Original Article

Prevalence of Metabolic syndrome among adults in a teaching hospital in Kochi, Central Kerala: A cross-sectional study

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Abstract

Background: Metabolic syndrome is an aggregation of conditions that together increase the risk of cardiovascular disease in individuals, which would not otherwise be recognized to be at risk. Metabolic syndrome increases the risk of developing diabetes mellitus and chronic kidney disease and is associated with a number of other disorders. **Objective:** To find the prevalence of Metabolic syndrome in people attending tertiary care center in Kochi, Kerala. **Materials and Methods**: A total of 520 participants attending the comprehensive health checkup clinic of a teaching hospital in Kochi, Kerala, India, for a period of three months were enrolled in the cross-sectional study. Waist circumference, weight, and height were measured and blood was withdrawn for investigations. **Results:** About 76% (395) of participants met the NCEP: ATP III criteria for Metabolic syndrome. Prevalence of Metabolic syndrome among males was 80.4% and among females was 67.8% (*P*-value < 0.001). **Conclusion:** Metabolic syndrome was highly prevalent in our population.

Keywords: Cardiovascular disease, diabetes mellitus, Metabolic syndrome

Introduction

Metabolic syndrome (MetS) has been widely associated with cardiovascular disease (CVD) and total mortality risks primarily in the middle-aged.[1] The incidence rate of coronary heart disease (CHD) and the prevalence of the MetS both increases with age, suggesting an association between the MetS and CHD risk in elderly. This association was found to have public health implications,[2] and if MetS is detected early by a family physician, who is the care giver at the primary level, and if proper lifestyle modifications and drugs started, CHD risk can be reduced in elderly.

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Background

MetS is a major clinical and public health challenge throughout the world due to urbanization, excess energy intake, increasing obesity, and sedentary lifestyle. MetS increases the risk of type-2 diabetes mellitus (T2DM) and increases the risk of developing CVD over the next 5–10 years.[1] Furthermore, patients with the MetS have increased risk of stroke, a three- to fourfold increased risk of myocardial infarction (MI), and twofold the risk of dying from such an event compared with those without the syndrome[2] regardless of a previous history of cardiovascular events.[3] MetS is often regarded as a first-order risk factor for atherothrombotic complications. Its presence or absence should, therefore, be considered an indicator of long-term risk. On the other hand, the short-term (5–10 years) risk is better calculated using the classical algorithms [Framingham, REGICOR (Registre GIroní del COR)], as they include age,

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sex, total cholesterol or low density lipoprotein (LDL), and smoking.[4] Underlying risk factors for MetS appear to be abdominal obesity and insulin resistance, a generalized metabolic disorder in which the body is unable to use insulin efficiently. MetS is also sometimes called insulin resistance syndrome. Some individuals are genetically predisposed to insulin resistance and physical inactivity and obesity can elicit insulin resistance in these individuals. However, most people with insulin resistance have abdominal obesity. Poorly understood complex biological mechanisms at the cellular level appear to link insulin resistance with other metabolic risk factors.

The history of MetS reflects the recognition of the concept of insulin resistance and its consequences as well as the recognition of adipose tissue as a physiologically active organ (Leslie, 2005, p. 264).[5] First to use the phrase "Metabolic syndrome" was Hanefield and Leonhardt. In 1981, they used this phrase to describe the joint incidence of hyperlipoproteinemia, diabetes, hypertension, gout, and obesity in combination with an increased incidence of CVD, fatty liver, and cholelithiasis (Leslie, p. 266).[5]

