A STUDY OF RISK FACTORS OF HYPERTENSION AMONG ADULT MALES IN SEMI-URBAN ENVIRONMENT OF PUNE, INDIA

By

DR. MANSI PATIL

COLLEGE OF ENGINEERING

(DEPARTMENT OF HEALTH, SAFETY AND ENVIRONMENTAL ENGINEERING)

Submitted

IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF THE DEGREE OF DOCTOR OF PHILOSPHY

TO

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

DEHRADUN

July 2016

UNDER THE GUIDANCE OF

Principal Guide	Co-Guide	External Co-Guide
Dr. Syed Mohammad Tauseef	Dr. Anjali Midha Sharan	Dr Manuel Durairaj,
Assistant Professor, UPES	Program Director, UPES	Professor of Cardiology, Ruby Hall Hospital

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Title of the Research Proposal	**A Study of Risk Factors Of Hypertension among Adult Males In Semi-Urban Environment Of Pune, India**
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Place of work	Pune

A Study of risk factors of Hypertension among adult Males in Semi-Urban Environment of Pune, India

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Declaration

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

Dr. Mansi Patil

Date :

Thesis Completion Certificate

This is to certify that the thesis on "**A Study of Risk Factors of Hypertension Among Adult Males in semi-urban environment of Pune, India**" by **Dr. Mansi Patil** in partial completion of the requirements for the award of the degree of Doctor of Philosophy to **University of Petroleum And Energy Studies** (College of Engineering) is an original work carried out by her under our joint supervision and guidance.

It is certified that the work, in full or parts, have not been submitted to any other Institute or University for the award of any other degree or diploma.

Dr. S.M. Tauseef

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EXECUTIVE SUMMARY

Hypertension or a blood pressure level above 120/80mm of Hg, is a type of cardiovascular disease (CVD) with rapidly growing prevalence rates globally. The deleterious effects of hypertension are evident not only on the cardiovascular system but also on other organs and systems of the body, thus increasing the burden of disease manifold. A consistently raised level of blood pressure has injurious effects on arteries, eyes, kidneys, liver etc. resulting in complications like Atherosclerosis, retinopathies, nephropathies etc. The rapidly rising prevalence of hypertension and other cardiovascular diseases over the few decades and the reduction in tropical diseases like cholera, malaria etc. reflects a shift in the epidemiology of diseases from communicable to non-communicable diseases (NCDs). Thus, CVDs are a major public health concern contributing 31% to the total world mortality. Of this, hypertension is responsible for 9.4 million deaths each year. By the year 2030, it is expected that globally, 23 million cardiovascular deaths will be due to hypertension, of which about 85% cases will be from low-resource settings and developing nations.

Hypertension has varied aetiology with a complex interplay of the risk factors. These causes of hypertension may be studied in different ways and also classified with diverse understandings. One of the most common classification of hypertension is as follows-

Table 0.1 Classification of risk factors of hypertension

Environmental (extrinsic) risk factors	**Genetic (intrinsic) risk factors**
Lifestyle factors- diet, exercise, alcohol consumption, smoking, Psychological factors, etc.	Age, Gender, etc.

Contd.

Pollution levels – Air pollution, noise pollution etc.	Ethnicity, Religion etc.
Work stress, occupational hazards, etc.,	Family history, Genetic disposition, etc.,

The most widely studied environmental causes are alcohol consumption, smoking, dietary preferences and physical activity levels whereas the less studied factors like ambient air quality parameters, ergonomics, work stress etc. still need extensive research to qualify them as risk factors. Intrinsic factors such as age, gender, family history etc. which cannot be modified also play a pivotal role in the pathogenesis of hypertension. Increasing age has shown to increase the prevalence of hypertension, with hypertension after the age of 60 years being considered more of a physiological development than pathological. Most modern day researches to study the risk factors of hypertension are based on the landmark study- The Framingham Study- which has studied the risk factors (lifestyle determinants, family history, age etc.) of CVD in cohorts and their offspring.

The INTERHEART study conducted at Mc Master University, Canada, was another major study to identify the universal risk factors of CVD. It was a case-control study carried out across 52 countries and has concluded that the risk factors (smoking, hyperlipidaemias, hypertension, diabetes, obesity, diet, physical inactivity, alcohol consumption and psychosocial factors) are consistent through all races and ethnic groups world-wide among both men and women. These risk factors have been identified as risk factors for Acute Myocardial Infarction (AMI) and thus the need for a separate risk factor identification, assessment and analysis for non-end-stage disease conditions of cardiovascular diseases is imperative. On the other hand, individual studies have reported that there are substantial regional variations in risk factors in India. The

report by the United States Institute of Medicine indicates that significant national variations are seen in cardiovascular mortality and risk. A similar study, the SCORE project (Estimation of ten-year risk of fatal cardiovascular disease: the SCORE project) was initiated in Europe and a risk stratification and scoring system was established. This is an effective tool for clinical practice for management of cardiovascular risk but the risk scoring system is specific for European population and is relevant to the age group of 40-65 years only. No similar researches to identify and determine risk factor scores of cardiovascular diseases and hypertension have been conducted in India. The WHO- Package of Essential Non communicable disease Intervention (PEN), has proposed a separate risk factor scoring analysis system for different regions of the world. India is included in the south-east Asian region (SEAR) of this classification. This risk scoring is based on the SCORE project and is pertinent to ages 40-65 years and not below 40 years. Most other researches in India have focussed on prevalence of hypertension only. A study of risk factors of hypertension was steered in 2010 in Chandigarh (Chandigarh Urban Disease Study) which established sedentary lifestyle, obesity and low HDL- cholesterol as the most prevalent risk factors of CVDs in the age group of 30-50 years in a north Indian population. A similar study in Chennai showed a significant association of Hypertension with BMI, age and glucose tolerance. According to the second and third National Family Heath Surveys (NFHS), the prevalence of hypertension and its risk factors (smoking, tobacco consumption and alcohol consumption) is increasing in the younger age groups (20-35 years). No comprehensive data is available for causes of morbidity and mortality across different populations in India. The data on burden of risk factors for various diseases requires a continuous and systematic method for data collection at various points of contact with the health care system along-with population based studies. A centralized and national database registry needs to be developed and made available to researchers and policy makers to help in further research initiatives and in formulating national health policies. The Registrar general of India and the Million Death Study investigators have started collecting data since 2001 on the causes of death retrospectively using the country wide sample registration system. In the first stage of this study, CVD

was found to be the largest cause of death in both males and females. The on-going projects in India- India Heart Watch (IHW) and Prospective Urban Rural Epidemiological Study (PURE) - are the first-of-their-kind-multi centre studies in India focusing on risk factors of cardiovascular diseases and other non-communicable diseases. Both these studies, do not have Pune as a centre of investigation and hence the need for understanding the relationship between the presence of risk factors of hypertension like: age, alcohol, smoking and chewing tobacco, body mass index (BMI), central obesity (defined as waist circumference>90 cm in men and >80 cm in women), low consumption of vegetables/fruits, high consumption of dietary fat and salt, alcohol, and smoking with absence/presence of hypertension in a population based in Pune is important.

A thorough review of literature suggests that environmental factors like air pollution levels and noise pollution levels may to some extent be associated with CVDs and hypertension, though these associations are weak. Hypertension may also be associated with safety hazards at work place e.g., constriction of blood vessels induced by a cold work environment, high work stress and work requiring heavy workloads leading to rise in blood pressure levels and a hot and humid work environment may result in excessive sweating and dilatation resulting in postural hypotension. To study these factors and to identify them as risk factors of CVDs, a cross cultural, multi-city study spanning a few decades with a follow-up cohort is needed which encompasses the study of the inter-relationship of factors like adaptability and population mobility.

A cross-sectional study was thus designed with only male subjects to study the risk factors of hypertension in the city of Pune. A sample of size 1000 has been studied for the same. In this study, females have not been included as the aetiology of hypertension in females includes pregnancy-induced-hypertension, out of which 1/3rd of the cases regress but the rest 2/3rd of the case progress to essential hypertension. Additionally, the regular consumption of oral contraceptives results in raised levels of blood pressure due to hormonal changes. Chronic use of oral contraceptives may raise blood pressure in certain

women and may have other adverse effects on cardiovascular risk. Early epidemiologic studies using high-dose oestrogen found mean elevations in blood pressure of 3 to 6 mmHg systolic and 2 to 5 mmHg diastolic, with approximately 5% of women developing hypertension as a result of oral contraceptive pill intake. Thus, Hypertension in females has additional aetiologies which are not attributed to underlying medical disorders or lifestyle or dietary factors.

This study is an attempt to determine age, family history, diet, medical history, alcohol consumption, tobacco consumption and different lifestyles as risk factors of hypertension in the city of Pune (in males). The study variables include demographics, individual characteristics associated with major risk factors of CVD, past medical history, and anthropometric measurements. Most of these factors are modifiable and hence the incidence of developing and progress of hypertension can be controlled to some extent.

Sources of Data Collection were as follows-

•Primary data – Face to face interview using questionnaires

•Secondary data – Previous history of medication, old prescriptions and other medical records if available

•Sample selection- The samples were drawn from a single hospital in Pune. Sample size of 1000 was taken with 500 as hypertensives patients and 500 and non-hypertensives.

The exclusion criteria included all individuals with age below 20 years or above 60 years. The respondents were mentally sane. Females were excluded from the study.

Descriptive statistics of the baseline characteristics were calculated. Patients were categorized as positive or negative for hypertension. Odds ratios, z value, estimate, standard error and P value were calculated using logistic regression analysis to estimate the relation between hypertension status and metabolic

syndrome (diabetes, hyperlipidaemia); cardiovascular diseases (CVD); age ; family and sibling's history of hypertension; medication and surgery; anthropometry (waist and hip circumference, Body Mass Index (BMI), and waist to hip ratio); dietary factors (fruit and vegetable intake, consumption of roots and tubers, amount and type of oil intake, salt and sugar intake); other factors such as residence, religion, mother tongue, monthly income, education, health status, etc. and habits (smoking, alcohol, salt intake, oral tobacco etc.). R statistical software was used for data analysis and $p<0.05$ was considered significant.

The study comprised of 1000 patients (500 Hypertensive and 500 Non-Hypertensive) and with a mean (SD) age of 47(±10.88). Hypertension was found to have a strong significant association with Metabolic Syndrome (Diabetes and Hyperlipidaemia) ($p< 0.001$ and $p < 0.01$) respectively.

Age as a risk factor showed significant association ($p< 0.001$) with presence of hypertension. The factors family history of sibling and family history of grandmother showed a strong relationship ($p< 0.05$ and $p < 0.01$ respectively) with presence of hypertension as well. Maternal family history of hypertension (maternal grandmother) and sibling indicates a hereditary or genetic influence on aetiology of hypertension.

Current or previous intake of drugs or medicines and history of minor or major surgeries did not show association with presence of hypertension. This aspect, needs a more in-depth study correlating the drug-drug interactions, food-drug interactions and drug-disease interactions which are beyond the scope of this project.

Presence of hypertension showed significant influence on all anthropometric factors such as weight, waist and hip circumference, BMI and waist to hip ratio ($p < 0.001$, $p<0.001$, $p< 0.01$, $p< 0.01$ and $p < 0.001$, respectively).

The factors religion and education showed significant association ($p < 0.05$ and $p < 0.01$ respectively) with presence of hypertension.

The factors smoking, oral tobacco consumption, physical inactivity/sedentary lifestyle, alcohol intake has a significant association ($p < 0.01$) with presence of hypertension.

None of the dietary factors has a significant correlation with presence of hypertension, except for salt and sugar consumption, which showed a discernible and clear significant risk ($P<0.01$ and $p<0.001$ respectively).

The findings of the current research clearly reflect the necessity for a comprehensive national program for hypertension and its associated risk factors well backed by intensive health awareness campaigns to spread information about the potential risk factors and the sequel of inadequately managed cases of hypertension as proposed by the World Hypertension League's International Society of Hypertension(ISH). The ISH has stressed that even though hypertension is a largely preventable disease, its mortality and morbidity rates are very high. The primary modifiable aetiology consists of unhealthy dietary habits especially high salt intake, physical inactivity, obesity and excessive alcohol intake. Effective public health policies suggested by ISH and World Health Organization (WHO) focus on supporting healthy lifestyles, organizing public health campaigns, strategies to reduce salt intake and early detection of hypertension.

In May 2008, the World Health Assembly (of WHO) has endorsed the implementation plan of the Global Strategy for Prevention and Control of NCDs. One of the objectives of NCD Action Plan emphasizes the need to establish national policies and plans for NCD prevention and control across the world. As one of the key components of this objective, WHO was called upon to "provide technical guidance to countries in integrating cost-effective interventions against major NCDs into their health systems". Additionally, the Action Plan proposes that member states "implement and monitor cost-effective approaches for the early detection of cancers, diabetes, hypertension and other cardiovascular risk factors" and "establish standards of health care for common conditions like CVD, cancers, diabetes and chronic respiratory diseases

integrating whenever feasible their management into Primary Health-Care Centre (PHC)".

The Package of Essential NCD Intervention (PEN) is a conceptual framework for strengthening equity and efficiency of primary health care in low-resource settings; it identifies core technologies, medicines and risk prediction tools; discusses protocols required for implementation of a set of essential NCD interventions; develops technical and operational outline for integration of essential NCD interventions into primary care and for evaluation of impact.

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1 INTRODUCTION

1.1 PROBLEM STATEMENT

Risk factors of Hypertension among adult men are a significant public health concern. Hypertension is also the most common cause for cardiovascular diseases (CVD) [1]. Long standing, poorly managed Hypertension, results in a number of complications ranging from atherosclerosis, coronary artery disease, heart failures, nephropathies, retinopathies, strokes, poor quality of life and eventually death[2,3,4,5]. Hypertension is itself one of the modifiable risk factors for CVDs. However, only about 25.6% of treated patients had their BP under control, in a multi-centre study from India on awareness, treatment, and adequacy of control of Hypertension[6]. In the Million Death Study, CVD was found to be the most common cause of deaths in India across all economic strata and among both genders[6].

The city of Pune is fast emerging as a Mini Metro. No previous study in the city of Pune on Hypertension with multiple variable risk factors, including dietary, lifestyle and anthropometric factors has been done. This study proposes to establish a relationship between Hypertension and its risk factors.

Research problem

> Is there a relationship between the presence of risk factors (age, alcohol, smoking and chewing tobacco, BMI, central obesity, low consumption of vegetables/fruits, high consumption of dietary fat and salt and alcohol) with absence/presence of hypertension in Pune?

1.2 BACKGROUND

With the advancement of medical technology, treatment regimens and better access to healthcare services, the control and prevention of communicable diseases has improved thus reducing the mortality and morbidity rates resulting from these diseases. Regular immunizations, prophylactic medicines, early medical intervention strategies are the prime reasons for reduction in the burden of communicable diseases. Tropical diseases like malaria, cholera etc. are declining where as there is a progressive rise in development of non-communicable diseases (NCDs) like Diabetes Mellitus, Chronic Obstructive Pulmonary Disease, Cancer, Cardiovascular Diseases etc. These are lifestyle disorders, an aftermath of rapid urbanization with multifaceted aetiology and a varied array of symptoms. They are a result of the cumulative effect of interaction between various risk factors where no apparent direct relationship can be established between one single risk factor and the pathogenesis of the disease. No one risk factor is an isolated entity and its effect on the development of the disease is a resultant of interaction of this risk factor with the others. It thus becomes important to identify and investigate the various risk factors responsible for the emergence of these diseases.

The change in the disease pattern from communicable diseases to non-communicable diseases is blamed to be an outcome of modernization and change in lifestyles. Urbanization is an event that is characterized by continuous alterations in lifestyles of people where in there is a considerable increase in the intake of energy dense foods, but a drastic decrease in the levels of physical activity, a heightened level of psychological stress, emergence of other lifestyle diseases, changed eating habits, increased environmental pollutants, increased use of chemicals etc. The effect of these factors is observed on all systems of the body resulting in conditions like Hypertension, Dyslipidaemia, Diabetes Mellitus, Cancers etc.[7]

31% of all non-communicable diseases world-wide mortality is attributed to cardiovascular diseases which is the highest among NCDs[2]. The worldwide mortality data[8] reported in 1990, showed that 19% of all the deaths, 16% of all

the deaths due to non-communicable diseases and 17% of all the deaths due to cardiovascular diseases were in India[8]. A two-fold rise in the number of cardiovascular disease cases is projected over span of 15 years from 2.9 crore cases in 2000 to 6.4 crore cases in 2015[8].

According to the World Health Organization (WHO), more than one-third of adults above the age of 25 years are affected by Hypertension which accounts for about a billion people world-wide and contributes to nearly 9.4 million deaths from cardiovascular diseases each year[9]. Almost 70% of cases of stroke and 50% of Coronary heart diseases are caused due to hypertension[7, 10]. Further, it has been estimated that by the year 2030, 23 million cardiovascular deaths are projected to be due to Hypertension, of which about 85% cases will be from low-resource settings and developing nations[9].

Hypertension is a type of Cardio-vascular disease and is a risk factor for other cardio-vascular diseases as well. It is of a great public health concern as improper treatment regime, side-effects of medications, complications of long standing and inadequate treatment affects different organ systems resulting in multiple organ disorders and an impaired quality of life.[3, 4, 5, 9, 11]. Adequate control of blood pressure is a critical element in the prevention of hypertension-induced-organ damage and life-threatening complications. Prevention of hypertension is possible and early detection and effective treatment can significantly reduce the incidence of adverse clinical outcomes and end stage disease[7, 12, 13].

In India, in the past five decades, rates of coronary disease among urban populations have risen from 4 per cent to 11 per cent. In urban China, the death rate from coronary disease rose by 53.4 per cent from 1988 to 1996[14] showing a rapid upward rise in the prevalence rates of hypertension in societies of developing nations.

1.2.1 Asia-pacific scenario: hypertension in Asia: Prevalence estimates and temporal trends

High blood pressure (BP) is ranked as the third most important risk factor for attributable burden of disease in south Asia (2010)[15]. Healthcare system in India is burdened by the high prevalence of hypertension and other cardiovascular diseases which is accentuated by a lack of a public health policy aimed at control and treatment of hypertension[16]. 57% of all Cerebro-vascular events resulting in death have a primary aetiology of hypertension whereas 24% of all coronary heart disease deaths are a result of hypertension[17]. The World Health Organization (WHO) rates hypertension as one of the most important causes of premature death worldwide[18]. In a meta-analysis conducted by Anchala et al, for prevalence of hypertension in rural and urban India, under the Global and Regional Burden of Disease and Risk Factors study in 2001 in South Asia, child underweight for age was ranked first and hypertension second for attributable deaths and attributable disease burden[19]. As per the World Health Statistics of 2012, hypertension is the fourth largest contributor to premature deaths in developing countries as compared to developed countries where it is the seventh largest cause[20].

1.2.2 Indian scenario

India has a population with high rates of cardiovascular disease (CVD). Hypertension is one of the modifiable risk factor for CVD. In an analysis of worldwide data for the global burden of Hypertension, 20.6% of Indian men and 20.9% of Indian women were suffering from Hypertension in 2005[7]. The rates for Hypertension in percentage are projected to go up to 22.9 and 23.6 for Indian men and women, respectively by 2025[7]. Recent studies from India have shown the prevalence of Hypertension to be 25% in urban and 10% in rural people in India[17, 21, 22]. In another study conducted in affluent north Indian population, the prevalence of Hypertension was 32.2% and of pre-Hypertension

was 32.3%[23]. According to the WHO 2008 estimates, the prevalence of raised BP in Indians was 32.5% (33.2% in men and 31.7% in women) [15].

Lancet 2000 study showed that, even after adjusting for all known risk factors; South Asians in Canada appeared to have a higher rate of heart disease than Europeans or Chinese living there. Some doctors blame this vulnerability on the "thrifty-gene" theory, which holds that South Asians adapted over many generations to the region's frequent famines. Over a period of time, the famines reduced and adequate food is now available to all individuals. Researchers suggest that South Asians have not been able to adapt to this over-abundance of food and their bodies have not adjusted to the metabolic changes initiated resulting in high insulin intolerances, with accompanying increasing cases of diabetes and obesity. [24].

The unusual susceptibility of South Asians to heart disease can be traced to lifestyle issues, diet, rapid urbanization and possible underlying genetic causes. It is considered that the common denominator is an increasingly sedentary lifestyle. And, similar to the epidemiological transition that took place in North America and Western Europe, India is undergoing a demographic shift in cardiovascular disease from the wealthy to the lower classes.

The thrifty-gene theory however remains hypothetical, as Dr Salim Yusuf of McMaster University in Canada points out, that the culprit gene itself has not yet been identified in the human genome. One of the world's foremost epidemiologists of cardiovascular disease, Dr Yusuf had earlier propagated the concept that ethnicity was a significant determinant of heart disease, but his recent research points to the fact that ethnicity is not significantly associated with the development of cardiovascular diseases. It has been postulated that the difference in the prevalence rates of cardiovascular diseases is because of the different lifestyles. Researchers suggest that 80% of the risk can be accounted for by known risk factors like smoking or obesity or blood pressure, indicating that genetic influence has a limited scope. The postulation that family history is an important risk factor overlooks the fact that families tend to have similar lifestyles and are exposed to the same environment and thus are exposed to

similar risk factors. Studies have shown that when Japanese emigrate from Japan, where their rates of heart disease are very low, and move to the West, these rates of lifestyle disorders quickly rise to the Western norm.

However, South Asians have not been the only race to survive centuries of famine; other nationalities of the Asian sub-continent like the Chinese have also faced famines and droughts. The Chinese, though have had lower rates of CVDs and thus the thrifty gene theory does not seem to be applicable to them. Human beings have evolved across all ethnic groups similarly. Thus, no one is considered doomed by uncontrollable factors like genes or family history and controlling the pathogenesis of the disease lies in modifying individual lifestyles to a great extent.

In view of the rapidly growing epidemic of CVDs, the Indian government has started a detailed and accurate reporting of CVD and hypertension mortality and morbidity from 2001. Regular collection of specific data has started after 2001 onwards by the Registrar General of India and Million Death Study using the country-wide Sample registration system. In the first phase of the study (2001-2003), it was seen that CVDs and respiratory diseases contribute to 57.5% of the total deaths with CVD as the leading cause mortality. CVD was found to be the most common cause of deaths in India across all economic strata and among both the genders. Table 1.1 enlists the most common causes of deaths in India[25] and emphasizes the fact that India is in a transitional phase with a dual burden of disease from both communicable and non-communicable diseases.

Table 1.1Top five causes of deaths in India classified according to areas of residence and gender

Rank	**India (all age groups)**	**Economically backward states**	**Economically advanced states**	**Rural populations**	**Urban populations**	**Men**	**Women**	**Middle-age (25-69 yr.)**
1	Cardiovascular	Cardiovascular	Cardiovascular	Cardiovascular	Cardiovascular	Cardiovascular	Cardiovascular	Cardiovascular
2	COPD, asthma	Diarrhoea	COPD, asthma	COPD, asthma	Cancers	COPD, asthma	Diarrhoea	COPD, asthma
3	Diarrhoea	Respiratory infections	Cancers	Diarrhoea	COPD, asthma	Tuberculosis	COPD, asthma	Tuberculosis
4	Perinatal	COPD, asthma	Senility	Perinatal	Tuberculosis	Diarrhoea	Respiratory infection	Cancers
5	Respiratory infection	Perinatal	Diarrhoea	Respiratory infections	Senility	Perinatal	Senility	Ill-defined

Registrar General of India has thus recommended that it is imperative to find and evaluate the "causes of the causes" of CVD. Hypertension is one of the leading causes of mortality and morbidity of CVD. The INTERHEART study started in 1999 and completed in 2002 was a large international case-control study with 12,461 cases and 14,637 controls across 52 counties by the McMaster University, Canada. It focussed on 9 risk factors (Smoking, Diabetes mellitus, Physical activity, Lipids, Obesity, Alcohol consumption, Hypertension, Diet and Psychosocial factors) of Coronary Heart Disease. Similarly a Global case-control study(INTERSTROKE study) - led by Dr Martin O'Donnell (Population Health Research Institute, McMaster University and HRB-Clinical Research Facility, NUI Galway, Ireland) and Dr Salim Yusuf (Population Health Research Institute, McMaster University, Canada) – to identify risk factors of Stroke was carried out from 2007 to 2014 across 32 countries and found 10 risk factors significant for development of stroke (Hypertension, hyperlipidaemia, smoking, physical inactivity, abdominal obesity, cardiac causes, diet, alcohol, diabetes mellitus and psychosocial factors). The Table 1.2 enlists the risk factors of CVD as reported by the INTERHEART and INTERSTROKE studies[26, 27]. Both studies show that Hypertension and high waist to hip ratio are key risk factors of CVDs. Apo lipoprotein levels are an important indicator for both stroke and AMI. High psychosocial stress levels were noted in 1/3rd of the studied population and was identified as a risk factor of AMI as well.

