Original Article

Identifying Pre-hypertensives in the Community: At Risk Approach for Prevention of Hypertension

Pallavi Singh, Vartika Saxena*

Department of Community and Family Medicine, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India

Abstract

Introduction: Pre-hypertension is a borderline health state of increased blood pressure (BP) that falls short of the measurable parameters at which surveillance and/or therapy would be required. The approach of identifying people "At Risk" of developing hypertension can be more cost-effective and feasible for applying lifestyle interventions.

Objectives: The objective of the present study is to find the prevalence of pre-hypertensives and associated bio-socio-demographic factors

Materials and Methods: A cross-sectional study was conducted among 1946 participants aged 19 years and more in the Doiwala block of Dehradun, Uttarakhand. Multistage sampling was used to arrive at desired sample size. A pre-validated, structured questionnaire was used for data collection. The questionnaire included information on the socio-demographic profile (age, sex, education etc.), awareness about hypertension and its associated risk factors.

Statistical Analysis: The chi-square test was used to compare proportions and draw inferences.

Results: 958 (49.2%) study participants out of a total 1946 were found to be pre-hypertensives. A statistically significant association was found between pre-hypertension and factors such as male gender, age, education, occupation and waist-hip ratio. ($p<0.05$)

Conclusion: It is recommended that identification on the pre-hypertensive group and subjecting them to lifestyle modification could be a fruitful strategy for preventing them from becoming hypertensive.

Keywords: Humans, Male, Prehypertension, Cross-Sectional Studies, Prevalence, Sample Size, Hypertension, Life Style, Surveys and Questionnaires, Occupations.

Introduction

The global burden and threat of non-communicable diseases constitute a major public health challenge that undermines social and economic development worldwide, and inter alia has the effect of increasing inequalities between countries and within populations.[1] Four non-communicable diseases diabetes, cardiovascular diseases, cancers and chronic respiratory diseases constitute about 80% of non-communicable diseases.[2]

Non-communicable diseases (NCDs) are one of the leading causes of adult mortality and morbidity globally. According to the "Global Status Report on NCDs 2014" published by World Health Organisation (WHO), NCDs were responsible for 38 million (68%) of the world's 56 million deaths in 2012. More than 40% of these deaths (16 million) were premature deaths in the population under age 70 years.[3] Hypertension was responsible for 53.8% of all deaths due to heart disease, 55.7% to stroke, and 54.3% to chronic kidney disease, per the "Global Burden of Disease Report 2016." Hypertension is one of India's leading causes of premature deaths and is directly responsible for 29% of all stroke and 24% of heart attacks."[4] The global prevalence of hypertension is estimated to be about 22%.[3]

Low- and middle-income countries contributed almost three-quarters deaths (28 million) of total deaths caused as

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Address for correspondence: Vartika Saxena, Department of Community and Family Medicine, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India
E-mail: vartika.cfm@aiimsrishikesh.edu.in

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a result of non-communicable diseases, out of which 75% were because of hypertension and its related complications. Hypertension is reported to be the fourth contributor to premature death in developed countries and the seventh in developing countries.[5] The majority of premature deaths (82%) occurred in low- and middle-income countries.

The population in India is passing through an epidemiological transition with high rates of urbanization. This has led to economic improvement, the consequences of which are increased food consumption, tobacco use and decreased physical activity.[6] According to the WHO NCD country profile (2018), the prevalence of raised blood pressure among Indian adults aged 18+ was 24%. It was almost the same in both sexes, with 24% men and 23% women having hypertension.[7]

Four major behavioral modifiable risk factors that are associated with increased risk of hypertension are: unhealthy diet, tobacco use, harmful use of alcohol, and physical inactivity. These behaviors lead to physiological/metabolic changes that increase the risk of raised blood pressure[8] If these faulty behaviors persist a normotensive person progresses to a pre-hypertensive and then hypertensive state, but this process takes several years.[9]

Pre-hypertension is a borderline health state of increased blood pressure (BP) that falls short of the measurable parameters at which surveillance and/or therapy would be required. Joint National Committee-7 guidelines define pre-hypertension as a systolic BP between 120 and 139 mm of Hg, and/or a diastolic BP between 80 and 89 mm of Hg. BP greater than the above values is considered hypertension.[10] The Eighth Joint National Committee (JNC 8) in its recently released evidence-based recommendations, categorized this group as elevated (SBP=120–129 mm of Hg and DBP= 80–89 mm of Hg) and Stage 1 Hypertension (SBP= 140–159 mm of Hg DBP= 90–99 mm of Hg) and advocated for appropriate treatment considering co-morbidities.[11]

In the state of Uttarakhand, where very high prevalence of hypertension has been reported in several studies, where less than 50% are aware of their hypertensive status and those who are taking anti-hypertensive treatment only 40% have controlled blood pressure it becomes necessary to implement preventive strategies for controlling exponential rise in hypertension.[12,13] One strategy could be to identify a pre-hypertensive group who are having 5 to 8 times higher risk of converting into hypertension than normotensive people and rigorously apply lifestyle modification approaches to prevent them from falling into the hypertensive category.

