

Review Article

Pervasiveness of metabolic syndrome and cardiovascular disease in tribal/rural population of India: a review

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ABSTRACT

Diseases classified as non-communicable diseases (NCDs) are those that are often caused by unhealthy behaviors rather than by infection or by contact with others. One of the main NCDs causing many fatalities is cardiovascular disease (CVD). Recent research has shown that the prevalence of metabolic syndrome (Mets) associated CVDs among tribal populations is increasing in rapid pace. In this review, we have included studies investigating the components of Mets and the relationships between Mets and CVDs. From the assessment of studies, we may predict a significant association between Mets and CVDs as a whole. Our evaluation of these studies revealed that carrying at least three Mets risk components, like hyperglycemia, obesity, dyslipidemia, and high blood pressure, significantly enhances the risk of CVDs. Undernutrition, smoking, and a low intake of fruits and vegetables in the Indian tribal population are the main risk factors for managing Mets associated CVDs. Furthermore, various studies have also shown that Mets may be influenced by genetic and environmental factors. Finally, healthy habits such as a balanced diet and frequent exercise should be introduced from a young age in individuals, to prevent Mets progression. In order to combat the Mets associated CVDs, functionally upgraded primary health centers and special IECs (Information, education and communication) programs may play a beneficial role. Furthermore, strengthening public healthcare systems and focusing on prevention, early identification, and treatment using medical and social interventions can be of immense help in managing the metabolic risk factors that can lead to CVDs.

Keywords: CVDs, Mets, Tribal

INTRODUCTION

Metabolic syndrome (Mets) can be characterized by a bunch of interrelated factors that enhance the risk of diabetes mellitus type 2 (T2DM), coronary heart disease (CHD) and other types of cardiovascular atherosclerotic illnesses. Dyslipidemia (high triglycerides, low HDL), raised arterial blood pressure (BP), and dysregulated glucose homeostasis are its primary constituents.¹ For quantifying Mets, several diagnostic criteria have been established. However, the international diabetic federation (IDF) and the national cholesterol education program adult treatment panel III are the most commonly used. According to the NCEP ATP III definition, Mets is

present if 3 or more of the following five criteria are satisfied: blood pressure above 130/85 mmHg, waist circumference measuring more than 35 inches for women and more than 40 inches for men, fasting TG level more than 150 mg/dl, fasting HDL cholesterol less than 50 mg/dl for women and less than 40 mg/dl for men, and fasting blood sugar level more than 100 mg/dl.² In India, 30% of adults are estimated to have Mets.³ A study of Mets prevalence by state revealed that Madhya Pradesh (50%) had the highest prevalence, followed by New Delhi (43%), Odisha (43%), and Telangana (42%). Jammu and Kashmir had the lowest combined prevalence of Mets (15%), followed by Haryana (18%) and Punjab (21%). On the basis of age group 13% (18-29 years group) to 50% (50-59 years group) had Mets, and the

burden increased steadily across age categories.⁴ People who lived in urban area had a greater prevalence than tribal/rural adult individuals. Prevalence of Mets was age-standardized at 33.5%, with males having a prevalence of 24.9% and females having a prevalence of 42.3%.⁴

Mets is a bunch of clinical and metabolic abnormalities leading to CVDs.⁵ Reportedly, people with Mets have a 3-10 times higher risk of developing cardiovascular disease.⁶ CVDs are primary explanation for death globally, 17.8 million people die annually from CVDs, an estimated 31% of all deaths worldwide.⁷ In absence of additional medical advancements, it is anticipated that approximately 23.6 million deaths from CVDs mostly from heart disease and stroke will occur by 2030. Most CVD deaths about 80% of them occur in low- to middle-income nations.⁸ In India, CVD is one of the most common reasons for NCDs (non-communicable diseases) related deaths. India accounts for 48% of fatalities from CVDs (Table 1).⁹ WHO projections indicate that by 2030, CVD would account for more than 35% of mortality cases in India, making it country's top cause of death (Ref from WHO).¹⁰ In India, ischemic heart disease and stroke cause 21.1% of all fatalities and 10% of all years of life lost. According to reports, the prevalence of coronary heart disease ranges from 6.5-13.2% in urban areas and from 1.6% to 7.4% across rural India. In metropolitan regions, prevalence of stroke ranges from 136-842/100,000 people, while in rural areas, it ranges from 143 to 165/100,000 people.¹¹