Table 1.2 Population attributable risks (%) of various cardiovascular risk factors for coronary heart disease and stroke in INTERHEART and INTERSTROKE studies

Risk factor	**INTERHEART(acute myocardial infarction)**	**INTERSTROKE(thrombotic or haemorrhagic strokes)**
Apo lipoprotein A/B ratio	49.2	24.9
Hypertension	17.9 (history)	34.6
Smoking	35.7	18.9
Diabetes history	9.9	5.0
High waist-hip ratio	20.1	26.5
Psychosocial stress	32.5	9.8
Regular physical activity	12.2	28.5
Diet/diet score	13.7	18.8
Lack of alcohol intake	6.7	3.8
Cardiac causes	-	6.7

The India Heart Watch (IHW) and Prospective Urban and Rural Epidemiological Study (PURE) studies are the two major studies coming up in India for the identification of regional differences in CVD risk factors. India Heart Watch is a national study with centres in 13 cities (Jammu, Chandigarh, Karnal, Bikaner, Ahmedabad, Jaipur, Lucknow, Patna, Dibrugarh, Indore, Madurai, Hyderabad, and Belgaum) in phase-1 of data collection. It is a study focusing on the socio-economic, anthropometric and bio-chemical risk factors. Phase-I of data collection has indicated that smoking, high fat intake and a low fruit and vegetable intake are more prevalent in lower economic cities where as

lower physical activity is more prevalent in higher economic cities. PURE is a prospective epidemiological cohort study evaluating individuals across 17 countries in more than 600 rural and urban regions in various income groups. In India, it is localized to five rural and five urban locations with a proposed follow-up design of 10 years. In the first phase of this study, a strong relationship was found between older age, higher salt intake and Hypertension. An intake of 3-6gms per day of salt was seen to be associated with low cardiovascular risk as compared to a lower or higher salt intake. On estimation of urinary sodium excretion, it has been found that, there is a significant rise in systolic and diastolic blood pressures with increase in sodium excretion especially in Hypertensive population and in subjects above the age of 55 yrs.

These studies reflect the results of INTERHEART and INTERSTOKE studies that raised blood pressure, dyslipidaemias, smoking, obesity, diabetes, physical inactivity, inadequate fruit and vegetable intake and psychological stress are important risk factors for cardiovascular diseases in India as they are globally. It is expected that the results of IHW and PURE studies will to a great extent give an insight in to the risk factors of hypertension and other Cardio-vascular diseases[28].

The table 1.3 summarizes different studies on Hypertension carried out in various parts of India. These studies have focused on the prevalence of hypertension. In a study carried out in 2000 in Mumbai, the prevalence of hypertension was found to be 34% where as in 2007, the prevalence of hypertension in Chennai was found to be lower at 20% and 27.2% in two independent studies. The prevalence of hypertension rose in Mumbai to 47.9% in the year 2004.

The prevalence of hypertension in rural populations of India were found to be as high as in urban populations except for Maharashtra and Haryana, where they were less than 10%.

Table 1.3Recent Studies (2000-2012) on prevalence of Hypertension in urban and rural Indian population[28]

First Author	Year	Place	Age(yrs.)	Sample Size	Prevalence (%)
Urban Populations					
Anand MP	2000	Mumbai	30-60	1662	34.0
Gupta et al.	2004	Mumbai	≥35	88653	47.9
Prabhakarn D	2005	Delhi	20-59	2935	30.0
Reddy KS	2006	National	20-69	19973	27.2
Mohan and Deepa	2007	Chennai	≥20	2350	20
Kaur P	2007	Chennai	18-69	2262	27.2
Yadav and Boddula	2008	Lucknow	≥30	1746	32.2
Rural Populations					
Hazarika et al.	2004	Assam	>30	3180	33.3
Thankappan and Sivasankaran	2006	Kerala	>30	2159	36.0
Krishnan A	2008	Haryana	15-64	2828	9.3
Todkar SS	2009	Maharashtra	≥20	1297	7.2
Vijaykumar G	2009	Kerala	≥18	1990	36.1
Bharadwaj R	2010	Himachal	≥18	1092	35.9
Kinra and Bowen	2010	National	20-69	1983	20.0

The Government of India through the Ministry of Health & Family Welfare (MOHFW), initiated a decentralized, state based Integrated Disease Surveillance Project (IDSP) [29] in India with the assistance of the World Bank in the year 2004. The component of non-communicable disease surveillance planned periodic community based surveys of population aged 15-64 years to provide data on the risk factors. Table 1.4 shows the results of the IDSP surveillance study where a high prevalence of low physical activity was seen in all the 7 states studied and high tobacco consumption was seen in Madhya Pradesh and Mizoram especially among males. 27.1% of the population of Kerala was obese and 11.8% of the population of Kerala was diabetic. In the first phase of IDSP, data on seven states (Andhra Pradesh, Madhya Pradesh, Maharashtra Mizoram, Kerala, Tamil Nadu and Uttarakhand) have been included.

Table 1.4Risk factor prevalence (%) among men and women (15-64 years) in 7 Indian states in Indian Council of Medical Research Non-communicable Disease Risk Factor Surveillance Study

Risk factor	**Andhra Pradesh**		**Madhya Pradesh**		**Maharashtra**		**Mizoram**		**Kerala**		**Tamil Nadu**		**Uttarakhand**	
	M	**W**	**M**	**W**	**M**	**W**	**M**	**W**	**M**	**W**	**M**	**W**	**M**	**W**
Sample Size	2719	3499	2857	2996	3084	3007	2297	2198	1710	3128	2077	3028	2147	3286
Current smoking	31.5	4.0	41.2	0.9	15.9	2.5	67	18.8	27.3	0.2	27.4	0.0	35.2	5.0
Smokeless tobacco use	13.6	4.5	53.8	22.6	40.7	23.6	46.5	55.4	7.0	3.4	13.6	8.4	21.0	2.2
Low physical activity	55.9	79.7	33.5	52.0	75.4	87.7	60.9	82.4	64.7	86.2	57.3	74.2	64.6	69.7
Obese, BMI ≥ 25 kg/m^2	19.4		8.2		13.1		10.3		27.1		22.6		14.5	
Hypertension	16.6		21.1		20.1		19.4		18.0		17.7		18.8	
Diabetes history	2.7	1.7	0.6	0.6	0.9	1.0	0.7	0.5	6.5	5.3	3.4	2.6	1.2	1.1

M: Men, W: Women

Various studies have been done to assess the risk factors of hypertension in India. The table 1.5 summarizes these studies. However, most of the risk factors were component of the Framingham multivariable risk formulation and thus the importance of identifying patients with metabolic syndrome applies more to therapeutic choices than to risk stratification.

Table 1.5Risk factors for Hypertension reported from Indian studies

Author	**Year**	**Risk factor**	**Magnitude of effect size - OR/RR: estimate (95% CI)**
Studies on Age (>60 years)- Risk Factor of Hypertension			
Borah et al.[30]	2010	Age : >60 years	2.9 (1.88-4.43)
Mohan et al., 2007[31]	2007	Age : >60 years	13.45 (8.07 – 20.78)
Manimunda et al.[32]	2011	Age : >60 years	6.83 (4.30-10.86)
Dutta and Ray[33]	2012	Age : >60 years	11.09 (6.56 – 18.74)
Hazarika et al.[34]	2002	Age : >60 years	9.29 (5.27 – 16.37)
Studies on Age (50-59 years)- Risk Factor of Hypertension			
Borah et al.[30]	2010	Age: 50-59 years	2.6 (1.72-4)
Manimunda et al.[32]	2011	Age: 50-59 years	5.49 (3.56 – 8.48)
Dutta and Ray[33]	2012	Age: 50-59 years	7.18 (4.31-11.95)
Hazarika et al.[34]	2002	Age: 50-59 years	2.99 (2-4.46)

Contd.

Author	**Year**	**Risk factor**	**Magnitude of effect size - OR/RR: estimate (95% CI)**
Studies on Age (40 – 49 years)- Risk Factor of Hypertension			
Manimunda et al.[32]	2011	Age: 40-49 years	3.73 (2.48 – 5.60)
Dutta and Ray[33]	2012	Age: 40-49 years	5.73 (3.60 – 9.10)
Hazarika et al.[34]	2002	Age: 40-49 years	1.72 (1.27 – 2.33)
Studies on Age (≥35 years)- Risk Factor of Hypertension			
Sathish et al.[35]	2012	Age: ≥35 years	4.00 (2.37-6.03)
Studies on Alcohol consumption- Risk Factor of Hypertension			
Borah et al.[30]	2010	Alcohol	3.9 (2.84 - 5.49)
Meshram et al.[36]	2012	Alcohol	1.4 (1.17-1.73)
Manimunda et al.[32]	2011	Alcohol	1.35 (1.02-1.78)
Hazarika et al.[34]	2002	Alcohol	2.49 (1.66 – 3.74)
Studies on Smoking- Risk Factor of Hypertension			
Sathish et al.[35]	2012	Smoking	1.99 (1.14-2.97)
Mohan et al.[31]	2007	Smoking	1.50 (1.18 – 1.91)

Contd.

Author	**Year**	**Risk factor**	**Magnitude of effect size - OR/RR: estimate (95% CI)**
Studies on Central Obesity- Risk Factor of Hypertension			
Sathish et al.[35]	2012	Central obesity	2.45 (1.45-3.70)
Ganguli et al.[37]	2013	Central obesity	2.55 (1.07-6.06)
Thankappan et al.[21]	2006	Central obesity	1.84 (1.55-2.19)
Mohan et al.[31]	2007	Central obesity	2.17 (1.76 - 2.69)
Gupta et al.[38]	2013	Central obesity	3.40 (2.39 – 4.83) males 1.70 (1.33 – 2.17) females
Studies on Anthropometry- Risk Factor of Hypertension			
Hazarika et al.[34]	2002	Waist hip ratio >0.88	2.24 (1.22 – 4.12)
Shanthirani, et al.[39]	2003	BMI≥25	1.12 – 4.10
Manimunda et al.[32]	2011	BMI≥25	2.86 (2.05 – 4)
Mohan et al.[31]	2007	BMI≥25	2.37 (1.87-2.99)
Dutta and Ray[33]	2012	BMI≥25	3.94 (2.65 – 5.86)
Thankappan et al.[21]	2006	BMI≥25	1.65 (1.37-1.98)
Ganguli et al.[37]	2013	BMI≥25	3.44 (2.80 – 4.23) males 1.70 (1.33 – 2.17) females

Contd.

Author	**Year**	**Risk factor**	**Magnitude of effect size - OR/RR: estimate (95% CI)**
Studies on Diet- Risk Factor of Hypertension			
Ganguli et al.[37]	2013	High dietary fat	1.85 (1.48 – 2.31) males
Ganguli et al.[37]	2013	Low fruits/vegetables	1.67 (1.31 – 2.14) males 1.84 (1.44 – 2.34) females
Hazarika et al.[34]	2002	Extra salt (< 6 gm/day)	1.97 (1.47 – 2.65)
Studies on Metabolic Syndrome- Risk Factor of Hypertension			
Borah et al.[30]	1994	Diabetes	3.2 (2.23-4.26)
Ganguli et al.[37]	2013	Diabetes	3.08 (2.36 – 4.02) males 4.42 (3.22 – 6.06) females
Ganguli et al.[37]	2013	Metabolic syndrome	7.09 (5.06 – 9.92) males 6.26 (4.77 – 8.20) females
Studies on Tobacco Consumption- Risk Factor of Hypertension			
Hazarika et al.[34]	2002	Khaini chewing	1.78 (1.25 – 2.55)
Hazarika et al.[34]	2002	Chewing tobacco	1.88 (1.27 – 2.79)

1.3 CARDIO-VASCULAR DISEASES

Cardiovascular diseases are a group of diseases involving narrowing or blockage of blood vessels that can lead to complications like myocardial infarction, angina or stroke.

Cardio-Vascular Diseases (CVD) is the leading cause of death in India[40], and its contribution to mortality is rising; deaths due to CVD were expected to double from 1985 to 2015[41] but instead, there has been a three- times increase in the Hypertension mortality. Regular physical activity for 150 minutes per week has been advised by the WHO to maintain a healthy lifestyle and reduce the risk of developing non-communicable diseases like Obesity, Dyslipidaemias, Hypertension, and Non -Insulin Dependent Diabetes Mellitus (NIDDM) [42] which are postulated to be risk factors for coronary heart diseases (CHD). Conversely, measures of sedentary lifestyles or physical inactivity have been associated with a 1.5- to 2.4-fold elevation in CHD risk[41, 43].

Ischemic heart disease and stroke are the two most common causes of death worldwide. Over 80 per cent of deaths and 85 per cent of disability from (CVD) occur in low- and middle-income countries [44].

The major CVDs include:

- Ischemic Heart Disease
- Cerebro-vascular disease (stroke)
- Peripheral Vascular Disease
- Congestive Heart failure
- Rheumatic heart disease
- Congenital Heart Disease

Of the 16.7 million deaths from CVDs every year, 7.2 million are due to ischemic heart disease, 5.5 million due to cerebro-vascular disease, and an additional 3.9 million due to hypertension and other cardiac conditions[2].

CVD affects people in their mid-life years, undermining the socioeconomic development, not only of affected individuals, but families and nations. Lower socioeconomic groups generally have a greater prevalence of risk factors, diseases and mortality in developed countries, and a similar pattern is emerging as the CVD epidemic matures in developing countries.

The rise in CVDs reflects a significant change in dietary habits, physical activity levels, and tobacco consumption worldwide as a result of industrialization, urbanization, economic development and food market globalization. People are consuming a more energy-dense, nutrient-poor diet and are less physically active. Imbalanced nutrition, reduced physical activity and increased tobacco consumption are the key lifestyle factors for development of CVDs. High blood pressure, high blood cholesterol levels, overweight and obesity and type 2 diabetes are among the major biological risk factors. Unhealthy dietary practices include a combination of high consumption of saturated fats, salt and refined carbohydrates, and a low consumption of fruit and vegetables and fibre rich foods. These risk factors tend to cluster[44] together and interact with each other to show a cumulative effect.

1.3.1 Coronary (or ischemic) heart disease (heart attack) -

The WHO has defined ischemic heart disease (IHD) as myocardial impairment due to imbalance between coronary blood flow and myocardial requirements. The most common cause of IHD is atherosclerotic coronary artery disease. The major risk factors for IHD are considered to be hyperlipidaemia, tobacco consumption, hypertension, obesity, and diet and glucose intolerance. The clinical presentation is that of

- Various types of angina
- Acute myocardial infarction
- Ischemic cardiomyopathy
- Silent myocardial ischemia in a known case of coronary artery disease

- Asymptomatic coronary artery disease diagnosed on routine examination
- Cardiac arrest and sudden cardiac death

1.3.2 Cerebro-vascular disease (stroke) –

Stroke is the death of brain cells due to inadequate supply of oxygen to the neurons. This occurs due to a problem in the blood supply to the brain which thus hinders the supply of oxygen and nutrients to the brain tissue. Such a condition may be present due to the rupture (Haemorrhagic Stroke) of the artery or due to a block (Ischemic Stroke) in the artery[45].

According to The U.S. National Institute of Neurological Disorders and Stroke[45], the five major signs of Stroke are:

- Sudden numbness or weakness of the face, arm or leg, especially on one side of the body. The loss of voluntary movement and/or sensation may be complete or partial. There may also be an associated tingling sensation in the affected area.
- Sudden confusion, difficulty in speaking or understanding. Sometimes weakness in the muscles of the face can cause drooling.
- Sudden difficulty in seeing in one or both eyes.
- Sudden difficulty in walking, dizziness, loss of balance or coordination.
- Sudden, severe headache with no known cause.

1.3.3 Peripheral Vascular Disease (PVD)-

Peripheral Vascular Disease is the arteriosclerosis and narrowing of the peripheral blood vessels (blood vessels outside the heart and brain). There are two types of PVD-

1. Functional PVD- There is no structural change in the blood vessels but symptoms occur erratically and are not long lasting.
2. Organic PVD- The symptoms occur due to inflammation, tissue damage or blockages in the blood vessels.

The major risk factors for developing PVD are cigarette smoking, sedentary lifestyle, Hypertension, Hypercholesterolemia and Diabetes Mellitus.

1.3.4 Congestive Heart Failure (CHF)-

Congestive Heart Failure occurs when the heart muscles are weakened. They are unable to sufficiently pump the blood to meet body's needs. The common causes of CHF are atrial fibrillation, valvular heart diseases, alcohol consumption, myocarditis and cardiomyopathies.

1.3.5 Rheumatic Heart Disease (RHD)-

Rheumatic Heart Disease is an infective disease (Streptococcus A) succeeding the onset of Rheumatic fever which primarily affects children. RHD causes permanent damage to the heart specifically the heart valves.

1.3.6 Congenital Heart Disease -

Congenital heart diseases are structural deformities present in the heart at the time of birth. The cause of congenital heart disease is often unknown.

1.4 HYPERTENSION AND ITS RISK FACTORS

Hypertension (high blood pressure)

Blood pressure is the pressure exerted by the blood and its components on the inner walls of the blood vessels. The arterial pressure is measured for diagnostic and prognostic purposes and is commonly called blood pressure[41]. A rise in this pressure exerted by the blood on the blood vessels is referred to as high blood pressure or Hypertension.

Hypertension is found to be closely related with age. Increasing age is a risk factor of Hypertension, both the incidence and prevalence of Hypertension rises with increase in age[45]. After the age of 60 years, Hypertension is considered to be a physiological development. Almost half of the population is Hypertensive in the age group of 60-69 years and more than three-fourths of the population becomes Hypertensive after the age of 70 years[47].

The seventh Joint National Committee (JNC) report in 2007 reclassified blood pressure for adults and redefined the ranges for normal and hypertension as given in table 1.6[48]. The eighth JNC has retained the classification for blood pressure from JNC-7.

Table 1.6 Blood pressure classification (SBP in mm of Hg, DBP in mm of Hg)

Category of BP	**Diastolic (mmHg)**	**Systolic(mmHg)**
Normal	<80	<120
Pre-hypertension	120-139	80-89
Stage 1 hypertension	140-159	90-99
Stage 2 hypertension	>160	>100

Risk factors of Hypertension

The aetiology of hypertension encompasses numerous risk factors, of which, high blood cholesterol, smoking, diabetes besides a poor diet and being overweight are the major ones. There is no conclusive evidence towards a single risk factor but a significant relationship is seen with all these risk factors. High blood cholesterol levels, smoking and diabetes have been proved to accelerate the process of Atherogenesis and Atherosclerosis and thus increase the risk of CVD and hypertension.

Certain biochemical markers have also been identified as risk factors of hypertension. A large body of epidemiologic studies has demonstrated a link between these risk markers and CVD. These other factors held responsible are C-reactive protein (CRP), Homocysteine, Fibrinogen, Apo-Lipoprotein (A). Researches have not yet established a significant relationship between these factors and CVD or hypertension.

These biochemical markers are found to be important in the diagnosis of CVD and are seen to have abnormal levels during the pathogenesis of the disease.

1. **C-Reactive Protein-** CRP is a protein produced by the liver as part of the normal immune system response to injury or infection[49]. CRP is an inflammatory marker and inflammation has a central role in atherosclerosis, accumulation of plaques of fats, cholesterol and other material in the arteries. High levels of CRP in the blood have been associated with an increased risk of cardiovascular disease, including heart attack and stroke. CRP is an established factor of inflammation, though its role in causing diseases like CVDs is still disputed. The American Heart Academy (AHA) and the Centres for Disease Control and Prevention recommend CRP screening for an intermediate risk assessment where a high CRP indicates a 10%-20% chance of developing coronary heart disease in the next 10 years. If the CRP is greater than 10 mg/L, it's likely the result of an infection or other condition

and is not useful in assessing the cardiovascular risk and the test for CRP should be repeated after atleast two weeks, or after the infection is gone, to assess cardiovascular risk[49].

2. **Homocysteine:** Homocysteine is an amino acid normally present in the blood and is utilized by the body to make protein and to build and maintain tissue. Studies indicate a link between high plasma levels of homocysteine and an increased risk of stroke, certain types of heart disease, and peripheral vascular disease. Raised levels may be associated with four time's higher risk than normal homocysteine levels. The exact mechanism of its action is not clear and as with CRP, it is not known if homocysteine is a cause of cardiovascular disease or a marker of its presence. Recent work suggests that increased homocysteine levels may eventually cause the tissues lining the arteries to thicken and scar. Cholesterol can build up in those scarred areas, providing a surface for blood clots to form. There's no consensus on optimal homocysteine levels, but in general, less than 12 micromoles is desirable. Readings in healthy people can range between 5 and 15 micromoles. Elevated homocysteine levels can be decreased by dietary supplementation of folate and vitamin B6[50].

3. **Fibrinogen:** Although fibrinogen is needed for normal blood clotting, its excess may promote excessive clumping of platelets and can result in thrombosis in an artery, leading to a heart attack or stroke. Besides physical inactivity and excessive alcohol intake which elevate fibrinogen, smoking is the most significant lifestyle factor that raises fibrinogen levels. The normal range for blood (serum) fibrinogen is 200 to 400 mg/dL, and levels around 400 mg/dL are associated with a two-fold increase in risk of AMI or stroke[51].

4. **Apo-Lipoprotein (A):** It is formed when a low-density lipoprotein (LDL) cholesterol particle attaches to a specific protein. Studies show that an increased level of Apo-Lipoprotein (A) is associated with an increased risk of cardiovascular complications, including early coronary heart disease, heart attack and stroke. Elevated Apo- Lipoprotein (A) level, generally do not respond to most lipid lowering agents but niacin, omega-3 fatty acids or oestrogen supplementation may help in some cases[52].

1.5 PREVALENCE OF HYPERTENSION AND ITS RISK FACTORS

The word prevalence is derived from a Latin word '*praevalens*' which means widespread in a particular area. In medical terms disease prevalence refers specifically to all current cases (old and new) existing at a given point in time, or over a period of time in a given population. According to "A Dictionary of Epidemiology" prevalence is "the total number of all individuals who have an attribute or disease at a particular time (or during a particular time period) divided by the population at risk of having the attribute or disease at this point in time or midway through the period"[53].

There is a progressive rise in the prevalence of cardiovascular diseases in the face of epidemiological transition. Cardiovascular disease is the world's leading killer, accounting for 16.7 million or 29.2% of total global deaths in 2015[24, 53]. Of the 16.7 million deaths from CVDs, 7.2 million were due to Ischemic Heart Disease, 5.5 million due to cerebro-vascular disease, and an additional 3.9 million due to hypertension and other heart conditions[54]. It is estimated by WHO that by the end of 2010, India will have 60% of the world's cardiac patients[52].

The World Health Report of 2002 projects CVD to be the largest cause of death and disability in India by 2020. The World Health Report of 2004 states that every year, more women than men die of CVD and that CVD leads to more deaths in women than cancer, HIV/AIDS and malaria combined. CVD is the largest cause of death in women and the risk for CVD rises with age in both males and females[52, 55].

Among the cardiovascular diseases, ischemic heart disease and stroke are considered to be the two most common causes for death in the world[16]. It is estimated that 80% of the deaths and 85% of morbidity is because of cardiovascular diseases in the low and middle income groups[44, 26]. Nearly 50 per cent of CVD-related deaths in India occur below the age of 70, compared with just 22 per cent in the West. The Indian subcontinent has 20% of the world's population and is said to have the highest burden of cardiovascular diseases in the world. Some experts have suggested that South Asians by virtue

of their ethnicity are at a higher risk of developing cardiovascular diseases in comparison to the populations in the western countries[24, 53].

