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Hypertension Treatment and its Consequences in Rural North Karnataka

Sudhirgouda H Patil
Jang Bahadur Prasad
Rajeshwari A Biradar
Balasaheb Bansode

Abstract

This study analyses hypertension treatment effect and its outcome in North Karnataka based on a survey of 712 rural women aged 40-55 years. It is observed that systolic BLOOD PRESSURE increased significantly by the age of women. Menopause attained was associated with an increase in systolic BLOOD PRESSURE by age. Diastolic BLOOD PRESSURE did not show any trend by menopause status. Systolic and diastolic BLOOD PRESSURE were the highest in women with 'Hypertension without treatment' and 'Diabetes with treatment', and lowest in the 'heart disease with the treatment group. Odds in Hypertension with and without treatment were highly significant than no Hypertension. The Odds in favour of 'diabetes without treatment' in Hypertension was 2.27 times, whereas 1.25 times in 'diabetes with treatment' than 'no diabetes'. The sensitivity and Specificity of the model were 77.5per cent and 69.4per cent respectively. Higher sensitivity can be used for treatment and higher specificity for screening purposes as per the need of health providers using ROC curve. The study will be useful for planners, policymakers, and system-level interventions. Further, it can be used for health and screening the community to minimize consequences.

Introduction

There are many factors that have contributed to the rise in the occurrence of lifestyle diseases. These include, among others, tobacco use, harmful use of alcohol, poor diet, and physical inactivity (Nagheer at al 2017). These causes are reflected in terms of raised blood pressure, high glucose level, abnormal blood lipids, overweight and obesity. There are modifiable risk factors as well as non-modifiable risk such as age and heredity, that describe most of the life style diseases including heart diseases, stroke, chronic respiratory diseases and even cancers. The association between main modifiable risk factors and the leading chronic diseases is similar in all regions of the world (WHO, 2005).

Hypertension and type-2 diabetes (T2D) are the two main modifiable risk factors that are associated with most of the life style diseases. The prevalence of both these factors is increasing in the low middle-income countries and pose a major health challenge to be addressed (Boutayeb , 2006; Lim et al, 2012). Hypertension is an important modifiable risk factor for the cardiovascular diseases (CVD) (Gupta, 2004) which has now emerged as a major cause of death worldwide (Forouzanfar, 2017). The prevalence of hypertension is the highest in Africa (46 per cent) (WHO, 2015). Low birth weight has been found to be associated with the increase in the blood pressure, heart diseases, stroke, and diabetes in the later life. Ageing is an essential indicator of accumulation of modifiable risks for chronic diseases (WHO, 2005).

In India, a significantly increased burden of hypertension has been reported from both urban and rural areas (Gupta et al, 1996; Gupta, 2016). In the mid-1950s, epidemiological studies of urban India, using older World Health Organization criteria for the diagnosis of hypertension (known hypertension or BLOOD PRESSURE ≥ 160 mm Hg systolic and/or 95 mm Hg diastolic), reported a hypertension prevalence of 1.2–4.0 per cent in adults (Gupta et al, 1996). In the 1960s, the prevalence of hypertension in the urban areas was reported to be 3.0-4.5 per cent, whereas in the 1990s, the prevalence of hypertension increased to 11.0–15.5 per cent (Gupta et al, 1996). The prevalence of hypertension was reported to be lower in the rural population compared to the urban population in the mid-20th century but there has been a significant increase in the prevalence even in the rural areas from around 1 per cent in the 1960s to 5–7 per cent in the 1990s (Forouzanfar et al, 2017; Gupta et al, 1996; Gupta and Yusuf, 2014).