This approach of identifying people "At Risk" of developing hypertension can be more cost-effective and feasible for applying lifestyle interventions. This group of people would be more receptive and compliant to lifestyle changes than the general population. Hence, the present paper analyses the data of pre-hypertensives and associated bio-socio-demographic factor from a comprehensive study conducted in 2018 to validate rule of half in Uttarakhand.[14]

Materials and Methods

Setting and Study Population

Uttarakhand is a hilly state of India with more than 70% rural population. Multistage sampling was used to arrive at desired sample size. The state has 13 districts, of which Dehradun was selected for the study. Dehradun has six blocks; and this study was conducted in the Doiwala block. As per census 2011, there are 44 villages in Doiwala. Of these 44 villages, 30 were randomly selected for the study. A cross-sectional survey was conducted covering all the households in the randomly selected villages by house-to-house visit.

Sample size was calculated based on the estimate of prevalence of controlled hypertension for rural Indians as 10.7% based on a meta-analysis of prevalence, awareness and control of hypertension.[15] Considering absolute precision of 2% at 5% significance level and 2 design effect, the final sample size was 1900.

Study Tool

A pre-validated, structured questionnaire was used for data collection. The questionnaire included information on the socio-demographic profile (age, sex, education etc.), awareness about hypertension and its associated risk factors. The questionnaire was administered to participants in Hindi language by 10 field research investigators. Each of them was briefed and trained in the methodology of asking questions. A training manual was developed and provided to each field research Investigator. To help reduce inter-observer variability, three Institute supervisors (medical and nursing faculty) assisted in data collection. Furthermore, every 10th questionnaire was checked by supervisors.

Inclusion criteria

Persons above 19 years of age, both male and female, were willing to participate in the study after obtaining written and informed consent.

Exclusion criteria

Pregnant women were not included in the study owing to physiological changes of pregnancy.

Blood pressure measurement

Blood pressure was recorded in a sitting position in the right arm to the nearest of 1-mmHg with an Omron digital blood pressure instrument. Participants were asked to sit quietly and rest for 5 minutes with uncrossed legs prior to measurement. Two blood pressure measurements were taken. Participants were asked to rest for three minutes between each of the readings. During data analysis mean of two readings was calculated. In case if there was a discrepancy of more than 20 mm of Hg in first and second readings, then third reading was taken and the mean of second and third reading was

calculated to assess the participant's blood pressure. JNC VII guidelines were followed to define awareness, treatment and control of pre-hypertension.[10]

Height measurement

The participant's height was taken in centimetres using a non-stretchable, flexible measuring tape with a least count of 1-mm. The participant was asked to stand without footwear or headgear against a flat surface (wall) with their feet together and with head, shoulders, buttocks and heels touching the wall. The participant was asked to look straight ahead and not tilt their head up or down so that an imaginary line drawn from their ear to eye was parallel to the floor. A rigid ruler was placed at a right angle with the wall and lowered until it firmly touched the crown of the head. The wall was marked at this point and the distance between the point and the floor was measured using a measuring tape.[16]

Weight measurement

Weight of the participant was measured in kg using a portable calibrated weighing scale with a least count of 100 gms, placed on a non-carpeted, hard floor. The participant was asked to remove his/her footwear and heavy clothing and step onto the scale with one foot on either side of the scale. He/she was asked to stand still, looking straight ahead with arms on the sides till the reading was taken.[16]

Waist circumference measurement

Waist circumference was measured in cm using a non-stretchable, flexible measuring tape having a least count of 1-mm. The measurement was taken directly over the skin or over light clothing. Measurement was taken at the midpoint between the lower margin of last palpable rib and the tip of the iliac crest, at the end of normal expiration, with arms relaxed at the sides.[16]

Hip circumference measurement

Hip circumference was measured in cm using a non-stretchable, flexible measuring tape with a least count of 1-mm, directly over the skin or light clothing. The participant was asked to stand with his/her feet together with weight evenly distributed over both feet and the arms relaxed at the sides. The measurement was taken at the maximum circumference over the buttocks.[16]

Body mass index (BMI) and waist hip ratio (WHR)