Lancet 2000 study showed that, even after adjusting for all known risk factors; South Asians in Canada appeared to have a higher rate of heart disease than Europeans or Chinese living there. Some doctors blame this vulnerability on the "thrifty-gene" theory, which holds that South Asians adapted over many generations to the region's frequent famines. Now with a very recent overabundance of food, their bodies are having difficulty making a metabolic U-turn and the result is high insulin intolerance, with accompanying raised levels of diabetes and obesity[24].

The unusual susceptibility of South Asians to heart disease can be traced to lifestyle issues, diet, rapid urbanization and possible underlying genetic causes. It is considered that the common denominator is an increasingly sedentary lifestyle. And, similar to the epidemiological transition that took place in North America and Western Europe, India is undergoing a demographic shift in cardiovascular disease from the wealthy to the lower classes.

The thrifty-gene theory however remains hypothetical, as Dr. Salim Yusuf of McMaster University in Canada points out that the gene responsible for CVDs has not yet been identifies in the human genome. One of the world's foremost epidemiologists of cardiovascular disease, Dr. Yusuf had once championed the idea that ethnicity was a significant determinant of heart disease, but his recent research points to the fact that ethnicity is not significantly associated with the development of cardiovascular diseases. It has been postulated that the difference in the prevalence rates of cardiovascular diseases is because of the different lifestyles. Researchers suggest that 80% of the risk can be accounted for by known modifiable risk factors like smoking or obesity or high blood pressure, and only about 20% of the risk can be attributed to non-modifiable risk factors like genetics, ethnicity and age. The postulation that family history is an important risk factor overlooks the fact that families tend to have similar lifestyles and are exposed to the same environment and thus are exposed to similar risk factors. Studies have shown that when Japanese emigrate from

Japan, where their rates of heart disease are very low, and move to the West, those rates quickly rise to the Western norm. Researchers suggest that, the diet of Japanese in Japan primarily consisted of fishes rich in omega-3 fatty acids which are easily available in Japan. When Japanese migrate to the Western countries, the amount of omega-3 rich fatty acid fishes is reduced considerably and contributes towards the increase in CVDs in migrant Japanese population.

Another theory put forth emphasises that South Indians have been exposed to repeated famines and droughts over the centuries. This has induced a genetic change in South Asians, making them genetically accustomed to disasters. In the present day scenario, the incidences of famines have reduced and the availability of food is better. This theory can however, not be generalized as Chinese have also faced natural disasters but the prevalence of hypertension among Chinese does not follow the same pattern as other South Asians. The evolution of all human beings has been similar across all ethnic and racial groups, thus genetic variations because of environmental factors will also be similar.

1.5.1 Gender as a risk factor for hypertension

Gender is considered as a non-modifiable risk factor for the development of CVD. A study carried out by the Centre for Chronic Disease Control, India in 1991-94 and 2003-05 showed a high burden of cardiovascular risk factors in women[56]. Rural women reported a higher tobacco use and smoking rates whereas they had lower rates of hypertension, diabetes and overweight. Prevalence of tobacco use was substantially lower in urban women. In the first survey, the prevalence of diabetes, hypertension, overweight and dyslipidaemia were high in urban women and comparable to men[56, 57]. The World Health Report of 2002 projects CVD to be the largest cause of death and disability in India by 2020. The World Health Report of 2004 states that every year, more women than men die of CVD and that CVD leads to more deaths in women than cancer, HIV/AIDS and malaria combined.

The transition to a high-risk category occurred at a younger age for men and women with diabetes than for those without diabetes (mean difference 14·6 years). For the outcome of acute myocardial infarction (AMI), stroke, or death from any cause, diabetic men and women entered the high-risk category at ages 47·9 and 54·3 years respectively[57].

1.5.2 Diabetes mellitus as a risk factor for hypertension

The Indian subcontinent has a higher prevalence of diabetes mellitus than any other region in the world, and 2-3 times more reported prevalence than in Western countries[58]. In India alone, an estimated 19.3 million people had diabetes in 1995, and this is expected to almost triple to 57.2 million in 2025. The Indian Council of Medical Research (ICMR) estimates that the prevalence of diabetes is 3.8 per cent in rural areas, compared with 11.8 per cent in urban areas[58].

It is estimated that 246 million people in the world were affected with Diabetes in the year 2007[52]. India and China were at the forefront of the Diabetes epidemic with 7.6% of the world's diabetics in India alone[52]. It is postulated that Diabetes is rare where traditional lifestyles have persisted; as in some areas of Japan; but where communities have undergone westernization and urbanization the prevalence of diabetes ranges from 14 to 20%. The Eastern Mediterranean and Middle East have the highest prevalence rates (9.2%) of diabetes followed by North America (8.4%) [59].

It has been found that high blood glucose levels are considered as a greater risk for ischemic heart disease and stroke as compared to smoking. In a study conducted by the International Diabetes Federation, it was found that people with diabetes have a higher prevalence of CVD risk factors and these are more harmful in the presence of diabetes than in people without diabetes[60]. For each CVD risk factor present, the risk of CVD death is about 3 times greater in people with diabetes compared to people without diabetes. it was further suggested that

people with diabetes are 2 to 4 times more likely to develop CVD disease than people without diabetes, making it the most common complication of diabetes.21 After a coronary event, people with diabetes have a 1.5 to 2 times higher death rate than those without[61].

In a study published in Lancet in the year 2006 adults with diabetes have 12–40 times higher rates of coronary heart disease (CHD) than those in people without diabetes[62]. According to the International Diabetes Federation women with diabetes lose the pre-menopausal protective effect of oestrogen so that their CVD risk is the same as most men's[22]. In the same study it was stated that Strokes happen twice as often in people with diabetes and hypertension compared to people with hypertension alone[22].

According to a recent study conducted in 2006, it was found that CVD accounts for 50% of all fatalities in people with diabetes[52]. Out of these 84% of CVD - diabetes-related deaths occur in low and middle income countries. South Asia accounts for 37% of worldwide diabetes-related IHD deaths and 30% of worldwide stroke deaths. The countries of the former Soviet Union have the largest CVD diabetes-related mortality rate of any region[61].

1.5.3 Hyperlipidaemia as a risk factor for hypertension

The ICMR surveillance project in 2005 reported a prevalence of Dyslipidaemia (defined as a ratio of total to HDL cholesterol >4.5) of 37.5% among adults aged 15-64 yrs., with a higher prevalence of Dyslipidaemia (62%) among young male industrial workers in rural India. It was reported that the prevalence of Dyslipidaemia (abnormal Apo lipoproteins- ApoB/ ApoA1 ratio) among controls without acute myocardial infarction was higher among study participants living in the South Asian countries (45%) compared with participants from the other 47 countries represented in the INTERHEART study (35%). As in the overall INTERHEART population, abnormal ApoB/ApoA1 ratio was the single largest contributor to the population attributable risk for

acute myocardial infarction in South Asian countries[63]. The impact of dyslipidaemia on the burden of CHD has been otherwise understudied at a population level in native South Asians, despite its large contribution to CHD in other world populations[64].

1.5.4 Obesity as a risk factor for hypertension

It has been recognized that higher BMIs are associated with a risk of incident type 2 Diabetes, and a central fat distribution appears to be a stronger risk factor than overall obesity. With increasing obesity, diabetes prevalence is also on the increase, and in turn, diabetes is associated with at least a double of risk for cardiovascular diseases. As for cardiovascular disease, it is only more recently that the obesity has again been brought into focus. In particular the INTERHEART study, an international case-control study of myocardial infarction has shown that obesity and in particular central obesity, is a potent risk factor[64].

Metabolic syndrome (X-syndrome) is a world- wide epidemic, setting the stage for type 2 diabetes and vascular complications. It is a clustering of risk factors including visceral obesity, insulin resistance, Dyslipidaemia, hypertension and chronic low grade inflammation[66]. A prothrombotic state due to disturbances in haemostasis and fibrinolysis, is now well documented in obese subjects with visceral obesity and could contribute to accelerated atherosclerosis. These alterations are the consequences of complex interrelations between insulin resistance, inflammation and the oxidative stress which occur at the level of ectopic fat depots, cardiovascular tissues and circulating cells. An up regulation of pro-inflammatory cytokines leads to disturbances in the function of the vascular endothelium reflected by impaired endothelium-dependent vascular relaxation, increased secretion of endothelium derived products such as von Willebrand factor[66]. Endothelial cells take a proadhesive phenotype (increased expression of VCAM, ICAM, E selectin etc.). There is an increased release of microparticles, and decreased number of endothelial cell progenitors which lead

to a decreased regenerative potential. In vitro studies have shown a number of anomalies in platelet functions in MS subjects[67]. Hypertriglyceridemia and Adiponectin deficiency facilitate platelet aggregation. These anomalies account for hypersensitivity of platelets to aggregants and hyposensitivity to anti-aggregants and are thought to contribute to enhanced atherosclerosis via increased platelet activity at sites of vessel injury and could be involved in the platelet resistance to anti-aggregating agents such as aspirin described in type 2 diabetic patients[51].

Metabolic syndrome (MS) has features of a hypercoagulable state, consisting of increased levels of clotting factors produced by the liver (factor VII and fibrinogen). Recently the highly vascularized adipose tissue has been proposed as a major source of tissue factor involved in the initiating step of coagulation. Its expression level and the resultant thrombin formation are influenced by insulin and glucose illustrating a possible link between glucose homeostasis and thrombosis. The delay in thrombolysis observed in obese subjects is the most documented anomaly described in the MS. It has been attributed to increased PAI-1 levels. PAI-1 is an acute phase protein and the main antagonist of plasminogen activators33. Beyond its function as an anti-fibrinolytic molecule, PAI-1 participates in processes involving angiogenesis and wound healing. Ectopic fat depots (peritoneal fat, liver steatosis, pericardiac fat) may represent privileged sites of PAI-1 synthesis during the MS. Interestingly there is also increasing evidence that PAI-1–dependent mechanisms may contribute to the pathogenesis of obesity and type 2 diabetes mellitus[66].

1.5.5 Socio-economic status as a risk factor for hypertension

Cardiovascular disease is one of the leading causes of mortality across the world. Its aetiology is multi-factorial and researches are trying to identify the modifiable risk factors which may influence its development and pathogenesis[51]. Socioeconomic status (SES) may also prove to be a risk factor. In westernized societies there is a consistent and continuous gradient between

the prevalence of cardiovascular disease (including both coronary heart disease and stroke) with SES, such that people from lower SES have more disease. Several studies have examined the roles of the major cardiovascular risk factors for explaining this gradient. There is a strong SES gradient for smoking, which parallels the gradient in disease, but the gradients for hypertension and cholesterol are weak or absent. Central obesity and physical inactivity may also be contributory factors. The principal measures of socio-economic status have been education, occupation, and income or combinations of these[54, 68]. Education has been the most frequent measure because it does not usually change, unlike occupation and income. After young adulthood, information about education can be obtained easily, and it is unlikely that poor health in adulthood influences level of education[54]. Also, the information about education is usually reliable. However, other measures of socio-economic status have merit, and the most informative strategy would incorporate multiple indicators of socio-economic status[69]. A variety of psychosocial measures, for example, certain aspects of occupational status, may be important mediators of socio-economic status and disease. The hypothesis that high job strain may adversely affect health status has a rational basis and is supported by evidence from a limited number of studies[52]. These findings have been replicated repeatedly for 80 years across measures of socioeconomic level and in geographically diverse populations[10]. During the past 40 years of research there has been a consistent inverse relation between cardiovascular disease, primarily coronary heart disease, and many of the indicators of socio-economic status[54, 68]. Evidence for this relation has been derived from prevalence, prospective and retrospective cohort studies. Of particular importance to the hypothesis that socio-economic status is a risk factor for cardiovascular disease was the finding by several investigators that the patterns of association of socio-economic status with coronary disease had changed in men during the past 30 to 40 years[45, 57, 68]. However, the declines in coronary mortality of the last few decades have not affected all segments of society equally. There is some evidence that areas with the poorest socio-environmental conditions experience later onset in the decline in cardiovascular mortality[41, 70]. A number of studies suggest that poor living conditions in childhood and adolescence contribute to increased risk of

arteriosclerosis. Some of these studies have been criticized because of their nature and others for inadequate control of confounding factors[47, 71, 72, 73].

1.5.6 Smoking and alcohol as a risk factor for hypertension

The first estimates of the health consequences of smoking in China and India has shown substantially increased risk of mortality and disease among smokers[74, 75, 76].

Recent researches have confirmed that cigarette smoking damages the blood vessels and is a contributing factor towards the development of cardiovascular diseases[77]. A study conducted on Young adults aged 15-34years who had died from accident, suicide or murder looked for evidence of fatty plaque formation in the blood vessels and measured levels of cholesterol and Thiocyanate (a marker for cigarette smoking). It was found that any person who had smoked showed more early signs of atherosclerosis than people who had never smoked. Passive smoking, in a research carried out in UK, was also identified as a contributor to cardiovascular diseases[78].

The deleterious effects of smoking are due to nicotine and carbon monoxide[79].

- Nicotine causes both immediate and longer term increases in blood pressure, heart rate, cardiac output and coronary blood flow.
- Carbon monoxide binds with haemoglobin to for carbamino-haemoglobin thus reducing the amount of haemoglobin available for oxygenation.
- The viscosity of the blood increases due to smoking thus resulting in atherosclerosis.

In the year 2000, there were an estimated 4.83 million deaths in the world attributable to smoking. The leading causes of death due to smoking were cardiovascular diseases with 1.69 million deaths, COPD with 0.97 million deaths and lung cancer with 0.85 million deaths[80]. In 2003, a study conducted

in Canberra by Australian Institute of Health and Welfare (AIHW) showed that 17% of the total deaths due to smoking were attributed to cardiovascular causes like stroke and ischemic heart disease[81].

Mild to moderate alcohol consumption has been associated with lower rates of CVD events in multiple Western-based observational studies. However, Joshi and colleagues in the INTERHEART (South Asia region) study reported that consumption of alcohol was not associated with myocardial infarction in any of the South Asian countries[45, 64, 82]. Conversely, several studies have shown a strong and independent positive relationship between alcohol intake and development of cardiovascular diseases, especially hypertension[83, 46].

1.5.7 Diet as a risk factor for hypertension

A higher intake of cholesterol and saturated fat and a low polyunsaturated to saturated fat (P: S) ratio were related to increased CVD risk among women with type 2 diabetes[49]. Among diabetic persons, replacement of saturated fat with monounsaturated fat may be more effective in lowering CVD risk than is replacement with carbohydrates[49]. The ratio of polyunsaturated to saturated fat (P: S) was inversely associated with the risk of fatal CVD. In a study conducted in the year 2001 in Edinburg, it was observed that the Cardiovascular mortality was reduced by 9% and cardiovascular events by 16% when either the total intake of dietary fat was reduced or the intake of saturated fat was reduced or the intake of dietary cholesterol was reduced or a shift from saturated to unsaturated fat was introduced. Trials with at least two years' follow up provided stronger evidence of protection from cardiovascular events (0.76; 0.65 to 0.90)[56, 84].

It has been observed that a diet high in saturated fats and Trans fats has deleterious effects on the human body and leads to abnormal levels of fats in the blood which is a potent risk factor for CVD[85, 86]. Saturated fats are found in animal products, which when replaced with unsaturated fats (Olive and canola

oils and nuts are sources of monounsaturated oils). Soybean and sunflower oils are sources of polyunsaturated fat[86] have shown to improve the cardiovascular health[85]. The omega-3 and omega-6 fatty acids are essential fatty acids which cannot be synthesized by the human body and thus must be included in the diet. They are found in oily fish, nuts and seeds and have a beneficial effect on the heart and the cardiovascular system[56]. Saturated fat intake should not exceed 10% of total energy and for high-risk groups, like people with diabetes; total saturated fat intake should be 7% or less of total energy. Total fat intake should not be greater than 30% of total calories consumed[56]. It is further seen that use of monounsaturated fats lowers the total cholesterol and low-density lipoprotein (LDL) cholesterol[87].

Although meat, poultry and fish along with dairy products and eggs are considered good sources of protein, they are high in total fat, saturated fat and cholesterol[87]. Skim milk rather than whole milk or skinless chicken breast rather than fried chicken have lower fat as compared to meat and poultry[84, 87]. Lean Fish is also a good alternative to high-fat meats[87]. Some types of fish such as cod and herring have less total fat, saturated fat and cholesterol than meat and poultry whereas certain types of fish like salmon, mackerel and tuna a beneficial effect on the heart and cardiovascular system because they are rich in omega-3 fatty acids[84,87].

It has been recommended that saturated fats should provide less than 10% of the total calories in the diet. The sodium levels in the diet should be 6 grams per day. Cereals should contribute atleast 6 servings (180 grams) per day of which at least 3 servings should be of whole grains. Some researchers suggest that fruits (>2 servings/day) and vegetables (>3 servings/day) are beneficial for cardiovascular health[88, 89, 90].

American Heart Association, 2006: Diet and Lifestyle Recommendations for Cardiovascular Disease Risk Reduction states the following measures[91].

- Balance calorie intake and physical activity to achieve or maintain a healthy body weight.

- Consume a diet rich in vegetables and fruits.
- Choose whole-grain, high-fibre foods.
- Consume fish, especially oily fish, at least twice a week.
- Limit intake of saturated fat to 10% of energy, Trans fat to 1% of energy, and cholesterol to 300 mg per day by
- Minimize intake of beverages and foods with added sugars.
- Choose and prepare foods with little or no salt.
- Consume alcohol in moderation.

The National Institute of Nutrition[92] (Indian Council of Medical Research), Hyderabad in the report (draft document) on Nutrient Requirements and Recommended Dietary Allowances for Indians, has given the dietary recommendations for Indians in the year 2010 where the guidelines have highlighted the need for reducing ready to eat foods, salt, sugar and processed foods. Due to change in the lifestyle and reduced activity levels, the calorie requirements have also reduced, thereby calling for a reduction in simple carbohydrates and fats. The fibre intake should be increased to 14 grams/1000 kcals per day, with an average intake of 30gm of fibre per day. Carbohydrates should be the primary source of energy for the body, with maximum portion of carbohydrates constituted by whole grains like semi-polished rice, whole grain flour, ragi, whole grain breads, multi-grain flour, jowar, broken wheat, brown rice etc. Refined flour, white bread, pasta and white rice are richer sources of starch and are low in fibre content and so should be avoided. Simple carbohydrates in the form of sugar, soft-drinks, candies, juices, bakery items etc. should be avoided. The total sugar intake should not exceed 5% of total calories (~25gms/day for a 2000kcal diet).

Protein is an important part of the diet as well. It helps in building muscles and is a major component of immunoglobulins. It helps in satiety and so, reduces the intake of fats and carbohydrates. The average intake of proteins of Indians is low, especially first class proteins. Thus, it has been recommended that both the amount and quality of protein should be improved by including different dals, whole pulses, skimmed milk and curd, lean meat, fishes rich in omega-3

fatty acids and egg white. Recommended dietary allowance (RDA) for protein for a healthy individual is 1gm/kg body weight (~ 60gm/day for a 60 kg person). This recommendation varies if co-morbidities like diabetes, renal failure, myocardial infarction etc. are present[92].

Apart from these macro-nutrients, vitamins and minerals too are vital for the normal functioning of the body. A balanced diet, especially rich in fruits and vegetables caters for their RDA. Salt is an important mineral which plays a crucial role in the body by maintaining the osmolarity of body fluids, integrity of muscles and nerves and maintains the electrolyte balance. The daily amount of salt consumed should be restricted to 6gms/day. Salty foods like pickles, namkeens, ketchups, chips, chutneys should be avoided as they contain a very high amount to salt[92].

2 HYPOTHESIS

2.1 HYPOTHESIS STATEMENT-

1. There is a significant relationship between prevalence of Hypertension and low consumption of fruit and vegetables and high consumption of oil, salt and sugar.
2. There is a significant relationship between prevalence of Hypertension with lack of physical activity, alcohol consumption and tobacco consumption.
3. There is a significant relationship between prevalence of Hypertension with increased Waist circumference, high Body Mass Index and high Waist to Hip ratio.

2.2 PRIOR KNOWLEDGE

The risk factors of Hypertension may be classified in various ways.

1. Genetic Factors (non- modifiable factors i.e., the factors which cannot be controlled and have a hereditary or genetic origin) and environmental factors (diet, physical activity and lifestyle).
2. Modifiable Factors (diet, exercise, alcohol and tobacco consumption etc.) and Non- Modifiable (family history, genetics, past history, etc.) risk factors.

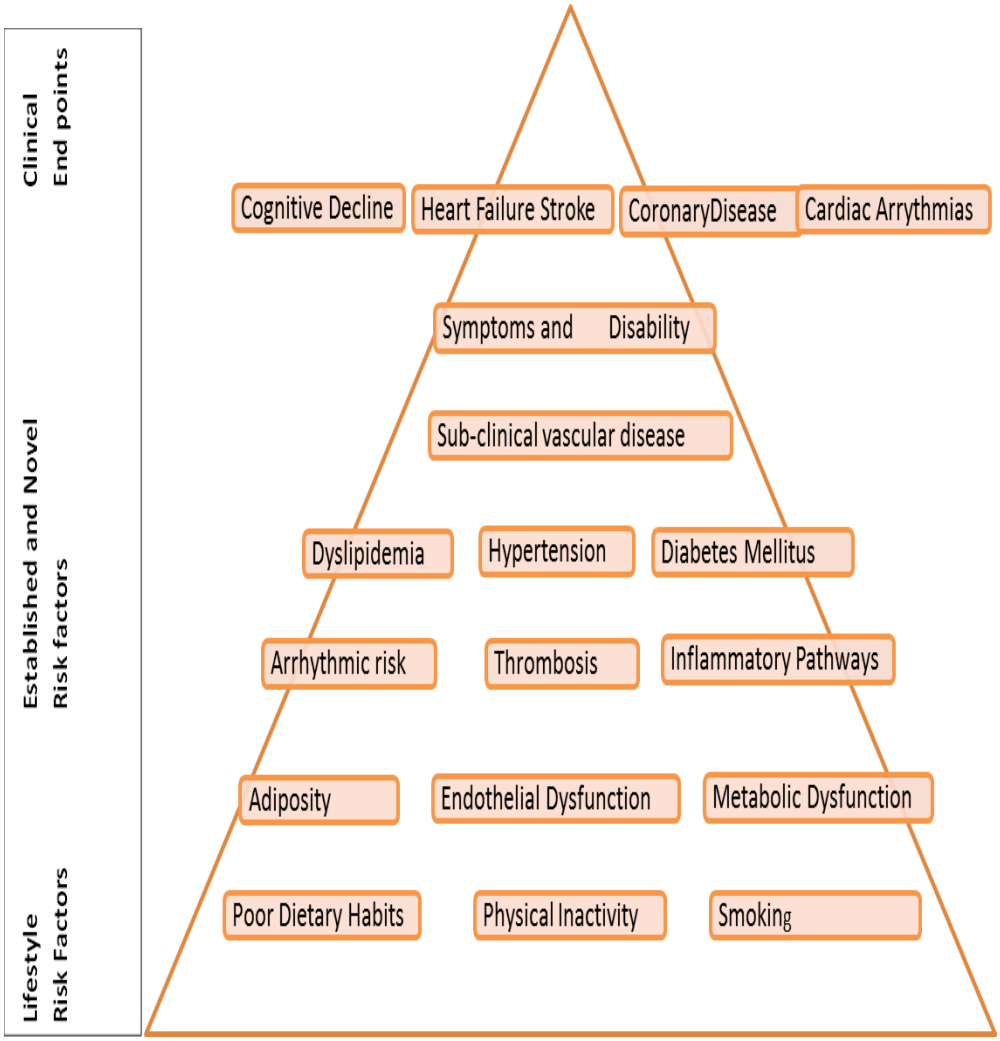

Figure 2.1Relationship of Risk Factors of CVD to Hypertension

Figure 2.1 emphasizes on the relationship of risk factors of cardiovascular diseases and its complex pathway of pathogenesis involving various risk factors. The combined effect of these risk factors culminates into permanent structural vascular changes and complications ranging from myocardial infarction to cognitive decline. The primary modifiable risk factors of CVD, i.e., Lifestyle factors like improper dietary habits, sedentary lifestyle and tobacco consumption conjointly act together to result in Obesity, endothelial dysfunction and metabolic abnormalities which are reversible structural changes. These may then progress through inflammatory pathways and Dyslipidaemia to Hypertension and Diabetes leading to clinical end points.

