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RESEARCH ARTICLE

ASSOCIATION OF LIFESTYLE RISK FACTORS WITH INCIDENCE OF HYPERTENSION

[1]Salma Sultana, [1]Shaista Urooj and [2,*]Anirban Goswami

[1]Regional Research Institute of Unani Medicine, New Delhi, under CCRUM, Ministry of Ayush, India
[2]Regional Research Institute of Unani Medicine, Patna, under CCRUM, Ministry of Ayush, India

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ABSTRACT

Background: At present scenario Hypertension is the principal risk factor for cardiovascular disease. Indeed treatment of high blood pressure is the most common reason to visit a physician. Hence it is of great importance for researchers to find out the risk factors that affect the onset.
Aim: The present study aimed to create awareness about lifestyle disorders which are associated with hypertension.
Methodology: In this study, the positive diagnosis of hypertension was made by the resting systolic blood pressure ≥140mmHg and/or diastolic blood pressure ≥90mmHg. Data regarding eventual hypertension was collected from patients attended in GOPD at Regional Research Institute of Uanani Medicine, New Delhi, India. Data on Height, Weight, tobacco chewing, smoking, alcoholism and other was collected. Multiple logistic regressions used to determine the association of these lifestyle risk factors of hypertension among in qualitative & quantitative outcome variables. In logistic regression, the Logit link used to determine and find the correlation between the variables. Data were analyzed with 'R' statistical software version 3.4.1 and the significant level of variables is chosen based on the p-value associated to the significant level of model that lies on $\alpha = 0.05$.
Results: As per logit model lifestyle factors such as BMI, tobacco chewing, alcoholism and laziness are determined as highly associated with the probability of having hypertension (p-value <0.05) where as smoking have found non significant (p-value>0.05) result.
Conclusion: Based on statistical model, hypertension is associated with BMI, tobacco chewing, alcoholism and laziness. We can conclude that effective lifestyle modifications may lower the chance of a person to develop a disease like hypertension.

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INTRODUCTION

Hypertension (HTN) or high blood pressure is a chronic medical condition in which the systemic arterial blood pressure is persistently elevated during rest above an arbitrary limit of 140/90 mm Hg. It is classified as either primary (essential) or secondary. About 90–95% of cases are termed "primary HTN", which refers to high blood pressure for which no medical cause can be found. The remaining 5–10% of cases (secondary HTN) is caused by other conditions due to the involvement of kidneys, arteries, coronary heart, or endocrine, etc system (Centers for Disease control, 2010; Hypertension, 2010). Although the exact cause of primary hypertension is unknown, there are several risk factors that have been associated with the condition. These risk factors are also associated with other non-communicable diseases (NCDs) such as diabetes mellitus, cancers, CVD, chronic respiratory disease, asthma, musculo-skeletal disorders, etc.

Corresponding author: **Anirban Goswami,**
Regional Research Institute of Unani Medicine, Patna, under CCRUM, Ministry of Ayush, India.

These factors can be depends on lifestyle patterns. The life style patterns that can be adjusted or changed to prevent the development of the disease. These risk factors include; obesity, excessive salt intake, inactivity or lack of exercise, tobacco use, smoking habit, alcohol consumption, etc. Hypertension is defined in an adult as a sustained elevation of blood pressure greater than or equal to 140 mm Hg systolic pressure or greater than or equal to 90 mm Hg diastolic pressure under rest. The prevalence of hypertension has been increasing in India, both in rural and urban regions. The prevalence of hypertension in urban areas of India ranged from 2.6-5.2 % between 1960 and 1980 and it has increased to 20-33 % last decade. The high prevalence of hypertension in the current study (32.2%), confirms this increasing trend. Another two studies carried out in rural areas of Haryana (1994-95) demonstrated 4.5% prevalence of hypertension (JNCVII criteria) while urban areas of Delhi had a higher prevalence of 45% during 1996-97 (Yadav *et al*., 2008). Hypertension is one of the major risk factors for CVD. Data derived from the Framingham study have shown that hypertensive patients show a four-fold increase in CVS accidents, as well as a six fold increase in

