ASSESSMENT OF CARDIOVASCULAR DISEASE AND ASSOCIATED RISK FACTORS IN RURAL GARO POPULATION

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By

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Dedicated To My Beloved Parents

Late Md. Moyen Uddin Khan

And

Late Saleha Khatun

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DECLARATION

I hereby declare that the research work entitled "ASSESSMENT OF CARDIOVASCULAR DISEASE AND ASSOCIATED RISK FACTORS IN RURAL GARO POPULATION" has been carried out under the Faculty of Biological Sciences, Institute of Nutrition and Food Science, University of Dhaka in fulfilment of the requirement for the Degree of Doctor of Philosophy. I have composed this thesis based on original research findings along with references from published literature. This thesis has not been submitted to any other institution for any other degree. I also certify that there is no plagiarized content in this thesis.

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CERTIFICATE OF THE SUPERVISORS

This is to certify that the thesis entitled "ASSESSMENT OF CARDIOVASCULAR DISEASE AND ASSOCIATED RISK FACTORS IN RURAL GARO POPULATION" is submitted by Ummy Salma Munni in partial fulfilment of the requirement for the degree of Doctor of Philosophy (PhD) under the Faculty of Biological Science, Institute of Nutrition and Food Science, University of Dhaka, Dhaka-1000, Bangladesh was carried out under the guidance of Professor Dr Khaleda Islam, Director, Institute of Nutrition and Food Science (INFS), University of Dhaka and Professor Dr Liaquat Ali, former Professor, Department of Biochemistry and Cell Biology & Vice-Chancellor, Bangladesh University of Health Sciences (BUHS)

So far as I am aware, this is an original research record and the researcher duly acknowledged the other researcher materials and sources used in this work. To the best of my knowledge no part of the work has been submitted for another degree or qualification in any other institute. It can be submitted to the examination committee for evaluation. All the given information is true to best of our knowledge.

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Abstract

Background: Cardiovascular diseases (CVDs) are the leading causes of death all over the world. These are associated with various genetic and lifestyle risk factors. Many risk factors like diabetes, high blood pressure, dyslipidemia, obesity and smoking may be potentially controlled or minimized leading to huge benefits in the control and prevention of the CVDs. Since cardiovascular diseases risk factors vary considerably in population to population it is important to explore those factors in different ethnic groups. In Bangladesh, few studies related to CVD risk have been conducted among Bangalee population, but data on other ethnic groups have not yet been reported. Garo indigenous are one of the important ethnic groups in Bangladesh. But, so far, CVD risk has not been assessed among them. Under this context, the present research work was undertaken to assess the prevalence of hypertension (as a marker of CVD) and its associated risk factors in a rural Garo population.

Objectives: The objectives of this study were to assess cardiovascular diseases (with hypertension as a surrogate marker) and its associated risk factors among a rural Garo Population.

Subjects and Methods: It was an observational analytical study conducted under a cross-sectional design. Recruited through a purposive sampling, the subjects comprised of 289 Garos (age 18-60 yrs.) located in a rural area (Modhupur) of Tangail district. Blood Pressure (SBP and DBP) were measured by an aneroid sphygmomanometer. Anthropometric measurements such as Body Mass Index, Waist-Hip Ratio were done by standard methods. Dietary intake and dietary habits were assessed by 24-hr recall and 7-day FFQ methods respectively. Fasting blood glucose was estimated in all subjects and a standard OGTT as per WHO Study group criteria was done in some cases. Serum glucose at fasting and 2h after 75g oral glucose load, and total cholesterol were estimated by enzymatic methods using a semi-autoanalyzer. Data were analyzed by univariate and multivariate statistical techniques, as appropriate, using SPSS for Windows v23.

Results: Of the total 289 subjects, the mean age was 43.24 years with a standard deviation of 14.34 years. BMI was 23.39 (±5.74) and mean Waist-Hip Ratio was 0.81 (± 0.125). Regarding addiction history, 18% respondents had smoking habit and 24.9% were used to drink alcohol.

About 34.6% of the male subjects were within the normal ranges of nutritional status (as assessed by BMI); 37.5% were overweight. 15.4% were underweight and 12.5% were obese. The corresponding percentages in females were 34.6, 31.4, 14.6 and 19.5, respectively, and there was no substantial difference between males with females (X^2=2.68, p=0.222). The mean calorie intake among all the subjects was 1854 kcal and carbohydrates were the dominant (mean percentage 73.6) source followed by fat (16.7) and protein (only 10.7). As per present RDA for calories, only 32% of the males consume optimum calorie; 59% suffer from underconsumption and 9% suffer from overconsumption. The calorie intake scenario is slightly better in case of females with underconsumption proportion at 40% and optimum proportion at 48%. The mean intake of salt among Garos is 6.81 g/day (SD 2.30). Among males 92% were smokers in contrast to only 7% among females. The mean (± SD) Fasting and 2hr PPG blood glucose levels (mmol/l) were 5.12±2.2 and 6.63 ± 2.94, respectively, among all the subjects. Based on FBG, 6.6% were diabetic and 9.8% had Impaired Fasting Glucose (IFG), and based on PPG, 5.4% had diabetes and 10.4% had IGT. There has no significant statistical difference between males and females. At time of combined analysis of both FBG and PPG, the prevalence of diabetes was 5.2% and that of IGT was 8.7% among all the subjects. Regarding serum cholesterol level, 26.9% of the subjects were found to present with hypercholesterolemia and 8.99% had low cholesterol as per AHA criteria. There was no significant difference between males and females regarding cholesterol levels overall,

The prevalence of hypertensive CVD respondents was 8%. The mean (±SD) systolic BP and diastolic BP (mmHg) were 118±16 and 79±06 respectively and the proportion of hypertensive subjects did not show significantly difference between males (7.7%) and females (8.0%). Also, the prevalence of systolic hypertension (overall, 4.5%), did not differ between males (4.8%) and females (4.3%). In case of diastolic hypertension female respondents (5.9%) were a little more hypertensive as compared to males (4.8). Hypertension did not show any relation with smoking habits, alcohol intake and nutritional status.

The systolic blood pressure (SBP) was positively correlated with Age ($r=0.217$, $p<0.001$), WHR ($r = 0.240$, $p < 0.001$), PPG ($r = 0.193$, $p < 0.05$), blood total cholesterol ($r=0.14$, $p < 0.05$) levels. On the other hand, a positive correlation was found between DBP with age ($r = 0.19$, $p < 0.01$), WHR ($r = 0.269$, $p<0.001$), fasting blood glucose ($r = 0.13$, $p < 0.05$), PPG ($r = 0.199$, $p < .003$) and blood total cholesterol ($r = 0.219$, $p < 0.001$). On logistic regression analysis it was found that hypertensive CVD is only significantly associated with age ($p < .001$, odds = 1.09), SBP is significantly related to age ($p <0.001$, odds=1.111) and total calorie intake ($p<.05$, odds=1.001). DBP is significantly related to age ($p < 0.001$, odds = 1.082) and fasting blood glucose ($p < 0.05$, odds = 0.650) level.

Conclusions: Deficient calorie intake is still a major problem among the Garos contributed by low amount of dietary protein and fat. At the same time, rising overweight and obesity among some subgroups is a growing concern among this community. CVD (with hypertension as a marker) has already started to create substantial disease problems among the Garo communities and the problem seems to be greater among males compared to females. Overweight and DM seem to be the major factors underlying hypertension in this community. A comprehensive strategy (using evidence-based guidelines) to prevent CVDs should be designed and implemented in this population to prevent a surge of this NCD among the Garo indigenous communities

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Abbreviations:

DU	: Dhaka University
INFS	: Institute of Nutrition and Food Science
BUHS	: Bangladesh University of Health Sciences
CVD	: Cardiovascular Disease
CVDs	: Cardiovascular Diseases
NCD	: Non-Communicable Disease
NCDs	: Non-Communicable Diseases
BP	: Blood pressure
SBP	: Systolic Blood pressure
DBP	: Diastolic Blood pressure
FBG	: Fasting Blood Glucose
DM	: Diabetes Mellitus
IFG	: Impaired Fasting Glycemia
PPG	: Post Prandial Glucose
OGTT	: Oral Glucose Tolerance Test
BMI	: Body Mass Index
WHR	: Waist-Hip Ratio

WHO	: World Health Organization
RDA	: Recommended Dietary Allowances
FFQ	: Food Frequency Questionnaire
SPSS	: Statistical Package For Social Sciences
AHA	: American Heart Association
SD	: Standard Deviation
BBS	: Bangladesh Bureau of Statistics
SEAR	: South East Asian Region
LMIC	: Low- and Middle-Income Countries
WHF	: World Heart Federation
CAD	: Coronary Artery Disease
CHF	: Congestive Heart Failure
CVA	: Cerebrovascular Disease
PAD	: Peripheral artery disease
CHD	: Coronary heart disease
LVH	: Left Ventricular Hypertrophy
ASCVD	: Atherosclerotic Cardiovascular Disease
CRP	: C-Reactive Protein
TIAs	: Transient Ischemic Attacks

WAT	: White Adipose Tissue
BAT	: Brown Adipose Tissue
LDL-C	: Low-Density Lipoprotein Cholesterol
TC	: Total Cholesterol
TG	: Triglycerides
HDL-C	: High-Density Lipoprotein Cholesterol
DALYs	: Disability Adjusted Life Years
T1DM	: Type 1 Diabetes Mellitus
T2DM	: Type 2 Diabetes Mellitus
COAD	: Chronic Obstructive Airways Disease
CDCP	: Centers for Disease Control and Prevention
PA	: Physical Activity
HTN	: Hypertension
NT	: Normotensive
TAVI	: Transcatheter Aortic Valve Implantation
IHD	: Ischemic Heart Disease
AI	: Artificial Intelligence
DNN	: Deep Neural Network

ICDDRB	: International Centre for Diarrheal Disease Research, Bangladesh
DMCH	: Dhaka Medical College and Hospital
MMCH	: Mymensingh Medical College Hospital
CMCH	: Chittagong Medical College and Hospital
ICMR	: Indian Council of Medical Research
USA	: United States of America

CHAPTER 1

INTRODUCTION

1.1 Background

Cardiovascular diseases (CVDs) are serious health problems and those are the most frequent reasons for early mortality and morbidity globally (*Muhit et al, 2012*). According to World Health Organization (WHO), CVDs are the number one cause of death worldwide. According to estimates, 17.9 million people worldwide died from CVDs in 2019, accounting for 32% of all deaths. More than 75% of CVD deaths occur in low- and middle-income countries (*WHO, 2021*). Almost one-third of all deaths in South-East Asia are caused by cardiovascular disease, which claims 4 million lives yearly. Air pollution is one of the major risk factors for CVD in the area, accounting for almost 17% of all deaths and 28% of CVD-related deaths, in addition to high blood pressure and an unhealthy diet. (*WHF, 2019*). In South East Asian region (SEAR) CVDs alone accounted for 35.5% death (*Joseph, 2022*) and in Bangladesh about 34% people died from CVDs (*Moral, 2022*). A Bangladesh Bureau of Statistics (BBS) report published in 2021 claims that, the death toll from CVD increased in 2020 compared to 2019. Around 20% people suffer from hypertension, which is a major issue for public health and medical sector in Bangladesh (Reports from 1st national NCD Conference, 2022 virtually).

There are several risk factors of CVDs: The harmful use of alcohol, inactivity, salt, fat, and calories in the diet, and tobacco use are the behavioural risk factors. (*WHO, 2014*). Raised blood pressure (hypertension), increased blood sugar (diabetes), and high blood lipids are the metabolic risk factors (ex: overweight, obesity and cholesterol). Lifestyle factors including nutrition play an important CVD risk factor. High blood pressure, obesity, uncontrolled blood sugar, and a high saturated fats diet are all food related risk factors. The other risk factors for CVDs are Age, gender, low educational background, poverty, inherited (genetic) disposition, and psychological factors all have a role (e.g., stress, depression). (*Mendis et al, 2015*)

The largest effects of these risk variables, which are a reflection of the underlying socioeconomic determinants, are increasingly felt by poorer individuals worldwide and in low- and middle-income countries. (*WHO, 2010*). One of the LMIC nations where CVD incidence and prevalence have been steadily rising is Bangladesh. Unless coordinated efforts are made and a national policy of risk factor prevention is implemented. The number of patients is anticipated to significantly rise during the next 10 to 15 years. Naturally, this will significantly tax the resources of the health care sector and place a heavy load on those who offer those services. (*Zaman, 2016*).

Due to their lifestyle and food habit indigenous people were often thought to suffer less from CVDs. However, many Aboriginal and Torres Strait Islander people have also been affected by CVDs. One-in-eight (13%) indigenous people reported in the 2012-2013 that they had some form of CVD (*Alam, 2009*). It was responsible for 25% of the deaths among Indigenous people living in different regions in Australia. Unlike other ethnic groups, American Indians appear to have an increasing incidence of CVDs. CVD-related studies among indigenous population in Bangladesh have not yet been reported. In the national survey on CVD risk factors of Bangladesh no attention was given on the CVD risk in ethnic minority groups.

The indigenous people are genetically, culturally and geographically different from the general population in any society; examination of such population groups can provide clue to the genetic predisposition to those disease entities. (*Health Info Net 2015*). The population census 2022 found only 16,90,159 ethnic community people-living in Bangladesh. In the census of 2011, the indigenous population was 15,86,141. If compare with latest census, indigenous populations have increased by only 64 thousand in last 11 years.

There are about 35 smaller groups of indigenous communities in Bangladesh, some major groups are the Chakmas, Marmas, Santals, Garos, Monipuri, Tripuri etc. (*Howard et al, 1999*)

One of Bangladesh's largest indigenous populations is the Garo, who make up one of the country's indigenous groups. The present population size is about 1,50,000 (According to National Encyclopedia of Bangladesh) (*Banglapedia 2021*). Most of them reside in

Bangladesh's north-eastern region, with the districts of Gazipur, Mymensingh, Netrokona, Tangail, Sherpur, and Jamalpur having the biggest concentration. (*Health Info Net 2015*)

In Bangladesh, there have been no known studies of CVD risk factors among the Garo or any indigenous population. Therefore, it is imperative that we do more to emphasize preventative measures in the larger issues of managing Bangladesh's cardiovascular diseases. If active risk factor management and long-term management strategies are not followed, the Bangladeshi health system will be heavily taxed as a result of this aging population's potential for many illnesses caused by diverse CVDs. (*Alam et al, 2009*).

1.2 What is cardiovascular disease?

A class of illnesses known as cardiovascular disease (CVD) affects the blood vessels or the heart (veins and arteries). Combinations of socioeconomic, behavioral, environmental risk factors, such as high blood pressure, diabetes obesity, unhealthy diet, physical inactivity, high cholesterol, renal disease smoking, excessive alcohol drinking, and stress might contribute to its development. The risk of CVD can also be influenced by a person's age, sex, ethnic background, and family history. (*WHF, 2019*).

Worldwide, noncommunicable diseases (NCDs) constitute the leading cause of death, accounting for 38 million deaths annually, with about three-quarters of these fatalities happening in nations with low and moderate levels of income. Most common NCDs are cardiovascular disease (CVD), cancer, respiratory disorders and diabetes (*WHO, 2018*).

The phrase "cardiovascular disease" (CVD) refers to any conditions that impact the heart and vasculature, which respectively pump and carry blood, make up the blood circulation system.. This complex condition includes a wide range of inherited and acquired illnesses.

Worldwide, cardiovascular diseases (CVDs) are serious health issues and the leading contributors to early morbidity and mortality. (*De Hert et al, 2022*).

1.3 Types of CVD

Heart and blood vessels make up the cardiovascular system. There are a variety of cardiovascular system issues, including endocarditis, rheumatic heart disease, and irregularities in the conduction system, among others. Cardiovascular disease (CVD) or heart disease refers to the four entities (*Benjamin, 2018)*

The majority of cardiovascular disorders are manifestations of chronic ailments, which are those that arise or last for a long time. However, when an artery delivering blood to the heart or brain gets clogged, it may result in acute occurrences like heart attacks and strokes, which happen rapidly.

The term "CVD" is most often used to describe illnesses connected to atherosclerosis, or the accumulation of fat and other debris in the inner walls of blood arteries. Smokers, those with high cholesterol, high blood pressure, those who are over-weight, those who are not habituated with exercise, and/or those with diabetes are more likely to get these disorders. By promoting a healthy lifestyle, quitting smoking, managing blood pressure, lowering cholesterol, engaging in regular exercise, and, if they have diabetes, keeping excellent control of their blood glucose, public health campaigns aim to lower the chance of CVD.

Some major types of CVD are:

a. Hypertensive heart disease
b. Coronary Artery Disease (CAD)
c. Congestive heart failure (CHF)
d. Cerebrovascular disease (CVA) or stroke
e. Peripheral artery disease (PAD)
f. Aortic atherosclerosis
g. Rheumatic heart disease

1.3.1 Hypertensive heart disease

The term "hypertensive heart disease" describes heart problems brought on by high blood pressure. Many heart problems are brought on by the heart's increased workload. Heart failure, heart muscle thickening, coronary artery disease, among other diseases, are all aspects of hypertensive heart disease. Serious health issues can result from hypertensive heart disease. High blood pressure is the main cause of death in this situation. High blood pressure-related heart issues typically involve the arteries and muscles of the heart.

These are some of the forms of hypertensive heart disease:

i) Narrowing of the arteries

Blood is delivered to the heart muscle via the coronary arteries. Blood flow to the heart may slow or cease when high blood pressure causes the blood arteries to become narrow. Coronary heart disease (CHD), commonly referred to as coronary artery disease, is the term used to describe this ailment.

The heart's ability to pump blood to the body's other organs is compromised by CHD. A blood clot that gets caught in one of the constricted arteries and stops the flow of blood to the heart could put someone at risk for having a heart attack.

ii) Thickening and enlargement of the heart

The heart has a hard time pumping blood when there is high blood pressure. The heart muscles thicken and expand as a result of consistent hard labor, just like other muscles in the body. The way the heart works is changed by this. The left ventricle, the heart's primary pumping chamber, is where these modifications typically take place. It is referred to as left ventricular hypertrophy (LVH). Both LVH and CHD can contribute to one another. Heart must work harder when CHD develops. The coronary arteries may get compressed if LVH causes the heart to expand. (*Hypertensive heart Disease, 2018*)

iii) Complications

Both LVH and CHD can result in:

Heart failure: When the heart cannot pump enough blood to the body

arrhythmia: Abnormal heart beats

ischemic heart disease: Heart doesn't receive enough oxygen

heart attack: Heart blood flow is disrupted, and the heart muscle dies from a lack of oxygen.

sudden cardiac arrest: suddenly heart stops working, breathing stops, and consciousness lose.

stroke and sudden death: A stroke, also known as a brain attack, happens when a blood vessel in the brain breaks or when something stops the flow of blood to a specific area of the brain**.** Any death that occurs fewer than 24 hours following the beginning of the initial symptoms is referred to as sudden death.

1.3.2

1.3.3 Coronary Artery disease (CAD)

Coronary artery disease is a disorder in which the myocardium receives insufficient blood and oxygen. It is brought on by coronary artery occlusion. and resulting in an imbalance between oxygen demand and supply. It often includes the creation of plaques in coronary artery lumens, which restrict blood flow. It is the major cause of death in the United States and globally. It was a rare cause of mortality in the beginning of the twentieth century. CVD deaths peaked in the mid-1960s and have since declined, although it still the greatest reason of death globally (*Gordon, 2021)*.

There are various underlying causes of coronary artery disease. Etiologic factors that can be changed and those that cannot be changed can be loosely separated into two groups. Examples of immutable factors include age, gender, genetics, and family history. Risk factors that can be changed include being overweight, smoking, having high cholesterol levels, and psychological problems. The incidence of ischemic heart illnesses has grown in the Western world as a result of individuals eating more fast food and unhealthy meals. The US has seen an increase in incidence in later age due to improved primary care in the middle and upper socioeconomic groups. The greatest contributor to cardiovascular illnesses is still smoking. In the United States, people who smoke on average 12.5 percent of the time in 2016 were determined to be smokers (*CDC, 2020)*.

Males are more susceptible than females are, on balance. Even today, a substantial modifiable risk factor for CAD is hypercholesterolemia risk. High levels of HDL (high-density lipoproteins) lower the risk for CAD while high levels of LDL (low-density lipoproteins) increase the incidence of the condition. The American Heart Association site provides an online version of the ASCVD equation that may be used to determine 10-year risk of atherosclerotic cardiovascular disease. Additionally significant risk factors for coronary artery disease are indicators of inflammation. Although its applications in real-world settings are debatable, high sensitivity CRP (hsCRP) is regarded to be the greatest predictor of coronary artery disease in certain studies (*Zhu et al, 2019*).

1.3.4 Cerebrovascular disease (CVA)

A cerebrovascular accident (CVA) or stroke is the term used to describe a neurologic symptom or cluster of symptoms brought on by cerebral ischemia or bleeding. Except in cases of subarachnoid hemorrhage, rapid or subacute onset and a localized neurologic impairment are the essential clinical characteristics. The origin, location, and duration of symptoms are used to further categorize cerebrovascular illnesses, which are a fairly heterogeneous set of disorders apart from these shared characteristics.

There are several etiologies for both cerebral hemorrhages and ischemic events, which are the two main subtypes of cerebrovascular disorders. The carotid or vertebrobasilar distribution of symptoms, as well as their duration, are used to further categorize ischemic episodes. Rarely lasting more than a few minutes, transient ischemic attacks (TIAs) seldom persist longer than 24 hours. As the most significant risk factor for stroke, hypertension has been established in all epidemiologic investigations. Hyperlipoproteinemia and smoking have a less strong correlation. (*Sanna et al. 2018)*.

1.3.5 Peripheral artery disease (PAD)

Peripheral artery disease (PAD) patients experience "poor circulation," or reduced arterial perfusion to the lower limbs. The majority of PAD cases involve atherosclerotic plaques limiting the arterial lumen, which prevents blood from reaching the extremities. Walking may induce discomfort in the thighs or calves owing to transient ischemia of the leg muscles caused by decreased blood supply. Pain associated with PAD is referred to as intermittent claudication, which literally translates to "to limp." Numerous PAD patients have either no symptoms or unusual complaints that do not fully match to the concept of claudication. Others may develop limb-threatening blood flow impairment demanding immediate surgery (*Tan et al, 2018)*.

PAD serves as a marker for systemic atherosclerosis, hence the diagnosis of PAD in asymptomatic individuals nevertheless has substantial clinical implications. Changes lifestyle, decrease of cardiovascular risk factors, medication, endovascular intervention, and surgery are among treatment possibilities for PAD (*YILDIZ et al, 2018 and Yuksel et al, 2018*).

Over 200 million persons worldwide are afflicted with PAD, and the prevalence of PAD climbs to as high as 20% in those over the age of 70. Although PAD has generally been considered as a disease affecting males, the incidence of PAD in older men and women seems to be equal. As the majority of patients with PAD do not come with the textbook-described claudication symptoms, underdiagnosis of PAD in the primary care context may be a serious concern. Smoking quadruples the chance of developing PAD and has the most significant effect on disease severity. Compared to nonsmokers, smokers with PAD have lower life spans and have critical limb ischemia and amputation more often. Additionally, diabetes, hyperlipidemia, hypertension, race, and ethnicity are risk factors for PAD (*Petrov et al, 2018)*.

1.3.6 Aortic atherosclerosis

Atherosclerosis, a chronic inflammatory condition of the arteries, is the underlying cause of around fifty percent of fatalities in westernized societies. Hyperlipidemia and lipid oxidation are the causes of atherosclerosis, which has long been a leading reason of death in affluent nations. It is a vascular intima disease characterized by intimal plaques that may affect the entire circulatory system, from the aorta to the coronary arteries. (*Baradaran ,2012)*.

It is a condition marked by an accumulation of fat and a thickening of the intima of the arteries. The center core of the plaque contains fatty material, which is covered by a fibrous cap. (*Ross, 1999)*.

Nowadays, atherosclerosis is a common disease in which atheromatous plaques—fatty deposits that develop inside the inner layers of arteries—occur. Little cholesterol crystals begin to accumulate in the intima and smooth muscle beneath these plaques, which is the first step in their creation. The plaques then expand inside arteries as a result of the development of fibrous tissues and surrounding smooth muscle, reducing blood flow. Sclerosis, or the hardening of the arteries, is caused by calcium buildup in the lesion and connective tissue production by fibro blasts. Finally, the arteries' uneven surface leads to the production of blood clots and thrombosis, which abruptly obstructs blood flow (*Chernysh et al, 2020*).

Hyperglycemia and hyperlipidemia are associated with raised oxidative damage that alters lipoprotein concentrations and antioxidant status (*Behradmanesh et al 2012 & Weber et al, 2011*). In addition to their antioxidant properties, lipid-lowering medicinal herbs have been demonstrated to decrease blood lipids, particularly after a meal, according to research. Therefore, they may prevent atherosclerosis and endothelial damage to the vascular system (*Behradmanesh et al, 2012)*.

Due to the asymptomatic nature of atherosclerosis, it is difficult to correctly measure its occurrence. (*Watson ,2019*).

1.3.6 Rheumatic heart disease

Rheumatic fever brought on by streptococcal germs can harm the heart valves and muscle.

1.4 Etiology of CVD

CVD and the risk factors

The individual's health condition has a significant effect of propensity to developing a CVD. Being overweight and obesity, as defined by the WHO as the accumulation of excessive fat, pose a health concern and raise the chance of developing a variety of chronic illnesses. Obesity is related with elevated levels of C-reactive protein and fibrinogen, both of which increase the risk of cardiovascular disease (CVD) events, together with hypertension, diabetes, dyslipidemia (*Akil and Ahmed, 2011*). Therefore, these chronic illnesses significantly raise the risk of cardiovascular disease. Persistent hypertension is one of the risk factors for arterial aneurysm, myocardial infarction (MI), stroke, and heart failure. In addition, it is a significant cause of chronic renal failure (*Anderson and Durstine, 2019*). Hypercholesterolemia is another disorder that affects the cardiovascular system. Individuals with hypercholesterolemia are more likely to develop coronary artery disease.

a. Hypertension
b. Overweight body mass and obesity
c. Dyslipidemia
d. Diabetes
e. Procoagulant factors
f. Markers of inflammation
g. Smoking
h. Inactivity
i. Family history of CVD

j. Ethnicity background

1.4.1 Hypertension

Hypertension (abnormally high blood pressure) is a cardiovascular disease risk factor for both hemodynamic causes and the acceleration of atherosclerosis (*Aboulhosn and Child, 2006*). A persistently high blood pressure (BP) in the systemic arteries characterizes hypertension. Blood pressure is often represented as the ratio of the systolic BP (the pressure exerted by the blood on the artery walls when the heart contracts) and the diastolic BP (the pressure when the heart relaxes).

The link between BP and the increased risk of cardiovascular disease is graded and continuous, beginning at 115/75 mmHg, well within the normotensive range. 3,5 billion individuals worldwide more than 110 to 115 mmHg), and 874 million people have systolic blood pressure of 140 mmHg. As a result, hypertension affects about 1 in 4 people. (*Forouzanfar et al, 2017*). The number of healthy life years lost globally to inadequate blood pressure increased by 43 percent between 1990 and 2015 as a result of population expansion, population aging, and an increase of 10% in the age-standardized incidence of hypertension. According to the Global Burden of Disease study, high blood pressure (BP) continues to be the leading risk factor for worldwide disease burden and all-cause mortality, accounting for 9.4 million annual deaths and 212 million years of healthy life lost (8.5% of the global total). (*Forouzanfar et al, 2017*).

It occurs in both sexes, at all ages throughout adulthood, and in all major cardiovascular disease manifestations, such as ischemic and hemorrhagic stroke, coronary artery disease, heart failure, peripheral vascular disease, and end-stage renal disease. (*Rapsomaniki et al, 2014*). The association is independent of other cardiovascular disease (CVD) risk factors, and all prediction models have shown that blood pressure is a substantial component of CVD risk (*Goff et al, 2014)*. A little over two thirds of adults with hypertension at age 30 had a 40% greater chance of developing a CVD incident than their age- and sex-matched peers with a lower BP. In addition, CVD manifestations tend to occur around five years sooner in those with hypertension compared to those with a lower BP (*Rapsomaniki et al, 2014)*.

A 20 mmHg rise in systolic blood pressure or a 10 mmHg rise in diastolic blood pressure, regardless of baseline values, is associated with a greater than doubling of the risk for stroke or ischemic heart disease mortality in individuals aged 40–69 years, whereas a 5-mmHg reduction in systolic blood pressure can reduce stroke mortality by 14% and CVD mortality by 9%. At later ages (80 years), the relative risk is somewhat reduced, but the absolute risk is much higher than in younger years (*Lewington, 2002*).

1.4.2 Overweight body mass and obesity

Obesity, which is commonly described as an excess of body fat mass, is a well-known worldwide pandemic that may have severe effects, such as an elevated risk of illness and a shorter life expectancy (*Schwartz et al, 2017)*. Obesity is assessed by BMI, it is calculated by dividing weight (in kg) by the square height (in meters). In general, BMI 30 or more is considered as obese. Individuals having BMI of 25 or above are considered overweight (*WHO, 2011*).

The world health organization (WHO) reported in 2016 that more than 1.9 billion individuals (39 percent of the population) were overweight and over 650 million adults (13 percent of the population) were obese (*WHO, 2018)*. According to the survey of third national health and nutrition examination in the United States, 68 percent of the population has an abnormal body mass, including 34,2 percent of overweight individuals and 33,8 percent of obese individuals (*Zhu et al, 2003*).

Obesity is related with several comorbidities, including cardiovascular illnesses, diabetes, hypertension, atherosclerosis, cancer, and sleep problems, despite the fact that its development is influenced by multiple genetic, environmental, and lifestyle factors (*Poirier, 2006 & Zhang 2014)*. The development of atherosclerosis is affected by obesity and increasing adipose tissue. White adipose tissue (WAT) and brown adipose tissue (BAT) make up the dynamic organ known as adipose tissue, which is also engaged in the metabolic and inflammatory systems and has protective effects on energy balance. WAT releases proteins and peptides that regulate physiological and biological circumstances that a vital role in insulin resistance, obesity, immunological and inflammatory activities, cardiovascular disease and atherosclerosis (*Farooqui et al, 2013 & Unamuno et al 2018*).

1.4.3 Dyslipidemia

Dyslipidemia is defined by an increase in blood low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), triglycerides (TG) and decrease in serum high-density lipoprotein cholesterol (HDL-C). These measurements are regularly taken in order to determine cardiovascular risk (*Guzzaloni et al 2000 and Niroumand et al 2015*).

Cardiovascular illnesses are at danger from lipid abnormalities, which may be changed. The current recommendations state that the average person should have a cholesterol level of less than 5 mmol/L (190 mg/dL), TG is less than 1.7 mmol/L (150 mg/dL). LDL cholesterol fraction less than 3 mmol/L (115 mg/dL), HDL cholesterol fraction in men less than 1.0 mmol/L (40 mg/dL) and in women less than 1.2 mmol/L (45 mg/dL), Globally. Dyslipidemia was responsible for about 2.6 million fatalities and 29.7 million DALYs (disability-adjusted life years). (*Mendis et al 2011*). In NATPOL PLUS, the prevalence of high cholesterol was 59.5 percent in men and 62 percent in females, respectively (*Zdrojewski et al 2004*). The incidence varies in dyslipidemia widely, although it is believed > 50% of the world's adult peoples is affected (*Brown et al, 2000 and O'Meara et al 2004*).

Globally, public health organizations have concentrated on lowering modifiable risk factors of CVD are unhealthy diet, obesity, dyslipidemia and hypertension, in order to decrease the growing incidence of CVD and related risk factors (*Niroumand et al, 2015 and Mathers et al 2006, and Després et al, 2006*). A diet rich in fat and calories may lead to dyslipidemia and subsequent endothelial dysfunction (*Tveden-Nyborg, 2016*). Independent predictors of cardiovascular disease risk include serum TC, TG, LDLC, HDLC, TC/HDLC, and LDLC/HDLC ratios (*Hadaegh et al, 2006*).

1.4.4 Diabetes

Diabetes is a set of metabolic illnesses defined by increased blood glucose levels caused by a deficiency in insulin activity or production (*Dardano, et al, 2014*). Typically, diabetes is accompanied with atherogenic dyslipidemia (*Orekhov, et al, 2014*). Globally, the prevalence of diabetes is rising dramatically. The burden of diabetes has increased from 30 million in 1985 to 382 million in 2014 worldwide, and current trends indicate that these rates will increase (*Wild, et al, 2004*). The international diabetes federation projects that 592 million people (1 in 10) will have diabetes mellitus by 2035 (*Cho, et al, 2018*).

As the prevalence of both type 1 diabetes (T1DM) and type 2 diabetes (T2DM) is on the rise, T2DM contributes disproportionately more to the increase than T1DM. The rising prevalence of diabetes mellitus imposes a substantial financial burden on both the healthcare system and the patient (*Wild et al, 2004)*. In the United States, the total annual expenses of diabetes mellitus are $2,108 per patient, about double that of non-diabetic individuals (*Bahia et al, 2011*).