Review of literature suggests that a number of risk factors are related with Hypertension. A few genes which have been encoded for drug-metabolizing or -transporting enzymes have been found to be associated with Hypertension in humans (e.g., ACE, CYP1A2, CYP3A5, ABCB1 and MTHFR). These genes are also involved in the metabolism and transport of endogenous substances and their effects may be modified by selected environmental factors, such as diet or lifestyle[21, 22]. However, little is currently known on the complex interplay between environmental factors, endogenous factors and genetic variants and no concrete proof of undeniable association of various factors and the presence of Hypertension in Indian population (especially in Chinchwad, Pune) exists.

2.3 EVIDENCE EVALUATION STRATEGY

If a project could be designed to decipher the granular habits persisting amongst the population and their quality of life, we may discern the environmental factors which contribute to increase in the risk of Hypertension.

2.4 ACTIONS TO ACHIEVE THE STRATEGY:

A detailed questionnaire to accrue the information regarding the risk factors and a statistical plan to establish the association of the risk factors could enable to delve into the landscape of the risk factors associated with Hypertension.

2.5 MOTIVATION FOR RESEARCH

Pune is a rapidly growing city with changing demographics. The rate of migration has increased manifold for this city. With urbanization, a huge change in lifestyle is seen and the epidemiology of diseases is transitioning from infectious diseases to Non-communicable diseases (NCD's). With the increasing burden of disease, it becomes important to study the aetiology of NCD's. No study exists for the city of Pune to analyse the risk factors of Hypertension in men in Pune. Similar researches over a period of time have been conducted for the cities of Jaipur, Chandigarh, Chennai, Mumbai, Delhi, Ahmedabad, Lucknow etc. However to extend this research to multiple location and multiple clinics within each of these locations would require a multi-state and multi-clinic involvement of independent researchers with a standardized framework. Hence, with a focus on a specific demography in a city where such research had not been carried out before, a renowned hospital in Pune with a large footfall in the cardiac clinic was finalized.

Hypertensive population, when compared to normotensives, develop twice as much peripheral arterial occlusive disease, three times as much coronary heart disease, four times as much congestive heart failure and seven times as much stroke[46, 74]. Recent studies have shown conclusive data that the mortality rate increases progressively with a rise in the systolic blood pressure (SBP) and diastolic blood pressure (DBP). There is a linear relationship between IHD and stroke risk and levels of blood pressure increasing from as low as 115mm Hg SBP and 75 mmHg DBP[93]. The increased risks are present in individuals belonging to age group of 40 to 89 years. For every 20 mmHg systolic or 10

mmHg diastolic increase in BP, there is a doubling of mortality from both IHD and stroke[94]. In addition, longitudinal data obtained from the Framingham Heart Study has indicated that BP values between 130–139/85–89 mmHg are associated with a more than twofold increase in relative risk from cardiovascular disease (CVD) as compared with those with blood pressure levels below 120/80 mmHg. Hypertension is even more prevalent (20-40% among urban and 12-17% among rural adults)[95], and has affected an estimated 118 million inhabitants in India in 2000; this number is projected to almost double to 214 million in 2025[96]. In a study based in urban Maharashtra the prevalence of Hypertension in 1963 was estimated to be 4.0%[46].

There have been numerous prior studies to study the prevalence of cardio-vascular diseases all around the world. But these studies have had the following limitations:

- No previous researches have focused on burden of Hypertension in Pune city
- Few studies focused on the burden of CVD especially Hypertension among South Asians living in their own countries;
- Data were collected on the presence or absence of certain risk factors, and not the intensity or pattern of exposure to these risk factors and their relationship to CVD
- Data on dietary patterns, physical activity, alcohol intake, and psychosocial factors were often not collected
- Data on Dyslipidaemias included only crude lipid measures such as total cholesterol instead of Apo lipoproteins (ApoA1 and ApoB)
- Data for prevalence of HTN was often not collected across all demographics.
- There were relatively few clinical events to reliably compare the contributions of various risk factors on the presence of CVD
- No previous studies have been done in the city of Pune to determine the risk factors of Hypertension.

Therefore the research was carried out in the city of Pune to encompass the elements of multi-culture, religion and socio-economic backgrounds.

3 OBJECTIVES

The objectives of this study were to determine a relationship between both the intrinsic and environmental (extrinsic) risk factors of hypertension. The environmental or the extrinsic risk factors studied are dietary habits, socio-economic status, levels of physical activity, alcohol consumption and smoking. The intrinsic factors studied are family history, age, medical history and anthropometry.

1. To study relationship of Hypertension and dietary factors
    a. To study the dietary risk factors for hypertension which includes-
        i. Dietary Habits (vegetarianism vs. non vegetarianism),
        ii. Low consumption of green leafy vegetables, fruits,
        iii. high consumption of roots & tubers
        iv. Type of milk consumed (low fat vs high fat)
        v. type and quantity of non-vegetarian food items- Chicken, Mutton(other red meats) and Egg
        vi. visible fat consumption and type of oil used
        vii. Amount of salt and sugar consumed

2. To study relationship of Hypertension and Lifestyle factors
    a. To study various lifestyles as a risk factor of hypertension including
        i. The levels and frequency of physical activity
        ii. Amount of Alcohol consumed and frequency of consumption
        iii. Amount and frequency of smoked and non-smoked tobacco consumed
3. To study relationship of Hypertension and Anthropometric measurements

a. To take anthropometrical measurements and assess them as a risk factor for hypertension including the waist circumference, hip circumference and weight of the subjects.
b. To calculate and evaluate the Body mass index and Waist to Hip ratio as a risk factor of Hypertension.

4. Other factors and Hypertension
    a. To study the risk factors of hypertension among adult males, between the age group of 20-60 years, in the city of Pune.
    b. To study the family history for hypertension, hyperlipidemia and diabetes, myocardial infarction and stroke and its role in hypertension.
    c. To determine the quality of life (QoL) of Hypertensive patients using specific questionnaires and gauge the impact of Hypertension on their quality of life.

4 METHODOLOGY

4.1 MATERIALS AND METHODS

This study was a cross-sectional survey with a sample size of 1000 patients drawn from a charitable hospital in Chinchwad, Pune. This research design was chosen to get a representative sample. A sample size of about 500 is considered adequate by WHO to identify a 20% difference in the mean level of biophysical and biochemical risk factors. The samples for this study were selected up from the cardiac Out Patient Department which has a footfall of 50 patients per day on an average. The data collection was done over a period of 1 year. First 1000 subjects who walked into the clinic were asked for their consent. 500 subjects were known Hypertensive (previously diagnosed with Hypertension) and on medication for Hypertension and the other 500 subjects were Non-Hypertensive and included in the study as controls. Only patients who gave their written consent were included in the study and for those who did not know how to write, a thumb impression was taken. This study was an attempt to ascertain the relationship of age, gender, family history, diet, medical history, alcohol consumption, tobacco consumption and different lifestyles as risk factors of Hypertension in the city of Pune (in males). The study variables include demographics, individual characteristics associated with major risk factors of CVD, past medical history, and anthropometric measurements. Most of these factors are modifiable and hence the pathogenesis of Hypertension can be controlled to some extent.

The questionnaires were administered by the investigator by a face to face interview and the questionnaires were filled by the investigator. Before the questionnaires were administered, written consent was taken from the respondent. In case the consent was not given, it was considered as a non-response. The questions were asked in the language understood by the respondent (English, Hindi or Marathi).

The data acquired though the questionnaires was entered in the Excel spread-sheets prepared by the investigator. The analysis of this data was also done by Excel by the investigator.

The entire methodology was aligned as per the defined objectives. The data acquisition forms were designed in local language and face to face interviews were conducted to determine the habits of the individuals. (Annexure I).

4.2 EXCLUSION CRITERIA

The exclusion criteria included all patients below 20 years of age or above 60 years of age. Females were not included in the study. The respondent should be mentally sane and not on any anti-psychotic medications.

A known Hypertensive was defined as a person with elevated levels of blood pressure who required medications. The person should have been consuming the anti-hypertensive medications for atleast 6 months on a regular basis.

A non- hypertensive was defined as a person who has not consumed any anti-hypertension medicines and has had a stable blood pressure within the normal range and without any history of cardiovascular events.

4.3 RESEARCH TOOLS

Data Collection

Sources of Data Collection are as follows-

- ❖ Primary Data – Face to face Questionnaires
- ❖ Secondary Data – Previous History of Medication, Old Prescriptions and Other Medical Records

•Sample selection- Samples were drawn from the same hospital (for both Hypertensive and Non- Hypertensive patients).

Samples for hypertensive patients were drawn from the cardiac out-patient department of the hospital. The first 500 hypertensive patients within the frame of inclusion criteria who gave the consent to be a part of the study were included.

Samples for non-hypertensive patients were drawn from the medicine out-patient department of the hospital. The first 500 non hypertensive patients within the frame of inclusion criteria who gave the consent to be a part of the study were included.

Sample collection for hypertensive and non-hypertensive patients was done simultaneously.

Three questionnaires were used to acquire the data from the subjects. The following were the questionnaires used.

1. Questionnaire for Study of risk factors of Hypertension in Adult Males-

This questionnaire was designed taking the WHO-STEPS[97] questionnaire as a template. The WHO-STEPS questionnaire was modified to suit Indian setting to determine the various risk factors, as the other questionnaires were not validated in this population set (Indian Hypertensives in Chinchwad, Pune). The questionnaire was divided into four broad sub-sections i.e., demographic

information, burden of disease, dietary habits, lifestyle determinants and Anthropometry. The demographic information included the residential address, contact number, type of residence (slum/non-slum), religion, mother tongue, and number of family members and monthly income of the family. Data analysis was done for all this information except for occupation which was not included in the data entry. For the purpose of analysis, the ages were grouped into various age brackets. Also the income has been grouped into three brackets instead of the seven income brackets according to which the data was collected.

Definitions used in this Questionnaire are given as follows-

SLUM: 'a compact area of at least 300 population or about 60-70 households of poorly built congested tenements, in unhygienic environment usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities'[65]. *(Census of India, 2001)*

EDUCATION: categorized as no education or illiterate, primary, secondary and higher[98] (NFHS-3 manual)

INCOME: categorized as per Kuppusmamy's Index into seven income groups, i.e. (figures in INR) <1,802; 1,803-5,386; 5,387-8,988; 8,989-13,494; 13,495-17,999; 18,000-36,016; <36,017[99].

Gururaj, Maheshwaran. Kuppuswamy's socioeconomic status scale--a revision of income parameter for 2014. International Journal of Recent trends in Science and Technology. 2014; 11(1):1-2.

PHYSICAL ACTIVITY- 'at least 30 minutes of moderate intensity physical activity atleast five times a week' or a total of 150 minutes of physical activity weekly[100].

Global recommendations for physical activity for health 18-64 years old. Global strategy on Diet, Physical Activity and Health. WHO, 2015

DIET-

1. Servings of **Roots and Tubers** and **Green Leafy Vegetables** classified into categories:

≤1 serving/week, 1-2 servings/week, 2-3 servings/week, >3 servings/week.

The risk of developing CVD decreases with increase in the number of servings of green leafy vegetables, whereas the risk increases with increase in the number of servings of roots and tubers[101].

Rastogi T, Reddy KS, Vaz M, Spiegelman D, Prabhakaran D, Willett WC, Stampfer MJ, and Ascherio A. Diet and risk of ischemic heart disease in India. Am J Clin Nutr 2004; 79:582–92.

2. Oil consumption upto 600 ml per month per individual is the recommended intake. This includes Oil, Butter, Cream and Ghee intake[102].

Crawford MA. The role of dietary fatty acids in biology: Their place in the evolution of the human brain. Nutr Rev 50:3, 1992

2. Questionnaires on Quality of Life(QoL)

The QoL of Hypertensive patients was studied using two pre-defined and validated questionnaires- MINICHAL scale and WHO-BREF scale.

MINICHAL Scale

MINICHAL scale[103] was developed in Spain in 2001 and contains 17 items. This instrument can be used both for population-based studies and clinical trials to assess a patient's QOL. The word MINICHAL is derived from "Mini Cuestionario de Calidad de Vida en Hipertensión Arterial". It consists of two domains – mental (nine items) and somatic (seven items). The mental domain includes questions one to nine and score ranges from 0 to 27 points. The somatic domain includes questions 10 to 16 and score ranges from 0 to 21 points. Last question is related to the overall impact of Hypertension on the QoL. The score scale is Likert scale with four possible answers (0 = No, not at all; 1 = yes, somewhat; 2 = yes, a lot; 3 = yes, very much). Total points range from 0 (best level of health) to 51 (worst level of health).

WHOQOL-BREF scale

This is a 26 item self-administered generic questionnaire. The WHOQOL-BREF[104] is one of the most commonly used generic QOL questionnaire which was developed simultaneously across a broad range of member countries, assuring that it could be used as a multi-cultural and multi-lingual tool. The other QoL questionnaires were specific to countries and certain populations, hence making the WHOQOL-BREF a more universal questionnaire than any other existing QOL tool. It emphasizes subjective response rather than objective life condition, with assessment made over the preceding two weeks. All items, on a five-point scale, could be classified into five domains: overall general health - global (two items), physical (seven items), psychological (six items),

social relationships (three items) and environment (eight items). The response option ranges from 1 (very dissatisfied / very poor) to 5 (very satisfied / very good). The total raw score for these five dimensions is transformed into 0 (lowest) to 100 (highest) with low score indicating poor QoL.

4.4 PROCEDURE FOR ACQUIRING DATA

4.4.1 Pilot Testing of Questionnaire

The questionnaire (Questionnaire for a study of risk factors of hypertension in adult males) was pre- tested among known people. A total of 30 questionnaires were pre-tested. Later, after some editing in the questionnaire, it was again pilot tested in a population not known to the investigator.

4.4.2 Steps in data collection

Patients, who walked into the hospital, first registered themselves as new or follow-up patients with the hospital. They then took cardiologists consultation and were then approached by me to be a part of this study. If they agreed, the Questionnaire for study of risk factors of hypertension in adult males was administered to them, wherein their socio demographic characteristics and clinical data were noted. Thereafter, their anthropometric measurements were taken by following the standard procedures. The Quality of Life questionnaires were then administered the MINICHAL scale and the WHO-BREF scale. The measurement of blood pressure was done after all the questionnaires were administered and anthropometric measurements taken.

Data Collection of Burden of Disease

Under burden of disease, the health status of all family members was noted along with the type of illness and the duration of the illness though these details have not been included in the data entry. Then information was taken about cardiovascular diseases, Hypertension, and diabetes mellitus along with their duration of illness and medication details of the subjects. The family history of

cardiovascular diseases, Hypertension, stroke and angina pectoris was noted. Also recorded were details about age at diagnosis.

Data collection of Dietary habits

Dietary data was acquired using food frequency tables for intake of green leafy vegetables, root and tubers, other vegetables (beans, gourds etc.), salads and fruits. Type (Cow's or Buffalo's milk) and quantity of milk were inquired into. Intake of curd and cottage cheese were also noted to calculate the total milk intake. Intake of non-vegetarian foods included data on type of non-vegetarian food consumed (chicken, mutton, pork, fish) and their quantities. Egg consumption was calculated by recording the weekly consumption of egg by the family. Oil intake was calculated by recording the monthly consumption of visible oil for the family and the type of oil (Soybean oil, groundnut oil, Vanaspati, ghee, corn oil etc.). Salt intake was calculated in grams per day by addition of top salt ('added salt' while cooking of food) and sodium found in processed foods (pickles, papad etc.). Sugar intake was similarly calculated in grams per day considering the daily sugar added and sugar from other foods (sweets etc.)

All values were converted into mgs/ml consumption per day by the individual. Oil intake was then categorized as less than 1 litres per month, 1-2 litres per month, 2-3 litres per month and more than 3 litres per month.

Data Collection of Lifestyle determinants

Lifestyle determinants included exercise frequency, tobacco intake and alcohol consumption.

Data on exercise frequency in the past 1 week was collected and classified as – no exercise, less than 3 times a week and ≥ 5 times a week or 150 minutes per

week. Exercise was defined as physical activity which is planned, structured and repetitive for the purpose of conditioning any part of the body (e.g. - brisk walking, running, yoga, gym, cycling etc.)

Data on Habits included frequency and duration of tobacco (cigarette, bidi, Gurkha, snuff and misery) consumption and the amount and frequency of alcohol consumption

Data collection of Anthropometry

Height, weight, Hip circumference and waist circumference (WC) were measured thrice and mean was noted. Height was recorded on a stadiometer to the nearest mm. Weight was measured by a digital weighing machine to the nearest 100 g and was calibrated using standard weight every day. The respondent was asked to stand with feet 12-15cms apart and equal distribution of weight on each leg. Waist circumference was measured with a non-stretchable tape at the midpoint between lower border of rib cage and upper border of iliac crest. Hip circumference was measured at the maximum circumference at the buttocks. The subject was asked to breathe normally, and measurement was taken at the end of gentle exhaling. Measuring tape was held firmly ensuring its horizontal position. Measuring tape was calibrated using a standard non-stretchable measuring tape. High WC was defined based on criteria modified for Asian Indians (WC ≥90 cm in men and ≥80 cm in women[20] BMI ≥ 23 kg/m^2 was defined as overweight).

Measurement of Blood Pressure

The measurement of blood pressure (BP) was done by a standard mercury sphygmomanometer using a standard size cuff. The subjects were first explained the procedure and asked to rest in supine position for 5 minutes in a quiet room at ambient temperature before the measurement was made. The

Brachial artery was located a cuff applied ensuring that the cuff is at the level of the heart and the bladder encircles atleast 80% of the arm after removing any tight clothing from the arm. The cuff was inflated to 20-30 mm of Hg above the palpated Systolic BP. The column was lowered at a speed of 2mm per second and BP was noted to the nearest 2mm. Readings were taken thrice for each subject at a time interval of 5 minutes, 10 minutes and 15 minutes. An average was then taken for the BP. BP was measured only for Hypertensive patients for assessing their Quality of Life.

Data collection for Quality of Life

The questionnaires on Health related Quality of life included data on signs and symptoms of Hypertension, duration of Hypertension, BP reading, co-morbidities / complications, drugs prescribed and non-pharmacological measures followed by patients. Patients were classified into four groups according to JNC[12] criteria. Patients falling into category of stage 1 and 2 of Hypertension were classified as "uncontrolled" while others as "controlled" Hypertension. Thereafter, patients were interviewed about QOL by using two QOL questionnaires – MINICHAL scale (Hypertension specific) and WHOQOL-BREF (generic).

Both instruments were translated in vernacular (Marathi) language and back translated to ensure content validity. The original and translated questionnaires were pilot tested in a population of 25 individuals not known to the researcher to ensure content validity. Questionnaires are designed for self-administration but most of the patients required structured interview owing to their lack of time to read the questionnaires and reduce the variability in the understanding of the questions. In the interviews, the patients were asked to respond based on the last seven days. It took approximately about 20 minutes to collect data from one patient (consent, history, QOL scales).

4.5 STATISTICAL ANALYSIS PLAN

Data Cleaning:

The data which was accrued was checked thoroughly for errors and omissions.

Data Analysis:

R- Statistical data modelling tool and Microsoft Excel 2010 were used for statistical analysis (multi-variate analysis). Descriptive statistics of the baseline characteristics were calculated. Odds ratios, z value, estimate, standard error and P value were calculated using logistic regression analysis to estimate the relation between Hypertension status and metabolic syndrome (diabetes, hyperlipidaemia); cardiovascular diseases (CVD); age and sex; family and sibling's history of Hypertension; medication and surgery; anthropometry (height, weight, waist inches/centimetres, hip inches/ centimetres, body mass index, and waist to hip ratio); Other factors (residence, religion, mother tongue, monthly income, education, health status etc. and habits (smoking, alcohol, salt intake, oral tobacco etc.).

Descriptive analysis included calculation of means, standard deviations (SD) and frequencies of categorical variables. The statistical correlations between two different QOL instruments, different domains of QoL, socio demographic and clinical parameters were analysed using Pearson correlation coefficient test. Student's t-test was used to compare means between two groups. The values were considered statistically significant if $P < 0.05$.

5 RESULTS

5.1 BASELINE CHARACTERISTICS

The study was conducted on a sample size of 1000 patients with a mean (SD) age of 47(±10.88) years. 82.9% of the population was from non-slum areas with 37% of the population from the 5th decade of life and 18% from the 3rd decade. A constant increase has been seen in the rise in the number of Hypertensive patients with increase in age. The second and third decade of age were seen to have a similar prevalence of hypertension. Individuals belonging to this decade were seen to have higher physical activity levels which was also reflected in the rising BMI ranges in higher age groups.

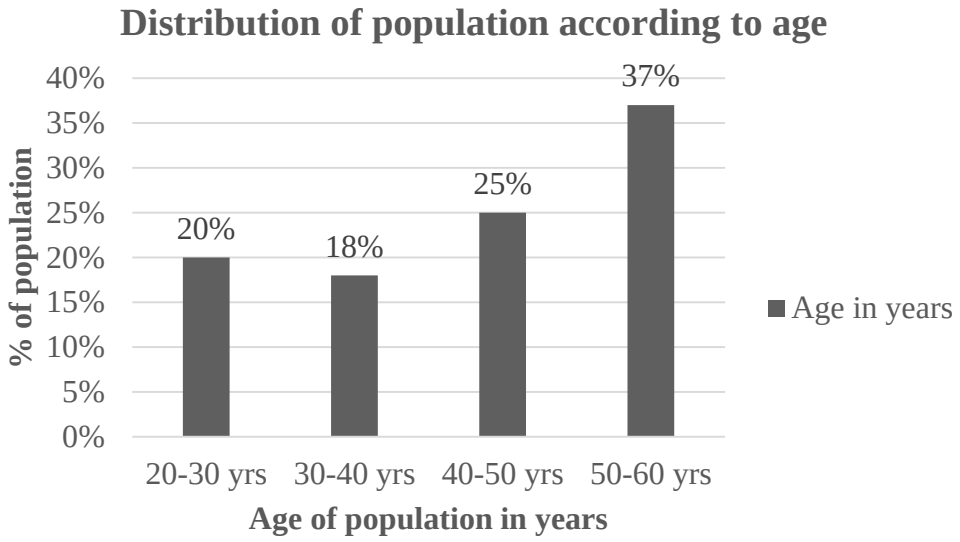

Figure 5.1 Population distribution across different ages

5.1.1 Demographic distribution of population

The sample population was derived from a single hospital. Most of the patients (95.7%) came from surrounding area of the hospital (a radius of 7kms). This residential area is pre-dominantly a non-slum (as per the Census of India classification) [65]. The population, is thus exposed to similar environmental factors like ambient air quality levels, sanitation standards and noise pollution levels. The PM_{10} (particulate matter) levels of this region were found to be very high during the course of data collection (average over a period of 1 year-134 $\mu g/m^3$) as per the Central Pollution Control Board[65]. Studies provide clues to possible causal pollutants in epidemiologic associations especially for organic carbon and fine particulate matter[105, 106, 107, 108]. Episodes of rise in blood pressure levels have been observed in a few studies after continued long term exposure to air pollutants[109, 110, 111].

Table 5.1 Distribution of population according to their place of residence

Type of residence	**Percentage (%)**
Slum	17.1
Non- Slum	82.9

The classification for slum/ non-slum is as defined by the Pune Municipal Corporation[65] (Census of India, 2001).

The place of residence is an extrinsic or environmental factor which is modifiable. It is an important factor as it indicates the accessibility to healthcare services, ambient air quality, and sanitation standards etc. which have a great influence on the health status of the population.