Hypertension exerts a considerable public health burden on cardiovascular health status and healthcare systems in India (Leeder et al, 2004; Reddy et al, 2005). Hypertension has been found to be directly responsible for 57 per cent of all stroke deaths and 24 per cent of all deaths due to coronary heart diseases (CHD) in India (Gupta and Yusuf, 2014). According to the World Health Organization, hypertension as one of the most important causes of premature deaths worldwide (Mackay et al, 2004). The global burden of diseases project suggests that, in India 20.6 per cent men and 20.9 per cent women were suffering from hypertension in 2005 (Kearney, 2005). It is also projected that the prevalence of hypertension in India will increase to 22.9 per cent in men and 23.6 per cent in women in India by 2025 (Ayah et al, 2013). Recent studies have suggested that the prevalence of hypertension in the country is around 25 per cent in the urban areas and 10 per cent in the rural areas (Gupta, 1997; Zachariah et al, 2003; Das et al, 2005). According to estimates prepared by the World Health Organization, the prevalence of elevated blood pressure in Indians was 32.5 per cent (31.7 per cent in women and 33.2 per cent in men) (WHO, 2014). It has, however, been observed that only around 25.6 per cent of those persons who are receiving treatment for hypertension have their blood pressure within the normal limits (Hypertension Study Group, 2001). Prevalence of hypertension of hypertension in India reported in other studies ranges between 13.9 per cent to 48.2 per cent in the urban areas and 4.5 per cent to 45 per cent in the rural areas (Devi et al, 2013; Gupta et al, 2012). Similar

variations have also been reported in the prevalence of cardiovascular diseases. There have also been regional differences in prevalence of chronic heart diseases (CHD) and stroke in the country. The prevalence and the mortality from CHD is reported to be higher in southern and eastern India (Gupta et al, 2012). However, to the best of our knowledge, there has been no study that has examined the prevalence of hypertension in the rural areas of north Karnataka. There is also little information about the prevalence of hypertension and the effect of the treatment on the prevalence of hypertension in this part of the country.

It is in the above context, that the present study has been undertaken. The study estimates, for the first time, the prevalence of hypertension in women living in the rural areas of North Karnataka and examines how the treatment of hypertension received by the women has influenced the prevalence of hypertension. It is argued that proper treatment of hypertension contributes to the change in the prevalence dynamics of hypertension.

The paper is organised as follows. The next section of the paper describes the data and the method adopted for the analysis of the data. The study is based on the primary data collected from a sample of rural women aged 40-55 years in one of the districts located in the northern Karnataka. Results of the findings of the study are presented and discussed in section three of the paper. The last section of the paper summarises the findings of the analysis and discusses it implications for meeting the health needs of the people.

Materials and methods

The study is based on a survey of 712 rural women aged 40-55 years in the rural areas of the Belagavi district of north Karnataka that was carried out during the period October 2016 through April 2017. The women covered under the survey were selected using the inverse cluster sampling technique. During the survey, the blood pressure – systolic and diastolic – was measured for each women and data were collected about status of menopause along with selected socio-economic characteristics of the respondents, anthropometric measurements – weight and height - and the disease(s) that they were suffering at the time of the survey. The status of menopause was classified in three categories – no menopause, menopause, and surgically induced menopause. Surgically induced menopause occurs when premenopausal women have their ovaries surgically removed. This removal causes an abrupt menopause. Women with surgically induced menopause often experience more severe menopausal symptoms as compared to women who have not removed their ovaries surgically.

Bivariate and logistic regression analyses was carried out to assess the effect of a set of explanatory variables on the prevalence of hypertension. The explanatory variables included age of the respondent, the menopausal status, hypertension, and

whether the respondent was suffering from diabetes and any heart disease. All respondents were also asked whether they were undergoing any treatment for hypertension or not. Odds ratio was calculated using the Logistic Regression in the presence of explanatory variables in those women who were receiving treatment for hypertension and women who were not receiving treatment for hypertension. The Logistic regression model is defined as

$$f(x) = Log_e\left(\frac{p}{1-p}\right) = a_i + \sum_{i=1}^{k} a_i x_i \quad (1)$$

where

$$p = \frac{e^{f(x)}}{1+ e^{f(x)}} \quad (2)$$

Here, a_i is the regression coefficient and x_i are the explanatory variables. The 95 per cent confidence interval of the Odds ratio has been computed as:

$$\text{95 per cent CI of Odds ratio} = e^{\left(\log_e(\text{OR}) \pm 1.96\sqrt{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}}\right)} \quad (3)$$

Here a and b are the number of women with hypertension in the positive attribute of the explanatory variables, and c and d are similar figures for the reference group. The collected data were cleaned for errors using Excel and analysis was carried out using the Statistical Package for Social Sciences (SPSS) version 22.