There is a close relationship between diabetes and CVD. In diabetic communities, CVD is the most frequent cause of death and morbidity (*Matheus et al, 2013*). This higher risk of CVD mortality is seen in both male and female diabetes individuals. In people with diabetes, the relative risk for CVD morbidity and death varies from 1 to 3 for men and 2 to 5 for women when compared to people without DM (*Rivellese et al, 2010*).

As the disease's incidence and economic impact continue to rise, effective management and treatment of diabetes are vital. As CVD is the leading cause of death and morbidity in individuals with DM, improving the cardiovascular (CV) risk of diabetic patients should be the main objective of diabetes therapy. The intricate and multidimensional nature of the association between diabetes and cardiovascular disease (CVD) is a challenge for managing diabetes and lowering CVD occurrences. Hypertension, obesity, and dyslipidemia are frequent CVD risk factors in people with DM, especially those with T2D. According to study, a number of conditions that are frequently observed in people with

DM and may directly influence the development of CV include elevated increased coagulability, oxidative stress, autonomic neuropathy and endothelial dysfunction. *(Matheus et al 2013).* Diabetes increases the risk of developing CVD and is directly linked to an increased incidence of MI, stroke, revascularization, and CHF in diabetics due to the high frequency of CV risk factors and the direct biological effects of diabetes on the cardiovascular system. (*Matheus et al 2013 and Li et al. 2019*).

1.4.5 Procoagulant factors

Fibrinogen is a protein that the primary components of coagulation. The elevated content of fibrinogen is associated with much worse atherosclerosis and an increased risk of heart disease. It circulates at 2-4 mg/mL and has a molecular weight of 340 kDa in healthy adults; nevertheless, the liver produces the acute phase protein fibrinogen, and its levels are in the blood during acute inflammation may surpass 7 mg/ml. Increased fibrinogen levels are related to high incidence risk of CVD (*Danesh et al, 2005 and Wilhelmsen et al, 1984*). A 1 g/L rise in fibrinogen concentration doubles the risk of cardiovascular events. Clotting factor VII, von Willebrand factors, plasminogen activator inhibitor type 1 and tissue-type plasminogen activator are the coagulation and fibrinolysis factors (*Chapin, 2015*).

Aα, Bβ, and γ are the three polypeptide chains in two sets that make up fibrinogen. Alternative splicing of the γA generates a γ′ chain with a distinctive 20-amino-acid region at the C-terminus. Greater levels of the γA/γ isoform have been associated with an increased risk of coronary artery disease in cross-sectional and retrospective studies. (*Lovely et al, 2002)*, ischemic stroke, myocardial infarction (*Cheung et al 2008,*). The discovery that some individuals exhibit an elevated ratio of γ′ to total fibrinogen (*Cheung et al, 2008)* indicates the fact that γA/γ′ fibrinogen is not just a biomarker for high total fibrinogen. Together with results from in vitro experiments revealing clots generated from isolated γA/γ′ fibrinogen include improperly shaped fibers and are extremely resistant to fibrinolysis (*Falls and Farrell, 1997*), these discoveries have established that A/Fibrinogen is a causative risk factor for CVD.

1.4.6 Markers of inflammation

Recent research has shown that inflammation has a significant role of the development of coronary heart disease. The emerging risk factors collaboration is based on a large number of population research and has demonstrated that CRP concentrations are strongly connected with coronary artery disease, ischemic stroke vascular disorders and cancer, (*Kaptoge et al, 2010)*. However, more notable is the comparison between men and women, since males acquire CVD sooner and the risk of CVD rises with age *(Jousilahti et al, 1999*). Early atherosclerosis is characterized by modest plaque development that has little effect on blood circulation. However, the plaques formed on the inner artery wall eventually enlarge, resulting in the constriction of the arterial lumen and/or the production of thrombus. At this point, the blood flow to each organ may be impaired, resulting in CVD symptoms (*Ross 1993)*.

In those who appear to be in good health, high CRP levels have been proven to predict the long-term risk of myocardial infarction, peripheral artery disease stroke, and sudden cardiac death. Moreover, the existence of metabolic syndrome corresponds with elevated plasma CRP concentrations. The most essential element of the biomarker is its independent prediction ability, which is known as high-sensitivity CRP (hs-CRP). Therefore, cardiovascular risk is divided into three categories: low risk (hs-PCR 1mg/L), moderate risk (hs-PCR 1-3mg/L), and high risk (hs-PCR >3mg/L). (*Folsom et al, 2006*).

1.4.7 Smoking

Smoking is an important global cause of mortality, causing at least 12 % of deaths among people in their 30s (men 16%, women 7%) (*WHO 2012 & Bilano et al, 2015)*. It is the greatest preventable cause of heart problems that encompass a vast range of illnesses and the main cause of death globally, resulting an annual death toll of 17.3 million to 17.5 million (*Aboyans, and Causes of Death Collaborators, 2013 & WHO, 2015)*.

Epidemiologic research have shown that smoking cigarettes raises the risk of coronary artery disorders and myocardial infarction (*Barua et al, 2013)*. Smokeless tobacco and low-tar cigarettes have also been connected to a higher risk of cardiovascular problems. Even inactive smoking increases the risk of ASCVD by 30%, which is only slightly less than the active smokers' risk increases of over 80%. (*CDCP, 2010*). Epidemiologic studies have sought in order to spot those who are most likely to have a heart attack in the future ever since the Framingham study in order to develop effective therapies to lower the risk. (*Kannel et al, 1961*).

Epidemiologic research has demonstrated the connection between CVD and smoking., but the exact processes behind this association are still unknown. Because cigarette smoking involves a combination of chemical components that are either free in the gas phase or attached to aerosol particles, it is a perplexing and complicated CVD risk factor. At least 72 carcinogens are among the nearly 7,000 chemical components from various types that have been determined to be present in cigarette smoke (*Burns D M, 1991)*. In an effort to connect chemical substances to toxicity, Fowles et al. in 2003 looked at the risk for chronic diseases, linked 1,3-butadiene to cancer risk, and linked cyanide, arsenic, and cresols to cardiovascular risk (*Fowles and Dybing, 2003)*.

Numerous consequences of tobacco smoking on the cardiovascular system contribute to the pathogenesis of CVD. When tobacco products are burned, two types of smoke are produced: mainstream and side stream. Side stream smoke is considerably more harmful than mainstream smoke (*Ambrose and Barua 2004*), since it originates from the burning end of the cigarette (*Schick and Glantz 2005*). Some of the greater than 7,000 compounds smoke from cigarettes is known to influence the mechanism through which cardiovascular disease develops (*Borgerding, and Klus, 2005*).

1.4.8 Inactivity

One of the most major modifiable risk factors for NCDs is considered to be physical inactivity (*WHO, 2012)*. Although they have diverse meanings, exercise, cardiopulmonary fitness, physical activity, and metabolic fitness are all connected concepts. Physical activity is defined as any skeletal muscle-driven motion of the body that considerably increases energy expenditure beyond that of rest, especially when it involves the continuous use of big muscles (*DHHS, 1996)*. Numerous studies indicate that inactivity is linked to increased risks of cancer, heart failure, stroke, and coronary artery disease. By reducing obesity, hypertension, dyslipidemia, and glucose intolerance, physical exercise may minimize the risk of CVD or cancer (*Moore et al, 2016)*.

Physical activity guidelines from the World Health Organization recommendation, each week should include at least 75 minutes of strong aerobic activity and 150 minutes of moderate aerobic activity, or an equal combining the two (*WHO, 2010)*. It is crucial to foster awareness of its potential influence on major NCD risk in order to motivate individuals to reach this level. Giving information on the lifetime risk of major NCD according to levels of physical activity may be one method to achieve that. Estimates of lifetime risks, which are absolute hazards up to a specific age, are sometimes simpler to comprehend than relative risks (*Lloyd-Jones et al. 1999)*.

1.4.9 Family history of CVD

Family history is an essential aspect of the health history of each patient and may suggest the common family conduct, environment and genetic ancestry.

A full family history that includes the number of relatives, age, and sex of the afflicted person may make it more difficult to gather during therapeutic appointments, the difficulty of collecting a complete family history is comparable to that of other behavioral risk measures. Family history of CVD is a substantial risk factor for future CHD development (*Rodriguez et al 2016*).

Ideally, CVD management should start early in life for decreasing the cumulative lifetime exposure to risk circumstances and to achieve worldwide risk reduction. However, it would be impossible to target everyone in the CHD preventive models or strategy. Risk stratification based on a very straightforward and affordable assessment methods may assist to identify high risk sub-groups for aggressive CVD risk reduction. Family history of CVD generally reveals lifelong exposure to common family conduct and environment (*Bachmann. et al 2012*). Although family history is a risk factor that cannot be changed, it is possible to minimize the overall CHD risk among persons with a strong family history of CHD by reducing their exposure to other known risk factors early in life (*Chacko et al, 2020)*.

1.4.10 Ethnicity background

Although cardiovascular disease (CVD) is a global issue, much current information is derived from studies of European descent among Caucasians.

Nonetheless, different ethnic groups are more likely to experience CVD and CHD at varied rates, leading to higher incidence of these disorders in particular populations., including Latino Americans, South Asians, and people of African descent. The most studied ethnic group to date, South Asians (including people from India, Sri Lanka, Bangladesh, Nepal, and Pakistan) have higher rates of diabetes, CHD, and CVD than do Europeans. Moreover, South Asians are more likely to develop the insulin resistance syndrome, which is linked to an increased risk of CHD. (*McKeigue et al, 1993*). Recent lifestyle changes, such as urban migration and "Westernization," may help to explain the increased incidence and acceleration of vascular and metabolic disorders in some ethnic groups.

One of the first ethnic groups to be identified as having a greater risk for CHD was South Asians. Throughout a series of about 10,000 autopsy conducted in Singapore in the 1950s, it was discovered that Asian Indian men had a prevalence of CHD that exceeded Chinese men's by seven times (*Danaraj et al 1959)*. Additionally, it has been proposed that lifestyle choices, including those related to diet, exercise, and obesity, may be South Asians' CHD risk factors. Higher socioeconomic status and eating vegetarian were found for acute myocardial infarction to be cardioprotective in a study from India (*Pais et al 1996)*.

The American Heart Association and the National Institutes of Health estimate that 40% of African American men and women and 30% and 24% of European American men and women, respectively, have coronary artery disease. These disparities are not attributable to dietary or lifestyle choices, but rather to genetic variations between ethnic groups. Also, compared to European American women, Black American women with coronary disease have a double the risk of suffering a myocardial infarction. Latinos in North America have higher rates of obesity and diabetes, but African Americans are more likely to develop hypertension. The South Asian population has the greatest incidence of coronary artery disease, while persons whose ancestry is African-Caribbean have the highest risk of stroke. and diabetes prevalence in these two ethnic groups is much greater compared to the white community.

In the United Kingdom, South Asians had a higher incidence of myocardial infarction than non-South Asians for both sexes, while black people have a higher incidence of stroke than white people, regardless of sex. The majority of CoAD cases in Pakistan and India are male. Compared to the black and Asian populations, the rate of revascularization is higher in the white population. Diverse racial groups have a propensity to retain fat in distinct areas of the body. The Black ethnic group has the greatest rate of obesity and overweight among young children. Diabetes is much more prevalent among Indian, Pakistani, Bangladeshi, and black Caribbean people males (*Scarborough et al, 2010*).

a. Importance of managing CVD risk factors

CVD is impacted by lifestyle choices. a bad diet, insufficient exercise and smoking have a significant impact on cardiovascular health. CVD risk rises with smoking. The main processes through which smoking causes Among cardiovascular events are the emergence of atherosclerotic changes, resulting in a constriction of the arterial lumen, and the generation of a hypercoagulable disorder, which raises the danger of acute thrombosis. (*Centers for Disease Control and Prevention, 2011)*

Conversely, physical exercise has a substantial favorable effect on the condition of the heart. To reduce the risk of heart disease, physical activity is crucial. Walking vigorously for at least 30 minutes each day at a speed of at least 4 kph reduces the risk of heart disease by 30%. (*Psaltopoulou et al 2017, Panagiotakos et al 2012 and Winkleby et al 1992*).

Preventive measures for CVD must play a major role in standard medical practice in order to get the greatest results. Therefore, it is crucial to establish the top priorities for CVD prevention. In order to obtain clear access to patients, CVD prevention recommendations give the processes for identifying the preventative actions to be done, taking into consideration the health policies of various nations and the incidence of CVD in various countries.

It is crucial to have a consistent methodology with well-defined monitoring criteria when determining a person's level of risk. One of the most crucial criteria that will determine how patients will be treated in the future is the risk assessment.

Clinical and population preventive measures aim to lower CVD morbidity and death. Given the complexity of CVD, several risk factors must be monitored and addressed concurrently. The likelihood of CVD is multiplied by the existence of several risk factors, whereas the risk of myocardial infarction gradually rises (*Thomopoulos et al 2014*). The CVD risk estimate is thus crucial for managing both prevention therapy in the best possible way (*Thomopoulos et al 2018*). Because some patients may acquire CVD even when they do not yet have atherosclerotic disease that is apparent, stratification of CVD risk is crucial (*Piepoli, 2016)*. Total CVD risk is the likelihood that a person will have a fatal cardiovascular event throughout time. It is crucial that the doctor can evaluate the danger rapidly and decide on subsequent therapy in a timely manner (evidence-based management).

Risk factors for CVD may be both variable and invariable. Risk variables that never change are those we have no control over. We may alter risk variables that are variable by giving up harmful behaviors. Smoking, insufficient exercise, high blood pressure, obesity, a rise in blood pressure, and fat levels and diabetes mellitus are examples of risk factors that are variable. To reduce CVD morbidity and death, variable risk factors must be managed.

b. Emerging rural Bangladesh population and CVD risk factors

In South East Asian region (SEAR) CVDs alone accounted for 25% death and in Bangladesh about 17% people died from CVDs in 2010 (*WHO, 2011*) CVDs are a general category of diseases that affects the heart and the circulatory system.

There are numerous CVD risk factors, including: The harmful use of alcohol, inactivity, salt, fat, and calories in the diet, and tobacco use are the behavioral risk factors. (*WHO, 2014*). High blood pressure (hypertension), high blood sugar (diabetes), and high blood lipids are the metabolic risk factors (e.g. cholesterol, overweight and obesity) (*Mendis et al 2015*). Lifestyle factors including nutrition play an essential CVD risk factor. Obesity, hypertension, uncontrolled diabetes, and a diet heavy in saturated fats are all risk factors associated to food. Age, gender, low educational attainment, poverty, inherited (genetic) disposition, and psychological factors are additional CVD risk factors (e.g., stress, depression).

Of the total CVD related deaths an estimated 7.4 million have been reported to be due to coronary heart disease and 6.7 million are due to stroke (*WHO, 2015*). 13% of CVD deaths are attributable to high blood pressure, compared to 9% from cigarette use, 6% from diabetes, 6% from inactivity, and 5% from obesity. As a reflection of the underlying socioeconomic causes, the largest effects of these risk factors increasingly affect lower- and middle-income countries as well as poorer individuals within all countries. (*WHO, 2021*).

Over the past few decades, noncommunicable chronic illness prevalence and related mortality have significantly increased in Bangladesh. Bangladesh had a rapid urbanization during the past several decades as a result of its quick economic expansion, and it has recently been recognized as a developing nation (*WHO, 2011*). Because of this expansion and urbanization, there is rising fear that the prevalence of chronic diseases will continue to climb as more people adopt sedentary lifestyles (*Alam et al,2009*).

In Bangladesh, around 85.0% of the population lives in villages. Due to their low socioeconomic status and lifestyle, as well as a lack of understanding, they are disinclined to see a physician when they get ill (*Haque, 2008).* Therefore, there are more undiagnosed and untreated CVD and hypertension patients in rural areas. Despite having a significant influence on physical, mental, and social burdens, the prevalence of hypertension in rural areas remains unreported. Numerous sociodemographic, nutritional, and lifestyle-related risk variables have been found in hypertension patients in a growing number of foreign contexts (*Tian, 2011 and Agyemang, 2008*).

Also, the risk of cardiovascular disease is rising among rural Bangladeshi communities. In this population, heart disease risk factors included advanced age, being a woman, living in temporary housing, being underweight and obese as measured by BMI, as well as central obesity (CVD, with females exhibiting a higher prevalence than men and possessing more than two risk factors (*Fatema et al, 2014 & Fatema et al, 2016*).

c. Cardiovascular disease risk factor among indigenous people: rural Garo population

Bangladesh is one of the LMIC nations where the incidence and prevalence of CVDs have been steadily rising, and this trend is expected to continue unless coordinated efforts are made and a national program of risk factor prevention is implemented. (*Schweinman & Eichner, 2006*) It is anticipated that there will be a significant increase of patients within the next 10 to 15 years. This will undoubtedly place a significant strain on the resources available for health care and place a heavy load on those who offer such services. In 70 different nations throughout the globe, there are more than 370 million indigenous people (*UN, 2009)*. In terms of worldview, culture, political forces, education, social level, living circumstances, and family variables, indigenous people are not a homogeneous group; there is substantial variance both across and within these indigenous communities.

Many Aboriginal and Torres Strait Islander people are also affected by CVDs. One-in-eight (13%) indigenous people reported in the 2012-2013 that they had some form of CVD. It was responsible for 25% of the deaths among Indigenous people living in different regions in Australia (*Kołtuniuk, 2016*). Unlike other ethnic groups, the CVD incidence among American Indians appears to be rising, probably as a result of the high prevalence of diabetes. (*Howard et al, 1999*)

The indigenous people are genetically, culturally and geographically different from the general population in any society; examination of such population groups can provide clue to the genetic predisposition to those disease entities. There are about 35 smaller groups of indigenous communities in Bangladesh, some major groups are the Chakmas, Marmas, Santals, Garos, Monipuri, Tripuri etc (*Sharmin, 2010*).

The population census 2022 found only 16,90,159 ethnic community people-living in Bangladesh. 15,86,141 indigenous people were counted in the 2011 census, making up 1.10% of the overall population of the nation. According to the most recent census, the number of indigenous people has only increased by 64 thousand during the past 11 years. (*The Indigenous World 2022: Bangladesh*)

One of Bangladesh's largest indigenous communities is the Garo, who make up the majority of the country's native population. Over 1,50,000 people live there at the moment (*According to National Encyclopedia of Bangladesh*). primarily inhabit Bangladesh's northeast, with the greatest concentrations in the districts of Gazipur, Mymensingh, Netrokona, Tangail, Sherpur, and Jamalpur. The 'Garos' consume foods which are available in the surrounding hills. The staple food of Garo is rice. They take it with fish, meat, vegetable curry, lentils etc. they also take polao, biriani, hotchpotch, bamboo shoots, mushroom. They also use to cook with soda water in cooking. They are still very fond of having pork, turtle meat (*Zaman et al, 2015*). Most of the elders including both males and females have a habit of chewing betel leafs and areca nuts in addition to smoking. They also drink alcohol a lot. In Bangladesh, there have been no known studies of CVD risk factors among the Garo or any indigenous population. Therefore, it is imperative that we do more to emphasize the preventative side of the issues overall in managing cardiovascular disease in Bangladesh. This aging population may develop several illnesses caused by diverse CVDs if early risk factor prevention and long-term management measures are not implemented, placing a significant strain on the Bangladeshi healthcare system. (*Hanif et al, 2021*).

d. Assessment of CVD associated risk factors

The World Health Organization (WHO) received help from a risk-chart working committee in 2019 to update the 2007 CVD risk chart using data from 21 geographical regions (*Howard et al, 1999*). The committee suggested a fresh chart that isn't laboratory-based in addition to updating the two earlier charts that were based on laboratories. The WHO graphic of non-laboratory CVD risk was created for environments with limited resources. This graph uses data based on systolic blood pressure, sex, age, smoking status, and body mass index to forecast CVD risk over the next ten years. These updated CVD risk charts have just been integrated into Bangladesh's "NCD management protocol," and primary healthcare providers are now receiving training (*Hanif et al, 2021).* However, because the laboratory-based charts require information on total serum cholesterol and blood sugar, using them in environments without these assays may be impractical.

e. Public Health Problem

In contrast to the many studies on reducing a single component, the public health problem I addressed in this study was the paucity of research on cardiovascular disease assessment and linked risk factors among the rural Garo indigenous. Even little research has been done explicitly on CVD and the consequences of numerous health-related risks in Garo populations. Several writers have investigated the prevalence of diabetes and smoking among Bangladesh indigenous population.

The main flaw I discovered in many earlier studies was the absence of research on the relationship between the CVD prevalence in the Garo community as a whole and the risk factors that may contribute to increased mortality and morbidity.

f. Purpose of the study

This doctorate study's goal was to learn more about the evaluation understanding of cardiovascular disease and its risk factors, including hypertension, obesity, diabetes, smoking, poor diet, sociodemographic status, and exercise.

In contrast to danger factors that are contributing like bad diet and socioeconomic standing, which have been acknowledged as potential influences of the major risk factors that may ultimately the primary risk factors are those for cardiovascular disease increase that have been scientifically proven, such as overweight, obesity, diabetes, and hypertension(*Centers for Disease Control and Prevention, 2016*). In this research, In a rural Garo community, I examined the prevalence of hypertensive CVD and related risk factors. In order to evaluate their eating habits, I have also looked at their nutritional condition. I have looked at sociodemographic, clinical, nutritional, and behavioral aspects related to CVD risk factors include smoking, eating poorly, being overweight or obese, having diabetes, and having high blood pressure., exercise restrictions, education and income. Since the community under investigation offers a distinct genetic and lifestyle viewpoint, this ethnicity-based research will help to find new classes about the pathophysiology of a disease.

1.5 Objective of the study

1.5.1 General Objective:

- To assess the CVD (with hypertension as a surrogate marker) and associated risk factors in a rural Garo population.

1.5.2 Specific Objectives:

- To assess the socio-demographic status of the study population.
- To explore the nutritional status of the study subjects as assessed by anthropometry.
- To find out the dietary habits of the rural Garo population.
- To assess the prevalence of hypertensive CVD in a rural Garo population.
- To find out the associated risk factors of CVD among the rural Garo population.

1.6 Rationale of the Study

The health status and consequently health care needs of various ethnic groups differ substantially due to a number of socio cultural, demographic, behavioral, economic, nutritional and cultural factors. These factors may affect their health both in positive and negative dimensions. Accordingly, it is important to conduct epidemiological studies on individual racial groups. Ethnicity – based research can also help to identify new class regarding the pathogenesis of a disease since the population under study provides a different genetic and lifestyle perspective (Sharmin. S, 2010).

CHAPTER 2

LITERATURE REVIEW

2. LITERATURE REVIEW

2.1 Introduction

Cardiovascular disease (CVD), which has been acknowledged as a significant contributor to morbidity and mortality throughout the globe (*Mensah GA, 2019*), encompasses conditions including atherosclerosis, coronary artery disease, hypertensive, and stroke that are caused by diseases of the heart and blood arteries (*Kaski 2019*). This literature review emphasizes the term of cardiovascular disease and its risk factors in rural areas Garo population. This critical review focuses on the dietary customs of the Garo people, risk factors of cardiovascular disease, nutritional status, socio-demographic, behavioral pattern among them and prevalence of hypertensive presence among rural Garo population.

A third of all fatalities worldwide till 2017 (almost 18 million) were attributable to CVD (*Amini, et al 2021*). In both industrialized and developing nations, cardiovascular disease (CVD) is among the top 3 killers (*Teo KK, 2017*). Since CVD risk factors are usually based in an unhealthy lifestyle, many of them are changeable. The onset of CVD is influenced by a number of lifestyle-related variables, including inadequate physical activity (PA), poor nutrition (e.g., choosing fast, fatty, and salty meals over fish, vegetables, and fruit), smoking, and exposure to many daily stresses (*Dennison, 2018*). Being overweight or obese, as well as connected conditions like diabetes as well as excessive blood pressure, significant CVD risk factors, especially for individuals with a family history of the illness. The best methods for preventing and treating CVD include dietary and lifestyle modifications, such as frequent PA, stress management, and weight control (*Sarrafzadegan 2019*). However, it's possible that a lot of individuals are unaware of how to adopt and sustain such practices or how doing so would improve their health. Health education, the World Health Organization (WHO) claims consists of learning opportunities that assist individuals and communities in enhancing their health literacy and life skills, which improves both individual and community health (*WHO, 2020*). Successful interventions in health education are based on a variety of theoretical frameworks. A well-developed model may assist researchers in creating an educational strategy aimed at improving the knowledge, attitudes, and frequency of health behaviors among certain populations.

2.2 Prevalence of hypertensive cardiovascular disease

The frequency of CVD and hypertension in the rural population was revealed by a Romanian study. Although CVD mortality rate in Romania is among the highest in Europe, it is underreported in rural regions with poor access to healthcare. The findings indicated an unanticipated high frequency of HT and a significant risk of cardiovascular disease development, highlighting the need for initiatives to enhance medical treatment (*Berbecar, 2021*).

Cardiovascular disorders are known to be greatly influenced by hypertension. An accurate representation of the Lebanese population was used in a study to determine the incidence of hypertension, as well as how frequently it occurs among additional cardiovascular risk elements, and its correlation with cardiovascular illnesses. In accordance with each region's population density, a pretested questionnaire was given to 2125 individuals in Lebanon who were at least 30 years old. No statistically significant difference between patients who are men and women, Nonetheless, 23,1% of those surveyed claimed to have high blood pressure. Age was connected to a higher prevalence a of hypertension (P 0.01), and those with lower educational levels and unemployment were greater likelihood of the condition (*Tohme, 2005*).

Community-based research was done to investigate the prevalence of cardiovascular disease, CVD risk factors and heart rate variability in an elderly East German population as well as their relationships. The CARLA Study's design and goals are described in this research from the population register, a random sample of people aged 45 to 80 living in the eastern German city of Halle (Saale) was selected. and detailed information is collected on own and economical, psychological, behavioral, and biological aspects, as well as family medical history. This study demonstrated how lifestyle factors and autonomic dysfunction might be used to identify the routes to CVD that may be to blame for the CVD epidemic in particular populations. (*Greiser, 2005*).

In order to examine the prevalence of CVD risk factors in surgical wards between patients over 65 and those in other age groups, a study was carried out. The 420 patients, aged 18 to 84, who were admitted to the hospital's surgical wards were the subject of the study, which aimed to evaluate and map out the distribution of the main risk factors for CVD. All subjects underwent an interview, anthropometric assessments, blood pressure checks, and fasting blood samples for biochemical analysis. The most prevalent CVD risk factors among patients over 65 years of age were overweight and obesity (68%), abdominal obesity (83.3%), hypercholesterolemia (33.3%), hypertension (65.1%), and a lack of physical activity (29.1%). However, overweight and obesity (36.1%), abdominal obesity (36.2%), were also significant CVD risk factors in this age group. (*Koltuniuk, 2016*).

Data from Scopus (2020)-based scientific publications and patents that contained the phrases aortic valve replacement surgery or transcatheter aortic valve implantation (TAVI) (SAVR)in the title, abstract, or keywords. A model used to assess technological change demonstrates how the conventional SAVR procedure in cardiology is being replaced by the TAVI technique. Statistics showed that TAVI is anticipated to become a dominating technique in order to treat aortic stenosis in society in the future due to its rising scientific and technological development (*Coccia, 2021*).

Because of its prevalence and the rise in linked concomitant cardiovascular disorders, in the United States, hypertension is the most common public health issue. Including the staggering $259 billion annual financial burden and the significant socioeconomic costs of continuing heart disease and stroke to be the nation's top two and top three killers, respectively., In the United States, the annual expenditures associated with the diagnosis, treatment, and monitoring of hypertension are around $10 billion. Despite the importance of these discoveries, there is still no blood pressure regulation in the US. (*Wali, 1999*).

The results from a study in urban and rural areas of Latin America indicated that there was a 44.0 percent prevalence of HTN, with Peru having the lowest rates (17.7 percent) and Brazil having the highest rates (52.5 percent). 53.3 percent were getting therapy, and 58.9 percent were aware that they had HTN. In all nations, the incidence of HTN is higher (44.8%) in urban groups than rural groups (42.1%). The majority of individuals (90.5%)

who were aware of HTN were getting medical care, however only 37.6% of those patients had their blood pressure under control, with urban (39.6%) versus rural (32.4%) rates being higher. Argentina had the lowest rate of dual or multiple substance usage (39.5%) while Brazil had the highest rate (44.6%). The usage of statins was modest (12.3%), particularly in rural regions (7.0 percent). People with HTN had greater levels of the majority of modifiable risk variables than those without HTN (*Lamelas et al, 2019*).

In comparison to the USA and Canada, England had higher mean systolic blood pressure (SBP) across all age-gender groups. Mean diastolic blood pressure (DBP) was similar in all three countries before the age of 50, but it fell more quickly in the USA, where it was the lowest. In England, just 34% of people had blood pressure that was less than 140/90 mm Hg, in contrast to 66% in Canada and 50% in the USA. The prevalence rates for stages 1 and 2 hypertensions, as well as prehypertension were greatest in England. Canada has a lower hypertension prevalence was at 19% compared to the United States (29%) and England (30 %) (*Joffres et al, 2013*).

In another investigation, data from 20,296 participants in the atherosclerosis risk in communities' study and the heart health Study who were over 45 years old at baseline were analyzed (CHS). The search for comorbid illness at baseline, deaths, and hospitalizations across a 5-year follow-up. It was discovered that more comorbid diseases were related with lung function decline. Comorbid illness was connected to a higher risk of hospitalization and death, which was exacerbated in those with poor lung function (*Mannino, 2008*).

More than half of the world's burden of cardiovascular disease is carried by Asia-Pacific countries. Another study calculated the World Health Organization's (WHO) gender-specific population-attributable fractions (PAFs) for stroke and fatal ischemic heart disease (IHD). Regions of the Western Pacific and Southeast Asia in order to calculate the number of cardiovascular illnesses (CVD) that hypertension contributes to on a national scale. In the 15 countries having data, the prevalence of hypertension ranged from 5 to 47 % for males and from 7 to 38 % for females. Overall, between 4 and 28 percent of IHD in males and between 8 and 39 percent of IHD in women might be attributed to hypertension. For ischemic stroke, ranges that correspond were 8-44 percent and 12-45 percent. (*Martiniuk, 2007).*

In China, HTN is quite prevalent and on the rise. According to several recent estimates, 335.8 million Chinese adults (There are 157.2 million women and 178.6 million men or 33.6 percent (35.3 percent in males and 32 percent in women) had HTN in 2010, which is a considerable rise from earlier studies. In Chinese adults, BP-related CVD is still the most common primary the reason for death, with stroke being the key factor in cardiovascular fatalities. Only 3.9 percent (men 3.5 % and women 4.3%) of people with HTN had their blood pressure under control to the officially advised goal of BP less than140/90 mm Hg. Of those with HTN, 33.4 percent were aware of their disease (*Bundy and He, 2016)*.

Using the global standard population in 2000 for China and taking age and gender into account, the frequency of hypertension rose 30% (from 39.9% to 51.7%) between 1991 and 2011. Women aged 35 to 44 had the largest rise (68 percent). In the meanwhile, the incidence of stage II hypertension rose by 75% overall, with a 4-fold rise in males between the ages of 45 and 54. Despite tremendous progress in the same time span, the knowledge, treatment, and management of hypertension remained unacceptably low levels (*Wang, et al, 2014)*.

Another study seeks to give a timely overview on the spread of the epidemic also to evaluate the advancement of CVD management and controlling. This book was anticipated to help prevent and manage CVD in China. (*ZHU, 2012*).

According to one research in Sub-Saharan Africa, those aged 15 and older had hypertension in Nigeria's village area19.3%, in village Kenya 21.4% , in city Tanzania 23.7% , and in city Namibia 38.0% .The percentage having grade 2 or 3 hypertension in those with hypertension varied from 29.2 percent (Namibia) to 43.3 percent overall (Nigeria). Between 6.1 and 17.4 percent of people in all research communities were obese (BMI 30), and BMI, along In all research populations, gender and age uniquely predicted blood pressure level. In Namibia, the prevalence of diabetes ranged from 2.1 to 3.7 percent. (*Hendriks et al, 2012)*.

Different South African research, found that Uncontrolled hypertension was very common, with a 75.5% prevalence. Uncontrolled hypertension was positively correlated with age 65, sex (male), drinking too much alcohol, eating a western-style diet and being jobless. (*Adeniyi et al 2016*).

Although there has been a continuous rise over time in this demographic as well, the incidence of hypertension is lower among rural Indians. Urban adults have a high prevalence of hypertension, according to a recent study employing modified criteria (BP 140 /90 mmHg) found that the rise of hypertension in India is strongly correlated with elements in the changing lifestyle (*Gupta, 2004)*.

The West Bengal study's female participants had a prevalence of hypertension of 24.7 percent, as well as 40.8% prehypertension and 6.4 % tachycardia. It was discovered that a higher body mass index (BMI), the use of biomass fuel for cooking, the absence of a separate kitchen, education, and average family income were all shown to be important contributors (*Dutta. and Ray, 2012)*.