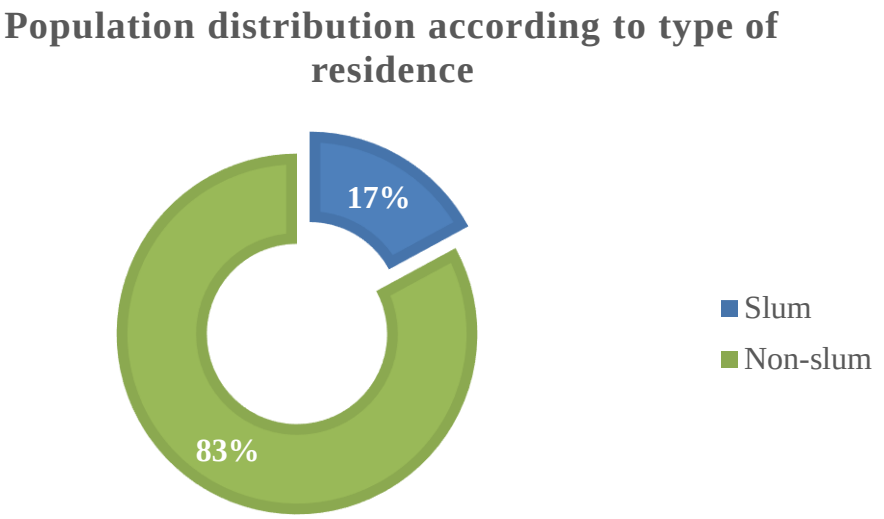

Figure 5.2 Distribution of population according to place of residence

82.9% of the total sample population resided in non-slum areas with good access to health care facilities, proper disposal of sewage, access to potable water and depleting green cover due to felling to trees for newer construction sites.

Distribution of population according to educational qualification

Education is an important determinant of the social dimension of health. Greater levels of education help in understanding diseases better and in identifying the most appropriate and suitable intervention needed to improve health. Level of education has different impact on health at various stages, e.g., it has more impact on mental plane in younger ages and physical functioning in older individuals[112, 113]. A lower education is found to be associated with lower socio-economic status subsequent to lower employment opportunities and thus a lower earning potential[114, 115]. It has been proposed that the chances of an individual with higher educational qualification to make healthier choices is better as compared to a person with lower education[116, 117].

Table 5.2 Distribution of sample population according to educational qualification

Educational Qualification	
No education/pre-primary	10.4
Primary level	34.1
Secondary level	14.4
Higher secondary	39.6
Non-response	1.4

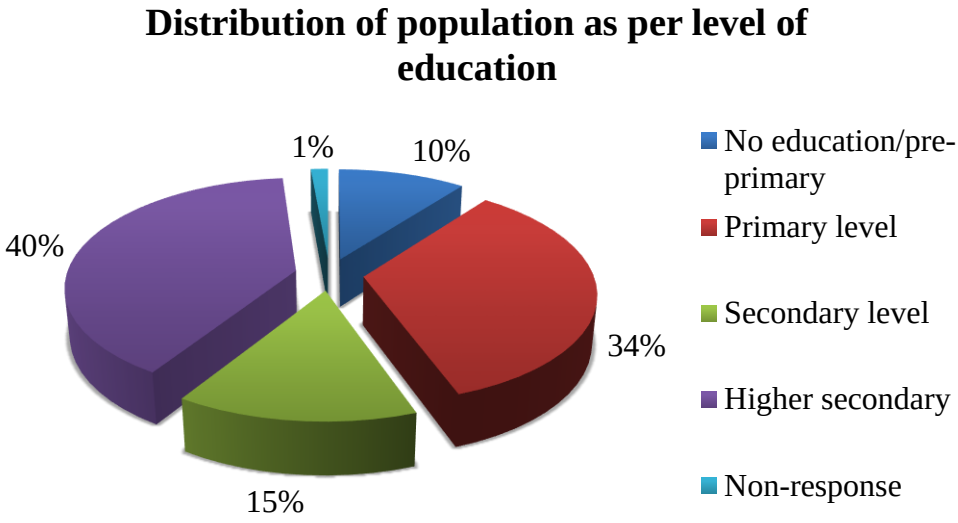

Figure 5.3 Population distribution according to educational qualification

Education is an acquired quality and varies drastically within a population. The level of education and literacy affects the standard of living, hygiene levels etc. thus affecting the rates of infectious diseases incidences and health status. The study of educational qualifications amongst the sample population reflects a distribution of respondents with 39.6% having received higher educational qualification and 44.6% having received primary level education or no education.

Distribution of population according to monthly household income

Monthly household income is a social determinant of health. Income level affects the health status of a family and individual in two ways- either directly related to enable economic independence and the power to access good healthcare facilities and access material conditions for better health or by increased social participation and opportunities to control life circumstances and sustain adverse life outcomes[118]. Also, health could affect income as well. A poor health condition results in higher absenteeism from work and thus lower incomes resulting in a vicious circle[119].

Table 5.3 Population distribution according to monthly household income

Monthly household income	**Percentage (%)**
Below 1802	13.8
1803-5386	18.6
5387-8988	11.4
8989-13494	13.4
13495-17999	17.2
18000-36016	18.8
≥36017	4.8
Non Response	2

Income is a major indicator of the socio-economic status (SES) along with the educational qualifications and the occupation. A higher SES indicates a better standard of living with less contagious diseases and more sedentary lifestyles. The sample population studied belonged mainly to the middle-income brackets. Only 4.8% of the total population had a monthly household income above Rs. 36,017. The classification of economic status is taken from the Kuppuswamy's Socio-economic Status scale[98] for 2014.

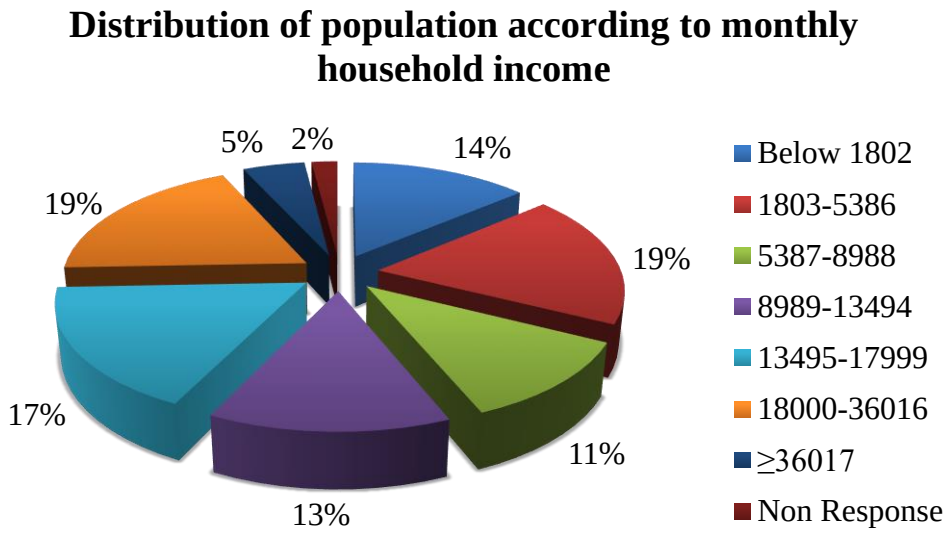

Figure 5.4 Population distribution according to monthly household income

Distribution of population according to religion

In medical research, religion and spirituality has been used interchangeably even though both are different. Spirituality is an individual phenomenon whereas religion is a social phenomenon, where they could be independent of each other[120]. Conceptualizing religion and spirituality in relation to health poses problems in methodology as randomization cannot be done and the allotment of religion and spirituality has to be done from the existing pool of data. There can be two approaches towards religion and spirituality- one where an unexplored factor (religion/spirituality) significantly improves health or the other where if a predictor (spirituality/religion) is entered after one or more other predictors (e.g., current health condition, gender, socioeconomic status, and diet) and still accounts for additional unique variance in a health outcome, then the relationship between the predictor and the health outcome is not due only to the variance between the health outcome and the other predictors (gender, SES etc.)[121].

Table 5.4 Distribution of population according to religion

Religion	**Percentage (%)**
Hindu	80.6
Muslim	9.6
Christian	1
Sikhism	5
Jainism	2.2
Buddhism	1.4
Other	0.2

The religion of an individual may point towards the lifestyle and habits of the person. The dietary habits vary widely among the different religions giving a chance to explore the effect of various diets on hypertension. The population distribution in our study is in alignment with national distribution of religious groups as per the 2001 Census of India[65] where Hindus were 80.6% of the total Indian population.

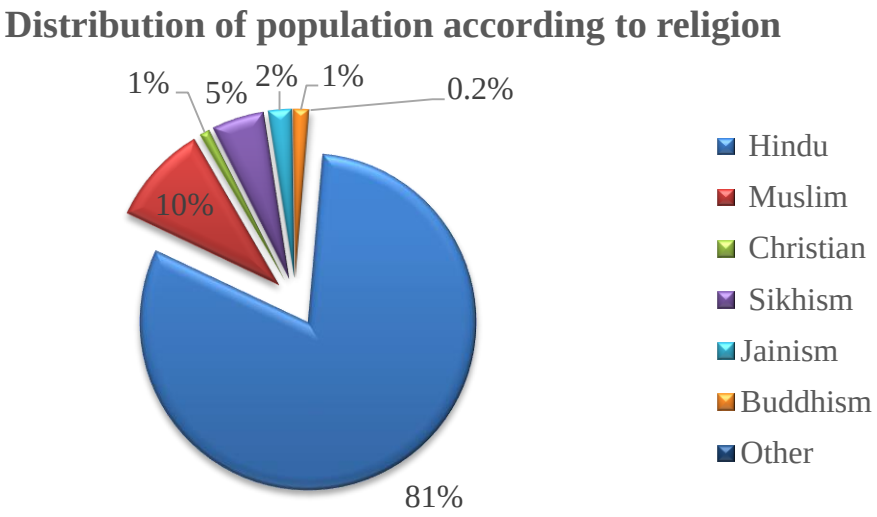

Figure 5.5 Distribution of population according to religion

5.1.2 Demography of population and Hypertension

With the fast changing lifestyles, it is imperative that environmental factors be studied as an aetiology of hypertension. The place of residence is important as it indicates the living standards, levels of sanitation, access to healthcare facilities, socio-economic status which play a vital role in an individual's well-being. Religion, represents not only the faith of individuals, but also the lifestyle followed and the diet consumed. India, being a country of multiple faiths gives an opportunity to study the variability in disease prevalence and pathogenesis of disease for people residing in the same area but following different religions.

The socio-economic status of a family determined by the monthly household income, highest education received by the head by the family and occupation of the head of the family indicates the level of health awareness, access to better healthcare facilities and the motivation and understanding for better lifestyle choices[115].

The factors religion and education showed significant association ($p < 0.05$ and $p < 0.01$ respectively) with presence of Hypertension. It was observed that Hindus, had a higher prevalence of hypertension as compared to other religions (Islam, Christianity, Buddhism, Jainism and others). It was also seen that the total monthly oil consumption in a Hindu family (1653 ml per month per individual as against the 600ml per month per individual recommendation) was higher than others as was also the salt and sugar intake. This indicates that the cumulative effect of high oil consumption, high salt intake and high sugar intake may be a risk factor for development of hypertension (even though high oil consumption independently was not found to be significantly associated with hypertension). Also, this in line with the results of this study where non-vegetarian food intake especially red meat (higher red meat intake in Christians and Muslims) was not found to be significantly associated with hypertension.

Table 5.5 Association of demographic profile of population and hypertension

Factors	Odds ratio	95%CI	Estimates	Std. Error	Z value	P value
Residence	0.947	(0.34-1.45)	-0.054	0.167	-0.324	0.74578
Religion	0.818	(0.49-1.33)	-0.201	0.089	-2.244	0.02486 *
Mother tongue	0.996	(0.56-1.45)	-0.004	0.025	-0.153	0.87832
Monthly income	0.997	(0.67-1.66)	-0.003	0.061	-0.050	0.96022
Education	0.782	(0.45-1.26)	-0.246	0.089	-2.781	0.00542 **
Health status	2.040	(1.62-2.89)	0.713	0.498	1.433	0.15193

*p<0.05, **p<0.01, ***p<0.001

Type of residence, mother tongue, monthly household income and the present health status had no significant association with Hypertension.

5.1.3 Distribution of population according to lifestyle determinants

Diet (modifiable environmental factor) plays an integral role towards the pathogenesis of various diseases. Dietary preferences like the amount of salt and sugar consumed, type and amount of oil used, amount of fibre consumed from fruits and vegetables etc. have been suggested to be risk factors for hypertension[49, 56, 84, 86]. In this study, only the amount of salt and sugar consumed have been found to have a statistical significance ($p < 0.05$) with incidence of hypertension. Other lifestyle choices like alcohol consumption, tobacco

consumption, smoking and physical activity levels have also been found to be statistically significant with the incidence of hypertension.

Distribution of population according to amount of salt consumed

The chemical composition of salt is sodium chloride where sodium is the cation and chloride is the anion. Sodium helps in maintaining the osmolality of body fluids. Kidneys play an important role in maintaining the electrolyte balance through sodium and water. An excess of sodium intake results in higher levels of sodium in the plasma which cannot be excreted by the kidneys. Excess sodium in plasma results in the water retention leading to increased extracellular and plasma volume thus increasing the blood volume. Increased blood volume increases the cardiac output leading to stroke, myocardial infarction and hypertension. Prolonged intake of high amounts of salt interferes with the calcium absorption hence leading to osteoporosis. The Two trials of Hypertension Prevention (TOHP) [122] concluded that individuals consuming less amount of salt were 25% less prone to develop cardiovascular disease as compared to people consuming higher amounts of salt. Salt intake can be reduced by limiting the consumption of bakery products, sauces and ketchups, cheese, processed meat etc. and increasing the amount of fruits and vegetables.

Table 5.6 Distribution of population according to amount of salt consumed

Salt intake(gm/day)	**Percentage (%)**
0-10	3.2
10-20	40.8
20-30	38
30-40	18

Salt, due to its extensive use in cooking and as a preservative, forms a major component of the diet. The recommendations for daily salt intake is 6gms/day

for adults which is well exceeded by the study population. About 40% of the hypertensive population consumed salt in the range of 20-30 grams/day. Only 3% of the studied population consumed less than 10 gm/day of salt. This salt intake calculated was the amount of salt added to the foods and the amount of salt consumed through preservatives and preserved foods.

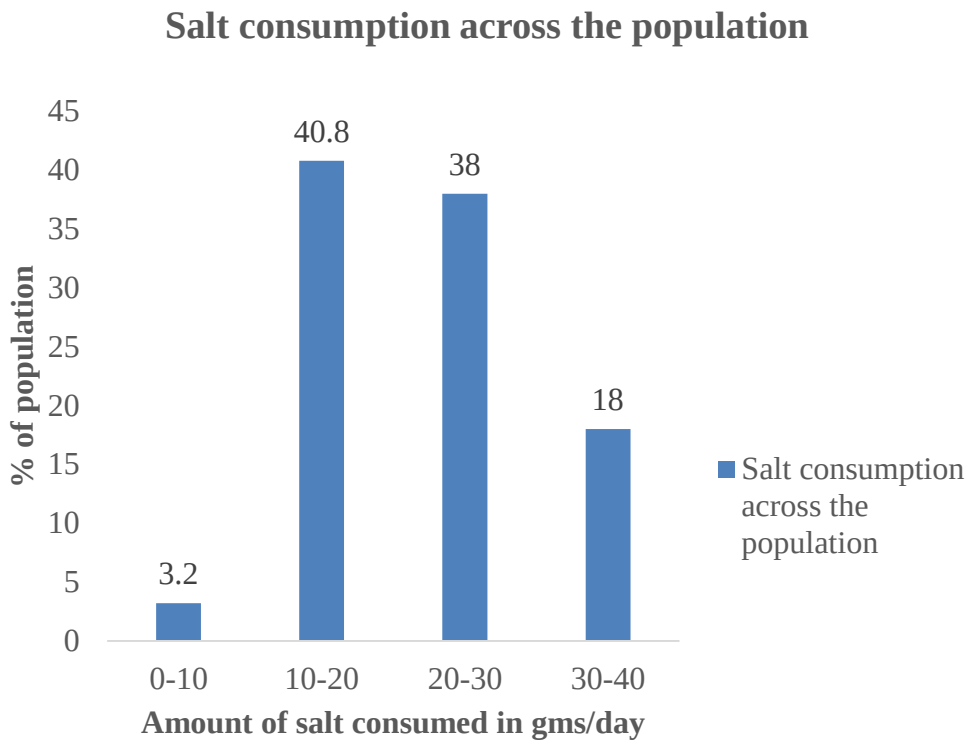

Figure 5.6 Distribution of population according to amount of salt consumed

It was noted that the amount of salt consumed through preserved foods was very high even though the added salt intake was moderately high. This indicates a lack of knowledge and awareness about sodium rich foods and a gap in imparting the knowledge by the physician to the patient.

Distribution of population according to amount of sugar consumed

Carbohydrates are an integral part of the diet comprising 60-70% of the total calories. They are the primary source of energy for the body. Simple carbohydrates are sugar, honey etc. which are mono- and di-saccharides which should be not more than 5% of the total calorie intake. Simple sugars can be easily broken down and are thus absorbed into the blood stream immediately. Intake of simple sugars leads to a sudden rise in blood sugar levels resulting in an insulin peak and thus concomitant hypoglycaemia[92].

Table 5.7 Distribution of population according to amount of sugar consumed

Sugar Intake (gm/day)	**Percentage (%)**
11-20	3.8
21-30	9.8
31-40	26.4
41-50	25.2
51-60	14.8
61-70	13
71-80	1.8
81-90	4
91-100	1.2

Sugar intake refers to the amount of sugar added to the beverages, foods etc. and simple carbohydrates consumed in any other form (preservatives, sweets, ice-creams, bakery items etc.). The prevalence of Hypertension was highest (51.6%) among individuals consuming 31-50gms of sugar per day. The WHO guidelines recommend less than 5% of the total calorie intake should come from sugar.

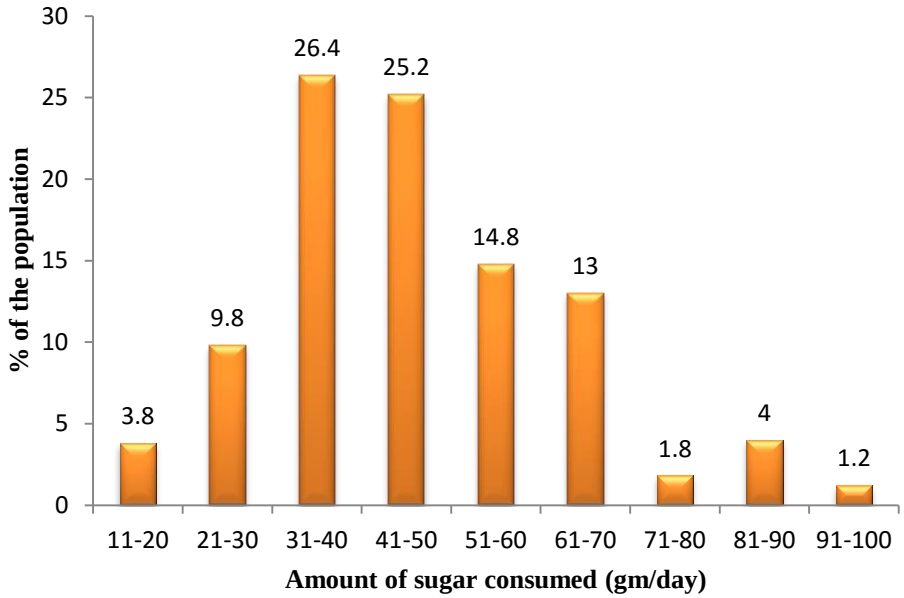

Figure 5.7 Distribution of population according to amount of sugar consumed

For a 2000 kcal/day diet, 5% of sugars amounts to 25 gms/day or 5 tsp/ day of simple sugar intake. Only 13.6% of the total population was consuming sugars within the prescribed limit. 7% of the population was consuming more than 70 gms/day of sugar per day. It was observed that the subjects were not aware of the high sugar content in preservatives, fruit juices, breakfast cereals etc.

Anthropometric profile of population

Anthropometry is the measurement of different of body parts to ascertain the sub-cutaneous fat accumulation in the body, appropriate weight ranges etc. A higher weight for height indicates obesity. Waist circumference (WC) is an indicator for abdominal obesity. These measures can be modified by regular healthy diet and exercise though in a few cases it may not be modifiable with no effect of any intervention. A comparison between the hip and waist circumferences also indicates gynoid (hip circumference> waist circumference) and android (waist circumference> hip circumference) types of obesity. Indian males tend to have android type of obesity as age advances. Android obesity is a risk factor for NCDs owing to the metabolic changes induced by accumulation of abdominal fat[123].

Table 5.8 Anthropometric characteristics (n ± SD) of study population

Age (yrs.)	47 (±10.88)
Weight (kgs)	71.85 (±7.89)
Height (cms)	172.0 (±4.82)
BMI (kg/m^2)	24.39 (±3.08)
Hip circumference (cms)	87.30 (±5.57)
Waist circumference (cms)	82.12 (±6.84)
Waist to hip ratio (WHR)	0.94 (±0.047)

The mean weight of the study population was 71.85 (±7.89) kgs with a mean BMI of 24.39 (±3.08) kg/m^2. The normal BMI range for Indians has been identified as 18.5 - 23 kg/m^2 . the WHR was 0.94 (±0.047) which is also above the recommended range for males.

Table 5.9: Prevalence of Hypertension according to tertiles of BMI, WC (cm) and WHR

Mean (±SD) WC and WHR according to tertiles of BMI	Prevalence of Hypertension (%)	WC (cm)	WHR
Lower (18.5-23.0)	6	80.59(±4.88)	0.93(±0.014)
Middle (23.1-29.9)	67.8	83.39(±5.51)	0.94(±0.019)
Higher (30.0-39.9)	26.2	92.50(±10.50)	0.98(±0.035)
p-value		P<0.0001	P<0.0001

The prevalence of hypertension was highest in people with BMI range between 23.1-29.9 kg/m^2. There is an increase in the waist circumference and WHR is observed with increasing BMI. The WHR of 0.93 is higher than the recommended WHR for Indians of 0.9 even though this WHR is of the population with normal BMI. This indicates android obesity in the population which is considered as a risk factor for hypertension and other NCDs as well.

5.2 INTER-RELATIONSHIP OF RISK FACTORS OF HYPERTENSION

Non-communicable diseases like hypertension do not have a single aetiology. They are an accumulation of years of lifestyle aberrations and an interaction of various risk factors. The pathogenesis of hypertension involves a combination of different causes acting with varying intensity. No lone cause can be isolated for the development of NCDs and hence they are also known as lifestyle

disorders implying that modernization, urbanization and changes in lifestyle result in these diseases with interplay of multiple aetiologies.

5.2.1 Metabolic Syndrome and risk of Hypertension

Metabolic syndrome is a cluster of conditions- hypertension, diabetes, obesity and hyperlipidaemia- that occur together. These are metabolic risk factors which when present increase the risk of developing cardiovascular diseases. Metabolic syndrome (Syndrome X or MS) is diagnosed when a patient has three or more than three of the following indices[124]-

a. Abdominal obesity (waist circumference of >40 inches in males, and >35 inches in females)
b. Triglyceride level ≥ 150mg/dL
c. HDL cholesterol level < 40mg/dL in males and < 50mg/dL in females
d. Systolic blood pressure greater than 130mm of Hg and diastolic blood pressure greater than 85mm of Hg
e. Fasting blood glucose levels ≥ 100mg/dL

Table 5.10 Metabolic Syndrome and risk of Hypertension

Factors	**Odds ratio**	**95%CI**	**Estimates**	**Std. Error**	**Z value**	**P value**
Diabetes	5.734	(3.23 – 8.96)	1.746	0.479	3.644	0.000268***
Hyper-lipidemia	0.264	(0.11 – 0.41)	-1.331	0.430	-3.095	0.001967**

*p<0.05, **p<0.01, ***p<0.001

Amongst the risk factors of metabolic syndrome, diabetes and hyperlipidaemia had significant association (p< 0.001 and p < 0.01 respectively) with presence of Hypertension. Diabetes and hyperlipidaemia result in higher circulating fats in the blood and thus a higher degree of plaque formation and deposition of fats

within the blood vessels thus hastening the process of atherosclerosis. This has been proven to be a cause for CVDs due to hardening and narrowing of blood vessels.