CVDs refers to a group of disorders that damage the heart or blood vessels. It is often connected with an accumulation of fatty deposits in the inner side of arteries (atherosclerosis) and an increased risk of blood clots and may even be related to destruction to arteries in vital organs like the brain, heart, kidneys and eyes.¹² There are gaggles of disorders of the heart and blood vessel such as coronary artery disease, myocardial infarction, heart failure, rheumatic heart disease, cerebrovascular diseases, peripheral arterial disease, stroke, atherosclerosis, damaging the different vital organs of body.¹³ One of the most common cardiovascular disorders affecting a vast number of people globally is coronary artery disease, or CAD. Commonness of CAD, is also known as coronary heart disease (CHD). CAD is a CVD which occurs due to atherosclerosis when there is arterial wall disruption in endothelial dysfunction, atherosclerosis starts due to the

deposition of lipoprotein in the innermost part of the coronary vessels.¹⁴ The word "myocardial infarction" (MI) refers to heart attack-related events when plaque builds up in the artery walls, reducing blood flow to the heart and causing damage to the heart's muscles from a lack of oxygen. People who are going through an episode of MI or an attack do not experience chest pain which is called "silent" MI, heart failure is a type of cardiovascular event with signs and symptoms caused by cardiac dysfunction. There are 2 main types of heart failure-diastolic dysfunction and systolic dysfunction.^{15,16}

CVDs in India can be represented by 3 facts such as (1) early onset (Indians get the disease at least ten years before Westerners do); (2) Increased case fatality (a greater proportion of Indians die from acute coronary syndrome [ACS] than in populations from the West); and (3) the condition developing at reduced risk factor thresholds, especially obesity and overweight. The world health survey indicates that more affluent people had higher rates of CVD risk factors, such as obesity and diabetes.¹⁷ Diabetes mellitus and atherosclerotic cardiovascular illnesses, which are important causes of morbidity and mortality worldwide and are constantly on the rise, may be seen as pre-conditions for Mets.¹⁸

India, a nation of great diversity, have several non-communicable disease prevalence and risk factors. Tribal populations, which are thought to be unaffected by lifestyle change driven diseases, are also becoming prone to various non communicable diseases (Table 1).¹⁹ India is inhabited to the second-largest tribal population in the world. According to the census of 2011, 8.6% of India's population is classified as tribal. Nearly 705 different types of tribal population groups are designated as Schedule Tribes under the Indian Constitution (Article 342). The indigenous people of the nation are known for their distinctive lifestyles, cultures, and heritage.²⁰ Around 83% of all Indian tribes live in the states of Madhya Pradesh, Maharashtra, Gujarat, Rajasthan, Orissa, Bihar, West Bengal, and Andhra Pradesh. It is important to investigate the prevalence of obesity and metabolic measures as well as their correlation with CVD among adult males and females of tribal groups in different geographic regions because various tribal communities are more vulnerable to different metabolic risk factors that could be connected to their dietary habits and level of physical exercise (Table 1).¹⁹

Table 1: Prevalence of Mets associated CVD among tribal/rural/urban population of India.

Study site	Authors	Prevalence (%)	Population	Population size (n)	References
Shirpur	Chaudhari et al	Mets-78.26%, 33%-female and 67%-males	Tribal	N=145, age= \geq 18 years	26
Mysore, Uttarakhand	Krupp et al	Mets-16.8% to 28.6% CVD-13.5%	Rural	Cohort, n=500, age=30-59 years	27
Uttarakhand	Kandpal et al	Mets-39.2 % predicting CVDs	Tribal	N=288, age=20-60 years	9
West Bengal and Odisha,	Kshatriya	Prevalence of Mets was higher in females	Tribal	N=1434, age=20-60 years.	19

Continued.