Results

Table 1 presents the mean systolic and diastolic blood pressure by the age of women surveyed their menopause status and the body mass index (BMI). The table shows that the systolic blood pressure increases, and the increase with age is found to be statistically significant ($p<0.05$). The diastolic blood pressure also increases with age, but the increase is not statistically significant. Menopause results in an increase in the systolic blood pressure but the increase is not statistically significant whereas the diastolic blood pressure does not show any increase with age. In the surgically induced group, the diastolic blood pressure was found to be the highest (Mean=93.6; SD= 18.0) but was the lowest in women having BMI less than 25 (Mean= 87.6, SD = 12.1). There was, however, no difference in the diastolic blood pressure in women having higher BMI. The systolic blood pressure was the lowest in women having BMI between 25 and 29.9 but the difference was not statistically significant.

Table 2 presents mean systolic and diastolic blood pressure by the disease history and treatment status. Both systolic and diastolic blood pressure were the highest in women who were hypertensive but were not taking any treatment. On the other hand, both systolic and diastolic blood pressure were the highest in those women who were diabetic but under treatment, whereas the blood pressure was the lowest in women having heart disease but were taking treatment.

Table 1: Systolic and diastolic blood Pressure by age, menopause status and BMI in women aged 40-55 years.

Variable	N	Systolic blood pressure		Diastolic blood pressure	
		Mean	SD	Mean	SD
Total	712	134.3	17.9	89.5	13.0
Age in Years					
<45	52	134.0	13.8	92.1	12.8
45-49	184	131.4	13.3	88.1	12.9
50+	476	135.5	19.6	89.8	13.0
Menopause					
No	122	132.9	14.2	90.3	11.7
Yes	550	134.4	19.0	89.1	12.8
Surgically induced	40	138.0	9.8	93.6	18.0
BMI					
<25	115	135.7	11.7	87.6	12.1
25-30	489	133.7	19.5	89.9	13.5
≥30	108	135.8	15.3	89.8	11.2

Source: Authors

Table 2: Systolic and diastolic blood pressure by disease history and treatment status in women aged 40-55 years.

Variable	N	Systolic blood pressure		Diastolic blood pressure	
		Mean	SD	Mean	SD
Total	712	134.3	17.9	89.5	13.0
Hypertension					
No hypertension	297	127.9	9.8	82.9	8.0
Without treatment	41	145.4	14.5	98.4	13.8
With treatment	373	138.2	21.2	93.8	13.7
Diabetes					
No diabetes	494	132.3	12.3	88.0	11.5
Without treatment	35	137.1	12.7	84.6	7.9
With treatment	183	139.2	27.8	94.6	15.7
Heart Disease					
No heart disease	669	134.2	18.3	89.6	13.2
Without treatment	22	138.8	5.7	90.3	5.1
With treatment	21	133.8*	8.0	86.3	9.8

Source: Authors

Table 3 presents results of the logistic regression analysis. The dependent variable is a dichotomic variable which takes value 1 if the woman was found to be hypertensive at the time of the survey and 0 other wise. The explanatory variables, on the other hand include selected demographic and physiological characteristics of the

woman, the disease history, and the hypertension treatment status. The table shows that women with surgically induced menopause are 2.6 times more likely to have hypertension than non-menopausal women and the difference was statistically significant at $p<0.05$. Similarly, women having diabetes but not taking any treatment of diabetes are 2.3 times more likely to have hypertension as compared to women not having diabetes. However, women having diabetes and taking treatment of diabetes are only about 1.25 times more likely to have hypertension as compared to women without diabetes and the difference is not statistically significant. Women having heart disease but not taking any treatment are found to be four times more likely to have hypertension as compared to women without heart disease but women with heart disease and taking treatment are found to be less likely to have hypertension as compared to women having no heart disease but the different is not found to be statistically significant.

The ROC Curve (Figure 1) exhibits the Sensitivity and Specificity of the logistic regression model. The model correctly identified 77.9 per cent of the women covered in the study in terms of their hypertension status along with a 95 per cent Confidence Interval of 74.3 per cent to 81.4 per cent.