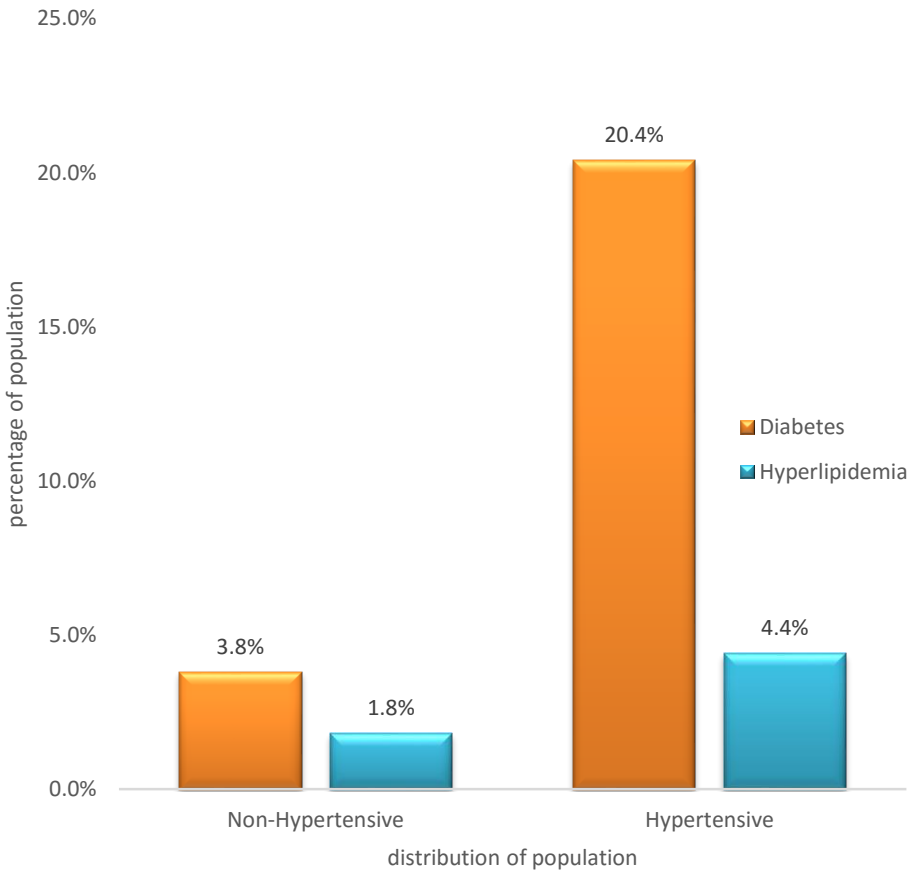

Figure 5.8 Association of Metabolic syndrome with hypertension

A comparison between the hypertensive and non-hypertensive populations showed that the prevalence of diabetes was more than 5-times higher in the hypertensive group and non-hypertensive group. The prevalence of hyperlipidaemia was found to be low in the complete study population, though it was more than 3-times higher in the hypertensive group. The data on hyperlipidaemia has been collected through self-reporting or from previous investigations. This highlights the fact that metabolic syndrome is in itself a risk factor for cardio-vascular diseases

5.2.2 Non-communicable Diseases and risk of Hypertension

Cardio-vascular diseases are a group of diseases which encompass all diseases of the heart and the blood vessels.

Table 5.11 Association of Hypertension with CVD

Factors	**Odds ratio**	**95%CI**	**Estimates**	**Std. Error**	**Z value**	**P value**
CVD	0.716	(0.46 – 0.96)	0.7945	0.489	1.627	0.00380*

*p<0.05

Table 6.11 illustrates a strong association of hypertension with the presence of other CVDs, thus indicating that presence of hypertension leads to development of other CVDs as well. 61% of the Hypertensive patients had Diabetes as co-morbidity and 11% had Hyperlipidaemia. The process of Atherosclerosis is hastened in Diabetes due to hyperglycaemia, hypertriglyceridemia and dyslipidaemias and hence a higher prevalence of Hypertension in seen in Diabetic patients than in non-Diabetic patients.

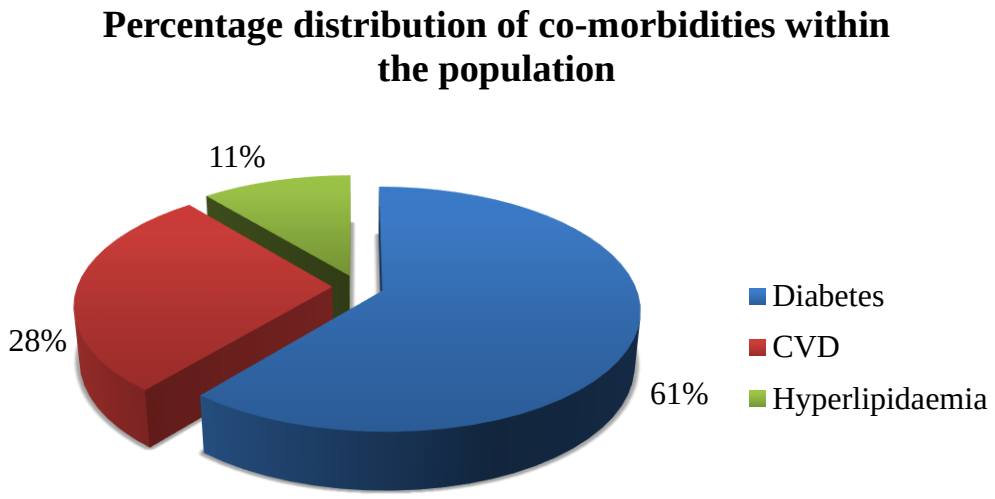

Figure 5.9 Prevalence of Hypertension alongwith DM, Hyperlipidaemia and CVD

5.2.3 Age and risk of Hypertension

As aging progresses, number of changes are seen in the body. The most prominent changes seen are in the cardiovascular system and the gastro-intestinal system. The functional capacity of both the systems is reduced resulting in weakening of cardiac muscles, increased cardiac load and sluggish peristalsis, indigestion etc. respectively.

Table 5.12 Association of Hypertension with Age

Factors	Odds ratio	95%CI	Estimates	Std. Error	Z value	P value
Age	0.886	(0.5-1.1)	-0.122	0.013	-9.620	0.00016***

*p<0.05,**p<0.01,***p<0.001

The factor age showed significant association (p< 0.001) with presence of Hypertension. Prevalence of hypertension was seen to increase with increasing age. This can be attributed to continued exposure to the same lifestyle and environment factors apart from the psychosocial stress and family history.

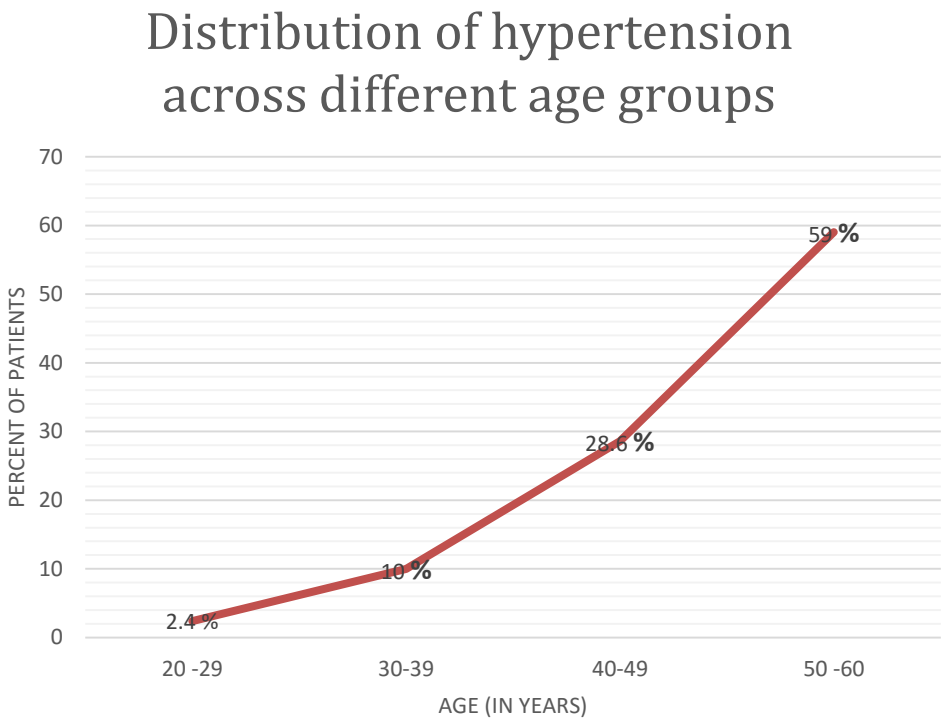

Figure 5.10 Prevalence of hypertension in different age groups

5.3 FAMILY HISTORY AND RISK OF HYPERTENSION

Family history of a disease is the susceptibility towards a disease which an individual acquires from hereditary influences which may be genetic or environmental (due to similar lifestyles). A family history of the first degree relatives are considered to be stronger than that of second or third especially if a first degree relative has suffered from a cardiovascular event before the age of 65 years[125].

Table 5.13 Family history and Risk of Hypertension

Factors	Odds ratio	95%CI	Estimates	Std. Error	Z value	P value
Fhsib	0.181	(0.10 – 0.34)	-1.709	0.737	2.317	0.0205 *
Mofh	0.889	(0.40 – 1.23)	-0.117	0.234	-0.501	0.6164
Fafh	0.339	(0.05-0.57)	-1.082	0.558	-1.937	0.0527
Grnm	13.984	(11.22-15.67)	2.638	0.769	3.432	0.0006**
Grnf	0.732	(0.55-0.97)	-0.312	1.223	-0.256	0.7983
Othf	0.847	(0.45-1.22)	-0.166	0.885	-0.188	0.8511

*p<0.05, **p<0.01, ***p<0.001

Codes: Fhsib: family history- sibling; Mofh: family history mother; Fafh: family history father; Grnm: family history grandmother; Grnf:family history grandmother; Othf:family history others

The factors family history of sibling and family history of grandmother showed significant association ($p < 0.05$ and $p < 0.01$ respectively) with presence of Hypertension pointing towards maternal genetic influence.

5.4 MEDICATION AND SURGERY AND RISK OF HYPERTENSION

Past medication history and present prescription medication did not show any significant relationship with presence of Hypertension

Previous Major and Minor Surgeries did not show a positive association with presence of Hypertension.

The type of medicines consumed and their pharmacological actions of the drugs were not studied. Further research needs to be carried out in the field of drug-drug interactions and drug-disease interactions.

Table 5.14 Association of Hypertension with medication and Surgery

Factors	**Odds ratio**	**95%CI**	**Estimates**	**Std. Error**	**Z value**	**P value**
Medication	0.927	(0.78-1.25)	-0.076	0.066	-1.153	0.249
Surgery	1.179	(0.67-1.56)	0.165	0.665	0.248	0.804

5.5 ANTHROPOMETRIC MEASUREMENTS AND RISK OF HYPERTENSION

The BMI and WHR have been shown to be strong indicators for obesity. Recent development has suggested that hip and waist circumference is also an indicator of obesity as well as other lifestyle disorders especially cardiovascular diseases. A high waist circumference indicates central obesity which has been shown to be a risk factor for cardiovascular diseases[123].

Table 5.15 Association of Hypertension with Anthropometry

Factors	Odds ratio	95%CI	Estimates	Std. Error	Z value	P value
Height	0.973	(0.56-1.23)	-2.487	0.464	-5.363	0.88878
Weight	0.818	(0.67-1.22)	3.006	0.546	5.510	0.0008 ***
Waist (cms)	0.777	(0.34-0.97)	0.819	1.237	0.662	0.00193 **
Hip (cms)	0.640	(0.43-0.97)	-8.506	2.976	-2.858	0.00426 **
Body mass index	0.948	(0.43-1.22)	-9.466	1.632	-5.800	0.00001 ***
Waist to hip ratio	0.781	(0.23-1.56)	-25.142	38.969	-0.645	0.00001***

*p<0.05, **p<0.01, ***p<0.001

Presence of Hypertension showed significant influence on all anthropometric factors e.g.: weight, waist cms, hip in cms, body mass index and waist to hip ratio ($p < 0.001$, $p<0.001$, $p< 0.01$, $p< 0.01$ and $p < 0.001$ respectively) in this study. The BMI and WHR were strongly associated to the risk of hypertension

emphasizing the importance of anthropometry in risk assessment. A higher BMI was seen with increasing age. The WHR was seen to be high even in subjects with a normal BMI indicating a trend towards obesity in the studied population.

5.6 HABITS AND RISK OF HYPERTENSION

A population is a combination of various types of people with varying lifestyles. Socio-economic status, family background and social influences determine to a large extent the lifestyle of an individual. The lifestyle choices determine the health status of a population as well. Habits are an important aspect of lifestyle, which encompasses tobacco and alcohol consumption, smoking, levels of physical activity etc.

5.6.1 Association of Smoking, Alcohol, and Tobacco with risk of Hypertension

Smoking, alcohol and tobacco consumption have deleterious effects on various systems of the body. Studies suggest that majority of the smokers start smoking before the age of 18 years, with the average age being 15-16years[126, 127].

Cigarette smoking impacts all phases of atherosclerosis, from endothelial dysfunction to acute clinical events, especially thrombosis. Acute and passive smoking are both risk factors of CVDs. Cigarette smoking increases inflammation, thrombosis and oxidation of LDL cholesterol. It also increases the oxidative stress leading to greater number of cardiovascular events[128].

Table 5.16 Association of Hypertension with Habits

Factors	**Odds ratio**	**95%CI**	**Estimates**	**Std. Error**	**Z value**	**P value**
Smoking	0.983	(0.67-1.62)	-0.052	0.162	-0.424	0.001578 **
Tobacco Consumption	0.837	(0.45-1.22)	-0.224	0.089	-2.844	0.00386 **
Alcohol	0.937	(0.65-1.34)	-0.032	0.132	-0.404	0.001238 **

*p<0.05, **p<0.01, ***p<0.001

The factors smoking, oral tobacco consumption, sedentary lifestyle, alcohol and excessive salt intake had a significant association ($p < 0.01$) with presence of Hypertension.

5.6.2 Physical activity and risk of Hypertension

A major reason for the emerging lifestyle disorders is the reduction in the levels of physical activity. Regular exercises have been proven to have beneficial health effects. Structured exercise schedule helps in expending the extra calorie intake and thus helps in maintaining a healthy weight. Exercise induces the release of endorphins, improves insulin sensitivity, helps in weight reduction and has cardio-protective effects. Regular exercise has long term health effects which helps in reducing the burden of lifestyle diseases.

Table 5.17: Association of physical activity with Hypertension

Factors	**Odds ratio**	**95%CI**	**Estimates**	**Std. Error**	**Z value**	**P value**
Physical inactivity	0.683	(0.37-1.72)	-0.035	0.134	-0.404	0.000178 **

*p<0.05, **p<0.01, ***p<0.001

The factor physical inactivity had a significant association ($p < 0.001$) with presence of Hypertension.

5.7 DIET AND RISK OF HYPERTENSION

Diet is an integral part of well-being of an individual. Dietary habits to a large extent determine the health status of a population. A healthy diet is calculated in terms of daily dietary requirements of an individual depending upon the height, weight, physiological needs and activity levels. The amount of energy, fat and protein intake may vary slightly within the population but a general guideline, i.e., Recommended Dietary Allowances (RDA) has been provided by the National Institute of Nutrition[92] for all Indians. The RDA provides the nutritional requirements for different age groups, both genders and varying levels of physical activity.

Table 5.18: Association of Hypertension with dietary habits

Factors	**Odds ratio**	**95%CI**	**Estimates**	**Std. Error**	**Z value**	**P value**
Sugar	0.657	(0.27-1.34)	-0.079	0.133	-0.494	0.00008**
Salt	0.600	(0.27-1.92)	-0.099	0.188	-0.498	0.00001***

**p<0.001; ***p<0.001

None of the dietary factors (green leafy vegetable intake, roots and tuber intake, oil consumption, type of oil consumed, milk intake, type of milk consumed, consumption of non-vegetarian foods, egg consumption) had a significant correlation with presence of Hypertension, except salt and sugar consumption, which showed a discernible and clear significant risk (P<0.01 and p<0.001).

5.8 QUALITY OF LIFE OF HYPERTENSIVE PATIENTS

Quality of life is a subjective feeling of an individual depending on his/ her expectations from life and social or psychological environment. The definition varies from one individual to the other and hence it is difficult to formulate a questionnaire which encompasses all aspects of health and quality of life. Questionnaires life Sickness impact profile (SIP) and Nottingham health profile (NHP) help in assessing long-term disabilities due a disease like loss of movement or inability to take care of self. These questionnaire are not very relevant to hypertensive patients as hypertensive patients are usually asymptomatic (except in clinical end-stage diseases) before diagnosis and QOL is related to the psychological factors, complications due to medications and symptoms which do not usually cause dependency.

WHOQOL-BREF is a generic scale for determining the health related quality of life which considers the overall general health of the person and the assessment of health on physical discomfort, social relationships, psychological and environmental domains.

Table 5.19 Distribution of responses (%) in WHOQOL-BREF items (N=500)

Items	**Very Poor**	**Poor**	**Aver age**	**Good**	**Very Good**	**Mean ±SD**
OG: Overall general health						
Q1 Genera QOL	1.7	32.6	44.0	21.7	-	2.88± 0.77
Q2 General health	0.7	32.8	33.9	32.5	-	2.98± 0.82
D1: Physical						
Q3 Pain and discomfort	6.9	9.0	29.0	49.1	5.9	3.4±0 .95

Q4 Dependence on medication	-	-	8.8	55.0	36.2	4.28+ 0.61
Q10 Energy and fatigue	5.1	53.2	25.8	15.2	0.7	2.55± 0.83
Q15 Mobility	3.9	18.3	44.1	32.7	1.0	3.14± 0.79
Q16 Sleep and rest	6.7	22.8	31.8	36.1	1.7	3.02± 0.96
Q17 Activities of daily living	2.5	16.1	52.3	29.1	-	3.09± 0.72
Q18 Working capacity	0.7	28.9	34.3	36.1	-	3.07± 0.82
D2: Psychological						
Q5 Positive feelings	4.5	42.4	42.4	10.8	-	2.59± 0.74
Q6 Spirituality, religion and personal beliefs	3.0	36.4	53.9	6.7	-	2.64± 0.65
Q7 Thinking, learning, memory, concentration	-	37.5	42.4	20.1	-	2.83± 0.74
Q11 Body image	0.7	30.1	66.9	2.2	-	2.71± 0.52
Q19 Self esteem	0.6	28.1	44.2	27.9	-	2.99± 0.99
Q26 Negative feelings	0.8	7.6	29.0	49.4	12.3	3.64± 0.83
D3: Social relationships						
Q20 Personal relations	1.5	32.0	41.3	25.2	-	2.9±0 .79

Q21 Sex	29.0	55.4	12.3	3.3	-	1.9±0.73
Q22 Practical social support	-	8.2	71.4	20.4	-	3.12±0.52
D4: Environment						
Q8 Safety	2.2	24.9	59.5	13.4	-	2.84±0.67
Q9 Home environment	1.5	40.9	40.5	17.1	-	2.73±0.76
Q12 Financial resources	14.5	62.1	18.2	5.2	-	2.14±0.72
Q13 Information	-	26.0	69.5	4.5	-	2.78±0.51
Q14 Recreation and leisure	1.5	26.4	43.9	28.3	-	2.99±0.78
Q23 Physical environment	1.5	6.3	22.7	69.5	-	3.6±0.68
Q24 Access to health care	-	6.3	36.4	56.5	0.7	3.52±0.63
Q25 Transport	-	6.7	48.3	45.0	-	3.38±0.61

WHOQOL-BREF questionnaire - For overall and general health related questions 60 – 70% of patients responded as average to good. As far as physical, psychological, social and environmental domains were concerned, majority of the patients responded as poor to good except a few responding as “very good” for physical domain. Age showed significant negative correlation with all WHOQOL-BREF domains ($P < 0.05$) except environmental domain. Systolic BP and number of symptoms showed significant positive correlation with MINICHAL scale ($P < 0.05$) and negative correlation with WHOQOL-BREF domains ($P < 0.05$). Number of co-morbidities showed significant positive

correlation with MINICHAL domains ($P < 0.05$) and negative correlation with WHOQOL-BREF domains ($P < 0.05$) except global domain. Number of drugs prescribed showed significant negative correlation with physical and social domains of WHOQOL-BREF scale ($P <$ correlation between different variables and HRQOL scales is depicted in above table. Social domain score was lowest while physical domain score was highest for WHOQOL-BREF. Among WHOQOL-BREF domains physical, psychological, social and total WHOQOL-BREF scores were lower in patients with co-morbidities compared to patients without co-morbidity ($P < 0.05$). Patients with uncontrolled hypertension had lower scores of WHOQOL-BREF except psychological domain and higher scores of MINICHAL scale compared to those with controlled hypertension. However the difference was not statistically significant.

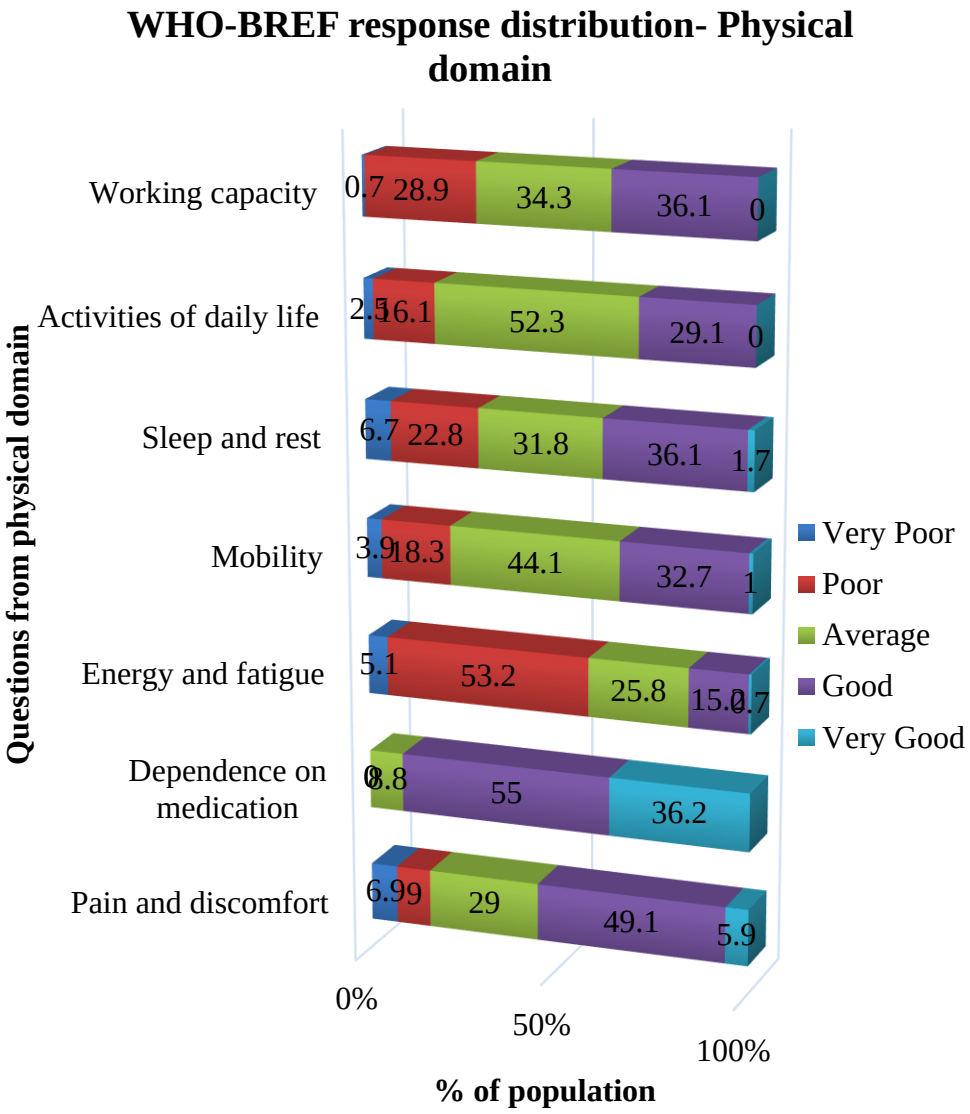

Figure 5.11 WHO-BREF response distribution on the physical domain

The MINICHAL questionnaire is a specific questionnaire for patients suffering from hypertension. It encompasses the mental and physical domains with specific questions relating to the symptoms of hypertension, success in social relationships, social interactions etc.