Study site	Author	Prevalence (%)	Population	Population size (n)	References
Mysore, Uttarakhand	Hathur et al	Mets-33.7% predicting CVDs	Tribal	N=7500, age=20-60 years	29
North India	Bhatti et al	Mets-71.9%, females-86%, males-57.9%.	Urban	Cohort, n=1522 age=25-91 years,	30
Kerala, Andhra Pradesh	Iyengar et al	Metabolic risk factors were greater in women (p<0.01).	Not mentioned	N=997, age=Men≥55, women ≥ 65 years	31
Kerala, Andhra Pradesh	Harikrishnan et al	Mets-24%, 29% and 33% ATP III, IDF and AHA/NHLBI	Urban/ rural	N=5063	32
Tripura	Sen et al	Cardio metabolic risk=27.24%	Tribal	Cohort, n=365, age=25-65 years	33
Pawapuri, Bihar	Swarn et al	Mets-Females-28.6% Males-20.7% predicting CVDs	Not mentioned	Cohort, n=260, age=≥18 years	34

RISK FACTORS RELATED TO Mets LINKED CVD

Mainly two types of risk factors are there I. Modifiable risk factors are those that can be reduced with the appropriate behavior includes 1. Obesity-The WHO defines overweight and obesity as abnormal or excessive build up of fat deposition that poses a risk to health. Body mass index (BMI), is determined by dividing a person's weight (in kilograms) by the square of his or her height (in meters), to quantify obesity Obese people are usually defined as having a BMI of 30 or higher. Anybody with a BMI of 25 or above is considered overweight.²¹ According to the survey, overweight people make up between 2 and 3% of the Indian tribes.²² 2. Hypertension-A systolic blood pressure of more than 140 mm Hg or a diastolic blood pressure of less than 90 mm Hg, together with the concurrent use of antihypertensive medications, was defined as hypertension in the seventh report of the joint national committee on prevention, identification, evaluation, and treatment of high BP.⁶ Undernutrition and the rise in overweight/ obesity have both been linked to hypertension. India's overall prevalence of hypertension was reported to be 29.8%, with rural areas having a prevalence of 27.6% and urban areas having a prevalence of 33.8%. According to a study Indian tribes had a 16.1% prevalence of hypertension, with significant variation, 3. Dyslipidemia is defined by a decrease in blood high-density lipoprotein cholesterol (HDL-C) concentration and an increase in serum total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), or triglycerides (TG).^{22,23} 4. The medical illness known as diabetes mellitus is characterized by excessively elevated blood sugar (glucose) levels because the body is unable to use or produce insulin as expected.²⁴ All the above characteristics are also the parameters of Mets. Smoking is a major contributor to CVD. Smoke plays a significant role in the development of heart diseases. Smoking has serious negative effects on the heart, endothelial dysfunction, oxidative stress in the blood vessels, and arterial hypertension, 2. Non-Modifiable risk factors are those that cannot be changed includes age, sex, familiarity, etc.^{13,25} A number of risk factors have been connected to CVD, including an unhealthy diet, a lack of

physical exercise, tobacco and alcohol use, pollution, poor sanitation, the absence of community healthcare facilities in rural areas, and dietary patterns. The effects of relating risk factors may show up in individuals as increase in blood pressure, blood glucose, blood lipids, and overweight and obesity. These “intervening risks factors” can be seen in primary care facilities and indicate a high risk of developing a heart attack, stroke, heart failure and other complications.⁸