Asian criteria for obesity was used at a cut-off point of BMI ≥ 24.9 kg/m^2 [15] and abdominal obesity was defined as WC $\geq$ 90 cm. for males and $\geq$80 cm for female and WHR $\geq .95$ for male and $\geq .85$ for females.[17]

Alcohol use

Someone who has consumed one or more than one drink of any alcohol in the year preceding the survey. (Current Drinker).[18]

Tobacco use

Someone who at the time of conducting the study, smokes in any form, either daily or occasionally. (Current Smoker)[18]

Data was collected and analyzed using SPSS 25. Data management tools were utilized to avoid duplication and entry error. Data was analyzed using descriptive statistics. Categorical variables were documented in terms of frequency and proportion and continuous variables in terms of mean with standard deviation and median with interquartile range. Inferential statistics were used to compare proportion or mean in two or more different groups. Chi-square tests was applied among groups to compare their differences. The *p-value* ≤ 0.05 was the cut-off point for statistical significance. Ethical approval for the study was obtained from the Research and Ethics committee of the Institute. All the patients were provided reports of blood pressure and diabetes and were appropriately referred to medicine OPD of the nearest tertiary care hospital if deemed necessary.

Results

As defined earlier, pre-hypertension is systolic BP between 120 and 139 mm of Hg, and/or diastolic BP between 80 and 89 mm of Hg. Out of total 1946 study participants, 701(36.0%) reported BP reading between 120–139 mm of Hg, and 643(33.0%) reported a diastolic BP reading between 80–89 mm of Hg. A total of 386 (19.8%) among the total study participants were reported as having both systolic and diastolic BP as per the diagnosis for pre-hypertension. Thus, 958 (49.2%) study participants out of total 1946 were found to be pre-hypertensives. The following tables depict the analysis of these 958 pre-hypertensives.

Table 1 depicts the distribution of pre-hypertensives according to their socio-demographic characteristics. It shows that among 1946 total study participants, 958 were found to be pre-hypertensives. There were a total of 1094 females and 852 males. A proportion of 44.4% (95% CI=41.5,47.4) among these 1094 females and 33.3% (95% CI= 11.6,55.1) of the 852 males were found to be pre-hypertensives. Applying the chi-square test found that pre-hypertension was more prevalent among females and this association was statistically significant (χ^2=23.08, *p-value* <0.01).

Regarding the age distribution, it was found that 451/823 (54.8%) participants aged 20 to 40 years were pre-hypertensives followed by 337/708 (47.6%) of those aged between 40-60 years. This association was found to be statistically significant on applying the chi-square test. (χ^2=22.7, *p-value*<0.01).

It was observed that most of the pre-hypertensives, 51.9% were found living in joint families, followed by 48.6% who were living in nuclear families. However, this was not statistically significant.

Among the 268 study participants who were educated up to postgraduation and professional level, 140 (52.2%) were found to be pre-hypertensive. This was followed by those who were educated from primary level to graduation, wherein 554/1092 (52.2%) were pre-hypertensives. The association was found to be statistically significant. (χ^2=6.05, *p-value*=0.04).

Table 1: Distribution of pre-hypertensives according to their socio-demographic characteristics

Socio-demographic factor		*Pre-hypertensives*			
		Total (N=1946)	*Number (n=958)*	*Percentage (95% CI)*	*Chi square, p-value**
Gender	Female	1094	486	44.4 (41.5-47.4)	23.08, <0.01
	Male	852	472	55.4 (52.1-58.7)	
Age (in years)	<20	18	06	33.3 (11.6-55.1)	22.7, <0.01
	20-40	823	451	54.8 (51.4-58.2)	
	40-60	708	337	47.6 (43.9-51.3)	
	>60	397	164	41.3 (36.5-46.2)	
Type of Family	Nuclear	1139	553	48.6 (45.6-51.5)	4.67, 0.09
	Joint	657	341	51.9 (48.1-55.7)	
	Three generation	150	64	42.7 (34.8-50.6)	
Education	Primary or Illiterate	586	264	45.1 (41.0-49.1)	6.05, 0.04
	Above primary to Graduate	1092	554	50.7 (47.8-53.7)	
	Postgraduate and Professional	268	140	52.2 (46.3-58.2)	
Occupation	Employed in formal sector	551	318	57.7 (53.6-61.8)	28.1, 0.01
	Unemployed	127	61	48.0 (39.3-56.7)	
	Student	69	33	47.8 (36.0-59.6)	
	Retired	110	44	40.0 (30.8-49.2)	
	Homemaker	765	340	44.4 (40.9-48.0)	
	Self-employed	190	100	52.6 (45.5-59.7)	
	Daily Wage Labourer	134	62	46.3 (37.8-54.7)	