The prevalence of HTN and DM was reported to be 54.5 percent and 14.6 percent, respectively, in rural area of Utthakhand, India, according to another research. Age, a high level of education, and BMI) were discovered to be crucial HTN risk factors., whereas a higher level of education and a BMI (≥25 kg/m2) were found to be important risk factors for DM (*Kapil et al 2018)*. Another study stated that high prevalence of HTN and other CVD risk factors are found in Central India. Rural regions are not far behind metropolitan locations despite practically all characteristics having a greater frequency there (*Bhadoria*, 2014).

Another study was carried in India showed that systolic hypertension was more common in rural areas than diastolic hypertension, with a greater incidence in those aged 60 years and older both gender. Males demonstrated a clear linear trend in systolic hypertension prevalence with respect to age group, in contrast to females (*Agarwal, 2011*).

A study showed that the frequency of ACE genotype polymorphism in Bengali, Garo and Rakhain populations of Bangladesh. The findings of this study highlighted the association between the II and ID variant genotypes of the ACE-1 gene and hypertension in Bengali and Rakhain patients, as well as the higher prevalence of the II genotype in Garo tribes. (*Faruque, 2017*).

According to a study done in Bangladesh, 30% respondents had hypertension, 20% were obese, diabetes 5%. Additionally, 77% of individuals smoked or used no tobacco products and 28% of people were not active. 4.5 percent of people had a CVD (*Khanam F, 2019)*. However, different research revealed that 58.0 percent of people had hypertension and that 52.8% of these people had uncontrolled blood pressure (*Jafar et al, 2018)*.

Another study by Rahman, 2018, showed that 20% of the study population had hypertension. Age and body mass index both increased the likelihood of having hypertension (BMI). Twelve percent of the populace has previously received a hypertension diagnosis. Nearly half of these people did not take any medication to lower their blood pressure. In addition, 43 percent of people had pre-hypertension, with levels being greater in men, older age groups, better educated people, those with higher income indexes, and people with higher BMIs. Older age, a high BMI, and co-existing diabetes were all predictors of hypertension. One in five adult Bangladeshis are thought to have hypertension. Age and a high BMI both raise the risk of hypertension. Pre-hypertension is also widely prevalent in Bangladesh, both in urban and rural regions (*Rahman et al, 2018)*.

2.3 Risk factors of cardiovascular disease

The term "CVD risk factor" refers to traits, both changeable and immutable, that raise the likelihood of having a CVD. The Framingham Heart Study discovered traditional CVD risk variables that raised the general population's CVD risk. These factors were eventually included in prediction equations to help doctors identify patients at higher risk (*Mark, 2019*).

In Sweden, socioeconomic change and urbanization have a decrease in the population of villages and a change in those characteristics who remain there. Northern Sweden's rural population in 2009 was older, less educated, had a higher BMI, had a more sedentary lifestyle, and had higher cholesterol levels than the city. With adequate regard for the social and cultural environment, targeted preventative interventions should be targeted at the rural population (*Lindroth, 2014*).

Findings from a study in Bangladesh found that men are more likely than women to experience CVD events, with one in four individuals in Bangladesh having excessive levels of CVD risk. The governments take should educate primary healthcare providers on how to utilize WHO CVD risk charts that are not reliant on laboratory testing, particularly in environments without access to lab testing (*Hanif, 2021*).

Those who have previously carried normotensive babies, as well as expectant mothers who have hypertension, and those who have a worse risk profile overall for cardiovascular disease years after the affected pregnancies are all at an elevated risk of heart and vascular disease and the fact that pregnancy-related hypertension illnesses — One explanation for this relationship is that pre-eclampsia and CVD share several risk factors. (*Garovic, 2007*).

The result of a research showed in Bangladeshi citizens, urban regions (8%) had a greater weighted pooled prevalence of total CVD than rural areas (4%). (2 percent). Adult Bangladeshi population showed significant CVD prevalence and an increasing trend. (*Chowdhury, 2018*)

Results from another work showed that Bangladesh's high rate of cardiovascular disease (CVD) and related risk factors, including diabetes and hypertension, are on the increase, particularly among older people, women, and high-income groups (*Khanam, 2019*).

A study described about the morbidity from coronary heart disease, and cardiovascular risk factors, mortality among Turkish citizens. Although the primary focus is on lipids and lipoproteins, other significant risk factors are also mentioned. Turkish people have notably low levels of hepatic lipase and lipid profile. Additionally, both sexes are inactive physically; close to 60% of males smoke, and a substantial percentage of Turkish women are obese, which increases their risk of developing diabetes and hypertension. These variables likely contribute to the unexpected finding that adults had a pattern of death causes that is typical of a developed population, despite the country's continuous industrialization process, youthful demographic makeup, and generally low cholesterol levels. According to estimates, Europe has one of the highest mortality rates from coronary heart disease by age. *(Onat, 2001).*

Another research used individual level data from a nationally representative survey to evaluate gender variations in people's experiences with heart disease in Turkey. This research created a binary indicator for people's experiences with heart illness using results from the survey on Turkish health, accounting for coronary heart disease, myocardial infarction and angina pectoris. For calculating the correlations between gender, other risk variables, and the prevalence of cardiac illnesses, binary logistic regression models are calculated (*Kose, 2019*).

According to a research work from the World Health Organization, cardiovascular diseases are the leading global cause of death for this decade (WHO). Through the use of computational tools, early diagnosis can prevent cardiovascular illnesses from taking human lives. By using artificial intelligence (AI) technology, another study aimed to distinguish between normal and pathological cardiac disease states. The deep neural network (DNN) used in this study helps accurately diagnose cardiac problems. The analysis clearly shows that DNN performs expertly compared to other applied methodologies, revealing an accuracy rate of 93.4%. Nine performance indicators are used to evaluate the effectiveness of the research, and the DNN consistently outperforms competing approaches in forecasting the development of heart disease (*Kumari, 2021*).

2.3.1 Prevalence of CVD associated dyslipidemia

Atherosclerotic CVDs which are a collection of illnesses with one of the highest death rates in the world, is dyslipidemia (DLP) (*Roy S, 2014).* In a study of Thai patients with a history of CVD, 79.6% of the patients had uncontrolled hyperlipidemia (*Lertwanichwattana et al. 2021*).

Similar findings were made by Kullawong, 2021, They discovered that 33.6% of participants had LDL-C levels that were above-optimal, and 69.6% had aberrant LDL-C values., 24.3 percent had levels that were borderline high, 8.0 percent had levels that were high, and 3.7 percent had levels that were extremely high. A total of 17.4% of individuals had low levels of HDL-C and high levels of LDL-C, whereas 14.9 % had high levels of both triglycerides and LDL-C. (*Kullawong, et al 2021*)

Another research conducted in Thailand found that 88.9% of the cohort's CVD patients also had dyslipidemia which is higher than other studies. A history of an unidentified stroke, coronary revascularization, diabetic nephropathy, or renal insufficiency, as well as age, WHR, therapy in a primary care setting, and all of these conditions were risk factors for dyslipidemia. (*Niroumand, et al, 2019).*

In the USA, heightened ischemic heart disease risk was substantially correlated with increased levels of cholesterol. According to the research, young individuals who had elevated cholesterol also had a higher chance of developing CVD (*Jeong et al, 2018).*

However, according to another research by Bucholz, 2018, estimated severe dyslipidemia prevalence in the US was 66 percent and definite/probable hypercholesteremia was 47 percent.

In UK, high-intensity statins were taken by 51% of persons with a history of cardiovascular disease (CVD) to manage their cholesterol levels (*Ho, 2018).* Another study showed the prevalence was 33% (*Trejo et al. 2018).*

In Indi, studies with unbiased samples from all demographics and ages suggest that 11.8% people had high LDL-C, 72.3% low HDL-C, 29.5% hypertriglyceridemia, and 13.9 hypercholesterolemia. Lp(a) (≥50 mg/dl) levels are elevated in about 25% of South Asians, including Indians, making it a significant risk factor. Risk factors for dyslipidemia include obesity, female gender, diabetes, sedentary behavior and hypertension (*Joshi et al, 2014).* HDL (83.9%) was the primary contributing factor for the CVD (*Kapil et al 2018).* According to a research work done in Bangladesh, 58 % had lower HDL levels and 50% had higher LDL levels (*Talukder, et al, 2021).* Another study showed, 71 % of female individuals had dyslipidemia, compared to 73 % of male respondents. (*Das and Banik, 2019)*

According to another research, the population of Bangladesh has a significant prevalence of hyperlipidemia and hypertriglyceridemia. Males were discovered to have greater TG and lower HDL-C than females. In this community, a negative association between BMI and HDL-C was discovered, much like in other ethnic groups. Additionally, Lp(a)-C and TG showed a significant connection, suggesting that Lp(a)-C should be routinely investigated in clinical settings as a biomarker for CVD risk (*Biswas et al, 2019)*.

2.3.2 Prevalence of CVD associated obesity

Obesity is a multifaceted illness with a complicated etiology linked to biological, psychological, socioeconomic, and environmental components as well as variation in the routes and processes through which it results in negative health effects.

Numerous studies revealed that high body mass index (BMI) and obesity were linked to an elevated risk of CVD events, including death, among the broader public, and that metabolic health status and cardiac respiratory fitness (CRF) seemed to evaluate the outcome risk for CVD. Person who had hypertension coronary artery disease or diabetes indicated a U-shaped connection between BMI and death (*Dwivedi.et al, 2020)*.

In India obesity prevalence is dangerously rising, particularly in metropolitan areas. Between 1975 and 2016, the prevalence of obesity almost quadrupled globally. The percentage of adult urban residents who are overweight or obese ranges from 30 to 65 percent. Indians who live in urban areas have a greater BMI than people who reside in rural areas (about 24–25). Concern should be expressed more about abdominal obesity than a higher BMI. Males in urban environments had a 0.99 waist-to-hip ratio, against 0.95 in rural regions. Additionally, compared to overall obesity, abdominal obesity is more prevalent. (*Kumari, 2020)*.

A research work conducted in Bangladesh revealed the incidence of overall and 28% and 49% of people had abdominal obesity, respectively. Urban women had considerably higher rates of overall and abdominal obesity (30.9% versus 58.6%, respectively). than rural women (26.6 % and 38.1%, respectively). The Dhaka region has the greatest prevalence of general obesity (39.3%), compared to Chattragram (23.3%), Rajshahi (24.9%), and Sylhet (3.5%). Contrarily, compared to the Chattagram (27.4%) and Rajshahi (37.3%) regions, Sylhet (72,4%) and Dhaka (61,5%) had higher rates of abdominal obesity. (*Islam. et al, 2020)*.

2.3.3 Prevalence of CVD associated diabetes

One in ten Indians over the age of 18 has elevated blood glucose levels. The biggest number of diabetes cases worldwide in 2017 occurred in India with over 73 million cases. With an 8.8% incidence among people between the ages of 20 and 70, diabetes has become a problem in India. The rising prevalence of noncommunicable diseases like diabetes has been linked to factors such as sedentary behaviors, rapid urbanization, poor diets globalization, overweight and obesity, smoking and longer life expectancies. CHD was the most often reported type of CVD in a study of 4,549,481 patients with T2DM who had an overall incidence of macrovascular complications of 32,2 percent (21.2 percent) (*Einarson, 2018*).

Acute myocardial infarction (MI), along with stroke, is the second most deadly consequence of T2DM and established ASCVD, behind sudden cardiac death, which accounts for 27 percent of cardiovascular deaths (21 percent).

Diabetes and cardiovascular disease prevalence and incidence are much greater so than in any other racial or ethnic group in the United States, it is more prevalent among American Indian/Alaska Native people, according to a research by Dal Canto (2019).

Mosenzon et al. shown in 2019 that about one-third of persons with T2D were diagnosed with CVD. A patient with diabetes for 10.7 years had a glycated hemoglobin level of 7.3%. The prevalence estimates for CVD and atherosclerotic CVD were 34.8% and 31.8%, respectively.

Another research revealed that patients with diabetes continue to having a 2- to 4-fold higher risk of hospitalization for significant CVD events and CVD-related clinical procedures than those without diabetes (*Harding, 2019).*

Diabetes is a complex chronic condition; non-compliant patients run the danger of mild to severe consequences, which are mostly unknown to the majority of Bangladeshis. Diabetes is responsible for 5% of worldwide mortality annually, and its incidence is constantly growing. The International Diabetes Federation (IDF) estimates that cardiovascular disease accounts for 75–80 percent of diabetic deaths.

In Bangladesh the incidence of both urban and rural areas, diabetes is increasing. A recent scoping assessment (1994-2013) indicated that diabetes incidence in Bangladesh is from 4.5% to 35.0%. It raises healthcare use and expenditures and creates a substantial financial strain on healthcare systems (*Mohiuddin, 2019*).

Another research revealed that in Bangladesh, which ranks 84 out of 163 countries on the WHO's mortality rate index, stroke is the third highest cause of death. Hypertension (63 %) was revealed to be the greatest risk factor for stroke, with diabetes (21%) and cardiovascular disease (24%) following closely. The majority of occurrences (83 percent) occur in those over the age of forty (*ICDDRB, 2017*).

Royal Society of public health research revealed that 37% of stroke patients had increased blood glucose levels (*Saha,. et al 2018*). In a prior study conducted at three medical college hospitals (DMCH, MMCH, CMCH), diabetes was revealed to be the third leading cause of stroke (21 percent) *(Islam et al, 2013*).

2.3.4 Prevalence of CVD associated dietary intake

In spite of the fact that vegetarians make up more than half of the Indian population, their diabetes, cardiovascular disease (CVD) risks are equivalent to those of non-vegetarians in the West. Indians adopt diets rich in carbohydrates with irregular dietary habits. The average Indian diet consists mostly of carbs, dairy goods rich in butter, fat, ghee, and cheese. Kerala has the highest incidence of CAD in India due to its culture and habit of using coconut oil for cooking. It is typical in Indian culture to reuse cooking oil, which raises trans fatty acids. Compared to the rest of the globe, Indians consume the least number of fresh fruits and vegetables. The prevalence of malnutrition on the Indian subcontinent is characterized by high rates of malnutrition, low birth weights, and quick rise in obesity with associated morbidities. Inadequate living circumstances and poor levels of education were also related with increased CAD mortality. Coronary artery disease (CAD) is more common among the poor and the wealthy due to various metabolic, social, and cultural maladjustments. Other possible factors include fast changes in lifestyle brought on by urbanization and the dietary shifts that accompany such economic growth. Less than 10% of the population assessed participated in regular physical activity, according to a study by the Indian Council of Medical Research-India Diabetes (ICMR-INDIAB). (*Anjana, 2011)*. A survey conducted in Bangladesh revealed that, based on their BMI, the majority of Overweight respondents. The respondent's degree of CVD-related practice was inferior to their knowledge and attitudes. Knowledge, attitude, and conduct of the responders were connected. Most CVD patients exhibited blood pressure readings and troponin values outside of the acceptable range. Moreover, their lipid profile level was low. While the most of them had a low to moderate CVD risk, a few had high risk. Blood LDL and TG levels were more likely to rise in patients who consumed more fast food, red meat, salty snacks, cheese, eggs and soft beverages which were the primary causes of cardiovascular illness, compared to people who routinely ate chicken, fish, legumes, fruits, nuts, and vegetables. (*Shammi, et al 2021)*.

2.4 Garo Population of Bangladesh with socio-demographic variables

A study conducted in Bangladesh, showed the evaluation of diabetes management skills and knowledge between urban residents and members of the Garo indigenous in Mymensingh division. The study's findings showed that Garo and neighboring urban residents had poor levels of awareness and attitudes about diabetes. Additionally, Other warning indications of knowledge gaps include a lack of self-efficacy and low family finances. (*Rafayat, 2019*).

In Bangladesh, ISLAM (2009) conducted a study intended to comprehend, with reference to the prevalence at the national level, the knowledge of prenatal and postnatal services provided by providers and subsequent care-seeking behavior among the Garo tribe, a matrilineal indigenous population in Bangladesh. For this research, 223 women who are presently married and have at least one kid under the age of five were chosen, including 158 from Haluaghat and 65 from Modhupur. The results showed that Garo population sought prenatal and postnatal care more often than Bangladeshi society as a whole. The research found that, unless prospective clients are made more aware of the services that are offered, the availability of services in a community does not always reflect the behavior of people seeking treatment. On this group of people who reside in Madhupur Sal (Shorea robusta) forests in Bangladesh, an empirical investigation was done. the goals were to examine the many socioeconomic and cultural facets of the Garo people in relation to their means of subsistence. It was discovered that this indigenous community has been facing several difficulties and that the legislation and its application frequently violate their human rights. The Garo peoples have lost their status as a dominant ethnic group in their own historic territory due to competing claims to the same parcel of land and unauthorized non-Garo settlements in the woods. According to this research, even with ongoing active social forestry techniques in the Sal woods, there was no certainty that the forests and farmland will remain productive. if delicate land tenure concerns are not resolved (*Mohammed, 2011*).

Another research in Bangladesh showed the overview of Garo community's cultural practices and family structure. Results of this research emphasized the whole lifestyle of Garo community which includes their cultural practices such as marriage pattern, behavior pattern, language and other related factors (*Jalil, 2012*).

The research was done on the Garo ethnic group by Roksana Akter stated that Garo community which inhabits the Tangail district's Madhupur Sal (Shorearobusta) forest regions. This study focused on the many socioeconomic and cultural variables and how they have influenced the way of life of the Garo people throughout history. It is often advised that current national laws and regulations that have an adverse effect on their rights l and life style be examined and reevaluated. (*Akhter et al, 2020*).

A study was carried out among 726 students from 214 Garo households and 235 non-Garo households in a distinguished tribal area of Jhenaigati Upazilla, Bangladesh during July

2011 to December 2011. The most important findings of this study were to assess and compare their socioeconomic information, lifestyle pattern, demographic information and nutritional status (*Rana, 2013*).

Another article's goal is to evaluate the senior Garo population in Tangail's Madhupur Upazila's self-reported health state. To achieve the goal of the report, a study among the Garo population, focusing on those who were 60 years of age or older. For this survey, 400 individuals in total were questioned. The findings indicate that among older Garo, 50% reported having bad health, 38% had acceptable health, and 14% had good health. Low vision (67 percent), walking issues (55 percent), rheumatism (54 percent), gastric (52 percent), colds or coughs (47 percent), headaches (39 percent), skin conditions (25 percent), high blood pressure (23 percent), and asthma were the most often reported ailments (14 percent). The prevalence of rheumatism, headaches, and stomach problems was found to be substantially greater in elderly women than in elderly men. The most important factors influencing self-reported health status were age, employment, cigarette use, and alcohol use (*Chowdhury, 2013*).

The Garo women engage in strenuous exercise, which is anticipated to modify both their physical makeup and the difficulties brought on by metabolic syndrome. The current study made an effort to determine the illness risk of Garo women using anthropometric measurements of the abdomen and gluteofemoral regions while controlling based on age, physical activity and education, among other variables. When hip and waist measurements are taken into account simultaneously, about 20% more persons are identified as having a greater risk of dying than when waist measurements are just taken into account. When asked to assess their own health, most of the study's female participants said that they were in good physical shape. No cases of heart-related illnesses, which may have been brought on by fat accumulation in the abdomen and gluteofemoral region, were documented in relation to them. This suggests that increasing physical activity in an obese patient may enhance their health, whether or not the patient stays obese (*Rabha, 2020*).

The fieldwork was done over the course of a year. Interviews, questionnaires, and focus groups were used to gather information from randomly chosen tribal, indigenous, and traditional health practitioners (THPs) are among the informants who resided in the research region. Plants that have been recorded are given together with their indication, component utilized, preparation method, and use value (UV). At least 77 distinct illnesses and ailments have been treated using the 78 species of therapeutic plants from 45 families that have been examined in this study. The classification of medicinal plant species was done using the following categories: tree, shrub, tuber, herb, and climber. (*Islam, 2014*).

CHAPTER 3

METHODOLOGY

3. METHODOLOGY

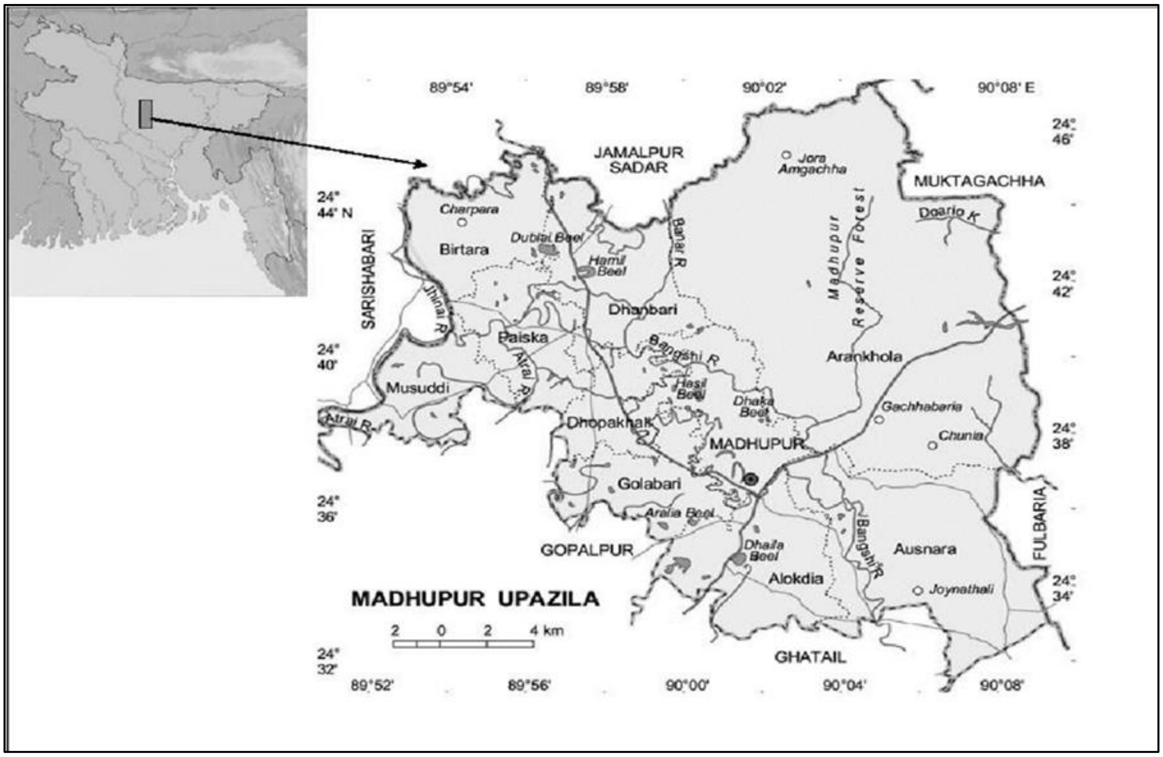
***3.1 Study design*:** The study was conducted as a cross-sectional design.

***3.2 Study period*:** Four years from the date of university registration. These study periods were from 3rd April 2019 to 2nd April 2023. Proposal defense, questionnaire developing, data collection, data processing, analysis, report writing, 1st and 2nd doctoral seminar, and thesis submission was done within this time line. Literatures were reviewing in the whole study period.

***3.3 Study areas*:** As Garos are available in our country in hilly and plain lands rural areas of Mymensing, Tangail and Netrokona districts in Bangladesh. It is conveniently selected for data collection because of availability of Garo ethnic community. But, most of the Garo ethnic community are lives in remote areas at those districts. For the Corona pandemic situation and lack of financial support we could not collect data from all those remote places. According to our ability, we have collected adequate data from Pirgacha village of Modhupur upazila in Tangail district.

Picture 1: Garo population areas in South Asia

According to Garo leaders in Madhupur, there are at least 1,25,000 Garos in the country. Of them, around 25,000 live in the Madhupur upazila.



Picture 2: Study area in Madhupur upazila, Tangail district, Bangladesh

***3.4 Study population*:** The study's target population was comprised of rural Garo adults (aged between 18-70yrs).

3.5 Inclusion & exclusion criteria

3.5.1 Inclusion criteria:

- All Garo adults from the selected areas who willing to participate in the study.
- Both females and males aged between 18 to 70 years

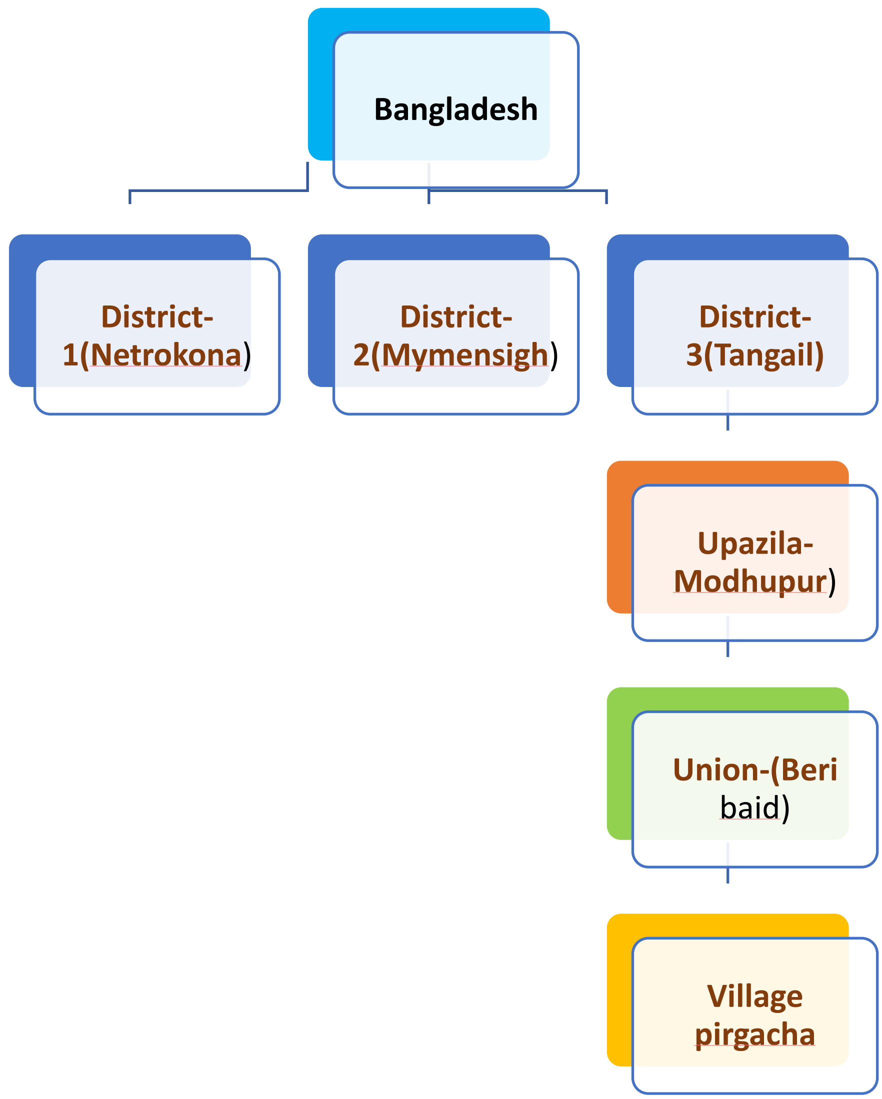
3.5.2 Exclusion criteria:

- Known person with any cardiovascular disease or events.
- Garo indigenous age below 18 years and above 70 years old.
- Severely ill adults by any other diseases or mental disease.

- Pregnant women.

3.6 Sampling technique:

The study sites were chosen using a purposive sampling technique. and, where 1 out of 3 districts (where Garos are mostly available) were selected by following a lottery method. Samples were collected from pirgacha village of Modhupur upazila in Tangail district.



Flaw chart 1: Sampling technique

3.7 Sample Size:

For the whole PhD sample size for the study has been calculated using the formula below:

$$n = \frac{Z^2pq}{d^2}$$

here,

Z = critical value of the normal distribution (1.96 with a 95% degree of confidence)

p = Prevalence of hypertensive CVD (20%). [*Chowdhury et al, 2020*]

q = 1-p

d= desired decision level [d as 0.05 (margin of error)]

n= desired sample size

z as 1.96 (for a confidence level of 95%) and,

Now, required sample size

$$n = \frac{(1.96)^2 \text{ x } 0.2\text{x}0.8}{(0.05)^2}$$

$$= 246$$

Considering 10% nonresponse rate and rounding, the sample size : 271

3.8 Data collection Procedure:

Data was collected in two settings;

- Face to face interview and physical examination;
- Sample collection camps where blood samples were collected.

***The procedure prior to data collection was as follows*:**

Meeting with local leaders

↓

Meeting with Garo leaders

↓

Discussion with Garo population

↓

Explained about the objective of the study

↓

Explained about the

↓

Necessity of the study

↓

Blood collection procedure were explained

↓

Introduced with the data collectors

↓

Rapport building with participants

↓

Blood sample collection were explained about

↓

Consent obtained was informed

↓

Data collection were started door to door

Flow chart 2

3.9 Data Collection Technique, Tools and Processing

- Data were processed with appropriate procedures and precautions.
- The methods used for data collection including interview of the respondents,
- Anthropometric measurements (height, weight)
- Blood pressure measurement by sphygmomanometer
- Data were collected through validated questionnaire and check-list.
- Dietary pattern measuring tools (e.g., plate, glass, spoon, bowl, show cards, demy for different food items) was used to measure the quantity of food items.
- Blood samples were collected from the respondents for 2 times (1st: fasting blood then 2nd time: 2 hour after 75gm glucose intake)

Picture no 3: Data collection procedure: meeting with Garo's leader (they called father of Garos in Pirgacha, Modhupur

3.9.1 Demographic variables:

To collect common demographic information, self-reported questions on age (as a continuous variable), sex (as a binary male/female), and education were employed. Education was categorized as illiterate, primary, SSC, HSC, graduate and post graduate. And the family's monthly income was categorized as low income (<9132), lower middle income (9132-35957.40 taka per month), upper middle (35957.40-85879.56) and high (>85879.56 taka per month) (*WORLD BANK DATA TEAM| 2019-20*). When asked about their marital status, respondents were divided into two categories: married or in a different type of relationship, and single, separated, divorced, or widowed. The ability to read and write was used to gauge respondents' levels of literacy.

Picture no 4: data collection procedure: collecting data from a local Garo leader

Picture no 5: Data were collecting by expert data collectors from tribal Garo communities in rural Bangladesh.

Picture no 6: Data were collecting from tribal Garo communities in Rural Bangladesh.

3.9.2 Anthropometric Measurements:

a Height (m): The heights were measured by standing position with stadiometer, a matric tape fix to a vertical surface and moveable headpiece attached on vertical surface. Eye forward, feet were remained together, knee straight and heel, buttocks, both shoulders were contact vertical surface of meter, both arms were hanging with palm faces forward. Deeply inhale and maintain erect posture fully. The headpiece touched the head, pressure was applied to the hair and the height measurement was done and recorded.

Picture no 7: Height was collected by expert medical assistants in this way.

b. Weight (kg): The body weight was measure by use of platform beam scale, the calibration of the scale before taking the weight. The bean of the platform scale must be graduated so that it can be read from each side. The respondents stand center portion of platform of the scale and weight were recorded. The weight data were kept at the nearest 0.1 kg.

Picture no 8: Weight was measured by digital weighting scale machine in this way.

c. BMI: *is a measurement of a person's weight and height***.**, BMI calculates their level of leanness. It is frequently used as a broad indicator of a person's body weight in relation to their height. According on the range the value falls within, a person is classified as being underweight, normal weight, overweight, or obese based on the value received from the BMI calculation. The Deurenberg et al. formula can be used to compute it (*Deurenberg P.*, *1991*).

$$\text{BMI} = \frac{Body\ weight\ (Kg)}{Height\ (m^2)}$$

Nutritional status (BMI) estimation units according to WHO (A healthy lifestyle, WHO recommendation, 2010)

Nutritional Status	**BMI**
Under Weight	Less than 18.5
Normal	18.5-24.9
Over Weight	25-29.9
Obesity	>30

3.9.3 Measurements of blood pressure:

Blood pressure was obtained and measured using OMRON BP742N manual sphygmomanometer. Before getting their blood pressure measured, participants had to be sat for at least five minutes with their feet level on the ground. The reading was an average of three measures. Each participant's left arm was clamped with the blood pressure cuff.

After receiving training and having four board-certified physicians observe the collection, team members took blood pressure readings.

Hypertension diagnosis

Hypertension was assessed based on clinically recognized cut off points: >=140/90 mmHg (ACC/AHA et al 2017).

Picture no 9: Blood pressure were measuring by local hospitals medical assistants and a expert senior lab assistant from BIRDEM was monitoring everything.

3.10 Blood Collection Procedure and Handling

For blood withdrawal, disposable syringes, cotton swabs, stripes, and reagents were utilized. There was a clinical need for blood sample analysis, a blood sample was obtained from a local diagnostic facility, and there was an anticipated turnaround time for results. To minimize variation and danger, the procedure for collecting and managing blood samples is straight forward and standardized. The samples were put into the Tempus 600 for that, which was able to drastically reduce the handling of samples. Blood samples were collected using a one-touch handling procedure.