In 1985, Modan and his associates proposed a syndrome of insulin resistance or hyperinsulinemia as a common pathophysiological feature for obesity, hypertension, and glucose intolerance, which could possibly explain their common association (Leslie, 2005, p. 266).[5] Syndrome X was the name proposed by Reaven in a 1988 lecture to the American Diabetes Association (ADA). According to Reaven, Syndrome X was a group of associated conditions that were important in the development of coronary artery disease and included hyperinsulinemia, glucose intolerance, hyperglycemia, elevated low-density lipoprotein cholesterol, and hypertension all resulting from resistance to insulin mediated glucose uptake. Syndrome X has also been called Reaven's syndrome (Leslie, 2005, p. 266).[5] Kaplan coined the term "deadly quartet" for the association of upper body obesity, hypertension, hypertriglyceridemia, and glucose intolerance in which hyperinsulinemia played the key pathogenic role. Defronzo and Ferrannini developed the term "insulin 10 resistance syndrome" to define a syndrome of noninsulin-dependent diabetes, hypertension, dyslipidemia, atherosclerotic CVD, and obesity. Zimmet developed "syndrome X plus" that included the elements of syndrome X as defined by Reaven, but also included upper body obesity, hyperuricemia, physical inactivity, and aging (Leslie, 2005, p. 266).[5]

Finally, Hjerrman proposed renaming syndrome X "metabolic cardiovascular syndrome" or "atherothrombogenic syndrome." In addition to the components of syndrome X, he noted the presence of atherogenic, small, dense low-density lipoprotein cholesterol that accompanied low high-density lipoprotein cholesterol in the presence of a raised level of very low density lipoprotein triglyceride, even in the absence of hypercholesterolemia. He also noted an increased tendency for thrombosis from elevated levels of fibrinogen, factor VIIc, and elevated plasminogen activator inhibitor-1 (Leslie, 2005, p. 266).[5]

In 2001, the Centers for Disease Control and Prevention approved the request by the American Association of Clinical Endocrinologists (AACE) for a new diagnostic code, ICD-9-CM 277.7 for "Dysmetabolic Syndrome X" and, thus, created a new disease. Although the AACE website lists 12 criteria for the dysmetabolic syndrome X, the CDC does not require that a given number of components be present to use the International classification of diseases (ICD) code. The code may be used if the physician determines that the dysmetabolic syndrome X is present based on their professional opinion (Leslie, 2005, p. 266).[5] Currently, there are many criteria for defining MetS. Most accepted ones are the International Diabetes Federation (IDF) criteria, World Health Organization (WHO) criteria, The European Group for the Study of Insulin Resistance (EGIR), American Association of Clinical Endocrinologists (AACE), and National Cholesterol Education Program–Adult Treatment Plan 3 (NCEP: ATP 3) criteria [Table 1]. In this study, the diagnosis of MetS was based on the NCEP: ATP 3 criteria.

Aim

To find the prevalence of MetS in people attending teaching hospital in Kochi, Kerala.

Materials and Methods

It was a cross-sectional study done in a teaching hospital in Kochi, Kerala, India. Study subjects included both males and females between the age group of 20–60 years attending comprehensive health checkup clinic of our hospital. Among the 520 participants, 337 were males and 183 were females. Each subject was interviewed and computed a standardized questionnaire containing information on demographics, anthropometric profile, individual characteristic associated with major risk factors for CVD, past medical history, and biochemical parameters. Hypertension was identified from self-reports or doctor measurement on the baseline and follow-up measures or questionnaires meeting at least one of three JNC8 criteria: systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or use of antihypertensive medicines. Incident hypertension was defined as newly developed hypertension among those free of baseline hypertension. The definition of incident hypertension is patient self-report or doctor measurement. Prevalence of diabetes and hypertension was ascertained based on self-report of the physician's diagnosis and/or use of prescription medications along with medical records. All participants gave their written informed consent to participate in the study that was approved by the institution ethics committee.

Inclusion criteria

- Age group–20 to 60 years
- Both sexes
- People with known/diagnosed for the first time, with hypertension, diabetes mellitus, and dyslipidemia.