**p-value <0.05 = significant*

Table 2: Prevalence of risk factors associated with pre-hypertension (Waist-Hip Ratio and BMI)

Risk Factor	Pre-hypertensives			
	Total (N=1946)	Number (n=958)	Percentage (95%CI)	Chi square, *p-value**
Body-Mass Index (Kg/m^2)				
Underweight (<18.5)	130	64	49.2 (40.6, 57.8)	0.28, 0.96
Normal (18.5-24.99)	925	454	49.1 (45.9, 52.3)	
Overweight (25.00-29.99)	627	310	49.4 (45.6, 53.4)	
Obese (>/= 30.00)	264	130	49.2 (43.2, 55.3)	
Waist-Hip Ratio				
Low risk: Male </=0.95, Female </=0.80	652	369	56.6 (52.8, 60.4)	21.57, <0.01
Moderate risk: Male-0.96 -1.0, Female-0.81- 0.85	340	159	46.8 (41.5, 52.1)	
High Risk: Male - >1.0, Female > 0.85	954	430	45.1 (41.9, 48.2)	

**p-value < 0.05 = significant*

A proportion of 57.7% (95% CI=53,61.8) among 551 participants who were employed in the formal sector were found to be pre-hypertensives, followed by 52.6% (95% CI=45.5, 59.7) among 190 participants who were self-employed. The least proportion was found among retired participants, wherein 40.0% (95% CI=30.8, 49.2) were pre-hypertensives. This association was found to be statistically significant. (χ^2=28.1, 0.01)

Table 2 depicts the prevalence of risk factors associated with pre-hypertension (waist-hip ratio and BMI). It can be observed here that 130 participants who were underweight (BMI <18.5), out of them 64(49.2%) participants were found to be pre-hypertensives. This proportion was comparable to the participants who were obese (BMI>/=30.00). The highest proportion of pre-hypertensives 49.4% (95% CI=45.6, 53.4) was found among those participants who were overweight (BMI=25.00–29.99). However, the association between BMI and pre-hypertension prevalence was not statistically significant.

With regard to waist-hip ratio, it was found that 56.6% (95% CI=52.8,60.4) of the participants who had a WHR in the low-risk category (Male </=0.95, Female </=0.80) were found to more pre-hypertensives followed by those who were in the moderate risk category (Male -0.96–1.0, Female-

Table 3: Prevalence of risk factors associated with pre-hypertension (Alcohol, Tobacco Use, Random Blood Glucose)

Socio-demographic factor		*Pre-hypertensives*			
		Total (N = 1946)	*Number (n=958)*	*Percentage (95% CI)*	*Chi square, p-value**
Alcohol Use**	Yes	329	167	50.8 (45.4, 56.2)	0.37, 0.54
	No	1617	791	48.9 (46.5, 51.4)	
Tobacco Use***	Yes	253	112	44.3 (38.1, 50.4)	2.86, 0.90
	No	1693	846	50.0 (47.6, 52.4)	
RBS (mg/dl)	Normal (<140)	1633	801	49.1 (46.6, 51.5)	0.15, 0.92
	Pre-diabetes (140-200)	188	95	50.5 (43.4, 57.7)	
	Diabetic (>200)	125	62	49.6 (40.8, 58.4)	

*p-value <0.05 = significant
** Someone who has consumed one or more than one drink of any alcohol in the year preceding the survey. (Current Drinker)[18]
****Someone who at the time of conducting the study, smokes in any form either daily or occasionally. (Current Smoker)*[18]

0.81–0.85) wherein, 46.8% (95% CI=41.5, 52.1) were in the pre-hypertensive category. This association was statistically significant. (χ^2= 21.57, *p-value*= <0.01)

Table 3 shows the prevalence of risk factors associated with pre-hypertension (Alcohol, Tobacco use, random blood glucose). It was observed that 167/329(50.8%) of the current alcohol drinkers and 112/253 (44.3%) of the current tobacco smokers were pre-hypertensives. Random blood sugar readings showed that 50.5% (95% CI=43.4,51.5) of the participants who were pre-diabetic (RBS between 140 to 200 mg/dl), were also pre-hypertensives. None of these risk factors were found to be significantly associated with pre-hypertension.