CHF when compared to normotensive subjects have hypertension (Morrison *et al*., 2004). An estimated one quarter of the adult population (approximately 75 million persons in US and 1 billion persons worldwide) have hypertension. It is the leading cause of death worldwide and accounts for 13.5 % of all deaths (Victor, 2007). It is also emerging as major health problem in India. It accounts for two-third of all strokes and one half of all ischemic heart diseases in India (Kau *et al*., 2012). Wasir *et al* found prevalence of hypertension (BP >160/95 mmHg) in men and women was 3.8% and 1.45% respectively, in those aged 20 years and above (Wasir *et al*., 1984). During 1984-87 Gopinath and Chadha *et al* reported the prevalence of hypertension in Delhi (criteria: >=160/90) to be 11% among males and 12% among females in the urban areas and 4% and 3% respectively in rural areas (Chadha *et al*., 1990). Dubey VD carried out one ofthe earliest study in India (1954), documented 4% prevalence of hypertension (criteria>160/95) amongst industrial workers of Kanpur (Dubey, 1954). Beta blockers are no longer recommended as first-line therapy in uncomplicated hypertension because of the increased risk of developing diabetes and the recently described trend towards worse outcomes in selecting an antihypertensive agent in patients treated with beta-blockers (mainly atenolol) compared with those treated with other classes of antihypertensive drugs. For patients with stable, well-controlled hypertension who are already taking a beta-blocker, it is reasonable to continue the regimen unchanged. Most classes of antihypertensive agents used as monotherapy lower BP by a similar average amount. However, the individual response to each agent isunpredictable (Heart Foundation, 2008).

In Unani system of Medicine hypertension (Zaghtuddum) and its clinical features described by Unani physician under the heading of 'Imtila" (congestion). Al Razi (820 AD), Majoosi (930 AD) and Ibn Sina (980 AD) have described the Imtilain detail and divided into two categories (Razi, 1997; Ibn Sina, 1927) as Imtila bi Hasb al-Aw'iya and Imtila bi Hasb al-Quwa. Imtila bi Hasb al-Aw'iya (repletion in regard to vessels) is an increase in blood volume leading to increased vascular pressure. In this condition, blood volume increases which raises intra-arterial pressure making the pulse hypervolemic. Such patient develops the tendency of frequent epistaxis, headache, visual disturbance and rupture of blood vessel causing the death. According to Allama Samarqandi, one of the causes of Khafaqan(palpitation) is Imtila-i-Damwi. In another description under the chapter of eye diseases, a term Zaght al Sharayeinwas used which means pressure in the blood vessels due to Imtila of blood that may affect brain as well as heart and lead to coma and paralysis. It is also quoted that Shabkiah-i-Mashimah(blood vessels beneath the brain) are ruptured due to Imtila-i-Uruq wa Intifakh-i-Uruq(congestion and distension of blood vessels) and lead to Ru'af(epistaxis) which also justifies that the symptomatology as well as the complications arising from hypertension were very clear to Unani Scholars (Razi, 1997). The aimed of present study is to create awareness about lifestyle disorders which are associated with hypertension.

MATERIALS AND METHODS

Data

The data for this study was collected during 2016-17 at Regional Research Institute of Unani Medicine, New Delhi. Data on age, sex, Height, Weight, systolic, diastolic blood pressure and life style risk factors such as smoking status, tobacco chewing, alcoholism, laziness, was collected from patients attended in GOPD. Positive diagnosis of hypertension was made when the resting systolic blood pressure was ≥ 140mmHg and/or diastolic blood pressure ≥ 90mmHg (Chobanian *et al*., 2003) BMI was calculated using a simple equation (body weight in kg divided by height in m^2). The independent variables are BMI, tobacco chewing, alcoholism, laziness and smoking status. The data description of the five independent variables and the dependent variable are provided in Table 1. Data analysis is performed using 'R' software version 3.4.1.

Logistic Regression Models

For model based inferences, logistic regression model was employed for hypertension presence-absence data. The probability of hypertension presence is determined by using following logit transformation:

$$logit(\pi) = log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_n X_n$$

where π is the probability of presence of a hypertension, X_i is the *i-th* independent variable (BMI, Smoking Status, Tobacco chewing, Alcoholism and Laziness) with corresponding regression coefficient β_i. Model was fitted by using maximum likelihood approach (McCullagh and Nelder, 1989) under binomial error structure. The null hypothesis underlying the overall model states that all β_i equal to zero. A rejection of this null hypothesis implies that at least one β_i does not equal zero in the population, which means that the logistic regression equation predicts the probability of the outcome better than the mean of the dependent variable Y. The interpretation of results is rendered using the odds ratio for both categorical and continuous predictors. The significant level of variables is chosen based on the p-value associated to the significant level of model that lies on α= 0.05.