Table 1: Diagnostic criteria proposed for the clinical diagnosis of the MetS

Clinical measures	WHO (1998)	EGIR (1999)	ATPIII (2001)	AACE (2003)	IDF (2005)
Insulin resistance	IGT, IFG, T2DM, or lowered insulin Sensitivity[a] plus any 2 of the following	Plasma insulin >75th percentile plus any 2 of the following	None, but any 3 of the following 5 features	IGT or IFG plus any of the following based on the clinical judgment	None
Body weight	Men: waist-to-hip ratio >0.90; women: waist-to-hip ratio >0.85 and/or BMI >30 kg/m^2	WC ≥94 cm in men or ≥80 cm in women	WC ≥102 cm in men or ≥88 cm in women	BMI ≥25 kg/m^2	Increased WC (population specific) plus any 2 of the following
Lipids	TG s ≥150 mg/dl and/or HDL-C <35 mg/dl in men or <39 mg/dl in women	TGs≥150 mg/dL and/or HDL-C <39 mg/dL in men or women	TGs≥150 mg/dL HDL-C <40 mg/dL in men or <50 mg/dL in women	TGs ≥150 mg/dL and HDL-C <40 mg/dL in men or <50 mg/dL in women	TGs ≥150 mg/dL or on TGs Rx.HDL-C <40 mg/dL in men or <50 mg/dL in women or on HDL-C Rx
Blood pressure	≥140/90 mm Hg	≥140/90 mm Hg or on hypertension Rx	≥130/85 mm Hg	≥130/85 mm Hg	≥130 mm Hg systolic or ≥85 mm Hg diastolic or on hypertension Rx
Glucose	IGT, IFG, or T2DM	IGT or IFG (but not diabetes)	>110 mg/dL (includes diabetes)	IGT or IFG (but not diabetes)	≥100 mg/dL (includes diabetes)[b]
Other	Microalbuminuria: Urinary excretion rate of >20 mg/min or albumin: creatinine ratio of >30 mg/g.			Other features of insulin resistance[c]	

[a]Insulin sensitivity measured under hyperinsulinemic euglycemic conditions, glucose uptake below lowest quartile for background population under investigation. [b]In 2003, the ADA changed the criteria for IFG tolerance from >110 mg/dl to >100 mg/dl[6] [c]Includes family history of T2DM, polycystic ovary syndrome, sedentary lifestyle, advancing age, and ethnic groups susceptible to T2DM. BMI: body mass index; HDL-C: high density lipoprotein cholesterol; IFG: impaired fasting glucose; IGT: impaired glucose tolerance; Rx: receiving treatment; TGs: triglycerides; T2DM: type 2 diabetes mellitus; WC: waist circumference.

Exclusion criteria

- Age group–below 20 years and above 60 years
- People with chronic renal, hepatic, cardiac, gastrointestinal, skeletal, endocrine diseases (except diabetes), acute critical illness, and pregnancy
- People on calcium or vitamin D supplementation.

Biochemical analysis

Peripheral venous blood samples (4 ml) were collected from all the participants after an overnight fast of 12–14 h. Serum was separated by centrifuging at 3000 rpm for 5 min. Blood glucose was estimated by hexokinase method on Olympus AU2700 analyzer. Blood urea was estimated by enzymatic urease method and serum creatinine by Jaffe's method. Serum calcium was estimated by the Arsenazo III method. Liver function was estimated by the colorimetry method on Olympus AU2700 analyzer. High-density lipoprotein (HDL), LDL, very low density lipoprotein (VLDL), and triglycerides were estimated by an enzymatic method on Olympus AU2700 analyzer.

Results

A total of 520 subjects [337 (64.80%) males and 183 (35.2%) females] participated in the study [Figure 1]. Average age of the participants were 45.92 ± 9.77. About 31.54% of the participants were below 40 years and 68.46% of the participants were above 40 years [Graph 1]. Prevalence of MetS in our population was 76% (395) [Table 2 and Graph 2]. Prevalence of MetS among males was 80.4% and among females was 67.8% [Graph 3]. About 80.4% (271) of males had MetS and 19.6% (66) of males did not have MetS. About 67.8% (124) of females had MetS and 32.2% (59) of females did not have MetS (*P*-value < 0.001) [Table 3].