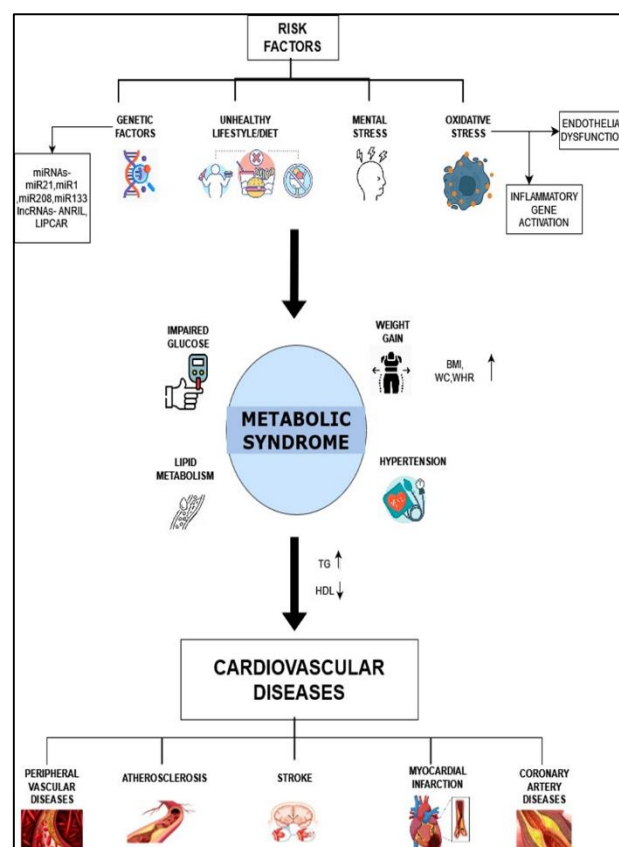


Figure 1: Pathophysiology of risk factors of Mets giving rise to CVDs.

BMI-body mass index, WC-waist circumference, WHR- waist hip ratio, HDL- high-density lipoprotein, LDL- low-density lipoprotein, TG-triglycerides.

In this Figure we are showing that various genetic factors such as [miRNAs and lncRNAs], unhealthy diet, lifestyles, mental stress and oxidative stress are leading to Mets and there are several risk factors of Mets according to NCEP ATP III criteria like hypertension, weight gain, impaired glucose, lipid metabolism which are giving rise to CVDs.

METHODOLOGY

The research articles included in the review were published during the last 15 years, from 2010 onwards. The majority of the publications that were selected showed research on Mets that is related to CVDs. We have mostly concentrated on Indian tribal or rural populations, who are restricted to the most vulnerable society yet becoming susceptible to diseases caused by a sedentary lifestyle.

IMPACT OF Mets IN CVDS

Another risk factor for CVDs that has recently been included is Mets. Heart failure, coronary atherosclerosis and calcification, cardiac dysfunction, myocardial infarction, and microvascular dysfunction are among the range of CVDs that are associated with the Mets. The combination of these risk factors raises the incidence and severity of CVDs. Each Mets component is a separate risk factor for CVDs.⁵ The population of rural and tribal areas in India, which may be confined to the most susceptible society, which are linked to poverty, illiteracy and malnutrition, also has increased frequency of Mets these days. They are earlier thought to be immune to NCDs, which are diseases that are caused by unhealthy lifestyles. However, recent research has shown that the prevalence of NCDs among indigenous population groups is increasing (Table 1).⁹

Resembling many developing nations, India's extensive development efforts and urbanization have resulted in major changes to the lifestyles, employment trends, and food practices of these tribal groups, which were formerly seen of as outreach groups. In tribal groups in India, undernutrition has been a significant source of health concerns.²² According to 2014 study young tribal men are exhibiting a rising tendency to gain weight. This tendency has been proven to be substantially correlated with metabolic risk factors. Regardless of age, tribal girls are high at risk for acquiring metabolic syndrome at lower BMIs, which demonstrates a definite trend towards a double burden of disease among Indian tribal groups (Table 1).¹⁹

Patients in tribal districts with co-occurring metabolic condition and hypertension have higher rates of CVD incidence and all-cause mortality. Farmer housewives with hypertension for 4 to 6 years had a significant prevalence rate. Smoking and chewing tobacco are causes of metabolic disorders, so it's crucial to educate patients

about cessation programs by providing them with the proper counseling (Table 1).²⁶

According to a cohort study conducted in Mysore, India, the Mets affects around one-third of the country's urban residents. The Mets is much less well-known among India's rural residents, who make up 70% of the country's population. Data from 500 rural and tribal women between the ages of 30 and 59 have been obtained; 47.1% of them have Mets. One out of every two women, had Mets (Table 1). In addition to having low HDL (88.4%), high glucose (57.9%), high triglycerides (49.3), and high blood pressure, they also had an increased waist circumference (15.3%) (Table 1).²⁷