The logistic model was evaluated on the basis of confusion matrix. Following Jimenez-Valverde and Lobo, 2007, we considered cut-off dependent and cut-off independent measures of performance of the model (Jimenez-Valverde and Lobo, 2007). The cut-off dependent measure is based on specificity (true negative rate), sensitivity (true positive rate) and Minimized Difference Threshold (MDT). A cut-off independent measure is based on receiving operating characteristics (ROC) curve. Overall performance of the model was evaluated by the value of area under curve (AUC) of the ROC. Stability of prediction has been judged with respect to the bootstrapped confidence intervals (Xavier *et al*., 2011) Logistic regression models are fitted using the method of maximum likelihood - i.e. the parameter estimates are those values which maximize the likelihood of the data which have been observed. McFadden's pseudo R^2 measure is defined as $R^2_{\text{McFadden}} = 1 - \frac{\log(L_{max})}{\log(L_{null})}$, where L_{max} denotes the (maximized) likelihood value from the current fitted model, and L_{null} denotes the corresponding value but for the null model - the model with only an intercept and no covariates (McFadden, 1979). A value of R^2_{McFadden} from 0.2-0.4 indicate that the excellent model fit. Goodness of fit is determined through the Homer-Lemeshow statistics, which is computed on data after the observations have been segmented into groups based on having similar predicted probabilities. It is used

frequently in risk prediction models (Hosmer and Lemeshow, 2008). It examines whether the observed proportions of events are similar to the predicted probabilities of occurrence in subgroups of the data set using Pearson chi square test. Small values with large p-values indicate a good fit to the data while large values with p-values below 0.05 indicate a poor fit. The null hypothesis holds that the model fits the data and in the below example we would reject H0. The Hosmer-Lemeshow test statistic is calculated with the following formula:

$$G_{HL}^2 = \sum_{j=1}^{10} \frac{(O_j - E_j)^2}{E_j(1 - E_j/n_j)} \sim \chi_8^2$$

Where:

χ_8^2 = chi squared (follow χ^2 distribution with 8 d.f.
n_j = number of observations in the jth group.
O_j = number of observed cases in the jth group.
E_j= number of expected cases in the jth group.

Akaike information criterion and the Bayesian information criterion were used to select the best model among of two logistic regression model (Frank *et al*., 2014).

RESULTS

Logistic Regression Model

Model-1

The results from the logistic regression with the first test result as the dependent variable are presented in Table 1 & 2.

The analysis of the data showed that the full logistic regression model containing all the four predictors was statistically significant out of five predictors, N=308, p-value<0.05, indicating that the independent variables significantly predicts the outcome variable, hypertension. The first factor was BMI (p-value <0.01), the second factor was the Tobacco chewing (p-value = 0.04), the third factor was Alcoholism (p-value = 0.02) and fourth factor was Laziness (p-value< 0.01), but factor Smoking Status showed no significant result and the all four significant factors were positively associated with Hypertension. Based on the Table 3, p-value of Hosmer and Lemeshow test was 0.18 and McFadden's pseudo R^2 was 0.67, i.e. the model was fit to the data well. In model-1, for each point increase in BMI, the odds of incidence of Hypertension also increases from 1.63 to 2.34 (p-value<0.01). An increase of 1.03 in Tobacco chewing will increase the odds of Hypertension to 6.39 (p-value=0.04). Similarly, increase in Alcoholism and Laziness from 1.54 and 8.71 will increase the odds of Hypertension to 63.33 and 62.81 respectively (p-value<0.05 both of case). Although the odds of having hypertension among smokers were 0.92 ≃ 1 (95% CI: 0.36 - 2.28) times that of non smokers, this finding was not statistically significant, i.e smoking status was not related to hypertension.

Model-2

The reduced logistic regression model containing all the four predictors was statistically significant after dropping smoking Status as non significant factor in model-1. The all four significant factors (BMI, Tobacco chewing, Alcoholism and Laziness) were positively associated with Hypertension.