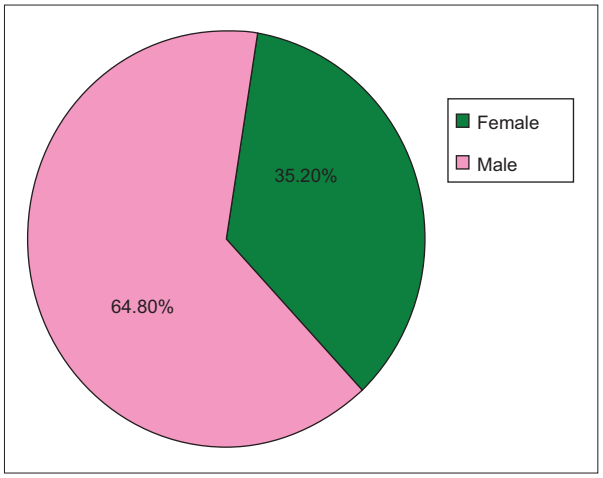


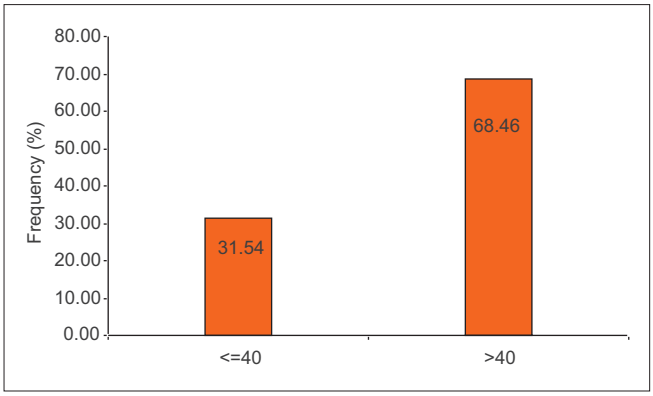
Figure 1: Percentage of males and females in the study

Conclusion

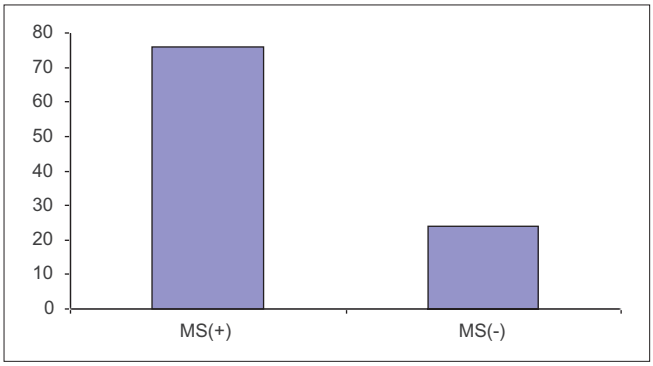
This study showed a high prevalence of MetS in this population of Kochi, Kerala, India, emphasizing the need for a widespread comprehensive noncommunicable disease prevention and control program.

Discussion

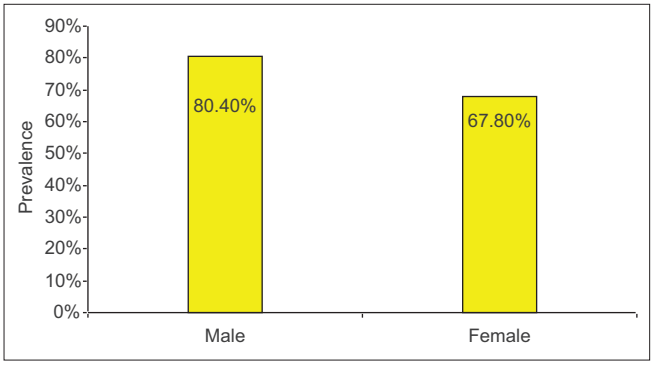
Out of 520 subjects, 337 were males and 183 were females. Prevalence of MetS in our population was 76% (395). Prevalence



Graph 1: Percentage of participants above and below 40 years



Graph 2: Prevalence of MetS (NCEP: ATP 3 Criteria)



