parameter as predictors. All the statistical analysis were performed using Prism8 and SPSS Statistics 27.0.1 and p-value <0.05 was considered statistically significant.

Results

Demographic details

A total of 110 individuals were enrolled from outpatient department of Advanced Cardiac Centre, PGIMER, and Bhai Ghanaiya Ji Institute of Health, Panjab University, Chandigarh, including hypertensive (n=60) and normotensive (n=50) individuals. As per demographic characteristics (Table1), all the participants in case and control groups, were of similar age but female participants were fewer among controls than cases. The Odds ratio for the association of gender and age with hypertension 0.2356 (0.1075 to 0.5476), indicating more risk association with higher age and male gender.

Table 1. Age and gender distribution among cases and controls groups.

Characterstics	HTN (n=60)	NTN (n=50)	p-value
Age (in years)	45.00±11.81	44.54±9.603	0.8213
Gender			
Male	58.33% (n=35)	80.00% (n=40)	0.0231*
Female	41.67% (n=25)	20.00% (n=10)	

Note- **p-value*<0.05

Association of lifestyle factors and blood pressure

Overweight individuals were significantly more among hypertensive group (p value <0.0001), clearly indicating higher possibility of hypertension among weight gainers (Table2). A positive family history of hypertension mostly correlates with early onset of hypertension, however, current study showed equal percentage of early- as well late-onset individuals within positive family history individuals. Additionally, high percentage of late onset (81.25% vs 18.75%), were seen with negative family history, indicating predominance of sporadic hypertension than familial type. The correlation of negative family history with late onset of hypertension when analysed by Fisher's exact test, showed statistical significance with *p-value* of 0.0142 and the Odds ratio was 4.333 (1.414 to 13.94). Lifestyle choices like sedentary versus active (p-value 0.4325), smoking (p-value 0.3769), and alcohol consumption versus non-alcoholic individuals (p-value 0.8739) did not show much difference. On the contrary, dietary habits did show significant (p-value 0.0036) difference between two groups. Another significant association was found with sleeping pattern (p-value <0.0001), where the Odds ratio was 0.1098 (95% CI:0.04818 to 0.2796). All the notable findings are mentioned in Table 2 and represented in Figures 1a and 1b.

Table 2. Distribution of lifestyle parameters among Normotensive (NTN) and Hypertensive (HTN) individuals.

Lifestyle parameters	Categories	NTN (n=50)	HTN (n=60)	p value
Age	20-45 years	67.50% (n=27)	32.50% (n=13)	0.0007***
	46-65 years	32.86% (n= 23)	67.14% (n=47)	
BMI(Kg/m^2)	Normal weight	66.67% (n=38)	33.33% (n=19)	<0.0001****
	Overweight	22.64% (n=12)	77.36% (n=41)	
Physical activity	Active lifestyle	48.00% (n=36)	52.00% (n=39)	0.4325
	Sedentary lifestyle	40.00% (n=14)	60.00% (n=21)	
Dietary pattern	Vegetarian	29.17% (n=14)	70.83% (n=34)	0.0036**
	Non-vegetarian	58.06% (n=36)	41.94% (n=26)	
Sleep pattern	Regular sleep	67.21% (n=41)	32.79% (n=20)	<0.0001****
	Irregular sleep	18.37% (n=9)	81.63% (n=40)	
Smoking	Smokers	33.33% (n=3)	66.67% (n=6)	0.3769
	Former	75.00% (n=43)	25.00% (n=1)	
	Non-smokers	44.79% (n=4)	55.21% (n=53)	
Alcohol	Drinkers	48.00% (n=12)	52.00% (n=13)	0.8739
	Former	37.50% (n=3)	62.50% (n=5)	
	Non-drinkers	45.45% (n=35)	54.55% (n=42)	

Note- *degree of statistical significance

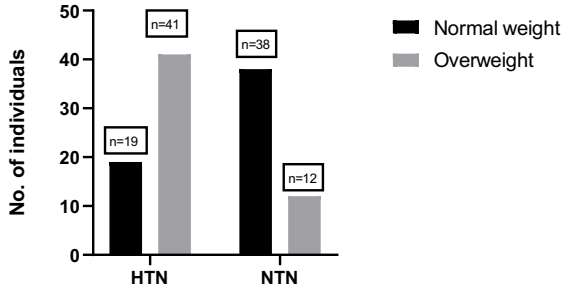

Figure1a. The prevalence of hypertension according to different BMI orders.