According to a study conducted in the rural parts of Gadchiroli India, specifically India's poorest districts, stroke is the most common cause of death, accounting for 1 in 7 fatalities. 229 (14.3%) of the 1599 deaths that occurred during the research period were due to stroke. Women and men did not experience any appreciable differences in the crude stroke fatality rate. A stroke killed 55.4% of those under the age of 70. In comparison to hospital fatalities, the cause-specific mortality proportion due to stroke was considerably greater among non-hospital deaths in terms of home deaths, women outnumbered men. The understanding of stroke symptoms and the effects of delaying treatment is seriously lacking in rural/tribal areas which is a cause for concern.²⁸

GENETIC ASPECTS OF Mets INDUCING CVD

The components of the ATP-III-defined Mets underwent various analysis, revealing common factors that seem to be influenced almost equally by genetic and environmental variations.³⁶ The final pathway of inflammation that results in CVD is influenced by both genetic and acquired variables that are involved in the pathophysiology of Mets.³⁶ The genetic and molecular processes driving the CVDs perturbations in Mets are complicated and interrelated, similar to the physiologic changes seen in obesity/Mets. Proteins, nucleic acids, or metabolites have the potential to offer insights into biological processes while also giving the chance to evaluate all concurrent molecular alterations.⁵ Non coding RNAs (ncRNAs) that participate in epigenetic processes are the RNA transcribed from genome that is DNA but does not code for proteins. By influencing oxidative stress, cell differentiation, proliferation, apoptosis, endothelial dysfunction, necrosis, and autophagy, ncRNAs have been linked to the development of a variety of CVDs. Gene control, chromatin modification, transcriptional and post transcriptional regulation are just a few of the functions that lncRNA (long non coding RNAs) can perform based on their location and interactions with DNA, RNA, and proteins. They may also act as decoys, scaffolds, and enhancer RNA.³⁷ Various types of lncRNAs such as LIPCAR, ANRIL expressions are associated with various CVDs. LIPCAR

expressions are strongly associated with cardiovascular mortality in patients with heart failure.³⁸ ANRIL gene expressions are related to atherosclerosis-associated diseases.³⁹ MicroRNAs (miR), a significant class of post-transcriptional modulators, have been shown to influence the control of cardiovascular and metabolic disorders.⁵ Various miRNAs such as miR21, miR1, miR208, miR133 are associated with the diagnosis and prognosis of CVDs like heart failure, acute myocardial infarction.⁴¹ Growing evidence suggests that circulating miRNAs, or endogenous, stable, single-stranded, short, non-coding RNAs, can be employed as diagnostic biomarkers for CVD. miRNAs and lncRNAs are also possible new therapeutic targets for a variety of cardiovascular diseases.⁴⁰

CHALLENGES IN DIAGNOSIS IN TRIBAL POPULATION

Ischemic heart disease, hypertensive heart disease, and cerebrovascular illness are the most common diseases in India. As the burden of Mets and CVDs are increasing there is a need to screen the patients at district hospital (DH)/community health centers (CHC)/primary health centers (PHC). At the DH/CHC/ PHC level, it is crucial to offer diagnostics for these illnesses, including lipid panels, creatinine and electrolytes, and liver function testing. Furthermore, it is crucial to diagnose acute coronary syndrome using both troponin and CK-MB (creatinine kinase-myocardial band). Although the usage of CK-MB has declined in high-income nations, serum troponin is a high cost test that may not be accessible in all regions of India. Additionally, diagnostic procedures that demand more materials or technical proficient are often only performed at higher tier facilities (such community and district health level).⁴¹ Similarly to diagnose stroke, availability of CT scan and MRI at each and every DH will be very helpful for diagnosis and managements. There are several therapies which demonstrate effective result in treating CVDs cell therapy is one of them in which stem cell therapy has shown to be a successful therapeutic strategy.⁴² But all these therapies are relatively very costly due to which it cannot be performed in rural or tribal areas which leads to increase in cases of Mets related CVD. Patients in low- and middle-income nations are expected to travel to higher levels of care on their own or to seek testing in the private sector because these nations lack an efficient system for delivering robust sample.⁴³