Picture no 10: Blood collection procedure

Picture no 11: Collecting blood by BIRDEM's expert senior medical assistant and a medical officer (Doctor) of local hospitals continuous monitoring the blood collection procedure.

After collecting blood sample, at first centrifuged it properly then, put only serum in to small Eppendorf tube and storage in deep cold refrigerator (- 20· C to—40c) for further lab test.

Picture no 12: Blood collection procedure. Picture no 13: Blood collection procedure

3.11. Lab test: **a.** Fasting Blood glucose (FBG), **b**. OGTT and **c.** Serum Total cholesterol.

A blood glucose test measures the glucose levels blood. We have applied two procedures for measuring blood glucose. (Blood glucose test 2022). Those were FBG and OGTT.

a. **Fasting Blood glucose (FBG) test:** Blood sugar is measured here after an overnight fast (not eating). A fasting plasma glucose of ≥7.0 mmol/l indicates diabetes.

Picture no 14: Blood glucose measurement kits.

b. **OGTT:** This checks blood sugar levels before and after consuming 75gm glucose. Before the test, at first have blood drawn to check fasting blood sugar level (Diabetes Tests, CDC 2023). After consuming the liquid, blood sugar level will be monitored after two hours. a 2-hour plasma glucose value in a 75 g oral glucose tolerance test of ≥11.1 mmol/L indicates that a person has diabetes.

Picture no 15: Respondents came 2nd times for blood glucose test after 2 hours of 75 gm glucose consumption (OGTT test)

c. **Serum Total cholesterol:** A measurement of the overall amount of cholesterol is total cholesterol. The test provides data that one must refrain from eating or drinking anything other than water for nine to twelve hours before to the test

.

Picture no 16: Blood total Cholesterol test kit

3.12 Dietary Habit Measurements

a. 24-hour recall methods for the three consequence days.

b. Food Frequency questionnaire (FFQ) method including name of the food item, cooking method, quality of food (gm) consumption was taken.

Picture no 17: Dietary food intake measuring tools

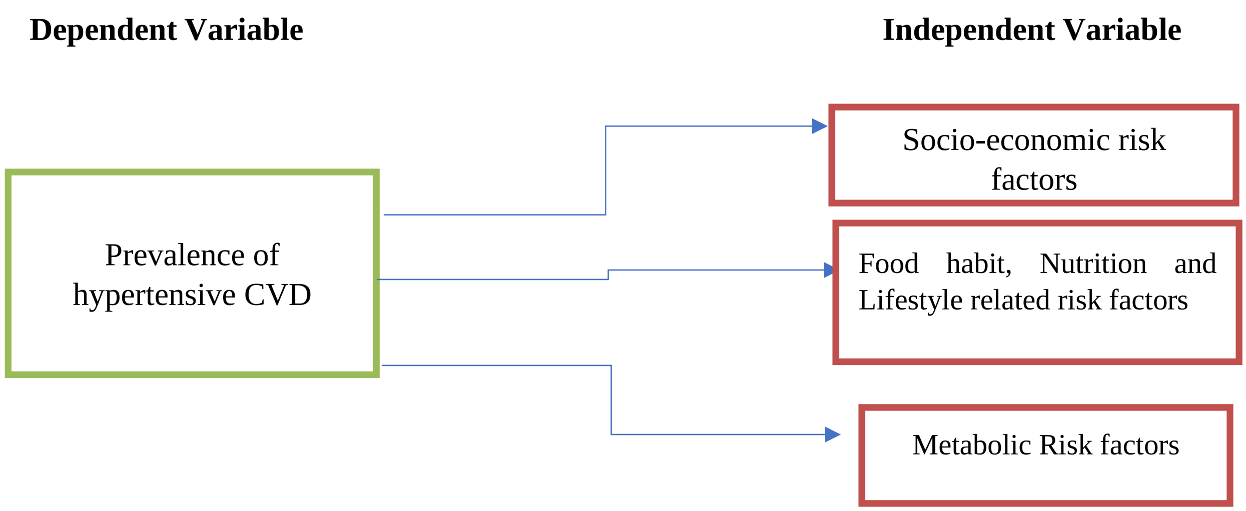
3.13 Pretest: Before finalization the questionnaire, it was validated through pretest**.**

3.14 Data analysis: Data was analyzed using SPSS version 26

3.15 Statistical analysis

Initially, for the sample's demographic components, mean and standard deviation were used to describe continuous variables while frequencies were used to describe categorical variables (sex, age, marital status, monthly income, education and literacy). Secondly, demographic information was investigated in relation to each of the three outcomes using chi2 tests, proportions, and confidence intervals, (hypertension > = 140/90 mmHg cut-point). Third, we performed logistic regression models to understand the independent correlates of hypertension. To enable the analysis of independent correlates accounting for other factors, it was decided a priority to keep all variables in the model regardless of their importance. Stata version 26 was used for all analysis. In order to evaluate significance, a two-tailed alpha of p 0.05 was used

3.16 Conceptual Framework



Flow chart 3: Conceptual Framework

3. 17 Operational Definition:

- *Socio-economic status:* Socio-economic status was determined by self-reported monthly family income and expenditure of the respondents.
- *Occupation:* Occupation was determined by the last 12 months main work of the respondents.
- *Tobacco Smoking*: Percentage of respondents who currently, occasionally, never and past smoke tobacco.
- *Extra salt intake*: Extra salt intake was determined by the table salt taken by the respondent during eating.
- *Dietary habit:* Food consumption by the participants in a day was taken at the same day night for three consecutive days which included name of the food item, cooking method, quality of food (gm).
- *Lifestyle:* Lifestyle pattern ex: exercise or any other working types was observed.
- *Glucose:* is a type of sugar. It is body's main source of energy. A hormone called insulin helps move glucose from your bloodstream into your cells
- *Diabetes:* The presence of diabetes was determined by fasting blood sugar levels greater than or equal to 7.0 mmol/L and a 2-hour plasma glucose value in a 75 g oral glucose tolerance test (OGTT) of ≥11.1 mmol/L (Zubin Punthakee 2018)
- *Prediabetes/IGT/IFG:* Impaired fasting glucose is defined as glucose levels of 100 to 125 mg per dL (5.6 to 6.9 mmol per L) in fasting patients.
- *Total Cholesterol:* A measurement of the overall amount of cholesterol is total cholesterol

3.18 Ethical Consideration

- The ethical clearance was obtained from ethical review committee of Bangladesh Medical Research Council.
- The aims and objectives of the study and its procedure were explained to the respondents.
- There was no human risk, no medication and no invasive procedure.
- Written informed consent was taken at the time of enrolling the respondents.
- Administrative permission from the authority of the nearby hospitals was taken.

3.19 Expected Outcomes and Mass People Benefit

- The present study is expected to generate quantitative data on the prevalence of hypertensive CVD and associated risk factors among the rural Garo population for the first time.
- The health care providers and policy makers will be highly benefited by this tool as those will be helpful to prioritize the most vulnerable groups for intervention with limited resources.
- The Garo people in general will be benefited with these evidence-based policies.

3.20 Time Table of the study (2019-2023)

Activities	2019		2020		2021		2022		2023
	March-June	July-Dec	Jan-June	July-Dec	Jan-June	July-Dec	Jan-June	July-Dec	Jan-March
Literature review									
Presentation of Proposal (25th June 2019)									
Questionnaire Develop and Pretesting									
1st time Data Collection and Data Entry									
Data Analysis									
Presentation of 1st Seminar (3rd march 2022)									
2nd time Data Collection and Data Entry									
Data Analysis									
Presentation of 2nd Seminar (16.10.22)									
Correction and Modification									
Thesis Submission									

CHAPTER 4

RESULTS

4. RESULTS:

A cross sectional analytical study was conducted to assess the cardiovascular disease where hypertension was a surrogate marker among the rural Garo population in Bangladesh. A pre-tested, modified, semi structured questionnaire was used to collect the information with sample size 289. Here, section A- contained socio-economic and demographic characteristics, section B- contained nutritional status, section C – contained dietary habits, section D- family history of disease and addiction history of the respondents, section E- clinical characteristics of the respondents and section F- contained the associated factors of hypertensive CVD. All the data entered and analyzed by using statistical packages for social science (SPSS) software, version 26.

4.1 Section A: Socio-economic and demographics characteristics of the study subjects:

Table 1: Distribution of the respondents by Age (n=289):

Variables	Frequency (n=289)	Percent (%)
30 years and less	62	21.5
31-40	75	26.0
41-50	77	26.6
51-60	42	14.5
61 years and above	33	11.4
Total	289	100.0
Mean ± SD	43.24 ± 14.34	

Table 1 shows the distribution of the respondents by age. Here 21.5%, 26.0%, 26.6%, 14.5%, 11.4% of the respondents were 30 years and less, 31-40 years, 41-50 years, 51-60 years and 61-65 years respectively with their mean age **43.24 ± 14.34**

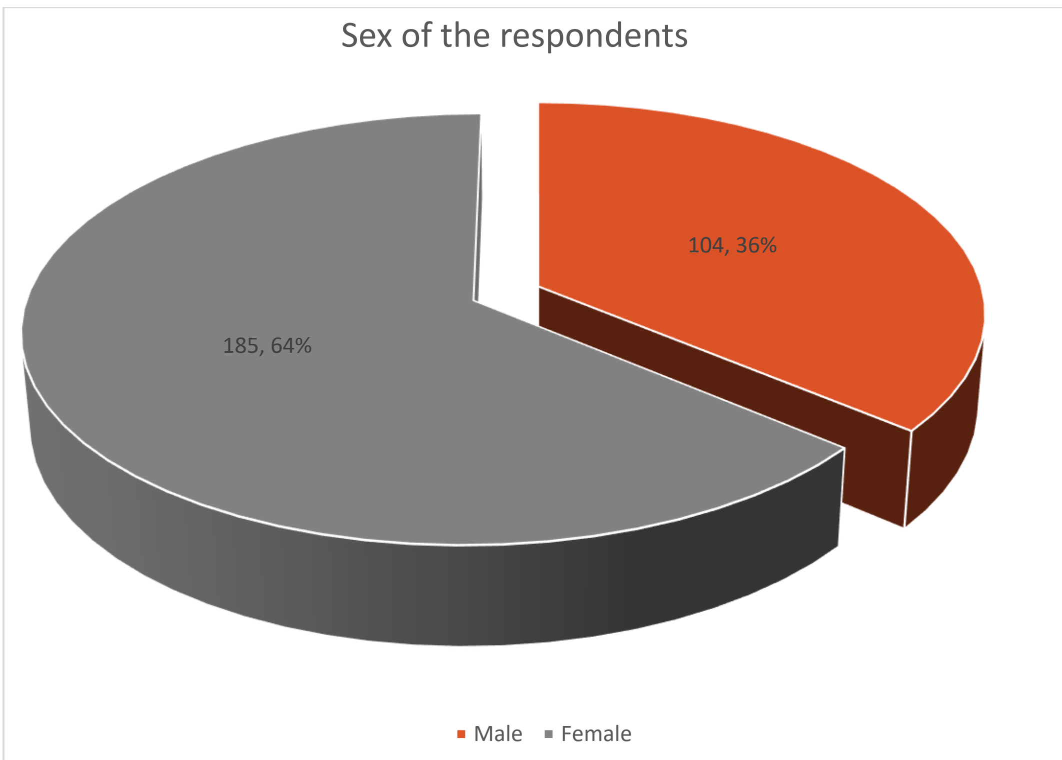


Figure 1: Distribution of the respondents by Sex (n=289):

Figure 1 shows the distribution of the respondents by sex. Of the total 289 subjects about 104 (36%) were male and 185 (64%) were female respondents.

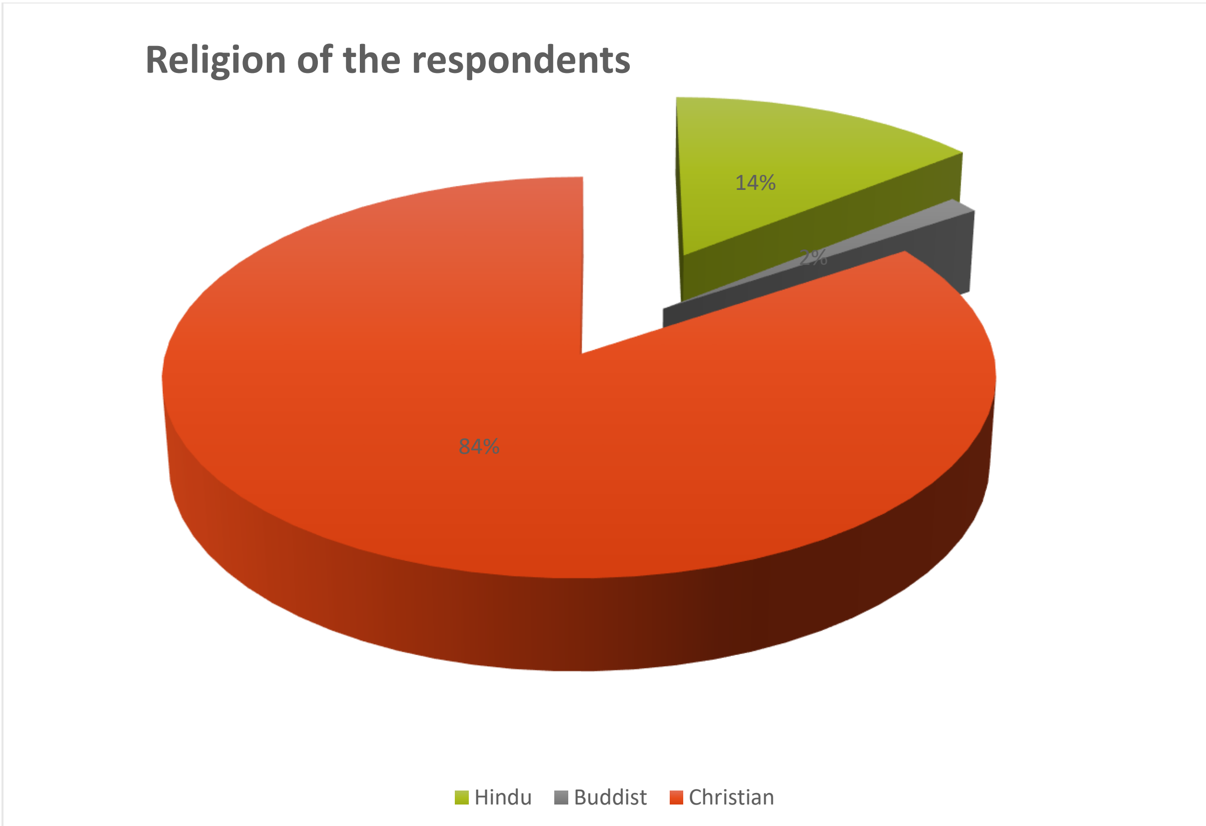


Figure 2: Distribution of the respondents by religion (n=289)

Figure 2 shows the distribution of the respondents by religion. Majority (84%) of the subjects were Christians, 14% were Hindus and rest are Buddhist.

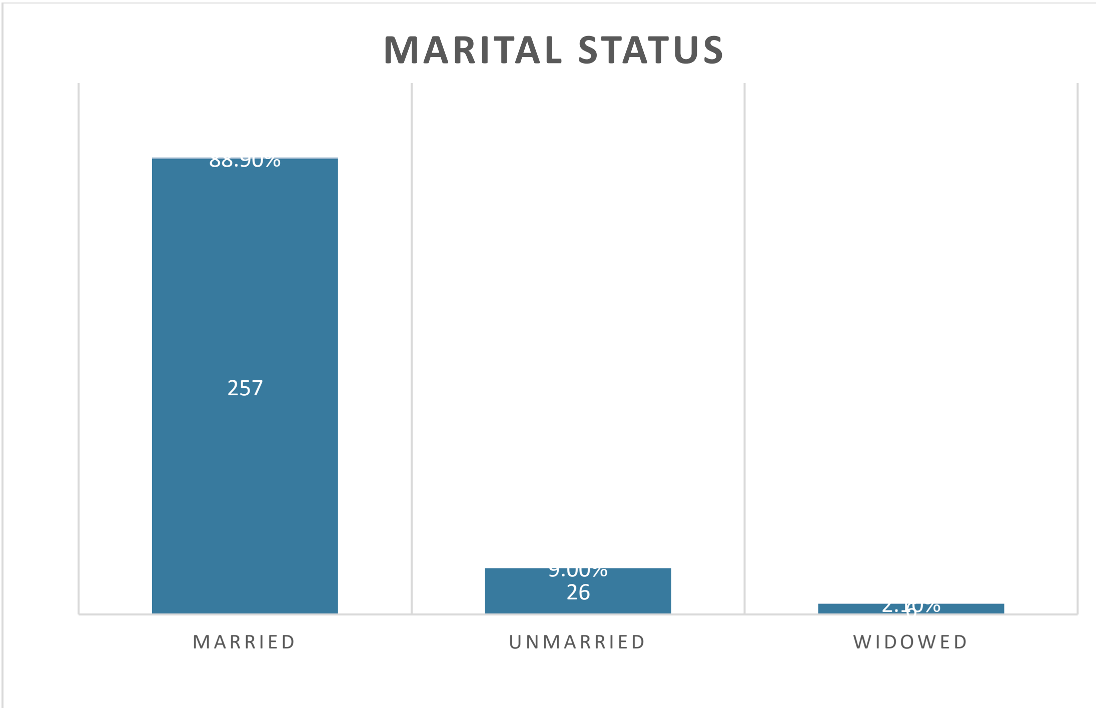


Figure 3: Distribution of the respondents by marital status (frequency, percentage)

Figure 3 shows the distribution of the respondents by marital status. Most of the respondents (88.9%) were Married. 9% respondents were unmarried and 2.1% were widowed.

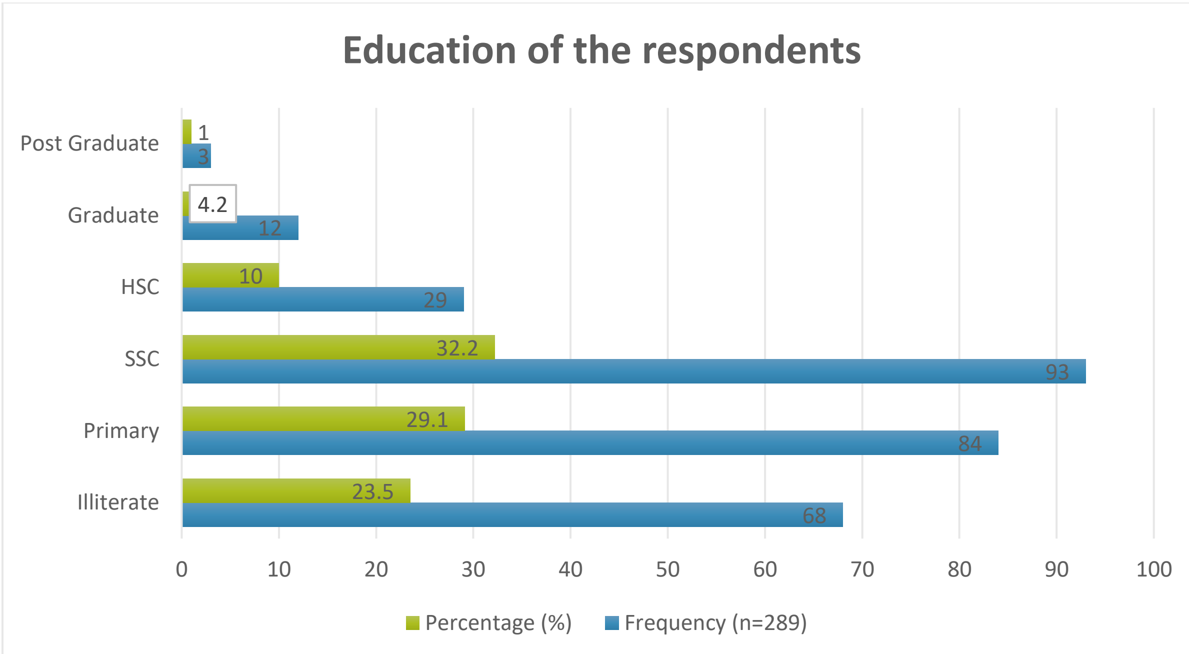


Figure 4: Distribution of the respondents by Education (frequency, percentage)

Figure 4 shows the distribution of the respondents by educations. if we see to the education level of the respondents: a big portion (23.5%) of them were illiterate, 29.1% have completed their primary education, 32.2% up to SSC, 10% up to HSC and rest 4.2% were Graduate and 1% were Post graduate.

Table 2: Distribution of the respondent by family members (n=289)

Variables (Family members)	Frequency (n=289)	Percentage (%)
1-2	**22**	**7.6**
3-4	**111**	**38.4**
5-6	**113**	**39.1**
More than 6	**43**	**14.9**

Table 2 shows the distribution of the respondent by family members. In this table we see that 7.6 % have the family members of 1-2 persons, 38.4% have the family members of 3-4 persons, 39.1% were 5-6 family members and 14.9% were more than 6 family members.

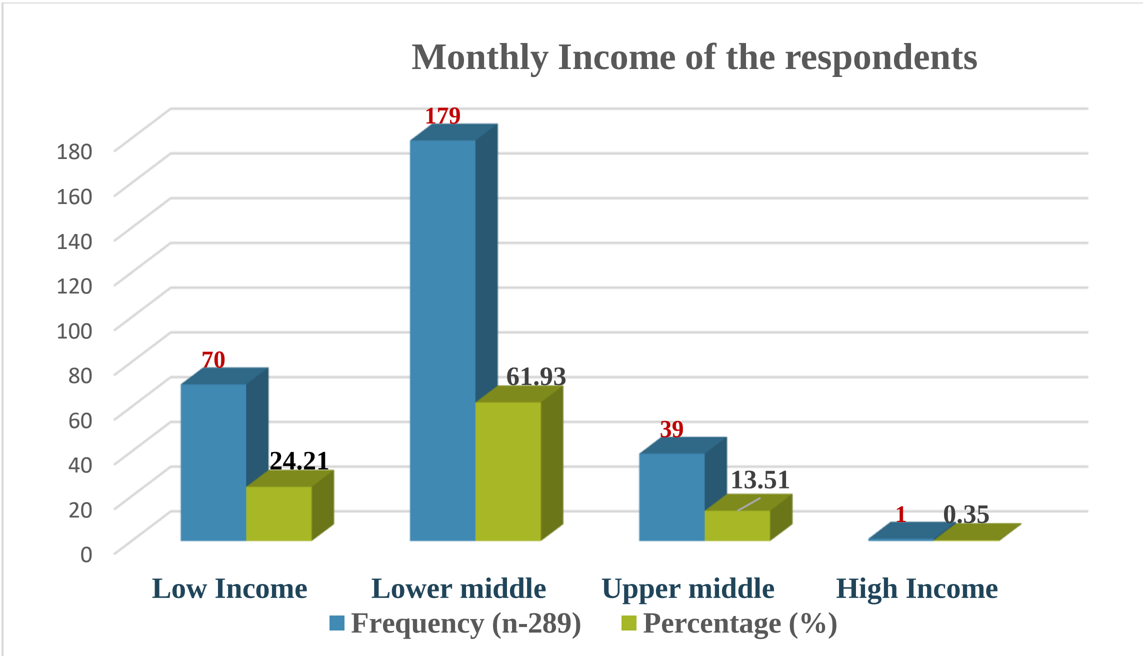


Figure 5: Distribution of the respondent by Income level (n=289):

Figure 5 shows the economic status of the respondents. In this figure 24.21% were low-income group, 61.93% were lower middle classes 13.51% were upper middle classes, and 0.35% were upper income group respondent.

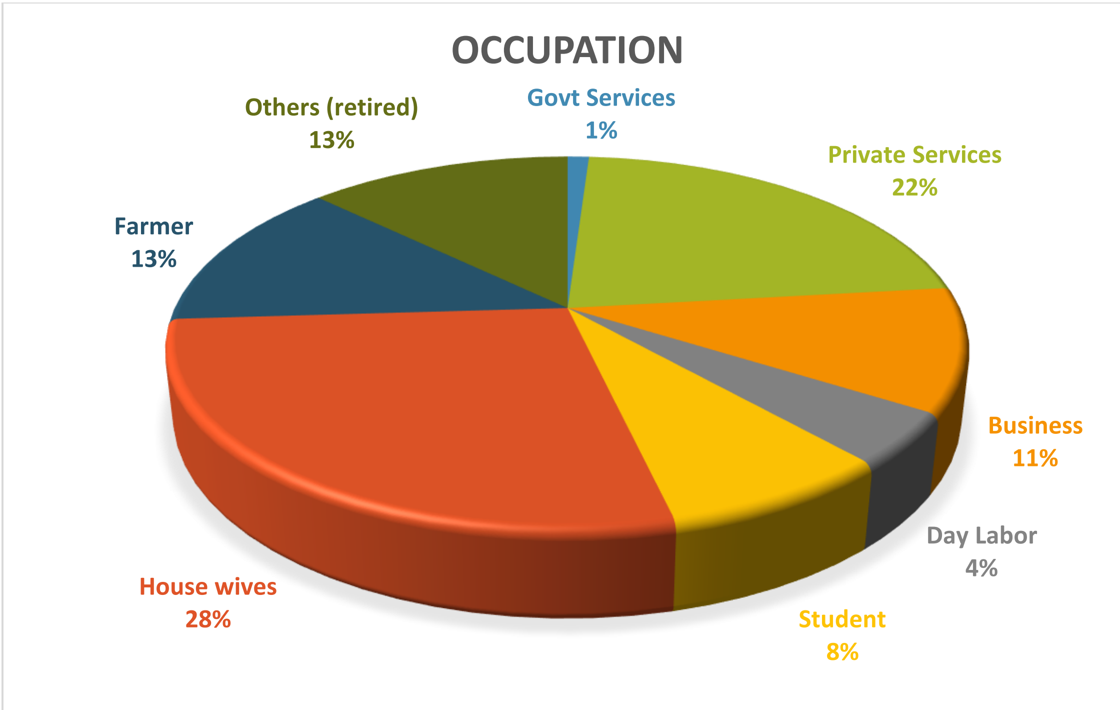


Figure 6: Distribution of the respondent by Occupation level (n=289, %):

In case of occupation, 28% of them were house wives, 13% were farmer, 22% of them were private service, 1% Govt service holders, 4%-day laborers, 11% business and 13% others.

4.2 Section B: Nutritional status of the respondents by anthropometric characteristics:

Table 3: Anthropometric characteristics of the respondents:

Variables	Mean ± SD
Weight (Kg)	57.08 ± 12.16
Height ()	156.80 ± 9. 60
BMI (kg/m^2)	23.39 ± 5.74
Waist hip ratio	.81 ± **.**125

Table 3 shows the anthropometric characteristics of the study subjects. In this table we find that mean weight was 57.08± 12.16, height 156.80 ± 9. 60, BMI 23.39±5.74 and mean waist-hip ratio was 0.81 ± **0.**125.

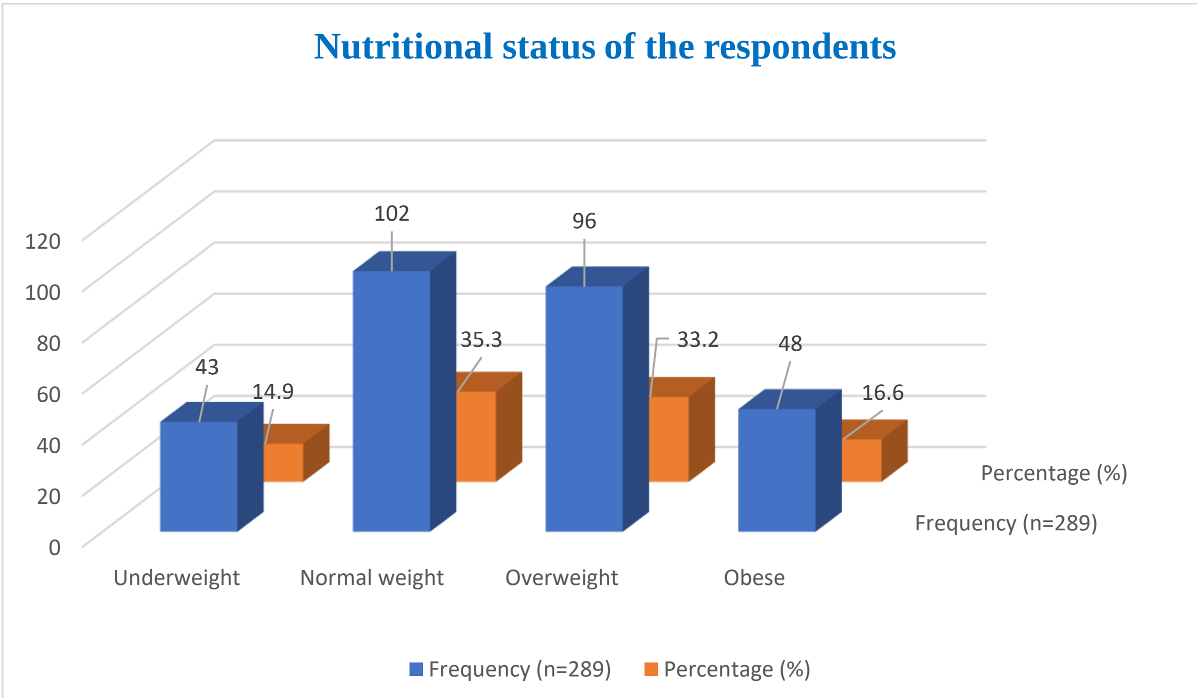


Figure 7: Nutritional Status (by Body Mass Index) of the study subjects:

Figure 7 shows the nutritional status of the study subjects. In this figure, we find that about 35.3% of the subjects were within the normal range of nutritional status (as assessed by BMI), 33.2% were overweight and 16.6% were obese, 35.3% were in normal weighed respondents and 14.9% were underweighted. So, in this figure, we can see that almost half of the respondents were in the overweight and obese group which is a factor of increasing CVD.

Table 4: Gender-wise Distribution of Nutritional Status among the Subjects (n=289):

Variables	Male (n=104)	Female (n=185)	Total (n=289)	χ2	P Value
	N (%)	N (%)	N (%)		
Underweight	16 (15.4)	27 (14.6)	43 (14.9)	2.68	0.22
Normal weight	36 (34.6)	64 (34.6)	100 (34.6)		
Overweight	39 (37.5)	58 (31.4)	97 (33.6)		
Obese	13 (12.5)	36 (19.5)	49 (17.0)		
Total	104 (100)	185 (100)	289 (100)		

Table 4 shows the Gender wise distribution of the nutritional status among the subjects. In this table we found that about 34.6% of the male subjects were within the normal ranges of nutritional status (as assessed by BMI), 37.5% were overweight, 15.4% were underweight and 12.5% were obese. The corresponding percentage in females were 34.6, 31.4, 14.6, and 19.5 respectively and there was no significant difference between males and females.

4.3 Section C: Dietary habits of the respondents:

Table 5: Total Calorie intake by the study subjects (n=289):

Variables	**Total Calorie Intake**			**% Of Total Calorie**
	(Mean ± SD)	**Median**	**Moderate**	
Calorie from CHO	1364.85 ± 502.66	1219.56	1170.00	73.62 ±6.17
Calorie from Fat	293.16 ± 102.25	274.00	171.00	16.7 ± 6.03
Calorie from Protein	195. 69 ± 67.92	185.00	291.24	10.67 ±2.33
Total Calorie	1853.70 ± 582.25	1704.00	2231	100.00

Table 5 shows the total calorie intake by the respondents. In this table, we have found that the mean calorie intake among all the subjects was 1854 kcal and carbohydrates were the dominant (mean percentage 73.6) source followed by fat (16.7) and protein (only 10.7).