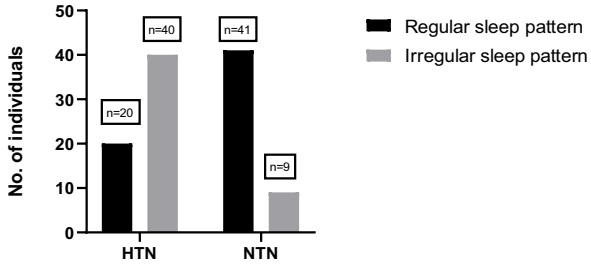

Figure1b. The prevalence of hypertension according to different sleep patterns.

Evaluation of Biochemical parameters

The biochemical parameters included HDL-C, LDL-C, total cholesterol, triglycerides, glucose, creatinine, total protein, electrolytes (such as sodium, potassium and chloride), urea, uric acid and CRP. Notable differences were observed between hypertensive and normotensive individuals as evident from Table 3. Additionally, logistic regression was performed to assess the risk of hypertension with one-unit change in biochemical parameters. The predictors, such as age, gender, creatinine, HDL-C, LDL-C, total cholesterol, triglycerides and CRP, fit best in the models for logistic regression (Table 4). The general form of the model used is as follows

$$log\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k$$

where,

P=probability of event occurring

β_0 = intercept (constant)

β_1 = coefficient of predictor *Xi*

$$log\left(\frac{P}{1-P}\right) = \log odds\ of\ outcome$$

The logistic regression model for hypertension in our study is as follows:

$log\left(\frac{P}{1-P}\right)$ = -18.264 + 0.088 (Age) + 2.969 (Sex) + 0.042 (Total cholesterol) + 0.286 (HDL-C) + 0.060 (LDL-C) + 0.014 (Triglycerides)

The model performs well with 84% accuracy, depicting older individuals to be more susceptible to hypertension, whereas males were 19.5 times more likely to have hypertension. As per data, increase in levels of LDL-C and triglyceride increases the risk of HTN by 6% and 1.4% risk per unit, respectively and total cholesterol also shows slight effect on BP. Though HDL-C is a positive factor for health but after a certain level, increase in HDL-C increases risk of high blood pressure and other cardiovascular conditions [24]. Surprisingly in this study, creatinine, glucose and CRP emerged as weak predictors for hypertension.

Table 3. Comparative assessment of biochemical parameters among HTN and NTN individuals.

Parameters	Controls NTN(n=50)	Cases HTN(n=60)	p-value
Glucose(mg/dl)	98.53±26.67	113.2±58.3	0.0794
Creatinine(mg/dl)	0.69±0.09	0.85±0.19	<0.0001****
HDL-C (mg/dl)	42.89±1.49	48.95±10.82	<0.0001****
LDL-C (mg/dl)	87.29±27.42	113.5±36.68	<0.0001****
Total cholesterol (mg/dl)	162.5±35.30	188.6±47.03	0.0036**
Triglycerides (mg/dl)	134.6±42.44	164.8±69.41	0.0235*
CRP (mg/L)	3.05±3.79	5.15±6.48	0.0249*
Sodium (mmol/L)	140.1±2.07	138.9±4.71	0.4736
Potassium (mmol/L)	4.208±0.31	4.36±0.47	0.0293*

Cont.....