Table 3: Results of the logistic regression analysis.

Variables	Odds ratio	Confidence interval	
		Lower	Upper
Age of women			
50-55	1.00		
40-45	1.03	0.45	2.34
45-50***	0.35	0.22	0.54
Menopause status			
No	1.00		
Yes	0.80	0.45	1.41
Surgical*	2.67	1.06	6.75
Hypertension treatment			
No hypertension	1.00		
No treatment***	7.01	2.89	16.99
Treatment***	7.16	4.91	10.43
Diabetes			
No Diabetes	1.00		
No treatment	2.27	0.95	5.40
Treatment	1.25	0.82	1.92
Heart disease			
No heart disease	1.00		
No treatment*	4.09	1.09	15.35
Treatment	0.75	0.28	2.00

Source: Authors
Remarks: *** $p<0.001$, * $p<0.05$

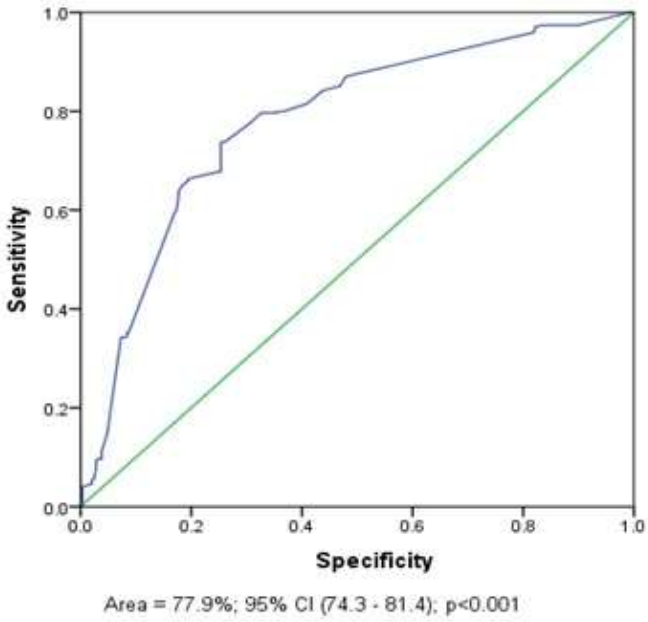

Figure 1: ROC Curve for hypertension using age of woman, menopause status, BMI, heart disease, diabetes and hypertension treatment
Source: Authors

Table 4: Sensitivity and specificity of the logistic regression model as computed by the ROC Curve for the diagnosis of hypertension

Positive ≥ p	Sensitivity	Specificity
0.351947	0.872	0.514
0.369706	0.870	0.521
0.393049	0.851	0.531
0.401614	0.842	0.562
0.404636	0.816	0.590
0.450867	0.799	0.646
0.524924	0.797	0.674
0.560603	0.775	0.694
0.626115	0.678	0.747
0.634107	0.664	0.802
0.644855	0.662	0.806
0.681827	0.650	0.816
0.786394	0.629	0.823
0.790726	0.600	0.826
0.792462	0.596	0.830

Source: Authors

Discussion

Hypertension wields a considerable public health burden on cardiovascular health status and health care system in India. Moreover, regional disparities in mortality and morbidity prevalence of coronary heart disease (CHD) and stroke have been observed. South India had higher CHD mortality, and eastern India has higher stroke rate (Gupta et al, 2021). Some studies are available on hypertension, but, to the best of our information, no study assessed morbidity pattern of hypertension in both untreated and treated population in Karnataka. Hence, the current study has been undertaken. Systolic and diastolic Blood Pressure by disease history and their treatment status in women of age 40-55 years were estimated to provide reference for health care personnel. Logistic regression analysis was carried out, to know the effect of demographic and physiological characteristics of women surveyed and their and disease history and treatment status on the prevalence of hypertension. Similar study had been carried out by Patil et al (2020) to study the impact of physiological, demographic characteristics and disease history on perimenopause symptoms in the same age group of women. Another study has used the Poisson regression model (Prenissl et al, 2019).