Discussion

Early detection and management of hypertension is the most important measure for the prevention of major cardiovascular deaths worldwide. Pre-hypertension has been shown to increase future risk of hypertension. The first step to early detection should always begin with the level of awareness regarding the risk factors of pre-hypertension and its susceptibility among the general population.[13,19]

The present study involved 1946 participants, out of whom 39.1% were found to be hypertensive in a previous study conducted by Saxena V *et al.*[12] Out of the total 1946 participants 958 (49.2%) were found to be pre-hypertensive. This prevalence was found to be 486/958 (50.7%) among males and 472/958 (49.3%) among females. A similar study conducted by Khanam MA *et al.* in Bangladesh found that prevalence of pre-hypertension was 31.9%. The males had a higher pre-hypertension prevalence (33.6%) than women (30.3%).[20] In another study conducted in Nepal by Agho KE *et al.*, the overall prevalence of pre-hypertension was 26.9%. Pre-hypertension was present in 30.4% of males and 24.3% of females.[21] These variations may be attributable to the difference in sample size, study settings and socio-demographic factors.

In a study conducted by Parthaje PM *et al.* in South India, 55% of the study participants were pre-hypertensive, and the proportion was higher among males.[22] In a large cross-sectional survey conducted by Tripathy JP in North India, the prevalence of pre-hypertension was found to be 40.8%.[23] These findings are comparable to the present study owing to similar study settings and larger sample size. Singh RB *et al.* studied the prevalence of pre-hypertension in five Indian cities and found that this prevalence was significantly greater in South India (Trivandrum: F 31.9%; M 35.5%) and West India (Mumbai: F 29.1%; M 35.6%) compared to North India (Moradabad: F 24.5%; M 27.0%) and East India (Kolkata: F 22.4%; M 24.0%).[24] These findings may not be comparable to the present study most likely because of the smaller sample size from each city, but it does indicate regional differences.

In the present study, it was found that 451/823 (54.8%) participants who were aged 20–40 years were pre-hypertensives, followed by 337/708 (47.6%) of those who were aged between 40–60 years and this association was found to be statistically significant(p<0.01). In a similar study conducted by Rani B *et al.* in Haryana, the highest prevalence of pre-hypertension, 33% was observed in the age group of 35–40 years and this association was also found to be significant. (p<0.01)[25] Tripathy JP *et al.* found that 43.8% of the pre-hypertensives belonged to the age group of 25 to 44 years.[23] Khanam MA *et al.* reported 37.3% prevalence of pre-hypertension in the age group of 25–39.[20] All these findings are comparable to the present study.

With regard to educational status the highest prevalence of pre-hypertension, 52.2% was observed among the study participants who were educated up to postgraduation/ professional level. Rani B *et al.* found this prevalence highest among those who were educated up to the primary level.[25] Khanam MA *et al.* found that participants who were illiterate had the maximum proportion of pre-hypertension which was 40.6%.[20]

The present study showed a similar proportion of pre-hypertensives in each BMI category. Rani B *et al.* in a similar study in Haryana found 61.4% of the pre-hypertensives to be obese.[25] Khanam MA *et al.* found the highest prevalence of pre-hypertension 48.6% among those with a BMI of 18.5–22.9.[20]

In the present study 56.6% of the pre-hypertensives had WHR under the category of low risk. Nkeh-Chungag BN *et al.* found the presence of pre-hypertension correlated moderately and significantly with WC in both females and males (r=0.345; r=0.237, respectively) while a significant moderate correlation was observed with HC (r=0.323) only in females.[26]

In the present study it was observed that 167/329(50.8%) of the current alcohol drinkers and 112/253 (44.3%) of the current tobacco smokers were pre-hypertensives. Random blood sugar readings showed that 50.5% (95% CI=43.4,51.5) of the pre-diabetic participants (RBS between 140 to 200 mg/dl), were also pre-hypertensives. Rani B *et al.* found a statistically significant association between tobacco and alcohol use and the prevalence of pre-hypertension in Haryana.[20] Parthaje PM *et al.* found a higher proportion of hypertensives and pre-hypertensives among current tobacco and alcohol users when compared to never users though this association was not found significant just like the present study.[22]

The inherent limitation of the present study is a cross-sectional study design that limits our ability to draw causal inferences. Community-based longitudinal long-term studies will provide further exploration of the risk factors for pre-hypertension. Various other factors, such as physical activity, diet, and knowledge regarding pre-hypertension, were not evaluated, which are known to influence pre-hypertensive status.

Conclusion

The current study highlights the high prevalence of pre-hypertension (49.2%), especially among male population in the age group of 20 to 40 years. Contrary to the common notion, pre-hypertension was more prevalent among people with a lower-risk waist-hip ratio.

It is recommended that timely identification of the pre-hypertensive group could be a fruitful strategy for preventing them from becoming hypertensive. The paper highlights the importance of education and occupation of a person and the risk of development of NCDs and therefore targeted interventions may be planned further.

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Nil

Conflicts of Interest

Nil

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