Table 5.20 Distribution of responses (%) in MINICHAL scale (N=500)

Items	**No, not at all**	**Yes, somew hat**	**Yes, a lot**	**Yes, very much**	**Mean± SD**
Mental Domain					
Q1 Poor sleep	42.4	21.2	29.4	7.1	1.01±1
Q2 Difficulty to maintain social relations	12.6	52.4	34.9	-	1.22±0. 65
Q3 Difficulty in interaction	10.2	47.6	34.2	-	1.16±0. 7
Q4 Not playing useful role	11.5	54.6	33.8	-	1.22±0. 64
Q5 Unable to make decisions	11.9	52.0	34.6	1.5	1.26±0. 68
Q6 Felt distressed continuously	17.5	24.5	39.4	18.6	1.59±0. 98
Q7 Life is a struggle	8.6	39.4	50.9	1.1	1.45±0. 67
Q8 Not enjoying daily activities	10.4	38.7	48.7	2.2	1.43±0. 71
Q9 Felt worn out	7.4	13.4	70.6	8.6	1.80±0. 69
Somatic Domain					
Q10 Felt sick	3.0	16.4	66.9	13.8	1.91±0. 64
Q11 Felt breathless	53.2	23.8	20.88	2.2	0.72±0. 87
Q12 Swollen ankles	61.3	10.4	24.9	3.3	0.70±0. 96

Q13 Frequent urination	32.0	12.3	49.4	6.3	1.3±0.99
Q14 Dry mouth	52.4	11.5	34.6	1.5	0.85±0.95
Q15 Chest pain without exertion	41.6	24.5	32.7	1.1	0.93±0.89
Q16 Tingling and numbness	21.6	12.3	60.2	5.9	1.51±0.90
Q17 Quality of life affected by Hypertension and its treatment	-	14.1	67.3	18.6	2.04±0.57

MINICHAL scale – the responses in the MINICHAL scale showed that the mental domain was more impaired than the somatic domain. Most of the responses in the mental domain indicated that the patients were feeling lethargic, slept poorly and were not able to maintain their social relationships. There was a feeling of being distressed and worthlessness. These factors were more overpowering that the physical discomforts. A subjective feeling of not being well was seen in 66.9% of the patients whereas more than 50% of the patients did not suffer from pedal oedema and dry mouth indicating that the medications prescribed were effective in countering the physical symptoms.

Table 5.21: Pearson Correlation between different variables of HRQOL Scales

	MINICHAL SCALE		**Total MINICHAL**	**WHO-BREF SCALE**				**Total WHO-BREF**
Domains	**Mental**	**Somatic**		**Global**	**Physical**	**Psychological**	**Social**	**Environmental**	
Age	-0.020	0.012	-0.002	-0.018	-0.262**	-0.138*	-0.234**	-0.119	-0.181**
SBP	0.132*	0.122*	0.157*	-0.183**	-0.266**	-0.129*	-0.154**	-0.155*	0.217**
DBP	0.069	0.045	0.097	-0.129*	-0.133*	-0.017	-0.120*	-0.22	-0.086
No. of Symptoms	0.42**	0.620**	0.454**	-0.346**	-0.319**	-0.189**	-0.294**	-0.292**	-0.385**
Duration of HTN	0.086	0.117	0.115	-0.095	-0.047	-0.199**	-0.189**	-0.062	-0.146*
No. of Co-morbidities	0.154*	0.187**	0.149**	-0.074	-0.208**	-0.192*	-0.197**	-0.137*	-0.189**
No. of Drugs	0.085	0.093	0.067	-0.009	-0.142*	-0.067	-0.229**	0.005	-0.070

*Correlation is significant at level of 0.05,

**correlation is significant at level of 0.01 (based on 2 tailed Pearson correlation coefficient) HRQOL – Health related quality of life, WHOQOL-BREF - World Health Organization Quality of Life – BREF, BP – Blood Pressure

Age showed significant negative correlation with all WHOQOL-BREF domains (P < 0.05) except environmental domain. Systolic BP and number of symptoms showed significant positive correlation with MINICHAL scale (P < 0.05) and negative correlation with WHOQOL-BREF domains (P < 0.05). Number of co-morbidities showed significant positive correlation with MINICHAL domains (P < 0.05) and negative correlation with WHOQOL-BREF domains (P < 0.05) except global domain. Number of drugs prescribed showed significant negative correlation with physical and social domains of WHOQOL-BREF scale (P < correlation between different variables and HRQOL scales is depicted in above table. Social domain score was lowest while physical domain score was highest for WHOQOL-BREF. Among WHOQOLBREF domains physical, psychological, social and total WHOQOL-BREF scores were lower in patients with co-morbidities compared to patients without co-morbidity (P < 0.05). Patients with uncontrolled hypertension had lower scores of WHOQOL-BREF except psychological domain and higher scores of MINICHAL scale compared to those with controlled hypertension. However the difference was not statistically significant.

6 DISCUSSION

6.1 HYPERTENSION: INEVITABLE BURDEN OF DISEASE

Hypertension is a significant public health concern of world-wide distribution and is also the most common cardiovascular disease risk factor. Adequate control of blood pressure is a critical element in the prevention of hypertension induced-organ damage and life-threatening complications. Prevention of hypertension is possible and early detection and effective treatment can significantly reduce the incidence of adverse clinical outcomes. Multiple socio-demographic and potential risk factors have been recognized in the causation and determining the long-term outcomes of the disease world-wide. As the natural history of hypertension is complex and aetiology is multi-factorial the strategy to combat also should be multi-pronged based on the trends and magnitude of the disease in variable settings.

6.2 HOW MAGNITUDE AND DIRECTION OF OUR FINDINGS FIT INTO THE CURRENT EVIDENCE BASE OF INDIA

Recent reviews have underlined the pivotal risk factors associated with hypertension in Indian population[15, 62]. Age, alcohol, smoking and chewing tobacco, BMI, central obesity (defined as waist circumference>90 cm in men and >80 cm in women), low consumption of vegetables/fruits, high consumption of dietary fat and salt, and sedentary activity were the significant risk factors among Indian patients[15]. A significant positive trend ($P<0.0001$) was observed over time in prevalence of hypertension by religion. Increasing age, body mass index, smoking, diabetes and extra salt and sugar intake were common risk factors[15, 62].

6.2.1 Diet

Lifestyle changes (unhealthy dietary practices, consumption of tobacco, and sedentary habits) occurring because of rapid urbanization and economic progress in urban areas has also contributed to the growing epidemic of hypertension. Unhealthy dietary patterns like excessive intake of salt and sugar, high consumption of oil and a low consumption of fruits and vegetables are held responsible for development of cardiovascular diseases[129].

Salt

A high salt consumption is noted in eastern and coastal parts of India due to humid conditions[34]. Salt is considered a major risk factor in the development of hypertension. In this study as well, the Salt consumption is seen to be very high with only about 3.2% of the total population consuming salt less than 10 gms/day. Chemically, salt is Sodium Chloride. The words salt and sodium are often used synonymously even though both are chemically different. Ninety percent of the sodium consumed is in the form of salt through the diet[130].

Physiology of Sodium regulation and its effect on Blood Volume

Kidneys play a major role in regulating the fluid and electrolyte balance within the body. They are responsible for maintaining the Osmolality (the amount of solute per unit volume) of body fluids. The Osmolality of the plasma is achieved by balancing the intake and excretion of sodium and water. Sodium is the major solute present in the extra-cellular fluid and so, it effectively determines the Osmolality of the extra-cellular fluids[131].

The Anti- Diuretic Hormone (ADH) increases the water resorption from the kidneys and thus lowers the Osmolality (reduces sodium concentration). To prevent Hypo-osmolality, the Aldosterone mechanism comes into play by reabsorbing

sodium in the distal tubules of the kidneys. Its secretion is controlled by the following mechanisms [132] :

1. The aldosterone secretion is inhibited when the osmolality increases above normal. The adrenal cortex directly senses plasma osmolality. The lack of aldosterone causes less sodium to be reabsorbed in the distal tubule. In this scenario, ADH secretion increases to conserve water, thus complementing the effect of low aldosterone levels to decrease the osmolality of bodily fluids. The net effect on urine excretion is a decrease in the amount of urine excreted, with an increase in the osmolality of the urine.

2. The kidneys sense low blood pressure (which results in lower filtration rates and lower flow through the tubule). This triggers a complex response to raise blood pressure and conserve volume. Specialized cells (juxtaglomerular cells) in the afferent and efferent arterioles produce Renin, a peptide hormone that initiates a hormonal cascade that ultimately produces Angiotensin II. Angiotensin II stimulates the adrenal cortex to produce Aldosterone.

Urinary Salt Excretion

Under normal activity conditions and sweating, humans excrete almost 90% of dietary sodium through urine. Therefore, 24 hrs. urinary sodium levels provide an indication to the daily intake of sodium. These levels vary among individuals with different medical conditions and depends on the salt intake as well. Thus, a single collection may not reliably reflect the habitual intake and repeated estimations of urinary sodium levels are suggested[133-138].

The INTERSALT study[139] published in 1988 established a statistically significant positive correlation between the 24hr urinary sodium excretion and the prevalence of hypertension. It was observed in this study that higher blood pressure values were seen in populations where the sodium excretion was higher. This indicated that the oral intake of sodium influenced the blood pressure levels and a direct

proportional relation is established between the two[140-143]. Additionally it was noted that the populations with a higher urinary sodium excretion and increasing age had higher blood pressure values. In a similar study conducted by Law and Co-workers, comparable findings were observed and a positive relation was established by the study between mean blood pressure and sodium intake[144].

The American Heart Association in its 2013 guidelines has propagated that maintaining a healthy diet and an active lifestyle contributes to a great extent towards reducing the risk for CVD and hypertension in general public. Diet and lifestyle are modifiable risk factors responsible for development of CVD of which hypertension is of major concern from public health point of view. Positive interventions in these factors are considered to be mainstay of the treatment protocol in spite of major advances in clinical medicine[133].

A substantial body of evidence strongly supports the concept that multiple dietary factors affect blood pressure[135]. Dietary modifications that lower blood pressure are reduced salt intake, caloric deficit to induce weight loss, moderation of alcohol consumption (among those who drink), increased potassium intake, and consumption of an overall healthy diet, based on the DASH (Dietary Approaches to Stop Hypertension) diet[136]. The latter is a carbohydrate-rich diet that emphasizes on fruits, vegetables, and low-fat dairy products; includes whole grains, poultry, fish, and nuts; and is reduced in fats, red meat, sweets, and sugar-containing beverages. Replacement of some carbohydrates with either protein from plant sources or with monounsaturated fat can further lower blood pressure[137].

Dietary Approach to Stop Hypertension (DASH) is a diet which is rich in vegetables and fruits and low in fats and high fat dairy products. It has been widely advised and propagated in Hypertensive patients. In United States, a multi-center trial was conducted to assess the effect of dietary sodium intake, in conjunction with DASH diet on blood pressure levels in persons with and without hypertension[144]. The participants were given a control and a DASH diet randomly.

In both the groups, the participants were given foods with high, intermediate and low sodium levels for 30 consecutive days, randomly. A reduction in systolic blood pressure was noted on reducing the sodium intake from the high to the intermediate level during the control diet and by 1.3 mm Hg during the DASH diet. Similarly systolic blood pressure reduction of 4.6 mm Hg during control diet and 1.7 mm Hg during DASH diet was seen when the sodium intake was reduced from the intermediate to the low level. This reduction was additional to the former reduction from high to intermediate sodium intake levels. These effects were observed in participants of African-American origin and other races, with or without hypertension and in both males and females. It was observed that the DASH diet was associated with lower blood pressure levels at each of the three sodium intake levels (low, intermediate and high) with a greater difference at the higher sodium levels than the lower sodium levels. The participants in the DASH diet consuming low sodium as compared to the control diet participants had a mean systolic blood pressure that was 7.1 mm Hg lower in the group without hypertension, and 11.5 mm Hg lower in the group with hypertension[145].

In a study where experimental diets of 1200-1600 mmol/day of sodium was given to 14 normotensive volunteers, a significant rise in the blood pressure was seen in all participants within three days.[116] Studies involving increasing the salt intake on a long term basis cannot be conducted due to ethical concerns. A 20-month study was carried out on chimpanzees who were given salt supplements and their systolic blood pressures measured. They were previously on a salt free diet. It was noted that an average rise of 33 mm Hg of systolic blood pressure was seen in them over the 20-month study period. There was no change in the chimpanzees in the control group living in the same conditions (on salt free diet). The blood pressures returned to baseline within six months in all chimpanzees when they were put on a salt free diet[146].

Salt reduction and blood pressure

In view of the above observations, researches have been continually trying to assess the efficacy of reducing the dietary salt intake in reducing blood pressure levels[135-142] through various systemic reviews and meta-analysis [147,148]. The meta-analysis of randomized controlled trials by He and Mac Gregor concluded that a reduction in the salt intake for four weeks or more achieved a reduction of 5 mm Hg of systolic blood pressure in people classified as hypertensive[149].

In another meta-analysis by Law *et al*[150] it was observed that a reduced sodium excretion significantly reduced the systolic blood pressure levels in both normotensive and hypertensive individuals.

Dietary Guidelines for Sodium

The 2010 Dietary Guidelines for Americans recommends limiting sodium to less than 2,300 milligrams (mg) per day. For individuals the age of 51 years and above, especially of the African- American origin or those people who already have hypertension, diabetes or chronic kidney disease should limit their Sodium intake to 1,500 mg per day[132] as per the guidelines.

Strategies to reduce sodium intake include:

- Preferring foods which have been processed without salt and foods labeled as ‘no added salt’ and avoiding all ‘high salt’ processed foods.
- A ‘low salt’ food label means that the food item contains no more than 120 mg of sodium per 100 g
- Reduced salt products have a higher salt content than the low salt containing products. These can be opted for if the latter is not available.
- Avoid adding salt during cooking and at the table.
- Food can be flavored with tamarind or lemon to enhance taste instead of salt.

- Low sodium salts usually have high potassium levels and these should be avoided in patients with renal dysfunction or in those who are taking potassium-sparing diuretics.
- Dosages of antihypertensive medications and of lithium carbonate may need to be reduced in patients who adopt a low salt diet.
- The combination of diuretic treatment and low dietary salt intake may result in unacceptable volume depletion and hyponatremia and thus adequate salt intake is necessary while consuming salt losing diuretics.
- Dietary salt restriction is inappropriate in patients with salt-wasting forms of renal and gastrointestinal disease even if they are hypertensive.

Sugar

Sugar is present in the food in various forms- monosaccharaides, disaccharides, oligosaccharides and polysaccharides. With increasing intake of fast foods and ready to eat foods, the consumption of monosaccharaides has also increased. Fructose, a monosaccharaide, is present abundantly in processed foods. A high intake of sugar, increases the cardiac oxygen demand, raises blood pressure, increases the nocturnal and diurnal variability in blood pressure, enhances the process of inflammation, predisposes towards insulin resistance and initiates a wider range of metabolic dysfunctions[151].

A high Sucrose diet similarly, stimulates the sympathetic nervous system which increases the heart rate, vascular resistance, renin secretion and renin induced sodium retention which contributes towards elevating the blood pressure levels.

Other dietary factors

Contrary to previous researches, the findings of this study have not found a positive relationship between high fat diet and low fruit and vegetable intake. Type of milk and quantity of milk also was not found to be significantly related to hypertension in the study population. Latest researches indicate a relationship between high red

meat intake and hypertension, whereas this research did not find any relationship of the same.

6.2.2 Smoking and oral tobacco

Authors have noticed a close to a two-fold increase in risk for hypertension among Indians when they smoked[21,31,35], orally consumed khaini and tobacco[34], had extra salt intake in their food[34], had a sedentary lifestyle[36], were centrally obese[21,31,35,37,38], had BMI of at least 25 kg/m^2 (normal range for Indians is now 18.5-23.0)[21,31,32,33,38], and consumed alcohol[30,32,36].

The findings of this study too allude and support the recent evidence base in a very strong manner and the undeniable role of smoking, oral tobacco and alcohol being primary villains leading to morbid conditions.

It has been recently reported that one-third of urban adult Indians and close to one fourth of rural adult Indians are Hypertensive. Regional differences exist in rural areas of India for prevalence of hypertension. Urban areas of India show no significant differences in hypertension prevalence. Only a quarters of rural Indians suffering from hypertension are aware of and are being treated for hypertension. Forty-two percent of urban Indian patients are aware of their medical status. Thirty-eight percent of urban Indians are being treated for their hypertension. Only one-tenth of rural Indians and one fifth of urban Indians suffering from high blood pressure have their blood pressure under control. In view of these findings, urgent steps to improve health education and health promotion (specifically on modifiable risk factors and awareness of blood pressure) measures have to be made by the policy makers on a large scale. Existing interventions should look at incorporating multicomponent and multilevel approaches for better managing blood pressure among Indians, as current rates for awareness, treatment of blood pressure, and control of blood pressure among those on treatment are very low[15,62].

These findings are in accordance with the results of this study and show that this study too has been able to underline the risk factors prevailing for hypertension in Indian society as determined by other researchers assessing various facets of Indian population.

6.2.3 Physical activity

Physical activity is defined as any bodily movement resulting in calorie expenditure, where as physical fitness or exercise is structured and planned set of bodily movements aimed at improving the flexibility, strength or endurance or specific muscle groups. Regular exercise helps in lowering the cardiovascular risk where as physical activity is unstructured and may result in repeated movement of the same muscle groups[152-155]. There is a more than 50% reduction in cardiovascular disease mortality in people who follow a regular physical fitness regime[156]. Furthermore, an increase in energy expenditure from physical activity and exercise of 1000 kcal (4200 kJ) per week was associated with lowering of mortality rates by 20%. Physically inactive middle-aged women (engaging in less than 1 hour of structured exercise per week) were found to have 52% more chances of developing cardiovascular diseases as compared to their physically active counter-parts[157]. These relative risks are similar to those for hypertension, hypercholesterolemia and obesity, and they approach those associated with moderate cigarette smoking.

An increase in physical fitness reduces the risk of premature death, and a decrease in physical fitness increases the risk[158, 159]. This effect appears to be graded, [157,158] such that even small improvements in physical fitness are associated with a significant reduction in risk. In one study[158], participants with the highest levels of physical fitness at baseline and who maintained or improved their physical fitness over a prolonged period had the lowest risk of premature death. Modest enhancements in physical fitness in previously sedentary people have been associated with large improvements in health status. For instance, in another study,

people who went from unfit to fit by including exercise in their lifestyle over a 5-year period had a reduction of 44% in the relative risk of death compared with people who remained unfit[159].

6.2.4 Anthropometry

The association between measures of body mass and blood pressure has been extensively documented, usually with body mass index (kg/m^2) as the measure of relative weight[160]. Despite the consistency with which this correlation is observed, systematic explanations for the phenomenon are still being debated, and no biological model of the process has been established[161]. Epidemiological investigations have been hindered by several factors. Furthermore, the use of BMI has been questioned because percent body fat, absolute fat mass, and body-fat distribution, or other relevant biological quantities, may not be linearly related to BMI across the entire range of possible values or across different population subgroups.[162] Finally, the effect of treatment in many populations truncates the distribution of blood pressures and therefore reduces the correlation that would be observed between BMI and blood pressure in untreated settings.

Obesity is defined in terms of BMI cut-points, correlations between BMI and blood pressure have been observed even in very lean populations, including groups in Africa[163], Asia[164], and South America[165]. Large studies of low-BMI groups in Asia appear to show a monotonic relationship between BMI and blood pressure among groups for whom treatment and other potential confounders are rare[166]. Interpreting the blood pressure–BMI relationship is further complicated by the suggestion from some studies of a threshold effect below which there appears to be no correlation between the variables[167]. Some authors have suggested that for women in low economic settings there is no identifiable association between blood pressure and BMI, even at levels that would be considered obese (i.e., 30 kg/m2)[168].

The higher prevalence of Hypertension in urban areas may have arisen as cardiovascular disease risk factors among the urban poor and middle class are rapidly increasing in India[129]. Presence of cardio-metabolic risk factors in southern India (such as central obesity and high BMI) [149] have been recognized as the principle contributing factors for high prevalence of Hypertension in both urban and rural parts of east and south India.

A positive relationship was seen with Weight, Waist circumference, BMI and Waist to Hip Ratio and prevalence of Hypertension. The prevalence of Hypertension was highest (67.8%) for over-weight patients (BMI- 23.1-29.9) in this study. These results bear very similar findings and patterns showing that central obesity and high BMI are the major drivers of increased risk of Hypertension.

6.2.5 Education and Income

Recent studies from India have shown that hypertension is significantly more prevalent in the lower education group when compared with higher education group[43].

This study too has found that education influences the presence or absence of Hypertension. Low/no education is a predictor of possible Hypertension. Results show that lower (32.4%) and higher (40.8%) income groups had a higher prevalence of Hypertension as compared to the middle (24.8%) income groups.

6.2.6 Age

Increase in Hypertension with advancing age has been shown by six studies[31-35, 96]. This study has also shown that the increase in age is positively associated with the increased risk of Hypertension.

6.2.7 Quality of Life (QoL) of Hypertensive Patients

The QoL of the hypertensive subjects was evaluated using the MINICHAL and WHOQOL-BREF questionnaires. A higher MINICHAL score indicates an impaired QoL whereas a higher WHOQOL-BREF score indicates a better QoL. A significant correlation between two scales is reported by Melchiors AC et al with WHOQOL-BREF physical domain best correlated with total MINICHAL score[104]. In this investigation, MINICHAL mental domain was the one that strongly correlated with total WHOQoL – BREF score.

The investigation showed that MINICHAL can be a useful instrument for determining QoL in Indian Hypertensive patients, whose results significantly correlated with the generic instrument WHOQOL-BREF. Age, systolic BP, number of symptoms and number of co-morbidities showed significant negative correlation with some of the WHOQOL-BREF domains and positive correlation with MINICHAL scale which suggests as these parameters increase, QOL worsens. Number of drugs prescribed showed significant negative correlation with physical and social domains of WHOQOL-BREF scale indicating worsening of QoL by poly-pharmacy.

This is the first study evaluating quality of life of Hypertensive patients in Maharashtra. Researcher has examined the relationship of QoL to various socio demographic and clinical variables. As the study population is from a single centre the findings cannot be generalized. Further multi-centric studies with larger sample size are required in this direction.

7 CONCLUSION

The results of this research highlight the urgent need for cognizance of, till now largely ignored, non-communicable diseases in addition to control of communicable diseases. CVD's are a fast emerging silent pandemic with a mortality rate which may exceed 35% of global burden of disease by 2025. Currently there are no local or regional or national health policies to combat to mitigate the presence of risk factors of Hypertension by developing nations.

7.1 IMPLICATIONS FOR PRACTICE FROM THE CURRENT STUDY

The findings of the current review clearly reflect the necessity for a comprehensive national program for Hypertension and its associated risk factors well backed by intensive health awareness campaigns to spread information about the potential risk factors and the sequel of inadequately managed cases of Hypertension.

The results of this research clearly indicate a need for reformulating the guidelines for age of screening for Hypertension from 40 years to 20 years. The presence of Hypertension in younger age groups reflects a shift in the aetiology, pathogenesis and susceptible population group. Thus, the guidelines should encompass a wider target population and continued medical education programs for practicing and research professionals should be conducted regularly. Sensitising the practicing and registered health force towards latest researches and guidelines is an important factor in identifying and treating hypertension.

Specific guidelines should be formulated and implemented for management of Hypertensive patients depending on their blood pressure levels. All the physicians from the public health sector and the private sector including practitioners from

other disciplines who are treating Hypertensive patients should be trained in the appropriate and adequate management of Hypertension. Non-physician health workers should be trained for monitoring the blood pressure levels at every opportunity to identify new cases of hypertension and monitor the control of blood pressure levels in pre-diagnosed patients. Regular trainings for the Standardized procedure of measurement of blood pressure to all health care professionals are also essential.