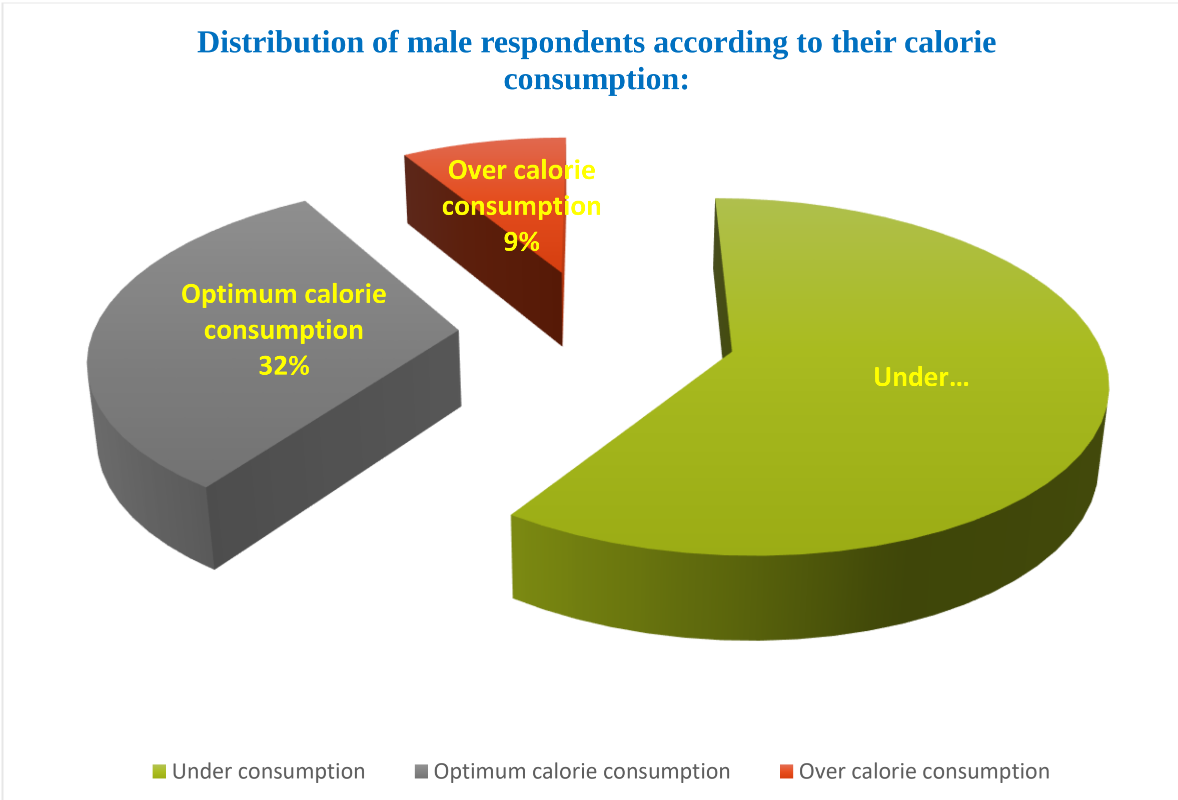


Figure 8: Distribution of male respondents according to their calorie consumption:

Figure 8 shows the distribution of male respondents according to their calorie consumption. As per present for calories, only 32% of the males consume optimum calorie, 59% suffer from underconsumption and 9% suffer from overconsumption. (For male, over calorie consumption: >3000, normal: 2000-3000, low: <2000) source: according to USDA guidelines, 2022.)

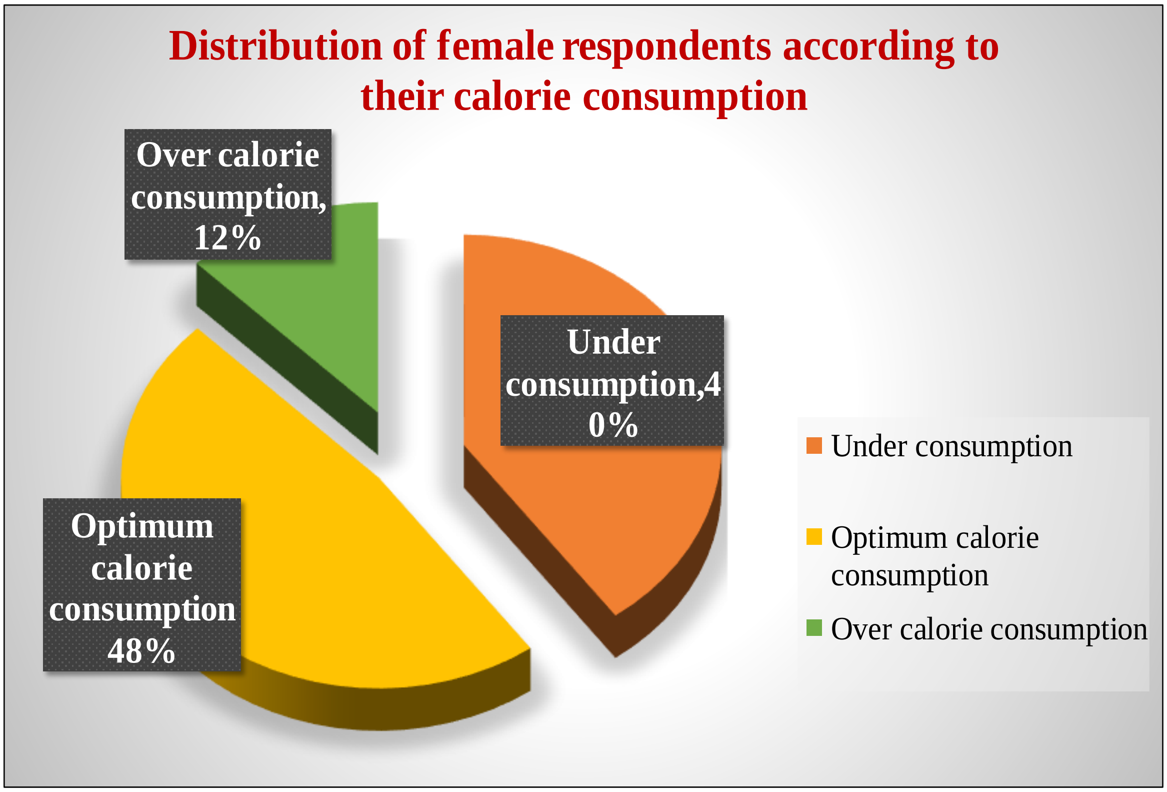


Figure 9: Distribution of female respondents according to their calorie consumption:

Figure 9 shows the distribution of female respondents according to their calorie consumption. The calorie intake scenario was slightly better in case of females with underconsumption proportion at 40%, optimum proportion at 48% and over consumption scenario is 12%. (For females, over calorie consumption: >2400, normal: 1600-2400, low: <1600) source: according to USDA guidelines, 2022).

Table 6: Total Salt Intake by the study subjects (n-289)

Variables	Mean ± SD
Total Salt Intake by the respondent (gm/day)	6.81 ± 2.30

Table 6 reveals that the total salt intake by the study subjects. In this study the mean intake of salt among Garos was 6.81 g/day with the standard deviation of 2.30.

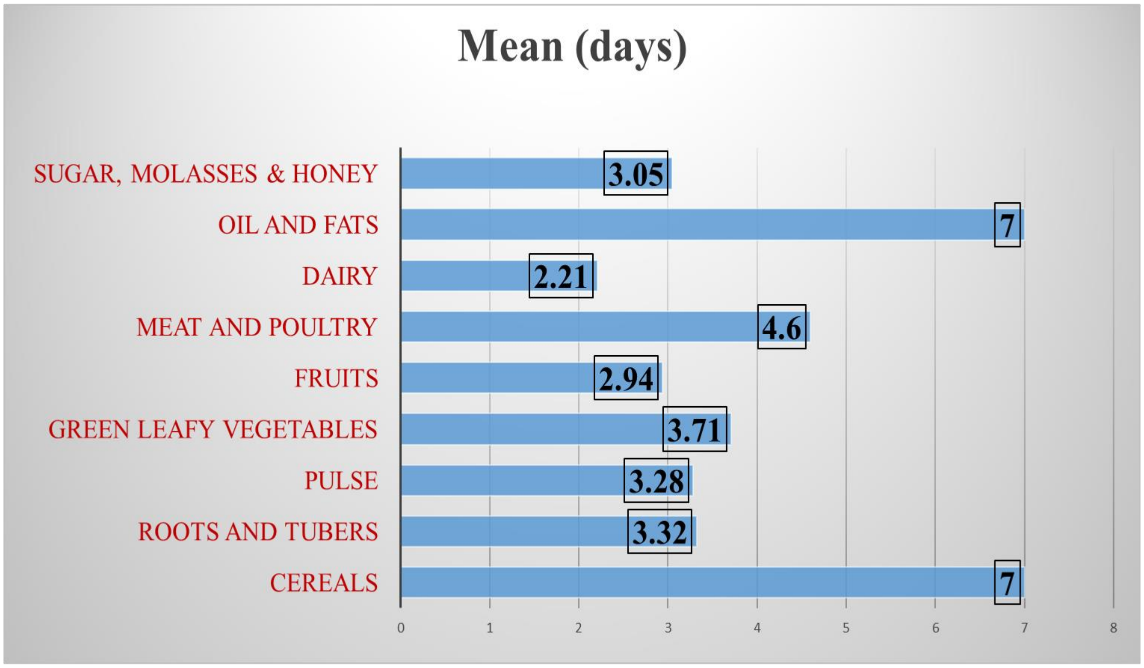


Figure 10: Consumption frequency (days) of different food groups among the respondents

Figure 10 portrays the mean days of different food consumption in last seven days. Cereals, oil and fats was consumed almost every day in last seven days. Mean meat and poultry, pulse, dairy and fruits consumption are 4.6, 3.28, 2.21 and 2.94 days respectively. Green leafy vegetables, roots and tubers and cereals consumption frequency are 3.71, 3.32 and 3.28 days respectively.

4.4 Section D: Family history of Disease and addiction history of the respondents

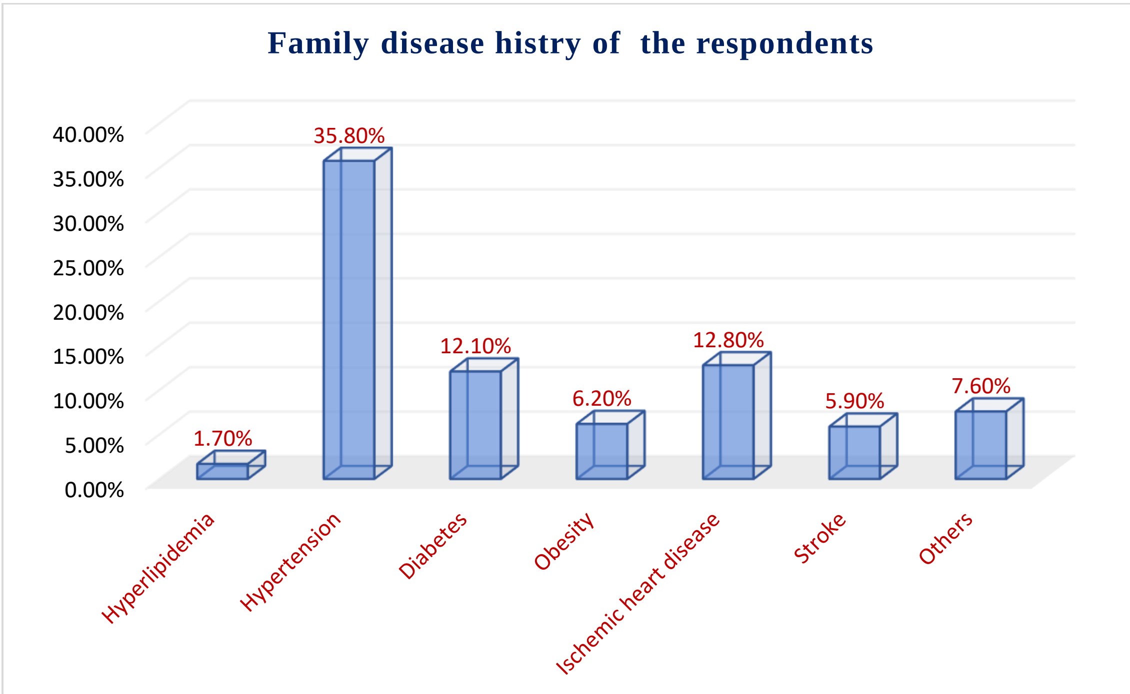


Figure 11: Family history of the diseases among the Study Subjects (n=289)

Figure 11 shows the Family disease history of the respondents. Here the results shows that 35.8% have the family history of hypertension, 12.10% have the family history of diabetes, 12.8% ischemic heart disease, 5.9% stroke, 1.7% hyperlipidemia and 7.6% have the family history of other diseases**.**

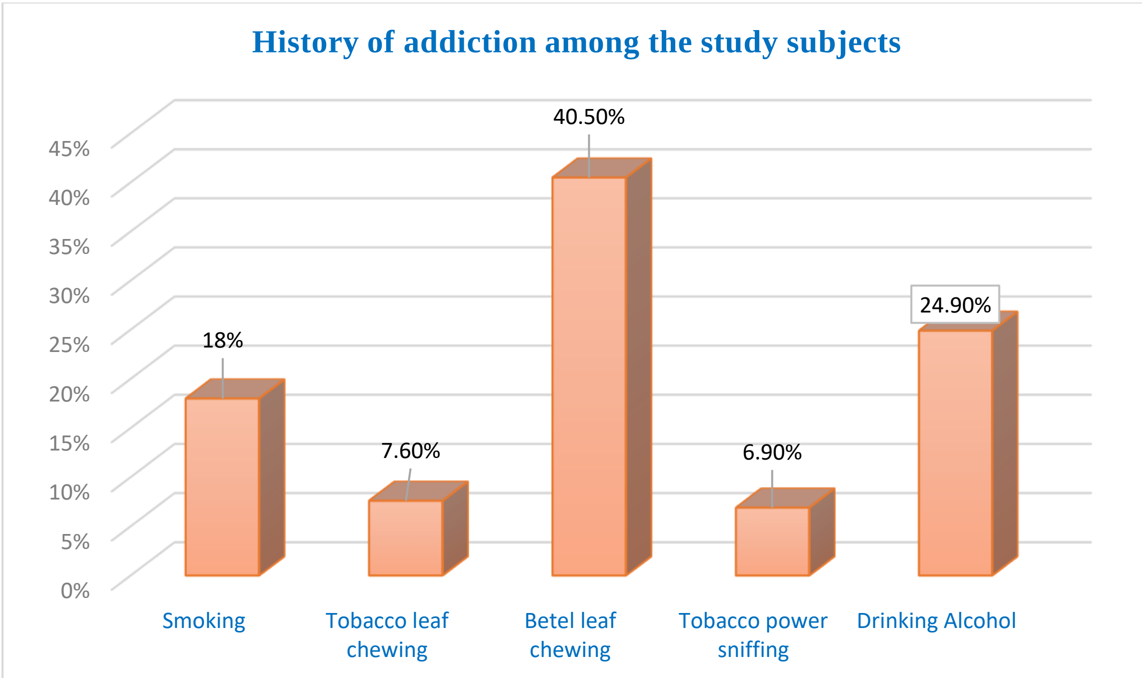


Figure 12: History of addiction among the Study Subjects (n=289):

Figure 12 shows the history of addiction among the study subjects. Of the total 18% have the addiction history smoking, 7.6% have tobacco leaf chewing habits, 40.50% are habituated with betel leaf chewing habits, 6.9% have tobacco powder sniffing habits and 24.90% are habituated with drinking alcohol.

4.5 Section E: Clinical characteristics of the respondents

Table 7: Clinical Characteristics of the study subjects:

Variables	Mean ± **SD**
FBG (mmol/L) (n=289)	5.12 ± 2.20
2-hr PPG (mmol/L) (n=222)	6.63 ± 2.94
Blood Total Cholesterol	178. 37 ± 40.65
Systolic blood Pressure	118.06 ± 15.47
Diastolic Blood Pressure	79.06 ± 10. 1

Table 7 reveals that the mean clinical and biochemical characteristics of the study subjects. The mean fasting and 2-hr blood glucose levels (mmol/L) were 5.12±2.20 and 6.63±2.94 respectively. Mean Blood total cholesterol were 178.37±40.65

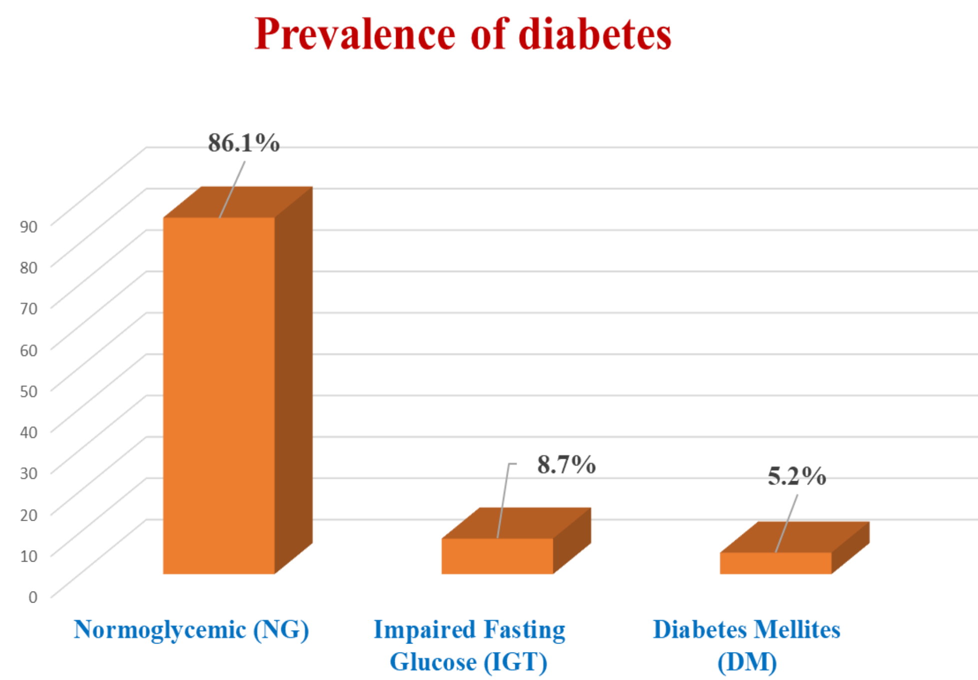


Figure 13: Prevalence of diabetes among the study subjects

Figure 13 shows the prevalence of diabetes among the study subjects. Diabetes mellitus (DM) was found to be 5.2% and that of IGT was 8.7% among all the subjects, normoglycemic was 86.1%.

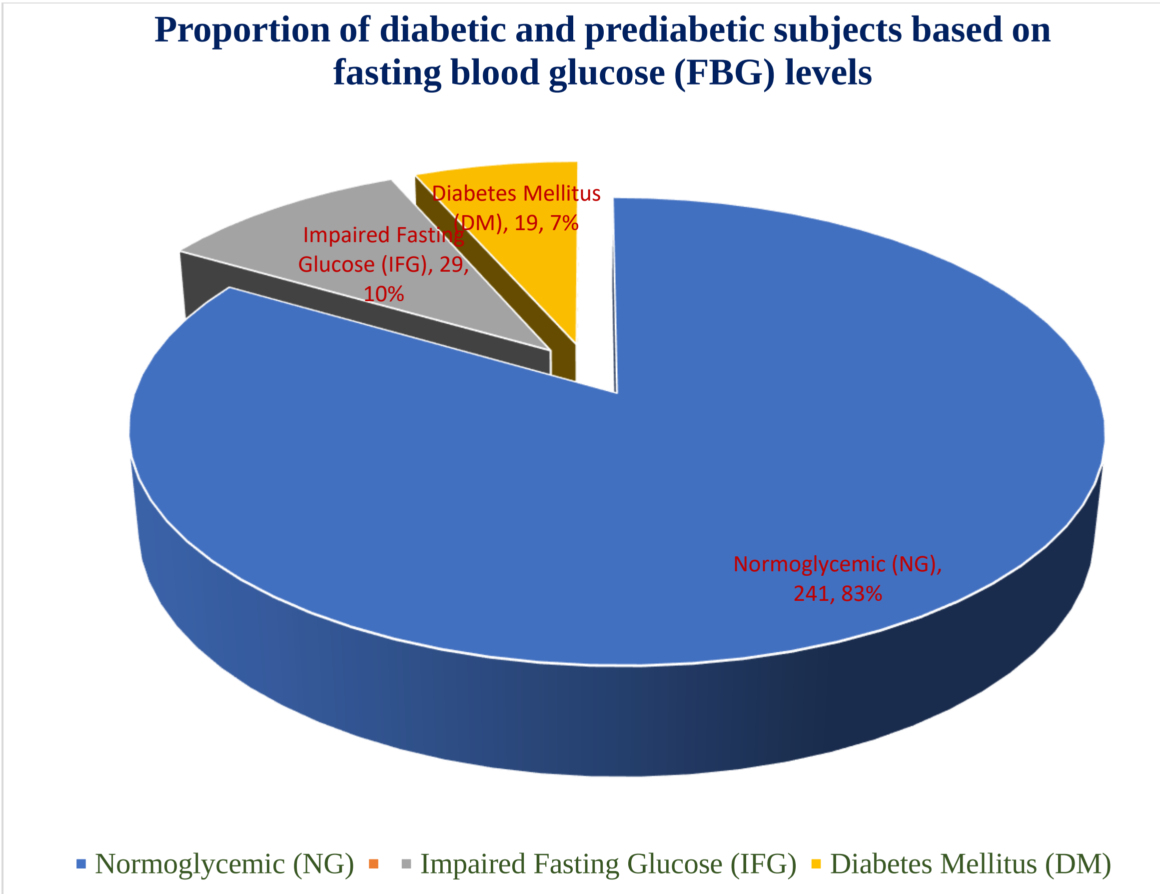


Figure 14: Proportion of diabetic and prediabetic Subjects based on fasting blood glucose (FBG) Levels

Figure 14 shows the proportion of diabetic and prediabetic Subjects based on fasting blood glucose (FBG) Levels (PPG). Based on FBG, 7% were diabetic and 10% had Impaired fasting Glucose (IFG) .

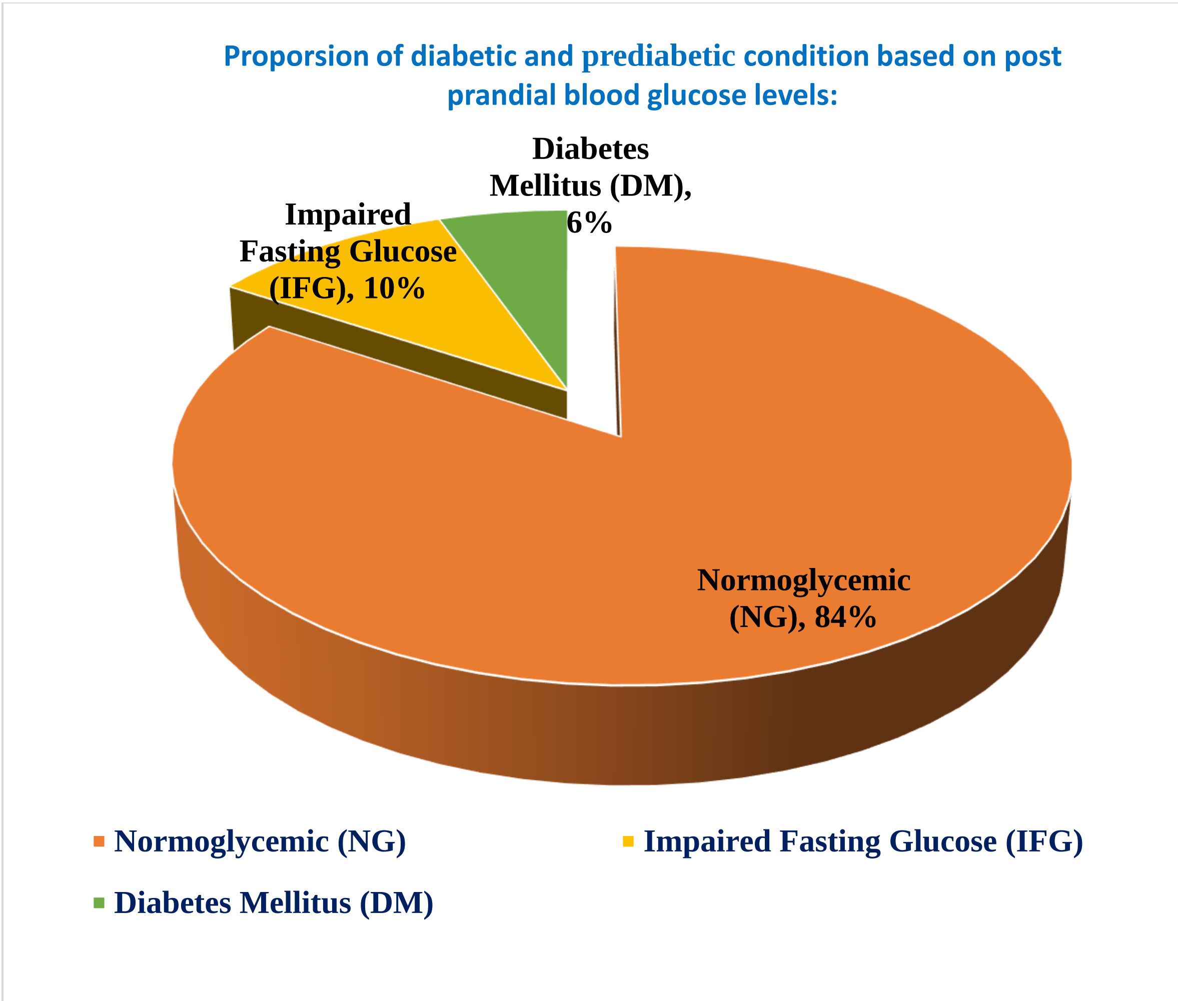


Figure 15: Proportion of Diabetic and Prediabetic Subjects based on Postprandial Blood Glucose Levels (PPG):

Figure 15 shows the proportion of diabetic and prediabetic condition according to post prandial blood glucose among the study subjects. Here we see 6% of the respondents have the condition of diabetic and 10% have prediabetic (Impaired fasting glucose level) and rest (84%) are non-diabetic subjects.

Table 8: Based on fasting blood glucose (FBG) and post prandial blood glucose (PPG) Distribution of Diabetic and Prediabetic Groups among Males and Females:

Variables		**Sex of the respondents**		**Total**	**χ2**	**P Value**
		Male N (%)	**Female N (%)**			
FBG	Normoglycemic (NG)	90 (86.4)	151(82.1)	241 (83.6)		
	Impaired Fasting Glucose (IFG)	10 (9.7)	19 (9.8)	29 (9.8)		
	Diabetes Mellitus (DM)	4 (3.9)	15 (8.2)	19 (6.6)	1.967	0.187
	Total	4 (3.9)	185 (100)	289 (100)		
	Normoglycemic (NG)	78 (83.0)	109 (85.2)	187 (84.2)		
	Impaired Fasting Glucose (IFG)	11 (11.7)	12 (9.4)	23 (10.4)		
	Diabetes Mellitus (DM)	5 (5.3)	7 (5.5)	12 (5.4)	0.316	0.427
	Total	94 (100)	128 (100)	222 (100)		

Results were expressed as number (%), χ2experiment was conducted and p<0.05 was level of significance

Table 8 shows the Distribution of diabetic and prediabetic among male and female. Here No significant statistical difference was observed between males and females. But, this table shows based on fasting women were comparatively more diabetic (8.2%) and prediabetic (9.8) than men (3.9%), (9.7). Whereas based on PPG male , female almost similar.

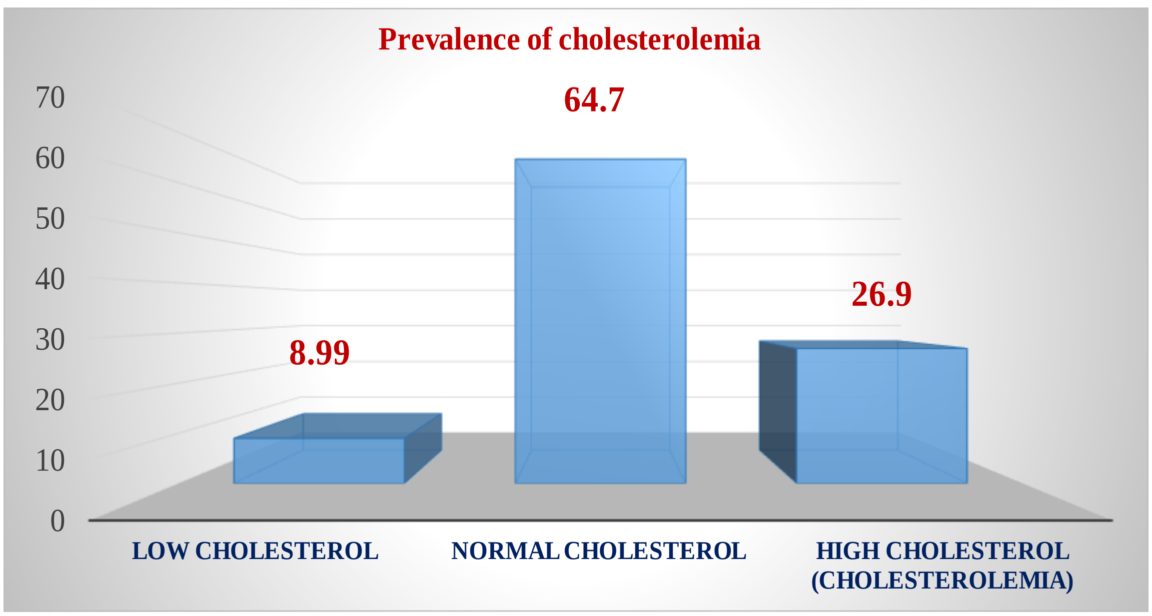


Figure 16: Distribution of the respondents by their total cholesterol level:

Figure 16 shows the prevalence of cholesterolemia; regarding serum cholesterol level, 26.9% of the subjects were found to present with hypercholesterolemia (which is a major risk factor of increasing hypertensive CVD) and 8.99% had low cholesterol as per AHA Criteria

Table 9: Sex distribution of the respondents by their total cholesterol level:

Variables		Sex of the respondents		Total	χ2	P Value
		Male N (%)	Female N (%)			
Total Cholesterol	Low cholesterol	13 (12.5)	13 (7.0)	26	3.063	0.108
	Normal cholesterol	63 (60.5)	124 (67.0)	187		
	High cholesterol (cholesterolemia)	28 (27.0)	48 (26.7)	76		
	Total	104	185	289		

Results were expressed as number (%), χ2experiment was conducted and $p<0.05$ was level of significance

Table 9 shows the Sex Distribution of the respondents by their total cholesterol level. In this table we found that, no significant difference was observed between males and females. High cholesterol level was similar among males and females, but low cholesterol level was higher in male compare to female.

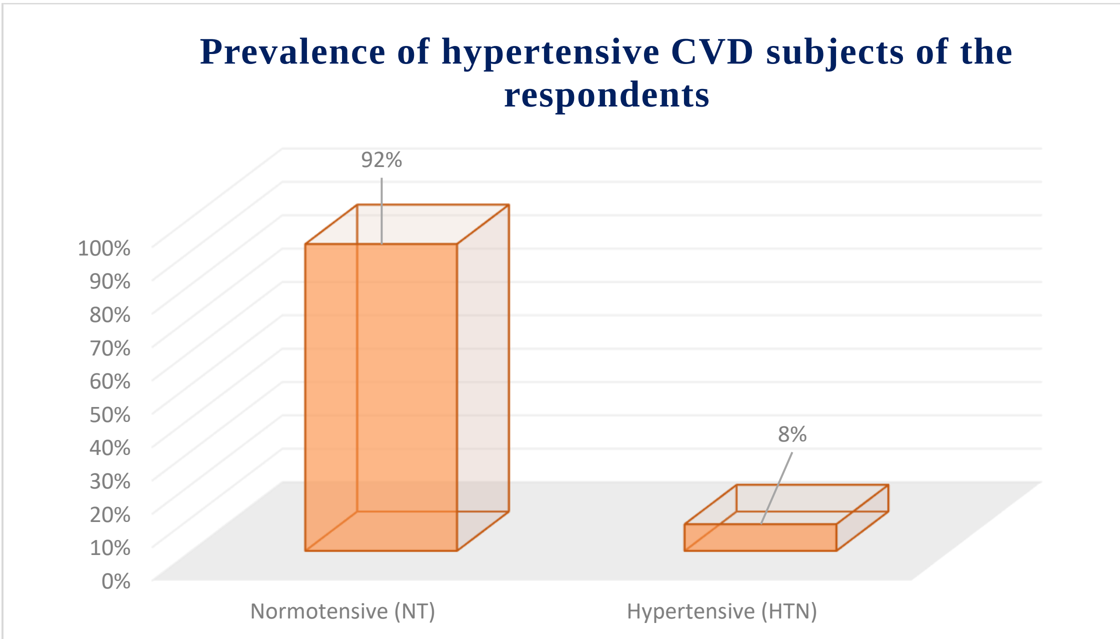


Figure 17: Prevalence of hypertensive CVD among the study subjects:

Figure 17 shows the prevalence of hypertension among the study subjects was 8%, which is less than half Prevalence than general population (In Bangladesh general population's prevalence is 20%)

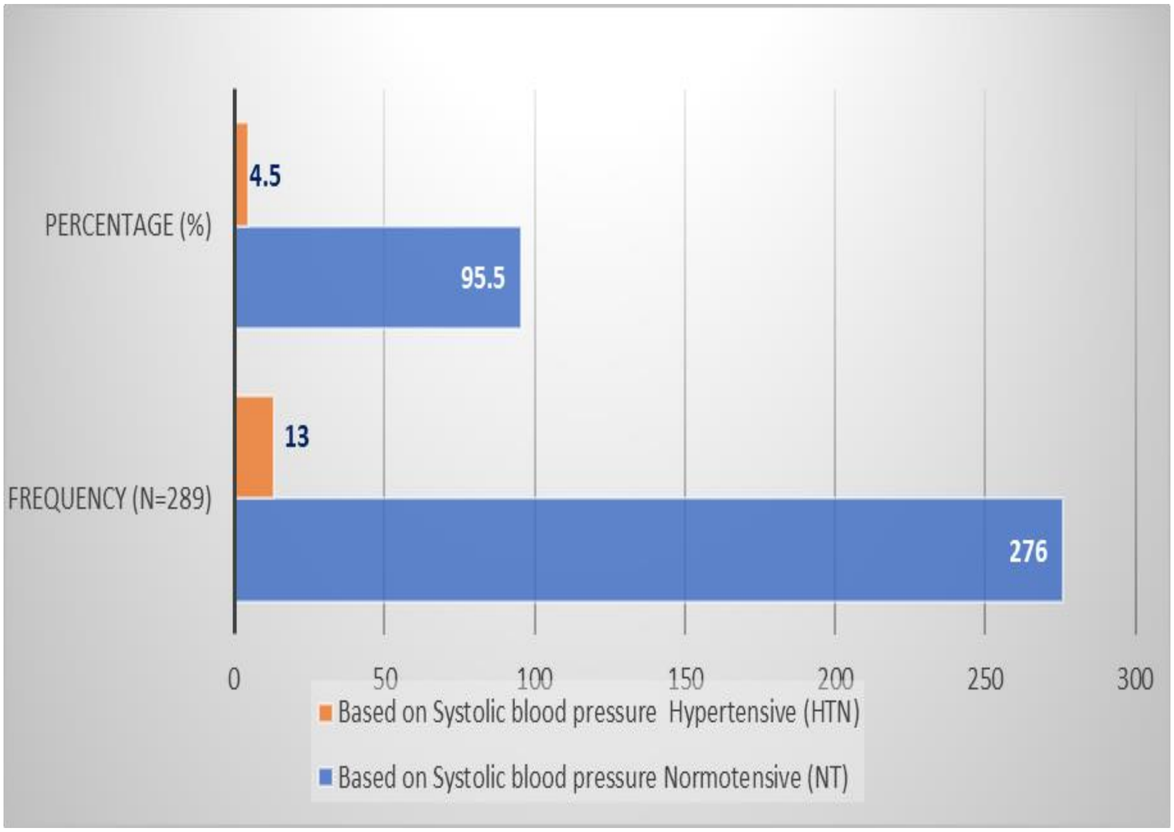


Figure 18: Distribution of blood pressure according to systolic blood pressure (SBP) among the study subjects:

Figure 18 shows the prevalence of Systolic hypertension among the study subjects. In this figure we find that 4.5%. of the respondents had systolic hypertensive CVD.