Chloride (mmol/L)	100.7±1.71	102.5±2.30	<0.0001****
Urea (mg/dl)	23.35±4.51	27.22±7.98	0.0077**
Uric acid (mg/dl)	4.386±0.5397	5.10±1.46	0.0382*
Protein (g/dl)	6.911±0.3381	7.32±0.67	<0.0001****

Note- The continuous variables are shown as Mean ± Standard deviation. BMI Body mass index, HDL-C High-density lipoprotein cholesterol, LDL-C low-density lipoprotein cholesterol, CRP C-reactive protein.*Degree of statistical significance.

Table 4. Logistic regression describes the association between biochemical parameters and hypertension with 95% confidence interval.

Variables	B	S.E.	p-value	Exp(B)	95% C.I. for EXP(B)	
					Lower	Upper
Age	0.088	0.034	0.009	1.092	1.023	1.167
Gender	2.969	0.974	0.002	19.468	2.887	131.274
Glucose	-0.002	0.010	0.821	0.998	0.978	1.018
Creatinine	-0.047	0.125	0.708	0.954	0.746	1.220
Total Cholesterol	0.042	0.016	0.011	0.959	0.929	0.991
HDL Cholesterol	0.286	0.083	<0.001	1.331	1.132	1.565
LDL Cholesterol	0.060	0.018	0.001	1.062	1.024	1.100
Triglycerides	0.014	0.006	0.014	1.014	1.003	1.025
CRP	0.099	0.072	0.171	1.104	0.958	1.272
Constant	-18.264	4.468	<0.001	0.000		

Note- Variables: age, gender, glucose, creatinine, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides and CRP. Interpretation coefficient (B) represents the average change in the log-odds of hypertension per one-unit increase in a predictor, adjusting for all other variables**.** Weak (p >0.05) & Strong Predictors (p <0.05).

Discussion

Present day automation and advanced technology brought major changes in the economy as well as the living conditions especially in developing regions. Individuals in the middle- and low-income class tend to imitate a carefree and luxurious lifestyle, which majorly includes an automation-led sedentary lifestyle, higher intake of alcohol, cigarette smoking, and inappropriate sleep and diet patterns. As per literature, all the above-mentioned factors have a tendency to increase the prevalence of hypertension and cardiovascular conditions [(25)]. Age is considered one of the major risk factors for hypertension due to the physiological changes that occur during ageing process and thereby, higher prevalence of hypertension was found among higher age (46-65 years) than the lower age (20-45 years) group. Most of the studies on hypertension have reported higher prevalence among men than women, and our data also indicates the same. This could probably be due to the cardioprotective role of estrogen found among women [(26-28)] but authors do acknowledge the lesser number of women in the current study. Higher BMI among HTNs than NTNs in this study mirrors the previous findings, where overweight individuals probably exhibited dysregulation of Renin Angiotensin Aldosterone System (RAAS) and vascular alteration due to particular cytokines such as IL-1, MCP-1, TNF-α, IL-6 which are known to regulate inflammation and oxidative stress, thereby, increasing the susceptibility towards hypertension [(29)]. As per this study, consumption of non-vegetarian diet was comparatively more among the normotensives but since consumption was not very high, it might represent the protein supplements provided as in DASH diet (Dietary Approaches to Stop Hypertension- includes mild non-veg diet) which helps prevent BP elevation [(30-32)]. In one of the previous

studies, prevalence of hypertension was reported high among cases with positive family history [33], but as per present study, non-significant differences were observed between positive family history and prevalence of hypertension. Comparatively, a higher proportion of hypertensive individuals were found with negative family history in comparison to those with positive family history (55% vs 45%) indicating more sporadic than familial cases. An active lifestyle which includes physical activities such as brisk walk, run and additional exercises is known to reduce BP, but as per current study, such association was not clear (Table 2). However, individuals with sedentary lifestyle were more among hypertension group than the other (60% vs 40%). A good sleep pattern mediated through circadian rhythm, but any factor leading to sleep deprivation could increase the risk for high BP. As per few reports, sleep deprivation reduces parasympathetic tone, increase sympathetic activity, and induce heart rate variability [34-36]. Similarly in this study, a higher proportion of sleep-deprived individuals were found among hypertensive (81.63% vs 18.37%) group, whereas individuals with regular sleep were found more among normotensives (67.21% vs 32.79%).