Graph 3: Prevalence of MetS in Males and Females (NCEP: ATP 3 Criteria)

of MetS among males was 80.4% and among females was 67.8% (*P*-value < 0.001). This cross-sectional study of adequate statistical power and representativeness (n = 520) was conducted for the first time among an urban population in Kochi, Kerala, India, named Gods own country and a region with unique lifestyles and culture. A very high prevalence rate was reported in our population. Older age, male sex, general obesity, and hypercholesterolemia significantly contributed to an increased MetS risk among our urban population. There is an increasing trend in the prevalence of MetS in India, both in the urban and rural population, ranging from 11% to 41%.[7] There are differences in the prevalence of MetS between studies from different parts of India, which can be due to different criteria, inclusion of different age groups, and different rates of

Table 2: Prevalence of MetS

Metabolic Syndrome	Frequency	Percent
Present	395	76.0
Absent	125	24.0

Table 3: Association between MetS and Gender

Gender	MetS		*P*
	MS (-)	MS (+)	
Females	59 (32.2)	124 (67.8)	<0.001
Males	66 (19.6)	271 (80.4)	

prevalence of individual components of the MetS. A prevalence study of urban population in northern part of India reported a prevalence of 22.37% for MetS.[8] Males had significantly higher rates of MetS (80.4%) compared to females (67.8%) in this study. In NHANES III data, the prevalence differed only little among males (24.0%) and females (23.4%).[9] In a study conducted by Agarwal in 2016[10] in Uttar Pradesh, MetS was associated with depression. In a study conducted by Yang[11] in Taiwan in 2016, MetS was associated with nonalcoholic fatty liver disease. In a study conducted by Acharyya[12] in 2016 in Bangladesh, MetS was associated with chronic obstructive pulmonary disease. In a study conducted by Efui *et al.*[13] in 2018 in Ghana, prevalence of MetS was 46%. In a review conducted by Rask *et al.*[14] in 2018, the pharmacological management of MetS has been discussed. In a systematic review conducted by Sivanesan *et al.*[15] in 2019, preventive effect of naringin on MetS and its mechanism of action have been discussed. We also found that the prevalence of MetS increased with age in both sexes. The higher prevalence of MetS in Asian Indians is of particular concern, as it implies that they will have a more prolonged exposure to atherosclerotic risk factors associated with MetS. In this study, MetS was significantly more prevalent in among upper socioeconomic classes compared to lower socioeconomic strata. Accordingly, socioeconomic status has emerged as an independent risk predictor for MetS in logistic regression analysis. In this context, this study presents the most recent prevalence rates for MetS in an urban population aged 20–60 years from Kochi, Kerala, India. This study estimated very high prevalence of MetS among the urban population in Kochi, Kerala, India. All the known classical cardiovascular risk factors were also found to be significant predictors of MetS in this study. However, published reports suggest that predictive risk factors are associated with risk of MetS in different combinations in different populations across the country.

Primary care physicians need to be more effective at helping patients adopt healthy lifestyle habits as lifestyle modification form an important part of MetS. Lifestyle counseling is a barrier for most of the primary care physicians. Patient-centered methodologies accompanied by supportive office systems can make the primary care physician more effective. Family physicians should be able to assess patient's knowledge about the relationship of their lifestyle to their health, then provide a clear message about the importance of diet and exercise for their specific

problem. Family physicians should try to help patients identify short- and long-term goals and barriers to change. Questions such as: "How do you think that your diet (or exercise level) affects your health?" or "What problems did you encounter in trying to change your diet (or level of activity)?" can help the physician identify effective next steps for each patient. The answers to these questions should be recorded in the medical record and reviewed at subsequent visits to help patients identify and address barriers to lifestyle changes. For patients, whose risk factors are not reduced adequately by lifestyle modifications, drugs to control their blood pressure, sugar levels, and lipid levels can be given at an earlier stage by family physicians, since they are the primary care givers.

This is the first study conducted in one of the cities of Kerala, with socioeconomic transition mainly attributed to large-scale industrialization and urbanization. Cardiometabolic risk is high in Asian Indians/South Asians, starting at an early age. Increasing awareness of cluster of risk factors and how to prevent them comprehensively should be emphasized in population-wide prevention strategies in Asian Indians, in particular, and South Asians, in general.

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Conflicts of interest

There are no conflicts of interest.

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