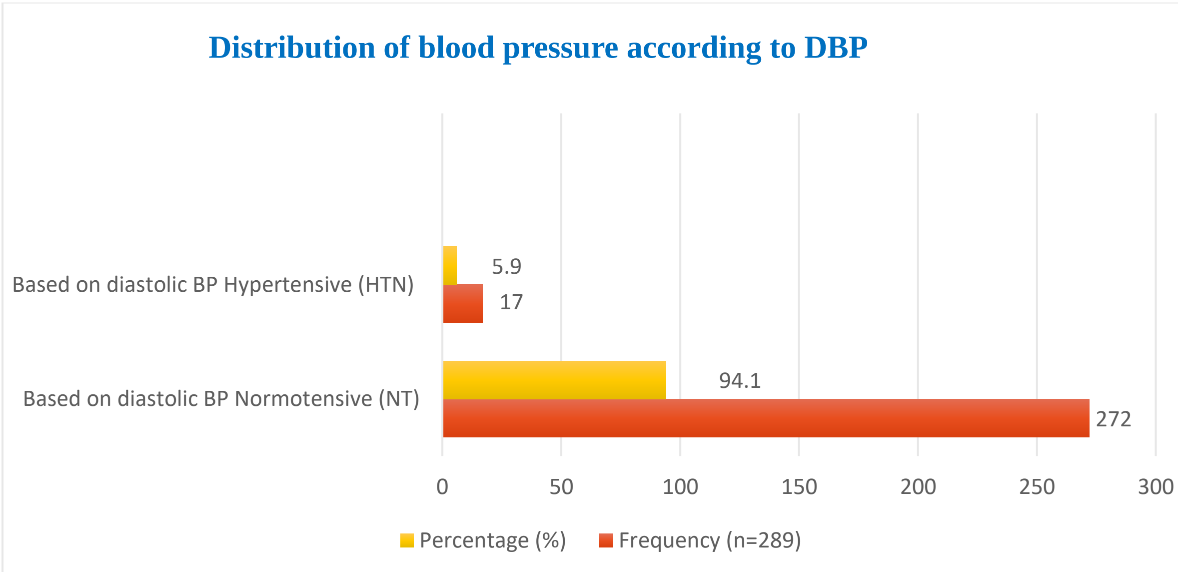


Figure 19: Distribution of blood pressure according to diastolic blood pressure (SBP) among the study the study subjects:

Figure 19 shows the prevalence of diastolic hypertension among the study subjects. The prevalence of Diastolic hypertension is 5.9%.

Table 10: Association between age category and Normotensive (NT) and Hypertensive (HTN) subjects among the respondents:

Variables (Age)	Total NT /HTN of the respondents		χ2	P Value
	Normotensive (NT%)	Hypertensive (HTN%)		
30 years and less	61(23)	1 (4.4)	**13.913**	**0.004**
31-40	73 (27.4)	2 (8.7)		
41-50	70 (26.3)	7 (30.4)		
51-60	36 (13.5)	6 (26.1)		
61-65	26 (9.8)	7 (30.4)		
Total	266 (100)	23 (100)		

Results were expressed as number (%), χ2experiment was conducted and $p<0.05$ was level of significance

Table 10 shows the association between age category and hypertension. Here hypertension is significantly associated with age group. Hypertension was gradually increases with age. In this table we can see that, in case of middle and older adult age group hypertension prevalence is higher than the younger adult group.

4.6 Section F: The associated factors of hypertensive CVD

Table11: Gender wise distribution of normotensive (NT) and hypertensive (HTN) subjects among the respondents (n=289)

Variables	Sex of the respondents			Total	$\chi2$	P Value
	Male	Female				
Normotensive (NT)	96 (92.3)	170 (91.9)		266 (92.0)	.016	.450
Hypertensive (HTN)	8 (7.7)	15 (8.1)		23 (8.0)		
Total	104 (100)	185 (100)		289 (100)		

Results were expressed as number (%), χ2experiment was conducted and p<0.05 was level of significance

Table11 shows the gender wise distribution of normotensive (NT) and hypertensive (HTN) subjects among the respondents. The results shows the proportion of hypertensive subjects were not significantly different between males (7.7%) and females (8.1%).

Table 12: Association between sex and systolic blood pressure (normotensive and hypertensive):

Variables	Sex of the respondents		Total	χ2	P Value
	Male	Female			
Systolic normotensive(NT)	99 (95.2)	**177 (95.7)**	**276 (95.5)**	0.04	0.17
Systolic Hypertensive(HNT)	5 (4.8)	**8 (4.3)**	**13 (4.5)**		
Total	104	**185 (100)**	**289 (100)**		

Results were expressed as number (%), χ2experiment was conducted and $p<0.05$ was level of significance

Table 12 shows the association between sex and systolic blood pressure (normotensive and hypertensive): The prevalence of Systolic hypertension (overall 4.8%) did not differ between males (4.8%) and females (4.3%). And there is No significant differ.

Table 13: Association between diastolic normotensive and hypertensive blood pressure according to Sex:

Variables	Sex of the respondents		Total	$\chi 2$	P Value
	Male	Female			
Diastolic Normotensive (NT)	99 (95.2)	173 (93.5)	272 (94.1)	0.339	0.280
Diastolic Hypertensive (HTN)	5 (4.8)	12 (6.5)	17 (5.9)		
Total	104 (100)	185 (100)	289 (100)		

Results were expressed as number (%), χ2experiment was conducted and p<0.05 was level of significance

Table 13 shows the association between diastolic normotensive and hypertensive blood pressure according to sex. In case of diastolic hypertension, female respondent (5.9%) were a little more hypertensive as compared to males (4.8%).

Table 14: Association between smoking and blood pressure among the study subjects:

Variables	Smoking History of the respondents N (%)		Total	χ^2	P Value
	Yes	No			
Normotensive (NT)	49 (94.2)	217 (91.6)	266 (92.0)	0.415	0.377
Hypertensive (HTN)	3 (5.8)	20 (8.4)	23 (8.0)		
Total	52 (100)	237 (100)	289 (100)		

Results were expressed as number (%), χ2experiment was conducted and p<0.05 was level of significance

Table 14 shows the association between smoking and blood pressure among the study subjects. Results shows no association between smoking and blood pressure.

Table 15: Relation of drinking alcohol and blood pressure of the study subjects:

Variables	History of drinking alcohol the respondents N (%)		Total	χ2	P Value
	Yes	No			
Normotensive (NT)	67 (93.1)	199 (91.7)	266 (92.0)	.135	.468
Hypertensive (HTN)	5 (6.9)	18 (8.3)	23(8.0)		
Total	72 (100)	217 (100)	289 (100)		

Results were expressed as number (%), χ2experiment was conducted and

p<0.05 was level of significance

Table 15 shows the association between drinking alcohol of the respondents and blood pressure. Here hypertension did not show any relation with drinking alcohol.

Table 16: Systolic normotensive and hypertensive blood pressure according to nutritional status (BMI):

Variables	Systolic (NT) *Number (%)*	Systolic (HTN) *Number (%)*	Total *Number (%)*	χ2	P value
Underweight	42 (15.2)	1 (7.7)	43 (14.9)	1.863	0.301
Normal weight	95 (34.4)	5 (38.5)	100 (34.6)		
Overweight	**91 (33.0)**	6 (46.2)	97 (33.6)		
Obese	48 (17.4)	1 (7.7)	49 (17.0)		
Total	276 (100)	13 (100)	289 (100)		

Results were expressed as number (%), χ2experiment was conducted and $p<0.05$ was level of significance

Table 16 shows the systolic normotensive and hypertensive blood pressure according to nutritional status (BMI). In case of Systolic hypertension and nutritional status there is no significant difference. Here 46.2% respondents who were over weighted and they have also Systolic hypertension. 7.7% who are obese also have systolic hypertension.

Table 17: Diastolic normotensive and hypertensive blood pressure according to nutritional status (BMI):

Variables	Diastolic (NT) *Number (%)*	Diastolic (HTN) *Number (%)*	Total *Number (%)*	χ2	P value
Underweight	42 (15.4)	1(5.9)	43 (14.9)	2.096	0.28
Normal weight	92 (33.8)	8 (47.1)	100 (34.6)		
Overweight	91 (33.5)	6 (35.3)	97 (33.6)		
Obese	47 (17.3)	2 (11.8)	49 (17.0)		
Total	272 (100)	17 (100)	289 (100)		

Results were expressed as number (%), χ2experiment was conducted and

p<0.05 was level of significance

Table 17 shows the diastolic normotensive and hypertensive blood pressure according to nutritional status (BMI). 35.3% over weighted and 11.8% obese respondents have diastolic HTN. No significant difference between diastolic hypertension and nutritional status.

Table 18: Correlation between blood pressure (systolic and diastolic) and anthropometric, biochemical and dietary factors:

Variables	**Systolic Blood Pressure (SBP)**		**Diastolic Blood pressure (DBP)**	
	Correlation coefficient (r)	**P-value**	**Correlation coefficient (r)**	**P-value**
Anthropometric				
BMI	0.070	0.236	0.091	0.121
WHR	0.240**	**0.000**	0.269**	**0.000**
Age	0.217**	**0.000**	0.190**	**0.001**
Biochemical				
FBG	0.113	0.054	.130*	.027
PPG	0.193* *	**0.004**	.199**	**.003**
Blood Total Cholesterol	0.140*	**0.017**	.219**	**.000**
Dietary Factors				
Total calories	0.024	0.680	0.012	0.836
Total salt	-0.012	0.840	-0.042	0.477

Correlation is significant at the 0.01 level (2-tailed).

Correlation is significant at the 0.05 level (2-tailed).

P value obtained from Pearson correlation test

Table 18 shows the correlation between blood pressure and anthropometric, biochemical, and dietary factors. Here The Systolic BP had a positive correlation with age, WHR, PPG and blood total cholesterol levels. On the other hand, Diastolic BP showed a positive correlation with age, WHR, fasting, blood glucose, PPG, and blood total cholesterol.

Table19: Associated factors of hypertension by binary logistic regression:

Dependent Variable	Independent Variables/covariates	β	p-value	Odds ratio/Exp (β)	95% CI for EXP c(β)	
					Lower	Upper
Hypertension	**Age**	0.086	**<0.001**	1.090	1.046	1.134
	Sex	0.417	0.471	1.518	0.488	4.259
	BMI	-0.057	0.389	0.945	0.831	1.046
	WHR	0.045	0.116	1.046	0.989	1.135
	FBG	0.424	0.152	1.528	0.855	2.525
	PPG	-0.093	0.604	0.912	0.643	1.346
	Total Cholesterol	0.009	0.202	1.009	0.995	1.026
	Total Calorie	0.001	0.215	1.001	1.000	1.001
	Salt Intake	0.204	0.115	1.226	0.952	1.507

*P<0.10; ** p<0.05; *** p<0.01

OR=1 indicates no effects of the events., OR >1 indicates increased occurrence of events

OR< 1 indicates decreased occurrence of events, CI & P value for statistical significance of the value

Table 19 shows the associated factors of hypertension by binary logistic regression. On logistic regression analysis showed hypertensive CVD was only significantly associated with age.

Table 20: Associated factors of hypertension by binary logistic regression according to systolic blood pressure:

Dependent Variable	Independents Variables	**β**	P-value	**Odds ratio/Exp(β)**	**95% CI for EXP (β)**	
					Lower	Upper
Systolic Blood Pressure (SBP)	Age	0.105	<0.001	1.111	1.050	1.176
	Sex	0.386	0.597	1.471	0.352	6.150
	BMI	-0.086	0.344	0.921	0.775	1.093
	WHR	0.061	0.115	1.063	.985	1.147
	FBG	-0.114	0.750	0.892	.443	1.797
	PPG	0.192	0.347	1.212	.812	1.810
	Total Cholesterol	0.000	0.990	1.000	.980	1.020
	Total Calorie	0.001	0.042	1.001	1.000	1.002
	Salt Intake	0.131	0.417	1.140	.831	1.563

OR=1 indicates no effects of the events., OR >1 indicates increased occurrence of events

OR< 1 indicates decreased occurrence of events, CI & P value (p=<0.001 or <0.005) for statistical significance of the value

Table 20 shows the associated factors of hypertension by binary logistic regression according to systolic blood pressure. Here we found the results that, SBP was significantly associated with age and total calorie intake.

Table 21: Associated factors of hypertension by binary logistic regression according to diastolic blood pressure

Dependent Variable	Independents Variables	β	P-value	Odds ratio/Exp(β)	95% CI for EXP (β)	
					Lower	Upper
Diastolic Blood Pressure (DBP)	Age	0.079	**<0.001**	1.082	1.033	1.133
	Sex	0.541	0.426	1.718	0.453	6.516
	BMI	-0.081	0.314	0.923	0.788	1.079
	WHR	0.057	0.096	1.059	0.990	1.133
	FBG	0.918	**0.013**	2.504	1.212	5.172
	PPG	-0.431	0.059	0.650	0.416	1.016
	Total Cholesterol	0.011	0.144	1.011	0.996	1.026
	Total Calorie	0.000	0.794	1.000	0.999	1.001
	Salt Intake	0.284	0.060	1.328	0.988	1.785

Table 21 shows the associated factors of hypertension by binary logistic regression according to diastolic blood pressure. Here we found the results that DBP was significantly associated with age and fasting blood glucose.

CHAPTER 5

DISCUSSION

5. DISCUSSIONS

One of the most crucial risks for early cardiovascular disease (CVD) and death is hypertension, which is a serious chronic condition in and of itself. This cross-sectional study in a rural Garo community of Bangladesh aimed to determine the prevalence of hypertensive CVD and its risk variables. Although there are many CVD-related studies undertaken among the general population in Bangladesh and other countries, the endogenous community is rarely the subject of these studies. In Bangladesh we did not find any CVD related study among Garo populations.

Our study subjects were 289 where females respondents were [185(64%)] more than the males [104 (36%)] respondents [Figure 1]. In our country there is no similar study reported but, there have been a similar study upon a group of Kuna people who are native to Panama's San Blas islands. Their study populations were 211 where females respondents [154(73%)] were also more than the male respondents [57(27%)] (*Hanna, 2019*).

The mean age of the respondents was 43.24 ± 14.34 where 21.5%, 26.0%, 26.6%, 14.5%, 11.4% of the respondents were 30 years and less, 31 to 40, 41 to 50, 51 to 60, and 61 to 65 years old, respectively [table-1]. Similar study among general population showed the mean age of the respondents as 53.9±11.6 years (*Zaman, 2020*). In a systematic meta-analysis, the age of the respondents had various ranges, with 35 years being reported by the most (13) studies, the second-highest number (11) of studies over 25 years, and 18 years via the third-most studies (8) (*Chowdhury, 2020*)

The scenarios of the family members in the present study showed the highest proportion (39.1%) have 5-6 family members, 38.4% have the family members of 3-4 persons, 7.6 % have the family members of 1-2 persons, and 14.9% were more than 6 family members [table-2]. But, a study among Garos conducted by Bappy (2017) showed that, mostly the Garo people have families with 4 - 5 members. Bappy showed most of the Garo people have an average family size but many of them also tend to have large families *(Bappy, 2017*).

The majority (84%) of the subjects of our study are Christians, 14% are Hindus and rest are Buddhists [Figure 2]. According to national Encyclopedia of Bangladesh, the majority of Garos currently identify themselves as Christians. As Christian missionaries visited their settlements around the end of the 19th century, they began to accept Christianity. With the aid of the missionaries, the Garo community's members had accomplished an impressive achievement in raising their literacy rate. Currently, there are primary schools in every Garo hamlet, and the literacy rate can reach 80%. (*Banglapedia, 2021*). But, in our study, if we see to the education level of the respondents the illiteracy rate was slightly higher (23.5%) as compared to previous study, and the rest are educated from primary up to postgraduate level. Of them, 29.1% have completed their primary education, 32.2% up to SSC, 10% up to HSC and rest 4.2% were Graduate and 1% were post graduate [Figure 4].

Another study among Garos in Bangladesh showed that almost half of the respondents were uneducated (49% respondents) only a few people are graduated which is about only 7%, 18% up to HSC, 26.4% Up to SSC level education. In our study most of the respondents (88.9%) were Married. 9% respondents were unmarried and 2.1% were widowed. (*Akhter et al, 2020*)

Considering their living style, the monthly income of Garo people may be assumed. Bappy (2017) conducted a study among Garos and he found that the Garo people are on the edge of the level higher of the poverty line. Maximum Garo families generally earn around 10,000 to 15,000 tk each month, which shows that maintaining a home, there is not particularly difficult for them, especially for small families. The majority of Garo households in the studied areas were in poor to medium economic state. As compared to other locations, these percentages were high at Modhutila and Dudhnai, respectively, 100% and 62.50%. All Garo households in Modhutila have poor economic conditions, it should be highlighted (*Bappy, 2017*). In my study, the economic status of the respondents revealed that the majority of them were from lower-middle classes (61.93%), 24.21% were low-income group, 13.51% were upper middle classes, and only 0.35% were upper income group respondent. We categorized their income level according to World Bank's reference ranges (*Hossain, 2012*). Another study in Bangladesh among Garo population showed thus the income of someone making more over 20,000 BDT is only about 34%, while the income of someone making less than 20,000 BDT is 35%. Also, the employment rate is 31%, and the unemployed are primarily women who worked in fields when they were younger but are now unemployed because they are older (*Akhter et al, 2020*).

In case of occupation of our study showed 28% of the respondents were housewives, 13% were farmers, 22% of them were private service holders, 1% Govt service holders, 4%-day laborers, 11% businessman and 13% others. In the study of Akhter et al (2020) almost 12% of the younger members work in a variety of professions, including education, business, private, government, or NGO work, nursing, etc. Now, their viewpoints are evolving. They are adjusting to civil life and are making an effort to uphold our original customs and cultures. Also, they want to improve their socioeconomic situation and bring about their prosperity (*Akhter et al, 2020*).

Another study showed that the Garo community depended on its agricultural sector of income. At many salons across the country, a large number of ethnic Garo women operate. Shopkeeping and manual labor are also carried out by women. Security guards, mechanics, and business are the main occupations of Garo males. They mainly work as shopkeeper, farmer, parlor owner, government employee, laborer, security guard, nurse, and company owner. (*Bappy, 2017*).

The mean weight was 57.08± 12.16, height 156.80 ± 9. 60, BMI 23.39±5.74 and mean waist-hip ratio was 0.81 ± 0.13 [table 3]. The nutritional status of the respondents in our study were 14.9% underweight, 34.6% normal weight, 33.6% overweight and 17% were obese. Of them, about 34.6% of the male subjects were within the normal ranges of nutritional status (as assessed by BMI), 37.5% were overweight, 15.4% were underweight and 12.5% were obese. The corresponding percentage in females were 34.6, 31.4, 14.6, and 19.5 respectively and there was no significant difference between males and females. Data from a national survey (2017) in Bangladesh among general populations showed the similar mean (± SD) age 54.9±12.9 years but, in case of nutritional status, 18.9% of people were overweight, 4.6% were obese, and 30.4% were underweight. In case of the prevalence of underweight 29.1% were male and 36.0% were female adults. There is a report that in case of overweight 17.4% were males and 18.4% were females and obesity was 3.0% and 6.0%, respectively (*Biswas, 2017*). However, Haque et al. conducted a study among indigenous peoples in 2014 where he reported that 15% were obese, 22% were overweight, and 46% were normal weight. (*Haque. 2014*). Actually, the participants in our study included Garo population living on a plain land, whether the study by Haque et al. was carried out in mountainous terrain. (*Haque et al, 2014*). Our study findings showed nutritional status was significantly associated with occupation ($\chi2=0.44$, p-value =0.001). On correlation analysis, nutritional status showed a significant association with age ($p=0.05$).

On the other hand, a study among Garos in Bangladesh showed that age, education level, and occupation all had a significant impact on nutritional status ($p<0.05$). A connection between malnutrition and monthly household income is revealed using a multivariate analysis (*Haque, 2015*). Our study did not show any relation between nutritional status and dietary calorie intakes.

In line with the usual dietary habits in Bangladesh, rice is a common food among the Garo people. They consume it with lentils, veggies, and fish and meat curries. Their favorite food is dried fish. The puti type of dried fish are among the most delectable foods that can be located in the Bhati area in places like Bhairab, Faridpur, Gopalganj, and Kishoreganj. They are accustomed to using a lot of green chiles when making curries. Vegetables like karola, chichinga, pumpkin, jheenga, bottle-ground, cucurbitaceous, sweat-groundand kidney beans are among the vegetables that Garos enjoy eating. they previously used soda water when cooking. However, since most of their recipes and tastes have evolved, several Garo households now cook with soda water. Garos have developed eating and cooking habits similar to those of their Bangali neighbors. In addition to their preferred nakham veggies, they also enjoy fried, mashed, and pulsed vegetables as well as fish and pork. They still enjoy eating pig, turtle meat, eel, and rich meals like hotchpotch, polao, and biriani, as well as vegetables like bamboo shoots and mushrooms. (*Banglapedia, 2021*).

It is evident that the former food habit of the Garo people has undergone a significant change and at present they mostly follow the food habit of local Bengali people along with their own traditional food habit (*Kabir, 2022*)

In our study we could not collected all types of foods specific history for the limited time periods in the corona pandemic situation. We have only collected 24 hours and 7 days dietary history. And our study findings shows that the mean calorie intake among all the subjects is 1854 kcal and carbohydrates are the dominant (mean percentage 73.6) source followed by fat (16.7) and protein (only 10.7) [table 5] where The calorie intake scenario is slightly better in case of females (with underconsumption proportion at 40%, optimum proportion at 48% and over consumption scenario is 12%) than males (only 32% of the males consume optimum calorie, 59% suffer from underconsumption and 9% suffer from overconsumption) . This study results (figure 11) portrays the contrast of the mean days of different food consumption in last seven days. Cereals, oil and fats was consumed almost every day in last seven days. Mean meat and poultry, pulse, dairy and fruits consumption are 4.6, 3.28, 2.21 and 2.94 days respectively. Green leafy vegetables, roots and tubers and cereals a decreasing (3.71, 3.32 and 3.28 days respectively) trend was observed in the mean days over the increment of empowerment status. In Bangladesh another study showed that 88% of the respondents said they didn't eat enough fruits and vegetables (*Hanif, 2021*). The total salt intake by the study subjects. The mean intake of salt among Garos is 6.81 g/day with the standard deviation of 2.30 which is almost similar to the intake of mainstream population. But WHO recommends that adults consume less than 5g/day (just under a teaspoon). According to data, all of the south Asian countries' salt intake exceeds the WHO's daily recommended intake of 5g (*WHO, 2023*).

Figure 12 shows the family disease history of the respondents. Here the results show that 35.8% have the family history of hypertension, 12.10% have the family history of diabetes, 12.8% ischemic heart disease, 5.9% stroke, 1.7% hyperlipidemia and 7.6% have the family history of other diseases.

In case of addiction history, Garos in the present study are habituated with smoking (18% of the respondents), tobacco leaf chewing (7.6%), tobacco powder sniffing (6.9%) and a large number of the respondents have betel leaf chewing (40.50%) habits and 24.90% have the addiction history of drinking alcohol. A study in Bangladesh among Garos showed that the majority of Garos (57.92%) smoke tobacco habitually, including 62.50% of men and 53.14 % of women. This shows that there are more male smokers than female smokers. The younger and better educated Garos were found to smoke less frequently than the older males.

The Garo population frequently consumes home-made wine, which is manufactured by fermenting boiling rice, and that many of them have developed a habit of consuming large amounts of it. Given that drinking too much alcohol is bad for health, this is not a favorable characteristic in terms of health management techniques (*Sarker et al, 2008*). In 2022 a study was conducted by Kabir; the findings from this study showed that Garos are habituated with Spirituous liquor distilled at home which is very popular item, generally served for entertaining guests as well as during festivities. Drinking liquor as a part of refreshment was available at their home; with the passage of time, the habit of drinking at home has been changed (*Kabir, 2022*). The Garos produce their own alcoholic beverage known as "Minil Bichi" by fermenting a particular variety of rice. Country booze, in addition to other libations, is significant in the lives of the Garo. (*Garo people, 2023*)

The mean blood total cholesterol was 178.37±40.65 [table 7]. A proportion of 26.9% of the subjects were found to present with hypercholesterolemia which is a major risk factor of hypertensive CVD. A proportion of 8.99% had low cholesterol as per AHA Criteria [figure 17]. There was no significant difference between males and females. High cholesterol level was similar among males and females, but low cholesterol level was higher in male compare to female [table 9]. A nationally representative survey showed mean cholesterol level of general population was 167mg/dl (SD 26 mg/dl). The results from the survey showed for men and women were practically same (Respectively, 169 mg/dl and 166 mg/dl). In both men (2.2%) and women (0.5%), the prevalence of high cholesterol levels was extremely low (1.3%). Yet, this group had a sizable (5.8%) frequency of borderline elevated cholesterol (*Zaman, 2016*). Thus, in the present study population among Garos, the cholesterol level exceeded the mean value of the general population.

The mean fasting and 2-hr blood glucose levels (mmol/l) were 5.12±2.20 and 6.63±2.94 respectively [table 7]. The prevalence of diabetes was found to be 5.2% and that of IGT was 8.7% among all the subjects; normoglycemic proportion was 86.1% [figure 14]. Based on FBG levels, the proportion of diabetic subjects were 7% and prediabetic were 10% [figure 15] and based on PPG, 6% of the respondents have the condition of diabetes and 10% have prediabetes [figure 16]. In comparison with the prevalence in the mainstream population of diabetes mellitus (7.8%) and prediabetes (10.1%) our study finding is slightly lower (*Akhter et al, 2020*). In our study among the rural Garos , no significant statistical difference was observed between males and females [table 8]. However, analysis based on fasting blood glucose levels showed that women are comparatively more diabetic (8.2%) and prediabetic (9.8) than men (3.9%), (9.7). Based on PPG, the proportions of males and females are almost similar [table 8]. The results of the univariable meta-regression analysis conducted by Akhter (2020) also found no statistically significant gender difference among mainstream population. Akhter's study demonstrated a relationship between the characteristics of study year, patient age, and presence of hypertension with the prevalence of diabetes. While there was, the incidence of diabetes was much greater in city/town than in village areas (*Akhter et al, 2020*)

According to the IDF Diabetes Atlas 2022, indigenous communities are also disproportionately affected by diabetes. Reports showed that approximately 476 million indigenous people in 90 countries and more than 5,000 different tribes worldwide, indigenous people make up 6.2% of the global populace. Diabetes mallitus among indigenous populations was summarized in that report. In 70% of the studies that were analyzed, the prevalence of type 2 diabetes in adult populations that were indigenous was greater than 10%. (*IDF Diabetes Atlas 2022*)

Several studies revealed that, relative to the endogenous community, the general public has a higher prevalence of hypertension. In our study we evaluated the occurrence of hypertensive CVD and the risk factors related with it in the rural Garo population. It has been found that the prevalence of hypertension is lower compared with other studies conducted among general population. The present data show that the proportion of study participants with hypertension is 8% [figure 18]; 4.5% of the respondents have systolic hypertensive cvd [figure 19] and the prevalence of diastolic hypertension is 5.9% [figure 20]. Mean Systolic BP is 118.06±15.47 and Mean Diastolic BP is 79.06±10 [table 7]. If we compare with hypertension prevalence of the general population in Bangladesh, our findings among the Garos show less than fifty percent of prevalence than that of general population. Results from a study in Bangladesh, the prevalence among general population is 20% (*Chowdhury, 2020*) which is remarkably comparable to the 22% global prevalence of hypertension among individuals aged 18 and older that was recorded in 2015 (*NCD Risk Factor Collaboration, 2017*).

According to a study, high blood pressure is 3–8 times more common in isolated rural villages than in urban areas (*Hoy et al, 2007*). Another similar study was conducted among indigenous Kuna population of Panama. The study findings showed that their total prevalence of hypertension (6.2%) was a little lower than that of our study populations, and that hypertension was much more common in men (31.6%) than in women (11%) in both the groups (*Hanna, 2019*). Results from the present study show that the proportion of people with hypertension are not different among males (7.7%) and females (8.1%) [Table:11]. The prevalence of systolic hypertension (overall 4.8%) did not differ between women (4.3%) and men (4.8%) [table 12]; but, in case of diastolic hypertension, female respondent (5.9%) was little more hypertensive as compared to males (4.8%) [table 13].

Similar studies among general population in Bangladesh showed that, compared to men (17%), women (21%) had a greater prevalence of hypertension (*Chowdhury, 2020*).

Several study results showed similar findings about the prevalence of hypertension. There are regional differences in the prevalence of hypertension, with the African region having the greatest frequency (27%) and the American region having the lowest (18%). In 2015, WHO estimated that the incidence of adult-onset hypertension was 24%, 25%, 26%, 24%, respectively, in the close-by nations of Sri Lanka, Nepal, Pakistan, and India. Similar to general population in Bangladesh, these nations with poor and moderate incomes also found hypertension becoming more prevalent (WHO, 2014). For instance, in Arab nations, women were observed to have a higher frequency of hypertension than men (*Chowdhury, 2020*). The frequency of hypertension in nearby South Asian nations does not differ much between men and women (*WHO, 2014*).

Several studies revealed that blood pressure briefly rises due to continuous smoking. Frequent smoking activates the sympathetic nervous system, which immediately raises blood pressure (SNS). Smoke also raises the chance of fatty substance accumulation (plaque) in the arteries (atherosclerosis), which is a process that it is well known that elevated blood pressure accelerates (*AHA, 2023*). In another study it was found that, there is a positive association between smoking quantity and hypertension (*Feng et al, 2013*). But, in our study among Garo indigenous, there is no association between smoking and blood pressure [table 14]. It may due to the period or quantity of smoking. Further research is required to clarify the issue. We also found that hypertension has no relation with drinking alcohol [table 15].

In case of systolic hypertension and nutritional status there is no significant difference. Here 46.2% respondents who were overweight and they have also systolic hypertension [table 16]. 35.3% over weight and 11.8% obese respondents have diastolic HTN. No significant difference between diastolic hypertension and nutritional status was found [table17].