Further, this study found no correlation of smoking, alcohol consumption with hypertension which could be attributed to lesser number of individuals with such preferences. The current study also analysed, if biochemistry profiles due to lifestyle choices show any significant differences between the two groups. The data from this study revealed a higher range of values for lipid profiles such as HDL-C, LDL-C, triglycerides and total cholesterol among HTNs than NTNs. Similar findings were reported among Chinese adults, where increased LDL-C and total cholesterol showed a strong association with the incidence of hypertension, whereas a positive relationship was seen between HDL-C and systolic blood pressure [37]. In the current study, glucose, creatinine, potassium, chloride, uric acid, and protein were though within the reference range, but were slightly higher among hypertensive individuals. As per earlier studies, CRP stimulates monocytes, elevates LDL uptake, expression of adhesion and proliferative molecules, and decreases the vasodilatory molecules [38]. Increased levels of CRP were also reported among hypertensive subjects[39-40] and unhealthy lifestyle choices were associated with high inflammation as determined by circulatory inflammatory factors, i.e., C-reactive protein (CRP)[4,16]. The present study also found significant differences (p=0.0249) of CRP inflammatory factor between HTN and NTN individuals [Table 1]. As per WHO-International Society of Hypertension guidelines and Joint National Committee VI, the increased level of creatinine and protein are predictors for stratification of cardiovascular risk. Therefore, long-term elevation of BP and the extreme range of the above-mentioned biochemical parameters probably indicate towards other complications associated with hypertension such as vascular stiffness and end organ damage.

Conclusion

The present study although represents pilot investigation on the corelation of lifestyle choices on susceptibility towards hypertension, it illustrates a significantly higher risk for hypertension among individuals with sedentary lifestyle, disturbed sleep patterns and high BMI. The knowledge about increased risk of hypertension would motivate individuals to modify their lifestyle choices and lead a more sensible healthy life at no additional cost. More individuals with sedentary lifestyles were found among hypertensive group (60%) and further analysis on normotensives with sedentary lifestyle, showed 78.5% individuals to be vegetarian and miniscule (7.1%) proportion were alcohol consumers. In contrast, hypertensives with sedentary lifestyle showed a higher consumption of non-vegetarian diet (76.2%) and alcohol (71.4%), which indicates, sedentary lifestyle along with alcohol and non-veg diet increases the susceptibility for hypertension. Consequently, hypertensive individuals with sedentary lifestyle showed disturbed lipid profile with high proportion of LDL (71.5%), total cholesterol (71.5%), triglycerides (76.2%), whereas lower percentage of individuals with disturbed lipid profile (14.2% for LDL and 7.1% for triglycerides) were seen among normotensives with sedentary lifestyle. Though the sample size analysed is small in this study but it depicts a trend of improving lifestyle choices to lower the risk of hypertension. This might further reduce the overall risk and incidences of cardiovascular diseases. Authors do accept small size

as a limitation of this study but the strength of the study lies in the selection of lifestyle choices which are prevalent across populations, and also correlating them with the biochemistry of participants, which represents the overall health conditions.

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Ethical Clearance: The study was designed and implemented following the Declaration of Helsinki, and the protocol was reviewed and approved by the Institutional Ethics Committees of Panjab University (240822-11-160) and PGIMER (IEC-12/2023-2968), Chandigarh.

Declarations of conflicting interests: The author(s) declared no conflicts of interest concerning this article's research, authorship, and/or publication.

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