The analysis reveals that diastolic blood pressure does not change with the increase in age, but the systolic blood pressure increases with the age. The similar results have been observed in other studies (Mkuu et al, 2019). A recent study conducted by Geldsetzer et al (2018), among 1.3 million adults in India has observed that 25 per cent Indian adults have raised blood pressure but the prevalence of high blood pressure was low in adults aged 18-25 years (12per cent). Menopause results an increase in the systolic blood pressure but not in the diastolic blood pressure. However, the diastolic blood pressure has been found to be the highest in women with surgically induced menopause. The diastolic blood pressure is found to be the lowest in women with BMI less than 25 but increases with the increase in BMI. The systolic blood pressure, however, was found to be the lowest in women with BMI 25-30. According to other studies, overweight or obese women are at higher risk of hypertension (Ayah et al, 2013; Olack et al, 2015). In general, women aged 30 years and above have higher risk of having hypertension (Mkuu et al, 2019). Other studies have also reported higher risk for hypertension among older women (Ayah et al, 2013; Olack et al, 2015). Hypertension is reported to be the result of the combination of demographic and epidemiological transition, changing lifestyle with an increase in dietary fat and salt and low physical activity (Ibrahim and Damasceno, 2012; Gupta et al, 2016; Gupta and Gupta, 2017). There has been a rapid increase in the prevalence of overweight and obesity in India in the last 20 years, resulting higher prevalence of hypertension (Siddiqui and Donato, 2016; Shrivastava et al, 2017).

The systolic and diastolic blood pressure have been found to be the highest in hypertension women who are not taking any treatment. Blood pressure has also been found to be high in women with diabetes, although taking treatment but the lowest in women having heart disease but taking treatment. There is evidence that awareness,

treatment, and control of hypertension is increasing in Indians, although there are huge rural-urban disparities (Anchala et al, 2014; Gupta et al, 2018). The awareness of treatment and control of hypertension has been found to be, respectively, 42.0 per cent, 37.6 per cent and 20.2 per cent in urban Indians, and 25.3 per cent, 25.1 per cent and 10.7 per cent in rural Indians (Gupta et al, 2018). Increasing the awareness about hypertension through screening programs is expected to lead to greater chances of treatment and better control of hypertension (Angell, 2015). The policy and system-level interventions should, therefore, be focused on public education and screening along with focus on reducing the intake of salt and alcohol, smoking cessation, promotion of healthy diet and facilitation of physical activity. Individual-level interventions should be on better physician education who should promote individual lifestyle changes, appropriate pharmacotherapy, and control of vascular risk factors along with the effort to improve treatment adherence (Gupta and Yusuf, 2014; Angell et al, 2015; Frieden and Bloomberg, 2018). The Million Hearts Initiative in the United States of America is focused on increasing hypertension control using policy, population-level, and clinic-based interventions (Lloyd-Jones et al, 2017). Similar programme needs to be developed and implemented to reduce hypertension-related cardiovascular morbidity and mortality in Karnataka.

The odds of having hypertension in women with surgically induced menopause found to be very high. Similarly, the odds of having hypertension in women with high blood pressure irrespective of their treatment status are also found to be high. Women having diabetes but not taking any treatment and women having heart disease but not taking any treatment have also been found to be at higher risk of having hypertension. A study supports these observations and have shown that that hypertension was directly responsible for around one-fourth of all deaths from coronary heart disease in India (Gupta and Yusuf, 2014), which is one of the most important causes of premature death worldwide (Mackay et al, 2004).

Conclusions

The present study has found that the systolic blood pressure increases with age but not the diastolic blood pressure. Menopause results in an increase in the systolic blood pressure but not the diastolic blood pressure. The increase in the diastolic blood pressure is, however, found to be very high in women with surgically induced menopause. Diastolic blood pressure is found to be the lowest in women with BMI less than 25 while the systolic blood pressure is found to be the lowest in women with BMI ranging between 25 and 30. The blood pressure is found to be the highest in hypertensive women who were not taking any treatment for hypertension. The blood pressure is also found to be high in diabetic women even though they were taking diabetic treatment. The blood pressure was the lowest in women with heart disease and taking treatment. There is a need to enhance health education and medical care to the women reaching menopause and in women with surgically induced menopause.

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