A study showed that, there may be a variety of causes behind the rising prevalence of hypertension in Bangladeshi adults. In addition to the typical causes of hypertension, such as excessive salt intake, obesity, excessive alcohol use, inactivity, stress, and smoking, Additional variables, like a regional shift in disease patterns from infectious to non-communicable diseases, fast urbanization, and an obsession with adopting western lifestyles, may also have an impact on the prevalence of high blood pressure. Urban and rural lifestyles, environments, and food habits differ significantly in emerging nations like Bangladesh. (*Chowdhury et al, 2020*)

In the present study, the relationship between the anthropometric, biochemical, and nutritional variables and blood pressure demonstrates a positive association between age, WHR, PPG, and blood total cholesterol levels and systolic blood pressure. On the other hand, diastolic BP shows a favorable correlation with age, WHR, fasting, blood sugar, PPG, and blood total cholesterol [table 18]. A study conducted by Mathew S and others showed that hypertension has a relation with age, BMI, high intakes of calorie and blood lipids (*Mathew et al, 2013*)

On binary logistic regression analysis, our study showed [table:19] hypertensive CVD is strongly influenced by age ($p<0.001$) and hypertension gradually increases with age [table 10]. In case of systolic BP, SBP is strongly related with age and total calorie intake [table 20] and DBP is also linked with age and fasting blood glucose [table 21]. The results of systematic reviews and meta-analyses among the mainstream population of Bangladesh showed that hypertension is significantly associated with age. In case of middle and older adult age groups hypertension prevalence is higher than the younger adult groups. The weighted pooled prevalence of hypertension is lowest in the age group of 15 years (13%), and highest in the age group of 60 (53%) (*Chowdhury et al, 2020*).

A study among rural indigenous Maya municipalities in Guatemala showed that the prevalence of multiple CVD risk factors increased between the age groups 18–29 years and 50–59 years before decreasing among older age groups (*Steinbrook et al, 2022*). Another study in India showed that high calorie diets cause an increase in blood pressure. (*Mathew et al, 2013*)

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6. CONCLUSIONS

The present data lead to the following conclusions:

- Deficient calorie intake is still a major problem among the Garos contributed by low amount of dietary protein and fat.
- Along with dietary energy insufficiency, rising overweight and obesity among some subgroups is a growing concern which is leading to a dual burden of malnutrition in this community.
- CVD (with hypertension as a marker) has already started to create substantial disease problems among the Garo communities.
- Age is an associated factor contributing to the development of hypertension among the Garos.
- Overweight, hypercholesterolemia and diabetes mellitus seem to be the major factors underlying hypertension in this community which may play a significant role in the onset of hypertension as well as in the rising risk of cardiovascular morbidity and mortality.

6. RECOMMENDATIONS

- A comprehensive strategy (using evidence-based guidelines) to prevent CVDs should be designed and implemented in this population to prevent a surge of this NCD among the Garo indigenous communities.
- All the relevant stakeholders (including the public sector, NGOs, civil society and Development Partners) should be made aware of the dual burden of malnutrition (undernutrition as well as obesity) in this community which, at present is focused almost solely to undernutrition;
- Promotional efforts to prevent NCDs among the Garos should pay attention to the demographic transition (like increasing age) and other sociocultural changes in the community;
- Given the reality of insufficient intake of many vital components of food (apart from inadequate calorie intake) balanced nutrition with dietary diversity should be emphasized in any health promotional initiative to prevent CVDs and NCDs in this community.

REFERENCES

REFERENCES

Aboulhosn, J. and Child, J.S., (2006). Congenital Heart Disease for the adult cardiologist left ventricular outflow obstruction. *Circulation*, *114*, pp.2421-22.

Aboyans, V. and Causes of Death Collaborators, (2015). Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study. (2013). *The Lancet (British edition)*, *385*(9963), pp.117-71.

Adeniyi, O.V., Yogeswaran, P., Longo-Mbenza, B. and Goon, D.T., (2016). Uncontrolled hypertension and its determinants in patients with concomitant type 2 diabetes mellitus (T2DM) in rural South Africa. *PloS one*, *11*(3), p.e0150033.

Agarwal, VK., Bhalwar, R and Basannar DR (2011). Prevalence and Determinants of Hypertension in a Rural Community. *Med J Armed Forces India*, *64*(1), p. 21-25.

Agyemang, C., Bruijnzeels, M.A. and Owusu-Dabo, E., (2006). Factors associated with hypertension awareness, treatment, and control in Ghana, West Africa. *Journal of human hypertension*, *20*(1), pp.67-71.

Akhter R, Rahman M (2020) Socio-Economic changes in the Life of Garo Ethnic Community in Tangail District. *International Journal of Humanities and Social Science Invention (IJHSSI), 9* (11), pp. 42-50.

Akhter, S., Nasir, JA., Sarwar, A., Nasr, N., et al, (2020). Prevalence of diabetes and pre-diabetes in Bangladesh: a systematic review and meta-analysis. *BMJ 10*(9): e036086. Doi: 10.1136/bmjopen-2019-036086.

Akil L and Ahmed H A (2011). Relationships between Obesity and Cardiovascular Diseases in Four Southern States and Colorado. *J Health Care Poor Underserved*. *22*(4 Suppl): pp. 61–72.doi: 10.1353/hpu.2011.0166

Alam, M.B., Ahasan, H.N., Islam, M.Z., Islam, M.N., Mohammed, F.R., Zannatun, N., Mahbub, M.S., Faiz, M.A., et al (2009). Pattern of Lipid Profile and Obesity among Secretariat Employees of Bangladesh. *J MEDICINE*. *10* (SUPPLEMENT 1): 3-6

Aljefree, N., Ahmed F., (2015). Prevalence of Cardiovascular Disease and Associated Risk Factors among Adult Population in the Gulf Region: A Systematic Review. *Advances in Public Health.* Volume 2015 | Article ID 235101 | https://doi.org/10.1155/2015/235101

Ambrose, J.A. and Barua, R.S., (2004). The pathophysiology of cigarette smoking and cardiovascular disease: an update. *Journal of the American college of cardiology*, *43*(10), pp.1731-1737.

American Heart Association (2023). Smoking, High Blood Pressure and Your Health. Available at: https://www.heart.org//smoking-high-blood-pressure-and-your-health.

Amini, M., Zayeri, F., & Salehi, M. (2021). Trend analysis of cardiovascular disease mortality, incidence, and mortality-to-incidence ratio: results from global burden of disease study 2017. *BMC Public Health*, *21*(1), pp. 1-12.

Anderson, E. and Durstine, J.L., (2019). Physical activity, exercise, and chronic diseases: A brief review. *Sports Medicine and Health Science*, *1*(1), pp. 3-10.

Anjana, RM., Pradeepa, R., Deepa, M., Datta, M., Sudha, V., Unnikrishnan, R., Nath, LM., Kumar, AD., et al. (2011). The Indian Council of Medical Research–India Diabetes

(ICMR–INDIAB) Study: Methodological Details. *J Diabetes Sci Technol*. *5*(4): 906–914.

Australian Institute of Health and Welfare (AIHW), (2017). Health-adjusted life expectancy in Australia: expected years lived in full health 2011. *Life expectancy.* 2 ISSN: 2204-4108 (PDF) 2006-4508 (Print), ISBN: 978-1-76054-260-3, p.13.

Bachmann, J.M., Willis, B.L., Ayers, C.R., Khera, A. and Berry, J.D., (2012). Association between family history and coronary heart disease death across long-term follow-up in men: the Cooper Center Longitudinal Study. *Circulation*, *125*(25), pp.3092-3098.

Bahia, L.R., Araujo, D.V., Schaan, B.D., Dib, S.A., Negrato, C.A., Leão, M.P., Ramos, A.J.S., Forti, A.C., et al, (2011). The costs of type 2 diabetes mellitus outpatient care in the Brazilian public health system. *Value in health*, *14*(5), pp. 137-140.

Banglapedia. National Encyclopedia of Bangladesh, (2021). Available at:

https://en.banglapedia.org/index.php/Garo,_The

Bappy, MI., (2017). Life of Garo People in Bangladesh. Available at: https://www.slideshare.net/MohaiminulIslamBappy/life-of-garo-people-in-bangladesh-81006089

Baradaran, A., (2012). Lipoprotein (a), type 2 diabetes and nephropathy; the mystery continues. *Journal of Nephropathol*, *1*(3), p.126-129.

Barua, R.S. and Ambrose, J.A., (2013). Mechanisms of coronary thrombosis in cigarette smoke exposure. *Arterioscler Thromb Vasc Biol*, *33*(7), pp.1460-7.

Behradmanesh, S. and Nasri, P., (2012). Serum cholesterol and LDL-C in association with level of diastolic blood pressure in type 2 diabetic patients. *J Renal Inj Prev, 1*(1), p.23-26.

Benjamin, E.J., Virani, S.S., Callaway, C.W., Chamberlain, A.M., Chang, A.R., Cheng, S., Chiuve, S.E., Cushman, M., et al, (2018). Heart Disease and Stroke Statistics-2018 Update: A Report From the American Heart Association. *Circulation*, *137*(12), pp. e67-e492.

Berbecar, V. T., Ismail, G., Mircescu, G., (2021). Prevalence of hypertension and cardiovascular disease in the rural population: Results from the Romanian mobile health caravans. *J Comm Med and Pub Health Rep, 2*(7). ISSN: 2692-9899 Journal Doi: 10.38207/Jcmphr

Bhadoria, A. S., Kasar, P.K., Toppo, N.A., Bhadoria, P., Pradhan, S., and Kabirpanthi, V., (2014). Prevalence of hypertension and associated cardiovascular risk factors in Central India. *J Family Community Med*, *21*(1), p. 29-38.

Bilano, V., Gilmour, S., Moffiet, T., d'Espaignet, E.T., Stevens, G.A., Commar, A., Tuyl, F., Hudson, et al, (2015). Global trends and projections for tobacco use, 1990–2025: an analysis of smoking indicators from the WHO Comprehensive Information Systems for Tobacco Control. *The Lancet*, *385*(9972), pp.966-976.

Biswas, P., Yunus, F.M., Hossan, T. and Ahmed, S., (2019). Detection of lipoprotein (a)-cholesterol expression in Bangladeshi adults with dyslipidemia. *Int J Publ Health Sci*, *8*(3), pp.287-93.

Biswas T, Garnett S P, Pervin S, Rawal L B (2017). The prevalence of underweight, overweight and obesity in Bangladeshi adults: Data from a national survey. *PLoS One, 12*(5): e0177395. Doi: 10.1371/journal.pone.0177395.

Borgerding, M. and Klus, H., (2005). Analysis of complex mixtures–cigarette smoke. *Experimental and Toxicologic Pathology*, *57*(Suppl 1), pp.43-73.

Brown, C.D., Higgins, M., Donato, K.A., Rohde, F.C., Garrison, R., Obarzanek, E., Ernst, N.D., et al (2000). Body mass index and the prevalence of hypertension and dyslipidemia. *Obesity research*, *8*(9), pp.605-619.

Bucholz, E.M., Rodday, A.M., Kolor, K., Khoury, M.J. and de Ferranti, S.D., (2018). Prevalence and predictors of cholesterol screening, awareness, and statin treatment among US adults with familial hypercholesterolemia or other forms of severe dyslipidemia (1999–2014). *Circulation*, *137*(21), pp.2218-2230.

Bundy, J.D. and He, J., (2016). Hypertension and related cardiovascular disease burden in China. *Annals of global health*, *82*(2), pp.227-233.

Burns, D.M., (1991). Cigarettes and cigarette smoking. *Clinics in chest medicine*, *12*(4), pp.631-642.

Cefalu, W.T. and Cannon, C.P., (2007). Atlas of cardiometabolic risk. eBook Published: 8 April 2013, *CRC Press,* Doi: https://doi.org/10.3109/9781420026481.

Centers for Disease Control and Prevention (US), (2010). How tobacco smoke causes disease: the biology and behavioral basis for smoking-attributable disease: a report of the Surgeon General. Atlanta (GA*). National Library of Medicine*, ISBN-13: 978-0-16-084078-4. Available at: https://www.ncbi.nlm.nih.gov/books/NBK53017/

Centers for Disease Control and Prevention. (2022). Overweight and obesity. Available at: https://www.cdc.gov/obesity/index.html

Centre for disease Control and Prevention, (2020). Current Cigarette Smoking among Adults in The United States. Fact sheet. Available at: https://www.cdc.gov/tobacco/data_statistics/fact_sheets/adult_data/cig_smoking/index.htm

Center for Disease Control and Prevention (2023). Diabetes Tests. *CDC 24/7*, Available at: https://www.cdc.gov/diabetes/basics/getting-tested.html

Chacko, M., Sarma, P.S., Harikrishnan, S., Zachariah, G. and Jeemon, P., (2020). Family history of cardiovascular disease and risk of premature coronary heart disease: A matched case-control study. *Journal of* Welcome *Open Research*, *5*: 70. PMC7256470, Doi: 10.12688/wellcomeopenres.15829.

Chapin, J.C. and Hajjar, K.A., (2015). Fibrinolysis and the control of blood coagulation. *Blood reviews*, *29*(1), pp.17-24.

Chen, Y., Freedman, N. D., Albert, P. S., Huxley, R. R., Shiels, M. S., Withrow, D. R., ... & de González, A. B. (2019). Association of cardiovascular disease with premature mortality in the United States. *JAMA cardiology*, *4*(12), pp.1230-1238.

Chernysh, I. N., Nagaswami, C., Kosolapova, S., Peshkova, A. D., Cuker, A., Cines, D. B., ... & Weisel, J. W. (2020). The distinctive structure and composition of arterial and venous thrombi and pulmonary emboli. *Scientific reports*, *10*(1), pp. 1-12.

Cheung, E.Y., de Willige, S.U., Vos, H.L., Leebeek, F.W., Dippel, D.W., Bertina, R.M. and de Maat, M.P., (2008). Fibrinogen γ′ in ischemic stroke: a case-control study. *Stroke*, *39*(3), pp.1033-1035.

Cho, N.H., Shaw, J.E., Karuranga, S., Huang, Y., da Rocha Fernandes, J.D., Ohlrogge, A.W. and Malanda, B., (2018). IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Research and Clinical Practice*, *138*, pp.271-281.

Chowdhury M Z, Rahman M, Akhter T, et al (2020). Hypertension prevalence and its trend in Bangladesh: evidence from a systematic review and meta-analysis. *Clinical Hypertension, 26*, (10), Doi: 10.1186/s40885-020-00143-1

Chowdhury, M. Z., Haque, MA., Farhana, Z., Anik, AM., Chowdhury, AH., Haque, SM., Marjana, LLW., Bristi, PD., et al, (2018). Prevalence of cardiovascular disease among Bangladeshi adult population: a systematic review and meta-analysis of the studies. *Vasc Health Risk Manage*, *14*: 165-181.

Chowdhury, MAH., Rabiul, HM., (2013-22). Geriatric Health Problems of the Elderly Garo People in Madhupur Upazila of Tangail District. *Dhaka University Institutional Repository (Faculty of Social Sciences).* URI: http://localhost:8080/xmlui/handle/123456789/1440

Coccia, M. (2021). Evolution of technology in replacement of heart valves: Transcatheter aortic valves, a revolution for management of valvular heart diseases. *Health Policy and Technology*, *10*(4):100512, Doi: 10.1016/j.hlpt.2021.100512

Dal Canto, E., Ceriello, A., Rydén, L., Ferrini, M., Hansen, T.B., Schnell, O., Standl, E. and Beulens, J.W., (2019). Diabetes as a cardiovascular risk factor: an overview of global trends of macro and micro vascular complications. *European journal of preventive cardiology*, *26*(2_suppl), pp.25-32.

Danaraj, T.J., Acker, M.S., Danaraj, W., Ong, W.H. and Yam, T.B., (1959). Ethnic group differences in coronary heart disease in Singapore: an analysis of necropsy records. *American heart journal*, *58*(4), pp.516-526.

Danesh, J., Lewington, S., Thompson, S.G., Lowe, G.D., Collins, R., Kostis, J.B., Wilson, A.C., Folsom, et al, (2005). Fibrinogen Studies Collaboration: Plasma fibrinogen level and the risk of major cardiovascular diseases and nonvascular mortality: an individual participant meta-analysis. *JAMA*, *294*(14), pp.1799-1809.

Daniel R. Hanna, Rebekah J. Walker, Brittany L. et al. (2019). Prevalence and correlates of diagnosed and undiagnosed hypertension in the indigenous Kuna population of Panamá. *BMC Public Health*, *19,* (843).

Dardano, A., Penno, G., Del Prato, S. and Miccoli, R., (2014). Optimal therapy of type 2 diabetes: a controversial challenge. *Aging (Albany NY)*, *6*(3), p.187.

Das, H. and Banik, S., (2019). Prevalence of dyslipidemia among the diabetic patients in southern Bangladesh: A cross-sectional study. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, *13*(1), pp.252-257.

De Hert, M., Detraux, J., & Vancampfort, D. (2018). The intriguing relationship between coronary heart disease and mental disorders. *Journal of Dialogues Clin Neurosci*. *20*(1), pp. 31–40.

Dennison RA, Feldman, A.L., Usher-Smith, J.A., & Griffin, S.J., (2018). The association between psychosocial factors and change in lifestyle behaviour following lifestyle advice and information about cardiovascular disease risk. *BMC Public Health*, *18*(Article no 731).

Department of Health and Human Services, U.S., (1996). Physical activity and health: a report of the Surgeon General. *National Center for Chronic Disease Prevention and Health Promotion*. Available at: https://www.cdc.gov/nccdphp/sgr/index.htm

Després, J.P. and Lemieux, I., (2006). Abdominal obesity and metabolic syndrome. *Nature*, *444*(7121), pp.881-887.

Deurenberg, P., Weststrate, J. A., and Seidell, J. C. (1991). Body mass index as a measure of body fatness: age-and sex-specific prediction formulas. British Journal of nutrition, 65(2), 105-114.

Dutta, A. and Ray, M.R., (2012). Prevalence of hypertension and pre-hypertension in rural women: A report from the villages of West Bengal, a state in the eastern part of India. *Australian Journal of Rural Health*, *20*(4), pp.219-225.

Dwivedi, A.K., Dubey, P., Cistola, D.P. and Reddy, S.Y., (2020). Association between obesity and cardiovascular outcomes: updated evidence from meta-analysis studies. *Current cardiology reports*, *22*(4), pp.1-19.

Einarson, T. R., Acs, A., Ludwig, C., & Panton, U. H. (2018). Prevalence of cardiovascular disease in type 2 diabetes: a systematic literature review of scientific evidence from across the world in 2007–2017. *Cardiovascular diabetology*, *17*(1), 1-19.

Falls, L.A. and Farrell, D.H., (1997). Resistance of γA/γ′ fibrin clots to fibrinolysis. *Journal of Biological Chemistry*, *272*(22), pp.14251-14256.

Farooqui, A.A. and Farooqui, T. eds., (2013). Metabolic syndrome and neurological disorders. ISBN: 978-1-118-39531-8. Available at: https://www.wiley.com/enus/Metabolic+Syndrome+and+Neurological+Disorders-p-9781118395318

Faruque, M. O., Kundoo, M., Khan, I., Das, M., Rahman, M.N., Ali, L., Hasan, Z., (2017). Garo Population of Bangladeshi Hilly Region Possesses Higher Frequency of ACE I/I Genotype in Angiotensin-converting Enzyme-1 (ACE-1) Gene. *Bioresearch Commmunication, 3*(1).

Fatema, K., Natasha, K. and Ali, L., (2014). Cardiovascular risk factors among Bangladeshi ready-made garment workers. *Journal of Public Health in Africa*, *5*(2), p. 373

Fatema, K., Zwar, N.A., Milton, A.H., Rahman, B., Awal, A.S.M.N. and Ali, L., (2016). Cardiovascular risk assessment among rural population: findings from a cohort study in a peripheral region of Bangladesh. *Public Health*, *137*, pp.73-80.

Flora, R., Gulrukh, B., (2020). Abdominal And Gluteofemoral Fat Distribution As Risk Factor Among The Plains Garo Women Of Kamrup District, Assam. *Online Journal of Anthropology*. *16* (2), p.375-387.

Feng, D., Liu, T., Su, DF., Wang, H., Ding, P., He, YH., Deng, XQ., Hou, MJ., et al, (2013). The association between smoking quantity and hypertension mediated by inflammation in Chinese current smokers. *J Hypertens. 31*(9):1798-805. doi: 10.1097/HJH.0b013e328362c21a.

Folsom, A.R., Chambless, L.E., Ballantyne, C.M., Coresh, J., Heiss, G., Wu, K.K., Boerwinkle, E., Mosley, T.H., et al, (2006). An assessment of incremental coronary risk prediction using C-reactive protein and other novel risk markers: the atherosclerosis risk in communities' study. *Archives of internal medicine*, *166*(13), pp.1368-1373.

Forouzanfar, M.H., Afshin, A., Alexander, L.T., Anderson, H.R., Bhutta, Z.A., Biryukov, S., Brauer, M., Burnett, R., et al, (2016). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The lancet*, *388*(10053), pp.1659-1724.

Forouzanfar, M.H., Liu, P., Roth, G.A., Ng, M., Biryukov, S., Marczak, L., Alexander, L., Estep, K., et al, (2017). Global burden of hypertension and systolic blood pressure of at least 110 to 115 mm Hg, 1990-2015. *Jama*, *317*(2), pp.165-182.

Fowles, J. and Dybing, E., (2003). Application of toxicological risk assessment principles to the chemical constituents of cigarette smoke. *Tobacco control*, *12*(4), pp.424-430.

IDF Diabetes Atlas 2022 Reports (2022). Diabetes among Indigenous Peoples. Available at: https://diabetesatlas.org/atlas/indigenous-2022/

Garo people (2023). Wikipedia, the free encyclopedia. Available at: https://en.wikipedia.org/wiki/Garo_people

Garovic, V. D. (2007). Hypertension in pregnancy: an emerging risk factor for cardiovascular disease. *Nature Clinical Practice Naphrology*, 613-22.

Goff, D.C., Lloyd-Jones, D.M., Bennett, G., Coady, S., D'agostino, R.B., Gibbons, R., Greenland, P., Lackland, D.T., et al, (2014). 2013 ACC/AHA guideline on the assessment of cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Journal of the American College of Cardiology*, *63*(25 Part B), pp.2935-2959.

Gordon, D., Moore E.A., (2021). The American Cardiovascular Pandemic: A 100-Year History (McFarland Health Topics). Available at: https://www.amazon.com/American-Cardiovascular-Pandemic-100-Year-McFarland/dp/1476685126

Graham, I., Atar, D. and Borch-Johnsen, K., (2007). Ghidul European de Prevenţie a Bolilor Cardiovasculare în Practica Clinică. *Revista Română de Cardiologie*, *22*(4), pp.370-418.

Greiser, KH., Kluttig, A., Schumann, B., Kors, JA., Swenne, CA., Kuss, O., Werdan, K., Haerting, J., (2005). Cardiovascular disease, risk factors and heart rate variability in the elderly general population: Design and objectives of the CARdiovascular disease, Living and Ageing in Halle (CARLA) Study. *BMC Cardiovasc Disord*, 33. doi: 10.1186/1471-2261-5-33.

Gupta, R., (2004). Trends in hypertension epidemiology in India. *Journal of human hypertension*, *18*(2), pp.73-78.

Guzzaloni, G., Grugni, G., Minocci, A., Moro, D. and Morabito, F., (2000). Liver steatosis in juvenile obesity: correlations with lipid profile, hepatic biochemical parameters and glycemic and insulinemic responses to an oral glucose tolerance test. *International journal of obesity*, *24*(6), pp.772-776.

Hadaegh, F., Harati, H., Ghanbarian, A. and Azizi, F., (2006). Association of total cholesterol versus other serum lipid parameters with the short-term prediction of cardiovascular outcomes: Tehran Lipid and Glucose Study. *European Journal of Preventive Cardiology*, *13*(4), pp.571-577.

Hanif, A.A.M., Hasan, M., Khan, M.S.A., Hossain, M.M., Shamim, A.A., Hossaine, M., Ullah, M.A., Sarker, S.K., et al, (2021). Ten-years cardiovascular risk among Bangladeshi population using non-laboratory-based risk chart of the world Health organization: findings from a nationally representative survey. *PloS one*, *16*(5), p.e0251967 DOI: 10.1371/journal.pone.0251967.

Haque, M. M., Akter, J., Ahmed, K. R., Chowdhury, H. A., Hossain, S., & Tripura, N. B. (2014). Nutritional status of settler and indigenous women of reproductive age group in Khagrachari district, Bangladesh. *Journal of Enam Medical College*, *4*(2), 98-101.

Haque, M. M., Mandal, S., & Sultana, J. (2015). Nutritional status and associated socioeconomic factors of 15-49years garo ethnic women residing in northern part of Bangladesh: a cross sectional observational survey. *Age*, *11*, 0.011.

Haque, M., Islam, K., Tripura, N., & Amin, M. (2014). Nutritional Status of Reproductive Aged Tribal Women in Bandarban District in Bangladesh. *South Asian Journal of Population and Health*, *7*(1&2), 1-7.

Haque, M.S. and Yamao, M., (2008). Can microcredit alleviate rural poverty? A case study of Bangladesh. *World Academy of Science, Engineering and Technology*, *46*, pp.648-656.

Harding, J. L., Pavkov, M. E., Magliano, D. J., Shaw, J. E., & Gregg, E. W. (2019). Global trends in diabetes complications: a review of current evidence. *Diabetologia*, *62*(1), 3-16.

Health Info Net (2015). Available at http://www.healthinfonet.ecu.edu.au/health-facts/health-faqs/cvd.

Hendriks, M.E., Wit, F.W., Roos, M.T., Brewster, L.M., Akande, T.M., De Beer, I.H., Mfinanga, S.G., Kahwa, A.M., et al, (2012). Hypertension in sub-Saharan Africa: cross-sectional surveys in four rural and urban communities. *PloS one*, *7*(3), p.e32638.

Herik, E.G.V, D., Cheung, E.Y., de Lau, L.M., den Hertog, H.M., Leebeek, F.W. Dippel, D.W., Koudstaal, P.J. and de Maat, M.P., (2011). γ'/total fibrinogen ratio is associated with short-term outcome in ischaemic stroke. Thrombosis and haemostasis, 105(03), pp.430-434.

Ho, K., Jamsen, K.M., Bell, J.S., Korhonen, M.J., Mc Namara, K.P., Magliano, D.J., Liew, D., et al (2018). Demographic, clinical and lifestyle factors associated with high-intensity statin therapy in Australia: The AusDiab study. *European journal of clinical pharmacology*, *74*(11), pp.1493-1501.

Hussain Z (2012). The Numbers Behind Bangladesh's Goal of Middle-Income Status by 2021. Available at: https://blogs.worldbank.org/endpovertyinsouthasia/numbers-behind-bangladesh%E2%80%99s-goal-middle-income-status-2021

Howard BV, Lee ET, Cowar LD, Devereux RB et al. (1999). The Strong Heart Study. *Circulation. 11;99*(18):2389-95.

Hypertensive Heart Disease (2018). Available at: https://www.healthline.com/health/hypertensive-heart-disease

Indian Health Service. Facts on Indian health disparities. Available at:

https://keepitsacred.itcmi.org/wp-content/uploads/2015/06/IHS-Fact-Sheet Disparities.pdf

Indigenous communities of Bangladesh (database) (2015). Available at http://www.ebbd.info/indigenous-communities.html (accessed on 15 December 2015)

Islam, F., Kathak, R. R., Sumon, A. H., & Molla, N. H. (2020). Prevalence and associated risk factors of general and abdominal obesity in rural and urban women in Bangladesh. *PloS one*, *15*(5), e0233754.

Islam, M. K. (2014). An ethnobotanical study of medicinal plants used by tribal and native people of Madhupur forest area, Bangladesh. *Journal of Ethnopharmacology*.

ISLAM, M. R. (2009). Antenatal and Postnatal Care Seeking Behavior In A Matrilineal Society: A Study On The Garo Tribe Of Bangladesh. *The Journal of Family Welfare*, 62-69.

Islam, M.N., Moniruzzaman, M., Khalil, M.I., Basri, R., Alam, M.K., Loo, K.W. and Gan, S.H., (2013). Burden of stroke in Bangladesh. *International journal of stroke*, *8*(3), pp.211-213.

Jafar, T.H., Gandhi, M., Jehan, I., Naheed, A., de Silva, H.A., Shahab, H., Alam, D., Luke, N., et al, (2018). Determinants of uncontrolled hypertension in rural communities in South Asia—Bangladesh, Pakistan, and Sri Lanka. *American journal of hypertension*, *31*(11), pp.1205-1214.

Jalil, M. A., Oakkas, M.A., (2012). The Family Structure and Cultural Practices of Garo Community in Bangladesh: An Overview. *Himalayan Journal of Sociology and Anthropology*.5 DOI:10.3126/hjsa. v5i0.7042

Jamerson, K. A. (2007). The Disproportionate Impact of Hypertensive Cardiovascular Disease in African Americans: Getting to the Heart of the Issue. *Department of Internal Medicine*. *J Clin Hypertens (Greenwich).* 6(4 Suppl 1):4-10. doi: 10.1111/j.1524-6175.2004.03563. x.

Jankowski, J., Floege, J., Fliser, D., Böhm, M., Marx, N., (2021). Cardiovascular Disease in Chronic Kidney Disease: Pathophysiological Insights and Therapeutic Options. Circulation, 143(11):1157-1172.

Jeong, S.M., Choi, S., Kim, K., Kim, S.M., Lee, G., Park, S.Y., Kim, Y.Y., Son, J.S., et al, (2018). Effect of change in total cholesterol levels on cardiovascular disease among young adults. *Journal of the American Heart Association*, *7*(12), p.e008819.

Joffres, M., Falaschetti, E., Gillespie, C., Robitaille, C., Loustalot, F., Poulter, N., McAlister, F.A., Johansen, et al, (2013). Hypertension prevalence, awareness, treatment and control in national surveys from England, the USA and Canada, and correlation with stroke and ischemic heart disease mortality: a cross-sectional study. *BMJ*, *3*(8), p.e003423.

Joseph, P., Leong, D., McKee, M., Anand, S.S., Schwalm J, D., Teo, K., Mente, A., Yusuf, S., (2017). Reducing the global burden of cardiovascular disease, part 1: the epidemiology and risk factors. *Circ Res, 121*(6), pp. 677-694.

Joshi, S.R., Anjana, R.M., Deepa, M., Pradeepa, R., Bhansali, A., Dhandania, V.K., Joshi, P.P., Unnikrishnan, R., (2014). Prevalence of dyslipidemia in urban and rural India: the ICMR–INDIAB study. *PloS one*, *9*(5), p.e96808.

Jousilahti, P., Vartiainen, E., Tuomilehto, J. and Puska, P., (1999). Sex, age, cardiovascular risk factors, and coronary heart disease: a prospective follow-up study of 14 786 middle-aged men and women in Finland. *Circulation*, *99*(9), pp.1165-1172.

Kabor I (2022). Livelihood Patterns of Garo Community: A Study on a village in Tangail District. *Journal of Research in Humanities and Social Science*. *10*(9) pp: 90-94 ISSN(Online):2321-9467.

KANNEL W B., DAWBER, T. R., KAGAN, A., REVOTSKIE, N., 3rd J STOKES (1961). Factors of risk in the development of coronary heart disease—six-year follow-up experience: the Framingham Study. *Annals of internal medicine*, *55*(1), pp.33-50.

Kapil, U., Khandelwal, R., Ramakrishnan, L., Khenduja, P., Gupta, A., Pandey, R.M., Upadhyay, A.D. and Belwal, R.S., (2018). Prevalence of hypertension, diabetes, and associated risk factors among geriatric population living in a high-altitude region of rural Uttarakhand, India. *Journal of family medicine and primary care*, *7*(6), p.1527.

Kapil, U., Khandelwal, R., Ramakrishnan, L., Khenduja, P., Gupta, A., Sareen, N., Pandey, R.M., Sati, H.C. and Belwal, R.S., (2018). Prevalence of metabolic syndrome and associated risk factors among geriatric population living in a high-altitude region of rural Uttarakhand, India. *Journal of Family Medicine and Primary Care*, *7*(4), p.709.

Kaptoge, S., Di Angelantonio, E., Lowe, G., Pepys, M.B., Thompson, S.G., Collins, R. and Danesh, J., (2010). Emerging Risk Factors Collaboration C-reactive protein concentration and risk of coronary heart disease, stroke, and mortality: an individual participant meta-analysis. *Lancet*, *375*(9709), pp.132-140.

Kaski, J.C., Kjeldsen, K.P., (2019). Cardiovascular pharmacotherapy: a new ESC handbook comprehensively addresses pharmacological treatment issues for patients with cardiovascular disease. *Eur Heart J Cardiovasc Pharmacother.*, *5*(4) pp.185-186.

Kaur, P., Rao, S.R., Venkatachalam, R., Kangusamy, B., Radhakrishnan, E., Kaliaperumal, K., Thota, V., Gupte, M.D., (2019). Risk factors for cardiovascular disease in rural South India: cohort study. *BMJ Open. 9*(10): e029759.

Khanam, F., Hossain, M.B., Mistry, S.K., Afsana, K., Rahman, M., (2019). Prevalence and Risk Factors of Cardiovascular Diseases among Bangladeshi Adults: Findings from a Cross-sectional Study. *Journal of Epidemiology and Public Health*, *9*(3), pp.176-84.