Table 1. Description of variables

Sl. No.	Name of variable	Type of variable	Characteristic
1.	Presence of hypertension (Y)	Dichotomous	0= no existence of hypertension 1= existence of hypertension
2.	BMI	Continuous	body weight in kg divided by height in m^2
3.	Smoking Status	Categorical	0=non smoker 1=at least one cigarette per day
4.	Tobacco chewing	Categorical	0=No Habit of chewing tobacco 1=Habit of chewing tobacco
5.	Alcoholism	Categorical	0=No intake of alcohol 1= Intake of alcohol
6.	Laziness	Categorical	0=Physical activity ≥ 30 minutes per day 1= Physical activity <30 minutes per day

Table 2. Estimates of parameters of logistic regression model for hypertension

Factor	Estimate ($\boldsymbol{\beta_i}$)	Standard Error	Z-value	p-value	Odds Ratio (Exp($\boldsymbol{\beta_i}$))	CI of Odds Ratio
Constant	-18.37	2.27	-8.09	<0.01	0.00	-
BMI	0.65	0.09	7.17	<0.01	1.92	1.63 - 2.34
Smoking Status	-0.08	0.46	-0.18	0.85	0.92	0.36 - 2.28
Tobacco chewing	0.92	0.46	2.01	0.04	2.53	1.03 – 6.39
Alcoholism	2.14	0.94	2.27	0.02	8.57	1.54 – 63.33
Laziness	3.08	0.49	6.18	<0.01	21.94	8.71 - 62.81

AIC: 151.37 ,AICc: 151.64 and BIC: 173.75

Table 3. McFadden's pseudo R^2 and Hosmer & Lemeshow Test

Test	Statistic Name	Statistics value	p-value
McFadden's pseudo R^2	R^2	0.67	-
	Adj. R^2	0.64	-
Hosmer and Lemeshow Test	Chi-square (χ_8^2)	11.34	0.18

Table 4. Estimates of parameters of logistic regression model for hypertension

Factor	Estimate (β_i)	Standard Error	Z-value	p-value	Odds Ratio (Exp(β_i))	CI of Odds Ratio
Constant	-18.37	2.27	-8.08	<0.01	0.00	-
BMI	0.65	0.09	7.18	<0.01	1.92	1.63 – 2.33
Tobacco chewing	0.91	0.45	2.01	0.04	2.50	1.03 – 6.19
Alcoholism	2.11	0.91	2.29	0.02	8.25	1.55 – 57.87
Laziness	3.09	0.49	6.20	<0.01	22.07	8.78 – 63.08

AIC:149.40 , AICc: 149.60 and BIC: 168.05

Table 5. McFadden's pseudo R^2 and Hosmer & Lemeshow Test

Test	Statistic Name	Statistics value	p-value
McFadden's pseudo R^2	R^2	0.67	-
	Adj. R^2	0.64	-
Hosmer and Lemeshow Test	Chi-square (χ^2_8)	8.96	0.34

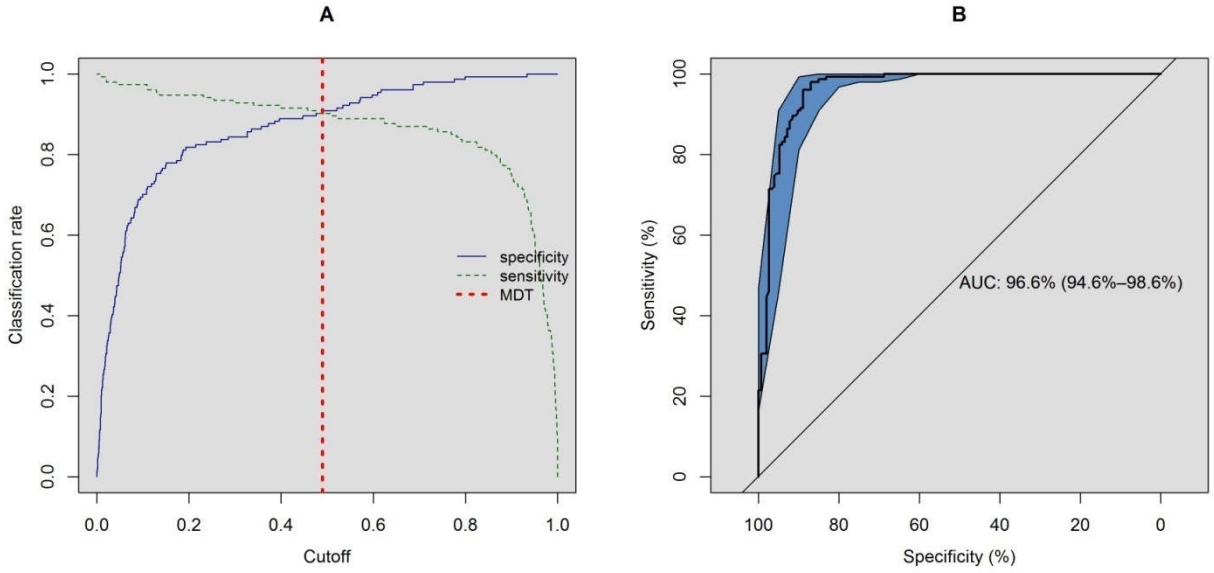

Figure 1. Model evaluation based on confusion matrix: (A) denotes cut-off dependent measure and (B) denotes cut-off independent measure