CHALLENGES IN MANAGEMENT IN TRIBAL POPULATION

In tribal groups in India, undernutrition has been a significant source of health concerns. Obesity is a complicated condition and a leading cause of CVD, stroke, cancer, hypertension, diabetes, and early mortality.²² The reversal of social gradients, which has increased the prevalence of tobacco use and low fruit and vegetable intake among people from lower

socioeconomic backgrounds or rural or tribal areas, is a hallmark of the NCDs growth. Additionally, the vegetables eaten in Indian meals are frequently overdone, resulting in the crucial loss of vitamins. Furthermore, those from lower socioeconomic backgrounds frequently do not obtain the best therapy, which has a negative impact on their outcomes.⁴³ It was frequently eminent that undernutrition and dietary deficiencies caused measurements of waist and hip measurements to be lower more than the typical cut-off level. As a result, even when patients met requirements for high blood pressure and high blood glucose cut-off level, they did not meet the IDF's definition of Mets, for example. Tribal populations choose their diet based on availability rather than nutritional merit. The fact that tribal villages are located in isolated and remote places makes it difficult to transfer samples because there aren't any labs within 40-50km of them and the only ones that are at PHC and CHC.⁴⁴

According to a community based cross sectional study conducted among tribal population of Mandla (Madhya Pradesh), it was discovered that the prevalence of hypertension is higher in people who take greater than ten grams of salt daily which suggests a link between salt consumption and hypertension as blood pressure rises with salt consumption. Concerning is the 19% prevalence of hypertension among people with low body mass indexes. Prevalence of hypertension in Madhya Pradesh's adult rural population is approximately identical to that in the adult tribal population.⁴⁵

In India, there is a lack of manpower in the existing health care system at all levels. Not only there is an unequal distribution of healthcare workers between rural and urban India, but also across and within various states and regions. This is demonstrated by Indians' poor compliance with evidence-based treatment options in terms of detection, therapy, and follow-up.⁴³

A study has been done in 12 districts of India with at least 50% of tribal population, surveyed 177 institutions including 156 PHCs/CHCs and 21 district/sub-district hospitals. Most PHCs and CHCs (82-96%) offered outpatient care for diabetes and hypertension. Two of the 14 CHCs lacked facilities for patient drinking water. Only 3% of PHCs had diabetic treatment guidelines, and only 17% had protocols for diagnosing and treating hypertension. This study suggests that the tribal regions under study's health system were underprepared to handle NCDs. The main issues are poorly trained personnel, a lack of supplies, and a lack of tools and medications.⁴⁶

PREVENTIVE MEASURES

Cardiovascular disorders are inversely related to physical activity. Exercise has beneficial effects on cardiovascular system and acts as a stress reliever. The patient is in the best possible physical, mental, and social conditions when engaging in physical activity.⁴⁷ Numerous vegetables, such as potatoes, soyabeans, sesame,

tomatoes, onions, and broccoli, show significant promise in preventing and treating CVDs. A healthy diet also lowers incidence of CVDs. Vegetables exhibit wide range of qualities, including antioxidant, anti-inflammation, anti-platelet, properties, as well as the ability to control blood pressure, blood glucose, and lipid levels.⁴⁸

CONCLUSION

Tribal populations are increasingly showing signs of various Mets-linked CVDs, which is currently a cause for concern. Premature deaths can be avoided by recognizing those at the increased risk of Mets-associated CVDs and ensuring that they get proper care and treatment. Due to the increasing prevalence of CVDs like hypertensive heart disease, stroke, heart failure, diabetes, peripheral vascular disease and obesity, suitable medical and social interventions must be initiated, including health education campaigns and prevention among tribal populations. Awareness camps related to this will play an important role in tribal or rural areas. Special IECs programs should be done in rural and tribal areas. The hub and spoke model for the diagnosis of dyslipidemia may be helpful. Strengthening with manpower, diagnostic facility and supplies should be done in rural and tribal areas because tribal people live in remote areas with fewer facilities. Early general screening for traditional risk factors may raise awareness and encourage lifestyle adjustments that can stop or reduce CVDs. Finally, to prevent NCDs, a healthy lifestyle, a balanced diet, and regular exercise should be a part of school curriculums to raise awareness among peoples from the early age. Management and prevention of cardiovascular morbidity and death might benefit from this.

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