Khoury, M.J., (2003). Genetics and genomics in practice: the continuum from genetic disease to genetic information in health and disease. *Genetics in Medicine*, *5*(4), pp.261-268.

Kołtuniuk, A., Rosińczuk, J., (2016). The prevalence of risk factors for cardiovascular diseases among Polish surgical patients over 65 years. *Clin Interv Aging*. *11*, p. 631–639. doi: 10.2147/CIA.S105201

Kose, T. (2019). Gender differences in heart diseases: Evidence from Turkey. *Health Policy and Technology,* 67-74.

Kullawong, N., Apidechkul, T., Upala, P., Tamornpark, R., Keawdounglek, V., Wongfu, C., Yeemard, F., Khunthason, S. et al, (2021). Factors associated with elevated low-density lipoprotein cholesterol levels among hill tribe people aged 30 years and over in Thailand: a cross-sectional study. *BMC public health*, *21*(1), pp.1-10.

Kumari, D. J. (2021). Diagnosing angiographic disease status with the aid of deep neural network. *International Journal of Medical Engineering and Informatics,* 474-486.

Lamelas, P., Diaz, R., Orlandini, A., Avezum, A., Oliveira, G., Mattos, A., Lanas, F., Seron, P., et al, (2019). Prevalence, awareness, treatment and control of hypertension in rural and urban communities in Latin American countries. *Journal of hypertension*, *37*(9), pp.1813-1821.

Lertwanichwattana, T., Rangsin, R. and Sakboonyarat, B., (2021). Prevalence and associated factors of uncontrolled hyperlipidemia among Thai patients with diabetes and clinical atherosclerotic cardiovascular diseases: a cross-sectional study. *BMC Research Notes*, *14*(1), pp.1-8.

Lewington, S., Clarke, R., Qizilbash,n., Peto, R., Collins, R., (2002). Prospective studies collaboration. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet*, *360*, pp.1903-1913.

Li, N., Li, L., Wu, H. and Zhou, H., (2019). Antioxidative property and molecular mechanisms underlying geniposide-mediated therapeutic effects in diabetes mellitus and cardiovascular disease. *Oxidative medicine and cellular longevity*, *2019*.

Libby, P., Bonow, R.O., Mann, D.L., Tomaselli, G.F., Bhatt, D., Solomon, S.D. and Braunwald, E., (2021). A Textbook of Cardiovascular Medicine. .*Braunwald's Heart Disease-E-Book: Elsevier Health Sciences.* Available at: https://www.amazon.com/Braunwalds-Heart-Disease-Textbook-Cardiovascular/dp/0323463428

Lindroth, M., Lundqvist, R., Lilja, M., Eliasson, M., (2014). Cardiovascular risk factors differ between rural and urban Sweden: the 2009 Northern Sweden MONICA cohort. *BMC Public Health*. *9*(14) :825. Doi: 10.1186/1471-2458-14-82

Lloyd-Jones, D.M., Larson, M.G., Beiser, A. and Levy, D., (1999). Lifetime risk of developing coronary heart disease. *The Lancet*, *353*(9147), pp.89-92.

Lloyd-Jones, D.M., Liu, K., Tian, L. and Greenland, P., (2006). Narrative review: assessment of C-reactive protein in risk prediction for cardiovascular disease. *Annals of internal medicine*, *145*(1), pp.35-42.

Lovely, R.S., Falls, L.A., Al-Mondhiry, H.A., Chambers, C.E., Sexton, G.J., Ni, H. and Farrell, D.H., (2002). Association of γA/γ'fibrinogen levels and coronary artery disease. *Thrombosis and haemostasis*, *88*(07), pp.26-31.

Mathew S, Chary T M (2013). Association of dietary caloric intake with blood pressure, serum lipids and anthropometric indices in patients with hypertension. *Indian J Biochem Biophys*. *50*(5):467-73.

Mannila, M.N., Lovely, R.S., Kazmierczak, S.C., Eriksson, P., Samnegård, A., Farrell, D.H., Hamsten, A. and Silveira, A., (2007). Elevated plasma fibrinogen γ′ concentration is associated with myocardial infarction: effects of variation in fibrinogen genes and environmental factors. *Journal of Thrombosis and Haemostasis*, *5*(4), pp.766-773.

Mannino, D.M.., Thorn, D., Swensen, A., Holguin, F., (2008). Prevalence and outcomes of diabetes, hypertension and cardiovascular disease in COPD. *European Respiratory Journal*, *2008*(32*)*: 962-969; DOI: 10.1183/09031936.00012408

Martiniuk, A. L., Lee, C. M. Y., Lawes, C.M M., Ueshima, H., Suh, II., Lam, T.H., Gu, D., Feigin, Valery., et al, (2007). Hypertension: its prevalence and population-attributable fraction for mortality from cardiovascular disease in the Asia-Pacific region. *J Hypertens*, *25*(1):73-9.

Mathers, C.D. and Loncar, D., 2006. Projections of global mortality and burden of disease from 2002 to 2030. *PLoS medicine*, *3*(11), p.e442.

Matheus, A.S.D.M., Tannus, L.R.M., Cobas, R.A., Palma, C.C.S., Negrato, C.A. and Gomes, M.D.B., (2013). Impact of diabetes on cardiovascular disease: an update. *Int J Hypertens*, *2013*;2013:653789. doi: 10.1155/2013/653789.

Mayorquin O, (2022). How many calories should you eat in a day? The USDA's guidelines for men, women and children. *USA TODAY June 13*, Available at: https://www.usatoday.com/story/news/health/2022/06/08/daily-calorie-intake-guidelines/7534147001/

McKeigue, P.M., Ferrie, J.E., Pierpoint, T. and Marmot, M.G., 1993. Association of early-onset coronary heart disease in South Asian men with glucose intolerance and hyperinsulinemia. *Circulation*, *87*(1), pp.152-161.

Mendis S, Puska P and Norrving B 2015.Available at http://apps.who.int/iris/bitstream/10665/44701/1/9789241564373_eng.pdf (accessed on 15 December 2015)

Mendis, S., Puska, P., Norrving, B. and World Health Organization, 2011. *Global atlas on cardiovascular disease prevention and control*. World Health Organization.

Mensah GA, R. G. (2019). The global burden of cardiovascular diseases and risk factors: 2020 and beyond. *J Am Coll Cardiol.*, 2529-2532.

Mohiuddin, A.K., (2019). Diabetes fact: Bangladesh perspective. *International Journal of Diabetes Research*, *2*(1), pp.14-20.

Moore, S.C., Lee, I.M., Weiderpass, E., Campbell, P.T., Sampson, J.N., Kitahara, C.M., Keadle, S.K., Arem, H., et al, (2016). Association of leisure-time physical activity with risk of 26 types of cancer in 1.44 million adults. *JAMA internal medicine*, *176*(6), pp.816-825.

Moral S., (2022). Heart disease behind 34 per cent deaths in Bangladesh. Available at: https://en.prothomalo.com/bangladesh/czhc83l0if

Mosenzon, O., Alguwaihes, A., Leon, J. L. A., Bayram, F., Darmon, P., Davis, T. M., & Vencio, S. (2021). CAPTURE: a multinational, cross-sectional study of cardiovascular disease prevalence in adults with type 2 diabetes across 13 countries. *Cardiovascular Diabetology*, *20*(1), 1-13.

Muhammed, N. (2011). A CASE STUDY ON THE GARO ETHNIC PEOPLE OF THE SAL (Shorea robusta) FORESTS IN BANGLADESH. *International Journal of Social Forestry*, 197-211.

Muhit, MA., Rahman, MO., Raihan, SZ., Asaduzzaman, M., Akbar, MA., Sharmin, N. and Faroque, ABM., (2012). Cardiovascular disease prevalence and prescription patterns at a tertiary level hospital in Bangladesh. *Journal of Applied Pharmaceutical Science*. *02* (03): 80-84.

Narindrarangkura, P., Bosl, W., Rangsin, R. and Hatthachote, P., (2019). Prevalence of dyslipidemia associated with complications in diabetic patients: a nationwide study in Thailand. *Lipids in health and disease*, *18*(1), pp.1-8.

NCD Risk Factor Collaboration, (2017). Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19· 1 million participants. Lancet (London, England). 2017 Jan 7; 389 (10064):37

Niroumand, S., Khajedaluee, M., Khadem-Rezaiyan, M., Abrishami, M., Juya, M., Khodaee, G. and Dadgarmoghaddam, M., (2015). Atherogenic Index of Plasma (AIP): A marker of cardiovascular disease. *Medical journal of the Islamic Republic of Iran*, *29*, p.240.

O'Meara, J.G., Kardia, S.L., Armon, J.J., Brown, C.A., Boerwinkle, E. and Turner, S.T., (2004). Ethnic and sex differences in the prevalence, treatment, and control of dyslipidemia among hypertensive adults in the GENOA study. *Archives of internal medicine*, *164*(12), pp.1313-1318.

Centers for Disease Control and Prevention (US), (2010). How tobacco smoke causes disease: The biology and behavioral basis for smoking-attributable disease. *A report of the surgeon general. Atlanta (GA)*, ISBN-13: 978-0-16-084078-4

Onat, A. (2001). Risk factors and cardiovascular disease in Turkey. *Atherosclerosis,* 1-10.

PMID: 11368991 DOI: 10.1016/s0021-9150(01)00500-7

Orekhov, A.N., Bobryshev, Y.V., Sobenin, I.A., Melnichenko, A.A. and Chistiakov, D.A., (2014). Modified low density lipoprotein and lipoprotein-containing circulating immune complexes as diagnostic and prognostic biomarkers of atherosclerosis and type 1 diabetes macrovascular disease. *International journal of molecular sciences*, *15*(7), pp.12807-12841.

Pais, P., Pogue, J., Gerstein, H., Zachariah, E., Savitha, D., Jayprakash, S., Nayak, P.R. and Yusuf, S., (1996). Risk factors for acute myocardial infarction in Indians: a case-control study. *The Lancet*, *348*(9024), pp.358-363.

Panagiotakos, D., Georgousopoulou, E., Notara, V., Pitaraki, E., Kokkou, E., Chrysohoou, C., Skoumas, Y., Metaxa, V., Pitsavos, C., Stefanadis, C. and ATTICA Study Group, (2016). Education status determines 10-year (2002–2012) survival from cardiovascular disease in Athens metropolitan area: the ATTICA study, Greece. *Health & social care in the community*, *24*(3), pp.334-344.

Petrov, M., Martinez, S.C., Holmvang, L., Al-Shaibi, K. and Alasnag, M., (2018). Peripheral arterial disease in women: an overview of risk factor profile, clinical features, and outcomes. *Current atherosclerosis reports*, *20*(8), pp.1-11.

Joseph, P., Kutty, VR., Mohan, V., Kumar, R., et al (2022). ‘Cardiovascular disease, mortality, and their associations with modifiable risk factors in a multi-national South Asia cohort: a PURE sub study. *European Heart Journal*, *43*(30), pp. 2831–2840. https://doi.org/10.1093/eurheartj/ehac249.

Piepoli, M.F., Hoes, A.W., Agewall, S., Albus, C., Brotons, C., Catapano, A.L., Cooney, M.T., Corra, U., et al, (2016). European Guidelines on cardiovascular disease prevention in clinical practice. *Kardiologia Polska (Polish Heart Journal)*, *74*(9), pp.821-936.

Poirier, P., Giles, T.D., Bray, G.A., Hong, Y., Stern, J.S., Pi-Sunyer, F.X. and Eckel, R.H., (2006). Obesity and cardiovascular disease: pathophysiology, evaluation, and effect of weight loss: an update of the 1997 American Heart Association Scientific Statement on Obesity and Heart Disease from the Obesity Committee of the Council on Nutrition, Physical Activity, and Metabolism. *Circulation*, *113*(6), pp.898-918.

Psaltopoulou, T., Hatzis, G., Papageorgiou, N., Androulakis, E., Briasoulis, A. and Tousoulis, D., (2017). Socioeconomic status and risk factors for cardiovascular disease: impact of dietary mediators. *Hellenic journal of cardiology*, *58*(1), pp.32-42.

Rafayat H M, (2019). Comparison of diabetes knowledge and self-efficacy in diabetes management among the urban people and the people from Garo tribe in Mymensingh division. Brac University, project report. URI. http://hdl.handle.net/10361/13689

Rahman, M., Zaman, M.M., Islam, J.Y., Chowdhury, J., Ahsan, H.A.M., Rahman, R., Hassan, M., Hossain, Z., (2018). Prevalence, treatment patterns, and risk factors of hypertension and pre-hypertension among Bangladeshi adults. *Journal of human hypertension*, *32*(5), pp.334-348.

Rahmatullah, M., Mukti, IJ., Haque, AF., Ariful, M., (2009). An Ethnobotanical Survey and Pharmacological Evaluation of Medicinal Plants used by the Garo Tribal Community living in Netrakona district, Bangladesh. *American Eurasian Network for Scientific Information, 3*(33), pp. 402-18.

Rana, M. M., Ferdoushi1, A., Huq, A. K. O., Sabrin, Farah., Choudhury T., (2013). Comparison of Sociodemographic and Nutritional Status of Garo and Non-Garo School Going Children at Jhinaigati Upazilla, Bangladesh. *Journal of Food Science & Technology*. *2* (1), ISSN: 2278 – 2249

Rapsomaniki, E., Timmis, A., George, J., Pujades-Rodriguez, M., Shah, A.D., Denaxas, S., White, I.R., et al, (2014). Blood pressure and incidence of twelve cardiovascular diseases: lifetime risks, healthy life-years lost, and age-specific associations in 1·25 million people. *The Lancet*, *383*(9932), pp.1899-1911.

Rivellese, A.A., Riccardi, G. and Vaccaro, O., (2010). Cardiovascular risk in women with diabetes. *Nutrition, Metabolism and Cardiovascular Diseases*, *20*(6), pp.474-480.

Rodriguez, J.L., Thomas, C.C., Massetti, G.M., Duquette, D., Avner, L., Iskander, J., Khoury, M.J. and Richardson, L.C., (2016). CDC grand rounds: family history and genomics as tools for cancer prevention and control. *Morbidity and Mortality Weekly Report*, *65*(46), pp.1291-1294.

Ross, R., 1993. The pathogenesis of atherosclerosis: a perspective for the 1990s. *Nature*, *362*(6423), pp.801-809.

Ross, R., 1999. Atherosclerosis—an inflammatory disease. *New England journal of medicine*, *340*(2), pp.115-126.

Roth, G.A., Forouzanfar, M.H., Moran, A.E., Barber, R., Nguyen, G., Feigin, V.L., Naghavi, M., Mensah, G.A. et al, (2015). Demographic and epidemiologic drivers of global cardiovascular mortality. *New England Journal of Medicine*, *372*(14), pp.1333-1341.

Roy, S., (2014). Atherosclerotic cardiovascular disease risk and evidence-based management of cholesterol. *North American Journal of Medical Sciences*, *6*(5), p.191.

Saha, U. K., Alam, M. B., Rahman, A. K. M. F., Hussain, A. H. M. E., Mashreky, S. R., Mandal, G., & Mohammad, Q. D. (2018). Epidemiology of stroke: findings from a community-based survey in rural Bangladesh. *Public health*, *160*, 26-32.

Sanna, T., Ziegler, P. D., & Crea, F. (2018). Detection and management of atrial fibrillation after cryptogenic stroke or embolic stroke of undetermined source. *Clinical Cardiology*, *41*(3), 426-432.

Sarkar, M M R., Ghani, A., (2008). Cultural and Health Management Practices of theGaro Community of Bangladesh: A Case Study ofthe Garos of Greater Mymensingh District. Stamford Journal of Pharmaceutical Sciences, S. J. Pharm. Sci.1(1&2): 29-37

Sarrafzadegan N, M. N., Mohammmadifard N., (2019). Cardiovascular disease in Iran in the last 40 years: prevalence, mortality, morbidity, challenges and strategies for cardiovascular prevention. *Arch Iran Med*, 204-210.

Scarborough, P., Bhatnagar, P., Kaur, A., Smolina, K., Wickramasinghe, K. and Raynor, M., (2010). Ethnic differences in cardiovascular disease. *British Heart Foundation Health Promotion Research Group:* 2010 edition.

Schick, S. and Glantz, S., (2005). Philip Morris toxicological experiments with fresh sidestream smoke: more toxic than mainstream smoke. *Tobacco control*, *14*(6), pp.396-404.

Schwartz, M.W., Seeley, R.J., Zeltser, L.M., Drewnowski, A., Ravussin, E., Redman, L.M. and Leibel, R.L., (2017). Obesity pathogenesis: an endocrine society scientific statement. *Endocrine reviews*, *38*(4), pp.267-296.

SchweinmanK, Eichner j, welty TK, Zhang Y. (2006). Cardiovascular disease risk factor awareness in American Indian communities: the strong heart study. The Strong Heart Study. *Ethn Dis,16*(3):647-52.

Shammi, F.A., Shuvo, S.D. and Josy, M.S.K., 2021. Dietary patterns and their association with CVD risk factors among bangladeshi adults: a cross-sectional study. *Journal of the American College of Nutrition*, *40*(4), pp.358-366.

Sharmin. S et al. (2010). Risk factors of major noncommunicable diseases among Santals. Thesis, Bangladesh Institute of health Sciences (BIHS), July 2010

South-East Asia - the World Heart Federation (WHF) 2019. Available at https://world-heart-federation.org/where-we-work/south-east-asia (accessed on 23 january 2023)

Statistics New Zealand. *New Zealand life tables: 2005-07.* 2008.

Streinbrook E, Flood I D, Barmoya J, Mantano C M et al (2022). Prevalence of Hypertension, Diabetes, and Other Cardiovascular Disease Risk Factors in Two Indigenous Municipalities in Rural Guatemala: A Population-Representative Survey. Glob Heart. 2022; 17(1): 82. Published online 2022 Nov 22. doi: 10.5334/gh.1171

Talukder, M.A.S., Hossain, D.S., Alamgir, S., Mehjabin, M., Afroz, F. and Begom, M.S.A., The prevalence of hypertension and pattern of associated Cardiovascular and Metabolic risk factors in rural people of Bangladesh. *Organization (WHO)*, *5*, p.7.

Tan, M.N.A., Lo, Z.J., Lee, S.H., Teo, R.M., Tan, W.L.G. and Chandrasekar, S., (2018). Review of transmetatarsal amputations in the management of peripheral arterial disease in an Asian population. *Annals of vascular diseases*, pp.oa-17.

Teo KK, D. H. (2017). The emerging epidemic of cardiovascular risk factors and atherosclerotic disease in developing countries. *Can J Cardiol*, 358-365.

The Indigenous World 2022: Bangladesh. Available at: https://iwgia.org/en/bangladesh/4647-iw-2022-bangladesh.html_edn2

Thomopoulos, C., Parati, G. and Zanchetti, A., (2014). Effects of blood pressure lowering on outcome incidence in hypertension: 3. Effects in patients at different levels of cardiovascular risk–overview and meta-analyses of randomized trials. *Journal of hypertension*, *32*(12), pp.2305-2314.

Thomopoulos, C., Parati, G. and Zanchetti, A., (2014). Effects of blood pressure lowering on outcome incidence in hypertension: 2. Effects at different baseline and achieved blood pressure levels–overview and meta-analyses of randomized trials. *Journal of hypertension*, *32*(12), pp.2296-2304.

Thomopoulos, C., Parati, G. and Zanchetti, A (2018). Effects of blood pressure-lowering treatment on cardiovascular outcomes and mortality: 14 - effects of different classes of antihypertensive drugs in older and younger patients: overview and meta-analysis. Hypertension, 36(8), pp.1637-1647

Tian, S., Dong, G.H., Wang, D., Liu, M.M., Lin, Q., Meng, X.J., Xu, L.X., Hou, H. and Ren, Y.F., (2011). Factors associated with prevalence, awareness, treatment and control of hypertension in urban adults from 33 communities in China: the CHPSNE Study. *Hypertension Research*, *34*(10), pp.1087-1092.

Tohme, R. (2005). The prevalence of hypertension and its association The prevalence of hypertension and its association with other cardiovascular disease risk factors in a representative sample of the Lebanese population. *journal of human hypertension*.

Trejo, R., Cross, W., Stephenson, J. and Edward, K.L., (2018). Young adults' knowledge and attitudes towards cardiovascular disease: A systematic review and meta-analysis. *Journal of clinical nursing*, *27*(23-24), pp.4245-4256.

Tveden-Nyborg, P., Birck, M.M., Ipsen, D.H., Thiessen, T., de Bie Feldmann, L., Lindblad, M.M., Jensen, H.E. and Lykkesfeldt, J., (2016). Diet-induced dyslipidemia leads to nonalcoholic fatty liver disease and oxidative stress in guinea pigs. *Translational Research, 168,* pp.146-160.

Unamuno, X., Gómez‐Ambrosi, J., Rodríguez, A., Becerril, S., Frühbeck, G. and Catalán, V., (2018). Adipokine dysregulation and adipose tissue inflammation in human obesity. *European journal of clinical investigation*, *48*(9), p.e12997.

United Nations. Dept. of Economic, Permanent Forum on Indigenous Issues (United Nations) and United Nations. Statistical Division, (2009.) *State of the world's indigenous peoples* (Vol. 9). United Nations Publications.

Valdez, R., Greenlund, K.J., Khoury, M.J. and Yoon, P.W., (2007). Is family history a useful tool for detecting children at risk for diabetes and cardiovascular diseases? A public health perspective. *Pediatrics*, *120*(SUPPLEMENT_2), pp.S78-S86.

Wali, R. K. (1999). Hypertensive cardiovascular disease in African Americans. *Clinical Dermiology*, 521-528.

Wang, J., Ning, X., Yang, L., Lu, H., Tu, J., Jin, W., Zhang, W. and Su, T.C., (2014). Trends of hypertension prevalence, awareness, treatment and control in rural areas of northern China during 1991–2011. *Journal of Human Hypertension*, *28*(1), pp.25-31.

Wang, Z., Yang, T., & Fu, H. (2021). Prevalence of diabetes and hypertension and their interaction effects on cardio-cerebrovascular diseases: a cross-sectional study. *BMC Public Health*, *21*(1), 1-9.

Watson, M., Dardari, Z., Kianoush, S., Hall, M.E., DeFilippis, A.P., Keith, R.J., Benjamin, E.J., Rodriguez, C.J., Bhatnagar, A., Lima, J.A. and Butler, J., (2019). Relation between cigarette smoking and heart failure (from the Multiethnic Study of Atherosclerosis). *The American journal of cardiology*, *123*(12), pp.1972-1977.

Web Global Health Insights. Understanding risk factors for stroke death in Bangladesh October 29,2017. Available at: "http://blog.icddrb.org/2017/10/29/understanding-risk-factors-for-stroke-death-in-bangladesh

Weber, C. and Noels, H., (2011). Atherosclerosis: current pathogenesis and therapeutic options. *Nature medicine*, *17*(11), pp.1410-1422.

Whelton, PK., Carey, RM., Aronow, WS., Casey Jr, DE., Collins, KJ., Himmelfarb, CD., DePalma, SM., Gidding, S., et al, (2018). ACC /AHA /AAPA /ABC /ACPM /AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection Evaluation, and Management of High Blood Pressure in adults: a report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines. J Am Coll Cardiol. 71: e127–e248.

World Health Organization. (2012). WHO Global Report: Mortality Attributable to Tobacco. Geneva: WHO.

Wild, S., Roglic, G., Green, A., Sicree, R. and King, H., (2004). Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes care*, *27*(5), pp.1047-1053.

Wilhelmsen, L., Svärdsudd, K., Korsan-Bengtsen, K., Larsson, B.O., Welin, L. and Tibblin, G., (1984). Fibrinogen as a risk factor for stroke and myocardial infarction. *New England Journal of Medicine*, *311*(8), pp.501-505.

Winkleby, M.A., Jatulis, D.E., Frank, E. and Fortmann, S.P., (1992). Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. *American Journal of Public Health*, *82*(6), pp.816-820.

WORLD BANK DATA TEAM| (2019). New country classifications by income level: 2019-2020.

World Heart Federation (2019). SOUTH-EAST ASIA. Available at: https://world-heart-federation.org/where-we-work/south-east-asia/

World Health Organization. (2010). A healthy lifestyle - WHO recommendations. Available at: https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations.

World Health Organization. (2022). Noncommunicable diseases. Available at https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases#:~:text=Key%20facts,-%20and%20middle-income%20countries.

World Health Organization. (2021). Cardiovascular diseases (CVDs). Available at https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds).

World Health Organization (2011). Available at http://www.searo.who.int/entity/noncommunicable_diseases/documents/9789290224136/en/ (accessed on 15 December 2015)

World Health Organization (2010). Available at http://www.who.int/nmh/publications/ncd_report_full_en.pdf(accessed on 27 April 2016)

World Health Organization (2014). Available at http://apps.who.int/iris/bitstream/10665/128038/1/9789241507509_eng.pdf?ua=1 (accessed on 15 December 2015).

World Health Organization (2023). Salt Intake, THE GLOBAL HEALTH OBSERVATORY. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/3082

World Health Organization. Fact sheet—obesity and overweight. (2018). "http://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

YILDIZ, P.A., Özdil, T., Dizbay, M., Tunçcan, Ö.G. and Hizel, K., (2018). Peripheral arterial disease increases the risk of multidrug-resistant bacteria and amputation in diabetic foot infections. *Turkish journal of medical sciences*, *48*(4), pp.845-850.

Yuksel, A., Velioglu, Y., Cayir, M.C., Kumtepe, G. and Gurbuz, O., (2018). Current status of arterial revascularization for the treatment of critical limb ischemia in infrainguinal atherosclerotic disease. *International Journal of Angiology*, *27*(03), pp.132-137.

Zaman, K., Naser, M., Khan, M.H.A., Habib, S.H., (2015). Association of periodontal disease with lifestyle, diabetes mellitus and oral health care practices in an indigenous Bangladeshi population. Journal of Diabetology. 6 (1), p. 5.

Zaman M M, Moniruzzaman M , Chowdhury K N , Zareen S, et al (2020). Estimated total cardiovascular risk in a rural area of Bangladesh: a household level cross-sectional survey done by local community health workers. BMJ Journal, Volume 11, Issue 8

Zaman M M, Chowdhury S R, Ahmed J, Talukder H et al (2016). Blood glucose and cholesterol levels in adult population of Bangladesh: Results from STEPS 2006 survey. Indian Heart J. 2016 Jan-Feb; 68(1): 52–56.

Zaman MA 2016. Available at http://www.orion-group.net/journals/Journals/vol17_jan2004/130.htm (accessed on June 3, 2016)

Zhang, Y., Liu, J., Yao, J., Ji, G., Qian, L., Wang, J., Zhang, G., Tian, J., Nie, Y., Zhang, Y.E. and Gold, M.S., 2014. Obesity: pathophysiology and intervention. *Nutrients*, *6*(11), pp.5153-5183.

ZHU, M. L. (2012). Outline of the Report on Cardiovascular Disease in China, 2010. *Biomedical and Environmental Sciences*.

Zhu, M., Lin, J., Wang, C., Yang, M., Lv, H., Yang, M., ... & Jiang, J. (2019). The relationship among angiotensinogen genes polymorphisms and hs-CRP and coronary artery disease. *Journal of Clinical Laboratory Analysis*, *33*(5), e22881.

Zhu, S., Wang, Z., Shen, W., Heymsfield, S.B. and Heshka, S., (2003). Percentage body fat ranges associated with metabolic syndrome risk: results based on the third National Health and Nutrition Examination Survey (1988–1994). *The American journal of clinical nutrition*, *78*(2), pp.228-235.

Zubin Punthakee (2018). Definition, Classification and Diagnosis of Diabetes, Prediabetes and Metabolic Syndrome.Canadian *Journal of Diabetes*. *42*(Suppl 1):S10-S15. doi: 10.1016/j.jcjd.2017.10.003

APPENDICES

APPENDICES:

Case Record Form

ASSESSMENT OF CARDIOVASCULAR DISEASE AND ASSOCIATED RISK FACTORS IN RURAL GARO POPULATION

General Information:			
1. Patient Name: ....ID No: .... Date:			
2. Present Address:			
3.Area:			
District 1:		District 2:	
vill-1.1:	vill-1.2:	vill-2.1:	vill-2.2:
4. Phone No (Relation with the subject): …………….			
5. Age			
6. Gender: a. Male b. Female c. Others			
7. Religion: a. Muslim b. Hindu c. Buddhist d. Christian e. Others			
8. Marital Status: a. Married b. Unmarried			
c. Widowed d. Separated			

Socio-Demographic Information:
9. Educational Background: a. Illiterate b. Primary c. SSC d. HSC
e. Graduate f. Post-graduate g. Others
10. Family Member:
11. Family Income (monthly):
12. Family Expenditure (monthly):
13. Occupation: a. Govt. Service b. Private Service c. Business
d. Day Labor e. Student f. Others

14. Family Diseases History		
i)	Hyperlipidemia	Yes /No /Don't know
ii)	Hypertension	Yes /No /Don't know
iii)	Diabetes	Yes /No /Don't know
iv)	Obesity	Yes /No /Don't know
v)	Ischemia	Yes /No /Don't know
vi)	Stroke	Yes /No /Don't know
Vii)	Others	Yes /No /Don't know

15. Anthropometric Measurement	
Height:	
Weight	
Waist-hip ratio	
Others	
16. Blood pressure	
Systolic:	…….......mm/Hg
Diastolic	…..........mm/Hg
17. Physical activity level	
Sedentary (desk job)	
Lightly active (1-3d/w)	
Moderately active(3-5d/w)	
Very active (6-7d/w)	
Extremely active (Labor / Rickshaw puller)	
18. History of Addiction	

a. Smoking: Yes/ No (if yes; duration ______ yrs; Average ____ sticks/ day)
Past history: Yes/ No (if yes; duration ______yrs; Average ____ sticks/ day)

b. Tobacco leaf chewing/ using powder (Gull): Yes/ No (if yes; duration _____ yrs) Past history: Yes/ No (if yes; duration _____ yrs)
c. Betel leaf chewing: Yes/ No (if yes; duration _____ yrs) Past history: Yes/ No (if yes; duration _____ yrs)
d. Tobacco Powder sniffing: Yes/ No (if yes; duration _____ yrs) Past history: Yes/ No (if yes; duration _____ yrs)
e. Drinking alcohol: Yes/ No (if yes; duration _____ yrs) Past history: Yes/ No (if yes; duration _____ yrs)

19.History of medication	
a. Oral intake	
b. Hypertensive	
c. Drug or Insulin	
d. lipid lowering drug	

Laboratory report :		
Test	Report	References
Fasting Blood Glucose		
OGTT		
Total cholesterol		

Dietary History (24 hr. recall method)

Meal Time	Description of Food	Cooked/ raw food			Weight of raw food (gm)
		Measurements	Weight(gm)	Ingredients	
Morning					
Mid- morning					
Noon					
After noon					
Night					
Before sleep					

Food Frequency Questionnaire

How often do you eat foods from each of the following categories (please put (√)

Food groups	Name of food	**2-3** / day (1)	1/day (2)	2-3 /week(3)	1 / week (4)	**Never (0)**
Cereals	Rice					
	Ruti					
	Parata					
	Muri					
	Others					
Milk, Fish, Meat& Egg	Milk					
	Fish					
	Meat					
	Egg					
	Others					
Fruits & vegetables	Leafy vegetables					
	Vegetables					
	General fruits					
	Dashy fruits					
	Others					
Fats & Oil	Ghee					

	Butter					
	Soya bean					
	Salt Intake					
	Others					
Pulse & legumes	Lentil					
	Simibichir dal					
	Kheshari dal					
	Motor dal					
	Mascolai					
	Others					
Snacks	Singara					
	Puri					
	Noodles					
	Biscuit					
	Soft drinks					
	Alcohol					
	Others					

……………………………….

Signature of the interviewer

Informed Consent Form

I am Ummy Salma Munni, want to take your consent regarding your disease for academic purpose.

Aim:

ASSESSMENT OF CARDIOVASCULAR DISEASE AND ASSOCIATED RISK FACTORS IN RURAL GARO POPULATION

Risk of the participant in this research:

If you participate in this research work you may not have any physical risk.

Alternate: If you want then you may not have any physical risk.

Expenditure:

For this research purpose you need not to pay or you will not get any financial expenditure.

Privacy:

Your personal information which will be conceals and this information will be use in research purpose.

Self-participation:

It's your own choice. You may or may not participate in this research work or any time quit from this research.

Questions:

If you have any query about research work you can ask researcher any time.

Consent of the participant:

The aim, purpose, advantage, risk, all about of this research work was fully explained by the researcher and I am satisfied about it and give my consent and some personal information with my own interest.

Research's Signature **Participant's Signature**

Date: **Date:**

A Glimpse of pictures of my PhD research work

A pic of meeting with local leaders of Modhupur, doctor, research assistants, data collectors and researcher.

A pic of 1st time data collection team: doctor, data collectors, researcher and local administration.

A pic of 2nd time data collection team.

A pic of data collection procedure.

At the time of data collection

Pic of Garo population (pic from internet)