The model criteria of AIC, AICc and BIC were less comparative as moel-1 (Table 4). Based on the Table 5, p-value of Hosmer and Lemeshow test was 0.34 and McFadden's pseudo R^2 and Adj. R^2 was 0.67 and 0.64 respectively, i.e. the model was fit to the data well. In model-2, for each point increase in BMI, the odds of incidence of Hypertension also increases from 1.63 to 2.33 (p-value<0.01). An increase of 1.03 in Tobacco chewing will increase the odds of Hypertension to 6.19 (p-value=0.04). Similarly, increase in Alcoholism from 1.55 will increase the odds of Hypertension to 57.87 (p-value=0.02) and in case of Laziness from 8.78 to 63.08 (p-value<0.01) for the same. The final multiple logistic regression models were as follows as per table 3:

$$\text{logit}\ (\pi) = \log\left(\frac{\pi}{1-\pi}\right) = -18.37 + 0.65\text{xBMI} + 0.91\text{xTobacco chewing} + 2.11\text{xAlcoholism} + 3.09\text{xLaziness}$$

Model evaluation

Cut-off based performance measure of the model (Figure 1A) produced the optimal classification at probability threshold of presence at 0.49 with overall accuracy of 90.5%. The accuracy of predicting hypertension presence and absence from the model were 90.25% and 90.90%, respectively. Similar results were obtained in the cut-off independent performance measure based on ROC (Figure 1B).

The 95% confidence interval was computed on the basis of 2000 simulated bootstrapped samples. Though compact confidence interval indicated a stable estimate of ROC over entire range of specificity, the AUC was estimated at 96.6% (CI: 94.6-98.6%) (Figure 1B). In view, this level of accuracy in prediction is moderate and useful for analysis of risk factors for hypertension (Yuet *et al*., 2016).

DISCUSSION

In our study, the logistic regression model was performed to analyze the interactions among influencing factors of lifestyle variables. BMI showed a positive and significant association with hypertension. The odds representing increasingly higher levels of BMI change leads to a higher risk of hypertension. In Asia, the prevalence of overweight and hypertension was most common in Japan, followed by Iran, urban India, Singapore, urban Sri Lanka, and urban Philippines (Singh *et al*., 2010). A study in Korea, BMI and abdominal circumference was found to be a risk factor for hypertension (Jo, 2001). Habit of chewing tobacco raises blood pressure temporarily which results increase in heart rate and this way has a contributing factor to damage arteries. In this study, Tobacco chewing showed significant association with hypertension. Alcoholism showed significant association with hypertension in our study. There were inconclusive evidences of the effect of alcohol on hypertension in most studies in Africa and Oghara (Ibekwe,

2015); some show association of regular and moderate alcohol intake and others show no association. Laziness showed positively significant association with hypertension. It is recognised fact that regular physical exercise helps to lower blood pressure. People with a sedentary lifestyle are at a much greater risk of developing hypertension than those who exercises regularly. The US Joint National Committee suggests that hypertension has emphasised the need for regular physical activity for all patients with hypertension (Prevention, 2006). This study did not show any statistically significant difference between smokers and non smokers (p-value = 0.85). Although it has been reported that regular and long time cigarette smoking is associated with higher blood pressure. Previous studies reported that regular and long cigarette smoking is associated with hypertension (Alikor, 2013; Onwuchekwa, 2012)

Conclusion

In this study, a significant association of life style factors such as BMI, tobacco chewing, alcoholism and laziness had a positive interaction effect for developing a disease like hypertension. Hence the study leads to establish the fact that these life style factors are important risk factors for hypertension. Therefore we can conclude that effective lifestyle modifications may lower the chance of a person to develop hypertension. Hence promoting life style changes may help to overcome the situation of incidence of hypertension.

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