The outreach health workers should also be trained, aligned and empowered in various aspects of life-style modifications with special emphasis on the conceptual understanding of each of them so that they can spread the awareness, knowledge and message to each and every household during their routine home visits. The primary health care centres (PHC), anganwadi workers and ASHA in the rural areas should be empowered and educated for imparting information on healthy dietary practices, regular physical exercise and ill-effects of consuming tobacco and alcohol.

A systematic and structured flow of information from the international to national to regional or local personnel should be established. A strong political will is desired for establishing a network between international and national agencies for ensuring external mentoring, and monitoring.

Patient education and training to identify signs and symptoms of complications and monitor their current health status through easy and inexpensive measures will reduce mortality and morbidity rates. Psychological guidance and support is an integral part of patient empowerment to enable them to continue the lifestyle changes and consumption of medications consistently and regularly. Table no 6.1 enlists a few measures which may help in combatting hypertension and help in preventing its complications by promoting health information flow, making patients more self-reliant, helping patients adopt a healthy lifestyle, training the health care professionals etc.

Table 7.1 Suggested strategies to combat Hypertension and its risk factors.

Strategy	**Implementation**
Health education and Health promotion	• Hypertension is a disease with high mortality rates. • Hypertension is a silent killer and hence blood pressure should be checked regularly for all adults • Lifestyle changes, simple and inexpensive drugs can help in preventing and controlling Hypertension
Making patients self- reliant	• Training patients to measure and record their own blood pressure • Guidance and counselling to adopt lifestyle changes and consume anti-hypertensive medicines lifelong. • Continued psychological, financial and medical support
Screening	• Screening for Hypertension should be done for all adults by all health care workers at all levels of contact with health care establishments • Referring to higher health care unit if blood pressure is raised
Lifestyle changes	• Reduction of salt, sugar, alcohol consumption, smoking, weight reduction and increasing physical activity • To continue lifestyle changes consistently and regularly for life time
Training of health care staff	• Regular training of the health care staff at all levels to standardize the procedure for measurement of blood pressure • Regular medical education programs to impart knowledge about the latest guidelines and pharmacotherapy regimes.

7.2 IMPLICATIONS FOR RESEARCH FROM THE CURRENT STUDY

The need of the hour is to strengthen and deepen community-based qualitative and quantitative observational studies to further determine the level of awareness, knowledge and practices among the general population regarding potential risk factors and importance of life-style modifications in different settings. This would sensitize them to the currently prevailing strategies being undertaken by the healthcare team to ensure actual optimal implementation of the policies.

In each of such efforts a conscious attempt should be made by the researchers to discern the perceived gaps or the barriers that hinder community members from availing routine screening services for Hypertension.

Research should also be conducted to explore the role of dietary issues and sedentary lifestyle in the causation of Hypertension. This needs to be followed-up with designing of a comprehensive yet lucid diet and exercise schedules for people with different needs and strata of society to eradicate this issue from the roots.

The findings of this research strongly support the current state-of-the-art evidence regarding the risk factors of Hypertension elucidated by major authors[1,6,7,10,12,15-19,26,27,29,31,62,64] and underline the need for formulation of national policy for its eradication. The findings also bolster the fact that Hypertension is almost of epidemic proportions along with other metabolic disorders in Indian population. The risk factors (smoking, alcohol, sedentary life style) are related with typical Indian lifestyle. These factors influence the risk of Hypertension and need to be addressed urgently. Hence, regimens like regular exercise, walking or defined physical activity may be of immense importance which needs to be incorporated as a part of lifestyle modification, for patients of Hypertension.

Quality of Life is a feeling of subjective well-being. It is a reflection of the difference between the hopes and expectations of a person and their present circumstances. An impaired QoL indicates distress and dissatisfaction on the

physical, mental or social domains. An impaired QoL is a rising trend amongst patients of Hypertension due to the symptoms of Hypertension, complications of Hypertension and medications for controlling Hypertension.

8 RECOMMENDATIONS

8.1 HEALTH POLICY AND PUBLIC HEALTH ORIENTED RECOMMENDATIONS, UNMET NEEDS AND THE WAY FORWARD

This study is perhaps first study in the urban city of Pune, India and findings show that Hypertension has serious implications on the quality of life of Indian society. In the light of this investigation, the risk factors if not controlled may also show the serious medical and resource utilization in this population. Hence, this research proposes certain measures to lower the prevalence of Hypertension in an urban setting. The foremost challenge for India is to develop a health policy for the future in the current scenario. While it is struggling to manage communicable diseases and maternal and child health, the change in epidemiological pattern from communicable to non-communicable diseases demands a different approach than is used for these current health-care priorities. However, India has strengths to build on. A largely non-physician, widespread community based primary health-care infrastructure exists. In the existing set-up of India, training volunteers to perform basic community-based Hypertension prevention and control activities appear an attractive option as suggested by the National Programme for Prevention and control of cancer, diabetes, CVD and Stroke (NPCDCS). The main focus of the NPCDCS is on Diabetes and Hypertension. The pilot study of this programme was initiated in 2008 and has not yet been implemented in any of the Indian states due to lack of political will and infrastructure.

Food laws of India (FSSAI Act, 2006) should be strengthened further and Nutrition Labelling guidelines laid out with respect to Sodium as well. It may be suggested that a warning with respect to the maximum consumption of Salt should be included on packaged products to create awareness among the common population.

WHO has advised a framework (figure 8.1) for implementation of the PEN in low resource setting where the onus of integrating the PEN into the primary health care of the country rests with the Ministry of Health which is the leading agency of the country for health sector planning and implementation. WHO provides technical support and training to establish protocols founded on evidence based guidelines. A manual developed at the national level will provide tools for key managerial elements in relation to mobilization of funds, situation analysis of primary care, financing approaches for the package, budgeting and procurement of essential medicines and technologies, development of training materials, training and supervision, feasibility testing, assessing impact at the district level and planning of national expansion.

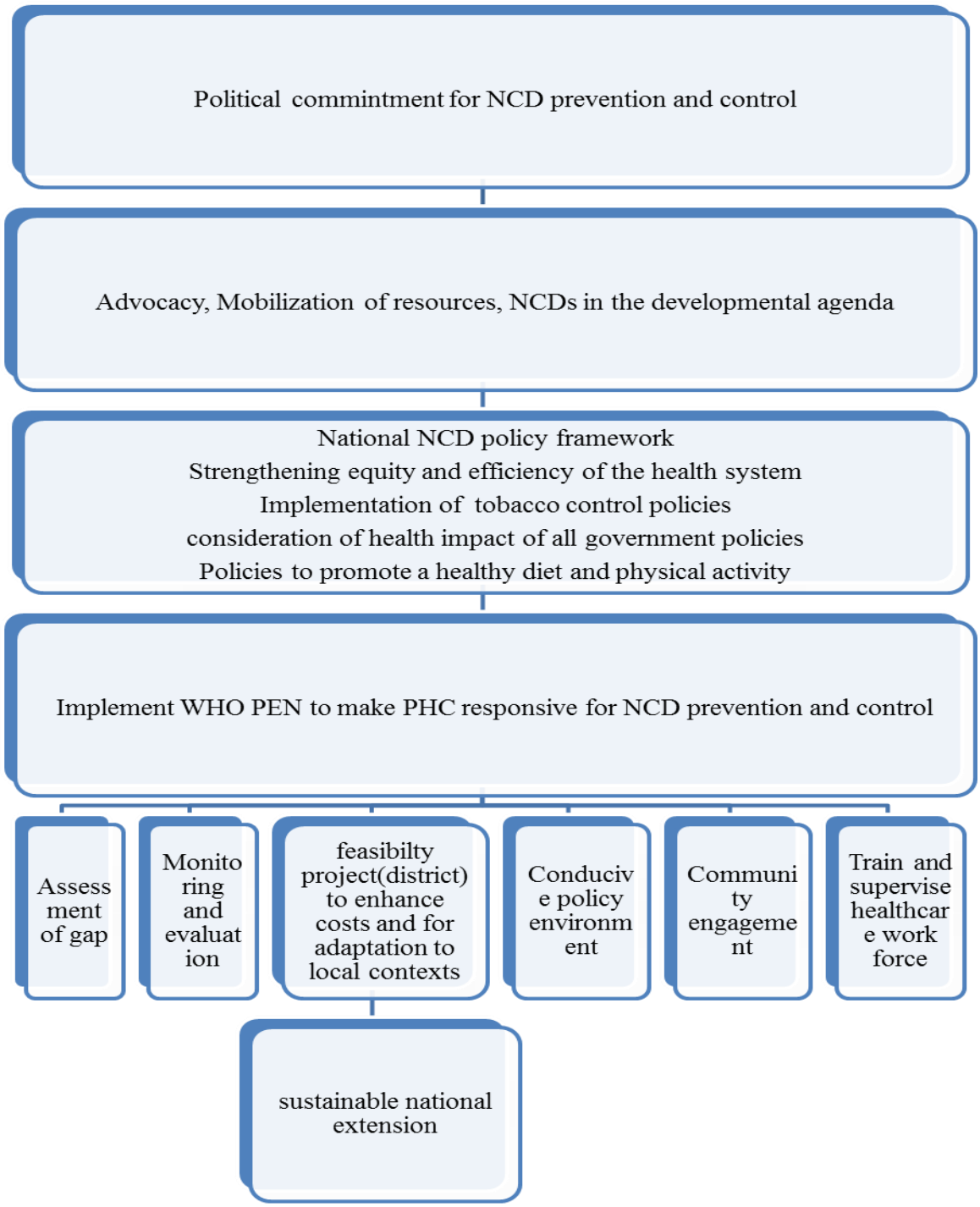

Figure 8.1 Framework for implementation of WHO PEN in primary health care

Sustainable scaling up of prevention and control of NCDs requires a strong political commitment from the national health authorities. The way forward for India will require a multifaceted approach. The proposals are as follows:

1. **Training the health workforce** to deal with Hypertension risk factors. Given the magnitude of the hypertension as an emerging healthcare problem, providing unimpeded access to health-care services at the community level is of critical importance: Existing community-based primary health-care workers can be trained in the prevention and screening of Hypertension and risk factors. The success story of the Iranian rural primary health-care system, where community members with at least a primary level of education were given two years of training and employed for the management of two major NCDs (hypertension and diabetes), offers evidence to support this proposition[170]. This would also require appropriate curricular changes in health workforce training institutions to include the management of hypertension. In addition, existing health workers should receive refresher training and reinforcement of knowledge to deal with the changing disease patterns. All levels of health workers and physicians should be educated on how to create personal and group-level behavioural change in patients. Since behavioural change lies at the heart of preventive efforts for hypertension, development of a health workforce that is capable of carrying out health educational activities at the community level will be very important.

2. **Primary health-care workers can feasibly function as educators and counsellors** for effectively modifying the behavioural risk factors for Hypertension.

3. **Making referral facilities available for evaluating and managing Hypertension risk factors**: the first level of referral for community health workers could be the sub-health posts or health posts, which are currently

staffed by mid-level health workers. Feasibility studies should be done to evaluate if these workers could be trained to do basic evaluation and treatment of Hypertension. If pilot studies prove the operational efficacy of this approach, the human resources capacity of the current health system to deal with Hypertension would be greatly enhanced. The mid-level health-care personnel working at the sub-/health posts would be expected to provide adequate care to patients with uncomplicated Hypertension. However, they would require access to the next level of care for patients with complicated Hypertension and those with associated serious co-morbidities. A robust communication mechanism between these referral systems will help ensure treatment compliance, regular follow up and risk factor modification. Strengthening the district health system, including effective deployment and retention of an adequate number of physicians, is critical for establishing an efficient referral system.

4. **Financing the cost of laboratory testing and medications**: for effective, holistic CVD and Hypertension risk management, laboratory testing for additional risk factors besides Hypertension will be required, for example, diabetes and dyslipidaemia. As discussed above, cost is a prohibitive issue for many patients. A plan to address Hypertension must address the cost of laboratory assessment and essential medications. Promotion of generic medications through education, government policies, market competition and efficient management to ensure adequate local supplies is likely to improve access to essential medications.

5. **Promoting lifestyle changes** through community engagement: effective community engagement is critical for a successful public education campaign by primary health-care workers, regarding the risks of tobacco consumption, excessive alcohol use, obesity, physical inactivity and unhealthy (including high salt) diet. Launching such campaigns in primary

and secondary schools to educate young children so that behaviours that could lead to hypertension are modified early on would have long term advantages. Likewise, working with community-based Women's Group to spread the message and induce desirable changes in behaviours might prove very effective. The media could be leveraged as a tool for public education. Even in rural areas, access to the local FM radio is widespread and can be utilized for health awareness campaigns. There is also an urgent need to create a pool of professionals with different skills sets, who are capable of training the health workforce, conducting research and helping to raise public awareness on modifying Hypertension-related behavioural risk factors.

6. **Developing local guidelines for Hypertension management**, laboratory testing and surveillance for complications: the value of simple, user-friendly guidelines for the diagnosis and management of Hypertension cannot be overemphasized. These guidelines should be based on global and local evidence, resource availability, cost-effectiveness and operational feasibility in the context of India.

7. **Endorsing an integrated Hypertension prevention and control policy**: a draft policy addressing Hypertension has been prepared but has not yet been endorsed by the government. The proposed strategy addresses many of the important issues related to health promotion and Hypertension management. Urgent endorsement and implementation of this policy is very important.

8. **Performing research that informs an effective response**: generating reliable local data related to Hypertension prevention and control is indispensable for formulating an effective response. Such data could come from epidemiological, health systems, behavioural and clinical studies.

Therefore, adequate investment in developing and/or strengthening the capacity of appropriate research institutions is vital.

In conclusion, the increasing prevalence of Hypertension poses a serious threat to India's health-care system. Appropriate policy changes based on available global and national evidence, and effective implementation of these policies through a robust, equity-oriented and community-responsive health system offers hope in dealing with the challenge of Hypertension in India.

9 LIMITATIONS OF THIS STUDY

This study has helped in filling a few research gaps by studying the risk factor profile of the population of Chinchwad, Pune. There still remain areas where intense research is needed. The limitations of this research are-

- Data collected on the intensity or pattern of exposure to lifestyle risk factors (alcohol consumption, smoking, tobacco consumption) was not complete due to high non-response among the population.
- No biochemical analysis was done to collect data on Dyslipidaemias such as crude lipid measures, total cholesterol and Apo lipoproteins (ApoA1 and ApoB) which are indicators of CVD
- Data for prevalence of HTN and its risk factors was collected from a single hospital and not across Pune.
- Data on medicines consumed and their effect on development and progress of hypertension has not been studied.
- Environmental factors like ambient air quality standards, noise pollution levels, standards of sanitation, occupational causes etc. as risk factors of hypertension have not been considered in this study.

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ANNEXURE

10.1 QUESTIONNAIRE FOR STUDY OF RISK FACTORS OF HYPERTENSION IN ADULT MALES

Consent takenWritten / Verbal

Topic: A STUDY OF RISK FACTORS OF HYPERTENSIONAMONG ADULT MEN

- **Date of interview:**

"Good morning. Thank you for consenting to this study. I would first like to ask you your name, phone number, address etc. please be assured that I will not use any names in my study."

A. Demographic Data

- Name of the respondent
- Address
- Slum/ Non Slum
- Phone No. Mobile Number
- ReligionMother tongue
- Age
- Educational QualificationOccupation

Monthly household Income

Income per month (in Rs)	Tick where applicable
≥36017	
18000-36016	
13495-17999	
8989-13494	
5387-8988	
1803-5386	
≤1802	

B. <u>Burden and Pattern of Illness</u>

- **Is there currently anyone in your family who is unwell?y/ n**

Sr No	Name	Type of Illness	Duration	Category (to be filled by the interviewer later)	Changed diet, missed school, college if any

- **Is there anyone in family who is on medication?**

Sr No	Disease	Family member	Medication	For how long
	Diabetes			
	Hypertension			
	Hyperlipidaemia			
	Other			

Risk factors- Family History and Medical History

Can I see a prescription/ medicines that he or she is taking?

Name of Person	**Name of medication**	**Diagnosis from prescription**	**Date of Diagnosis**

- **Family History of CVD**
  - I now want to ask more questions about heart disease. For my first question I would like to ask you if there is any relative (like your or your spouses, parents, grand -parents, brothers, sisters, uncles, cousins etc.) who has or have had heart disease (stoke, Hypertension, angina etc.)

Family member	Relative	Age at diagnosis	Hypertension	MI	Stroke	Other CVD	Living/ Deceased	Age at death

C. Risk Factor- Diet

- **I would like to ask questions on your food habits.**

1. Are you a vegetarian or non-vegetarian?
2. How many time a week do you have-

	<1	1-2	2-3	>3
Green leafy vegetables				

3. How many times a week do you have-

	<1	1-2	2-3	>3
Roots & Tubers (Potatoes, Yam, Sweet Potato etc.)				
Other vegetables				
Fruits				
Salads				

4. How many litres of milk do you buy every day?

Cow	Buffalo	Both	Other
Paneer/ Curd etc.			

- **Is there anyone in the family who does not consume milk or milk products?**

5. **Is there anyone in the family who does not consume meats?**

❖ How many kilograms of meat do you buy in a week?

Type (Chicken, Mutton etc.)	Amount	Per individual

❖ **How many kilograms of fish do you buy in a week?**

Type	Amount	Per individual

❖ **How many eggs do you buy in a week?**

Egg	Amount	Per individual

6. How many litres of Oil/ Ghee do you consume in a month?

- Name of Oil/ Ghee

Type of fat	Quantity per month		Type of fat	Quantity per month	
Soyabean Oil				Mustard Oil	
Groundnut Oil				Blended Oil	
Rice Bran Oil				Corn Oil	
Safflower Oil				Cotton seed Oil	
Sunflower Oil				Ghee	
Til,Olive Oil				Vanaspati	

- **Consumption per individual per month (to be calculated by the interviewer later)**

<1 litres	1-2 litres	2-3 litres	>3litres

7. **How much Salt do you buy each month?_____kgs**

   How much of preserved foods do you consume?

Food item	Quantity	Frequency	Salt content(calculated by interviewer later)

Total Salt consumed per day_____gms/day

8. **How much Sugar do you buy each month?_____kgs**

   How much of preserved foods do you consume?

Food item	Quantity	Frequency	Sugar content(calculated by interviewer later)

Total Sugar consumed per day_____gms/day

D. Risk Factors- Physical Activity and Habits

- Takes effort to exercise Y/N
- Do you exercise for 30 min 3 times a week?

Type*	Number of times last week	Occupation

(*type- brisk walking, running, yoga, gym, cycling, other)

❖ **Risk Factors- habits**

a. Alcohol consumption

	Frequency					Quantity (drinks)				
Alcohol consumption Y/N	Never	Monthly or less	2-4 times/ month	2-3 times /week	>4 times/week	1-2	3-4	5-6	7-9	>10

b. Tobacco Consumption

Tobacco Y/N	Type	Frequency/ Number of times				Duration			Former Smoker Y/N	Years since cessation	
		1-9	10-19	20-29	>30	<1 year	<5 years	>5 years		1-9	>10

Do you use tobacco (cigarette, *bidi*, *gutkha*, snuff, *misri*)?

10.2 QUESTIONNAIRE FOR -QUALITY OF LIFE (MINICHAL SCALE)

MINICHAL SCALE For Quality of Life					
	Questions	**No, not all**	**Yes, some what**	**Yes, a lot**	**Yes, very much**
	Mental Domain				
1.	Have you been sleeping poorly?				
2.	Have you had difficulty maintaining your usual social relationships?				
3.	Have you has difficulty interacting with other people?				
4.	Have you felt that you are not playing a useful role in life?				
5.	Have you felt unable to make decision and start new things/project?				
6.	Have you felt continuously distressed and tensed?				
7.	Have you felt that life is a constant struggle?				
8.	Have you felt incapable of enjoying your daily activities?				
9.	Have you felt worn-out and powerless?				

Contd.

	Questions	**No, not all**	**Yes, some what**	**Yes, a lot**	**Yes, very much**
	Somatic Domain				
10.	Have you felt sick?				
11.	Have you had difficulty breathing or felt breathless for no apparent reason?				
12.	Have your ankles been swollen?				
13.	Have you noticed that you are urinating more frequently?				
14.	Has your mouth been dry?				
15.	Have you felt pain in the chest without doing any physical exertion?				
16.	Have you noticed numbness or tingling sensation in part of the body?				
17.	Would you say that your Hypertension and its treatment have affected your quality of life?				

10.3 QUESTIONNAIRE FOR- QUALITY OF LIFE (WHOQOL- BREF)

WHOQOL-BREF

The following questions ask how you feel about your quality of life, health, or other areas of your life. I will read out each question to you, along with the response options. **Please choose the answer that appears most appropriate.** If you are unsure about which response to give to a question, the first response you think of is often the best one.

Please keep in mind your standards, hopes, pleasures and concerns. We ask that you think about your life **in the last four weeks.**

		Very poor	Poor	Neither good nor poor	Good	Very good
1	How would you rate your quality of life	1	2	3	4	5

		Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
2	How would you rate your General health	1	2	3	4	5

The following questions ask about **how much** you have experienced certain things in the last four weeks.

		Not at all	A little	A moderate amount	Very much	An extreme amount
3	To what extent do you feel that your physical pain prevents you from doing what you need to do?	1	2	3	4	5
4	How much do you need any medical treatment to function in your daily life?	1	2	3	4	5
5	How much do you enjoy your life?	1	2	3	4	5
6	To what extent do you feel your life to be meaningful?	1	2	3	4	5

		Not at all	A little	A moderate amount	Very much	Extremely
7	How well are you able to concentrate	1	2	3	4	5
8	How safe do you feel in your daily life?	1	2	3	4	5
9	How healthy I your physical environment?	1	2	3	4	5
6	To what extent do you feel your life to be meaningful?	1	2	3	4	5

The following questions ask about how completely you experience or were able to do certain things in the last four weeks.

		Not at all	A little	A moderate amount	Very much	Extremely
10	Do you have enough energy for everyday life?	1	2	3	4	5
11	Are you able to accept your bodily appearance?	1	2	3	4	5
12	Have you enough money to meet your needs?	1	2	3	4	5

13	How available to you is the information that you need in your day-to-day life?	1	2	3	4	5
14	To what extent do you have the opportunity for leisure activities?	1	2	3	4	5

		Very poor	Poor	Neither good nor poor	Good	Very good
15	How well are you able to get around?	1	2	3	4	5

		Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
16	How satisfied are you with your sleep?	1	2	3	4	5
17	How satisfied are you with your ability	1	2	3	4	5

	to perform your daily activities?					
18	How satisfied are you with your capacity for work?	1	2	3	4	5
19	How satisfied are you with yourself?	1	2	3	4	5
20	How satisfied are you with your personal relationships?	1	2	3	4	5
21	How satisfied are you with your sex life?	1	2	3	4	5
22	How satisfied are you with the support you get from your friends	1	2	3	4	5
23	How satisfied are you with the conditions of our living place?	1	2	3	4	5
24	How satisfied are you with your access to health services?	1	2	3	4	5
25	How satisfied are you with your transport?	1	2	3	4	5

The following question refers to how often you have felt or experienced certain things in the last four weeks.

		Never	Seldom	Quite often	Very often	Always
26	How often do you have negative feelings such as blue mood, despair, anxiety and depression?	5	4	3	2	1

[The following table should be completed after the interview is finished]

		Equations for computing domain scores	Raw score	Transformed scores*	
				4-20	0-100
27.	**Domain 1**	(6-Q3) + (6-Q4) + Q10 + Q15 + Q16 + Q17 + Q18 ++++++	a. =	b:	c:
28.	**Domain 2**	Q5 + Q6 + Q7 + Q11 + Q19 + (6-Q26) + + +++	a. =	b:	c:
29.	**Domain 3**	Q20 + Q21 + Q22 ++	a. =	b:	c:
30.	**Domain 4**	Q8 + Q9 + Q12 + Q13 + Q14 + Q23 + Q24 + Q25 + + +++++	a. =	b:	c: