

DOI: <https://dx.doi.org/10.18203/2319-2003.ijbcp20233913>

Review Article

Metabolic syndrome: a comprehensive review

Ramachandra Bhat C.*, Santhosh T., Sudha K. M.

Institute of Pharmacology, Madras Medical College, Chennai, Tamil Nadu, India

Received: 09 October 2023

Revised: 07 November 2023

Accepted: 08 November 2023

***Correspondence:**

Dr. Ramachandra Bhat C.,

Email: Bhatcr@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Metabolic syndrome (syndrome X) includes several components like diabetes, hypertension, hyperlipidemia etc. Every patient should undergo detailed assessment for the silent presence of the components of metabolic syndrome. Genetic predisposition, increased nutrient-dense food, decreased physical activity and chronic stress are common in metabolic syndrome. Insulin resistance, obesity and hyperglycaemia are commonly seen which can later lead to serious consequences like cardiovascular complications, thrombotic events etc. Clinical features depend on the components of the metabolic syndrome in a patient. Some may present with complications and advanced disease. For non-diabetic individuals, oral glucose tolerance test is indicated. It is better to study serum uric acid level and to screen for silent kidney stones. Specific drugs are prescribed as indicated. Drugs for stress and insomnia are also prescribed. Thrombotic status of the patient should be considered, and antiplatelet drugs are prescribed if risk factors are present. Non-pharmacological measures like diet modification and increased physical activity should be given on a priority basis. Patient compliance of these two measures should be monitored regularly. Future deployment of “artificial intelligence – powered” predictive diagnostic tests will help in detecting and controlling metabolic syndrome. “At risk” individuals and patients showing some components of metabolic syndrome should undergo full investigations to detect other components of metabolic syndrome. Full range of therapeutic drugs, diet modification and increased physical activity should be prescribed.

Keywords: Metabolic syndrome, Hypertension, Diabetes, Hyperlipidaemia, Insulin resistance, Hyperglycaemia, Hyperinsulinemia, Kidney stones

INTRODUCTION

Metabolic syndrome, otherwise called as “Syndrome X” is a major public health issue. Diagnosis is made on individual component basis as and when abnormalities are noted. For ex. diabetes or hyperlipidaemia etc. It includes obesity, hyperglycaemia, hyperlipidaemia, hypertension, higher plasminogen activator inhibitor levels etc.¹ It also includes hyperuricaemia and hepatic steatosis.² Comprehensive clinical approach with broad based investigations will reveal the whole picture. This will help better management aided by specific lifestyle recommendations. This will also help improve metabolic syndrome patients’ quality of life.³ This article aims to bring out the need for all investigations needed for

metabolic syndrome and outline the management approaches required.

ETIOLOGY

Common causative agents leading to metabolic syndrome are increasing sedentary lifestyle, lack of physical activity with simultaneous nutrient-rich “fast” food. These factors are also accompanied by increasing stress levels.

PATHOGENESIS

When the above-mentioned etiological factors lead to obesity, that stage involves increasing insulin levels, insulin resistance along with obesity heralding

carbohydrate intolerance. Obesity, in turn, contributes to more insulin resistance. Hyperglycaemia is a silent factor during this pathogenesis stage.¹ Physical fitness, as measured by maximum aerobic capacity also modulates insulin action.¹⁻³ Obese individuals having insulin resistance are at higher risk for cardiovascular diseases. Impaired insulin action, insulin secretory dysfunction, obesity and increased endogenous glucose output are commonly seen in diabetes.⁴ Diabetes, hypertension and metabolic syndrome had higher association with bladder cancer in a study.⁵ It is right time to note that Dr Gerald Reaven, in his Banting lecture in 1988, proposed “insulin resistance” as the underlying factor for all the abnormalities included as “Syndrome X”.² Obesity leads to aging in adipose tissues with consequences like inflammation, short telomeres and loss of tumor suppressor genes.⁶ High insulin levels following insulin resistance will have more actions of insulin in those tissues not showing insulin resistance. This may lead to consequences like hypertension, polycystic ovaries etc.⁷ Insulin resistance also causes systemic inflammation.⁷ Reactive oxygen species levels, ectopic fat accumulation and reduced fat oxidation are implicated in insulin resistance.⁸ It is interesting that insulin resistance develops earlier in liver as seen in animal experiments when overnutrition was studied but skeletal muscle insulin resistance develops earlier in human beings.⁹ These factors highlight that management of “insulin resistance” should take the main role in managing patients with metabolic syndrome. It is interesting to note that those who sleep less have more chance of metabolic syndrome.¹⁰

CLINICAL FEATURES

It depends on specific component of metabolic syndrome in a particular patient. Symptoms of diabetes or hypertension are more common presentations. Insomnia may be a presenting symptom in some patients. Acanthosis nigricans can be a presenting symptom. Otherwise, it must be looked for in suspected insulin resistance individuals.¹¹ Stress, if any, should be identified. Dental pathology is often overlooked in many situations. It is to be noted that metabolic syndrome patients tend to have higher probability of periodontitis.¹²

INVESTIGATIONS

All investigations as required for the symptoms are done. Additionally, it is desirable to investigate for the presence of other components of metabolic syndrome as well. Investigations to look for all comorbid conditions and for complications like prothrombotic states are carried out. Regarding hyperglycaemia, oral glucose tolerance test is indicated in non-diabetic individuals.³⁻¹² As hyperuricemia is a component of metabolic syndrome, it is better to monitor serum uric acid levels also. Serum uric acid level was found associated with metabolic syndrome in a previous study.¹³ It is also desirable to look for stones in urinary tract which might be asymptomatic as fructose is thought to be a contributing factor leading to kidney stones

in metabolic syndrome.¹⁴ Metabolic syndrome patients are at higher risk for adverse cardiovascular events.¹⁵ Hence, careful assessment of their cardiovascular status is needed.

Table 1: Tests indicated in a metabolic syndrome patient.

Tests
Blood sugar tests. GTT needed before ruling out diabetes mellitus
Lipid profile
BMI calculation
Blood pressure measurement and ECG for cardiovascular assessment
Serum uric acid level
USG abdomen for fatty liver changes and renal calculi
Skin examination for acanthosis nigricans

MANAGEMENT

Pharmacological approach

It includes drugs as indicated for the specific components of the metabolic syndrome. For ex: anti diabetes drugs, antihypertensive drugs, antihyperlipidemic drugs besides antiplatelet drugs wherever indicated. Drugs, if needed, for relieving stress and insomnia are indicated.

Table 2: Recommended action plan for a metabolic syndrome patient.

Action plan
Diabetic diet. Salt restriction for hypertensives
Walking, at least 30 minutes a day
Weight loss diet for obese individuals
Insulin sensitizers for individuals with insulin resistance
Lifestyle modification with focus on reducing stress. Sedative-hypnotics, if indicated
Dental care
Counselling for lifestyle modification, stress etc
Health education regarding ADRs to drugs used
Patient education to stress the importance of follow-up visits

Non-pharmacological approach

This includes diet modification as indicated by the presence of diabetes or hypertension. Weight loss diet is also beneficial, especially for those with insulin resistance.¹ Patients must be motivated to increase fibre intake which has numerous beneficial roles. Resveratrol is also beneficial for metabolic syndrome patients.¹⁶ Regarding the role of probiotics in metabolic syndrome, probiotics showed benefits in metabolic parameters in some studies, but larger studies need to be done to show their benefits.¹⁷ Counselling for stress management is a must for patients with Syndrome X. Sympathetic overactivity must be looked for while treating

hypertension. Short term substitution of simple sugars in diet will go a long way in reducing intra hepatic fat.⁷ Sleep time and media time also to be monitored for better results in children.⁷ Shift workers have a higher chance of developing metabolic syndrome.¹⁸ Hence, they need modification in shift time also. Lifestyle intervention, in general, is beneficial in improving quality of life of metabolic syndrome patients.¹⁹ Diet modification and increased physical activity are the twin corner stones in the management of metabolic syndrome. Dairy fat also seems to have beneficial effect in metabolic syndrome.²⁰

CONCLUSION

At risk individuals and individuals showing some component of metabolic syndrome must undergo investigations for the presence of other components of metabolic syndrome. All such individuals must undergo diet modification and increased physical activity on a priority basis besides having drugs as prescribed by the physician.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: Not required

REFERENCES

1. Reaven G, Abbasi F, McLaughlin T. Obesity, insulin resistance, and cardiovascular disease. *Recent Prog Horm Res.* 2004;59:207-23.
2. Metabolic syndrome. Available at: https://en.wikipedia.org/w/index.php?title=Metabolic_syndrome&oldid=1174758966. Accessed on 20 August 2023.
3. Saboya PP, Bodanese LC, Zimmermann PR, Gustavo AD, Assumpção CM, Londero F. Metabolic syndrome and quality of life: a systematic review. *Rev Lat Am Enfermagem.* 2016;24:e2848.
4. Zaman SG. Pathogenesis of insulin resistance, Cellular Metabolism and Related Disorders. Intechopen. 2020.
5. Ahmadinezhad M, Arshadi M, Hesari E, Sharafoddin M, Azizi H, Khodamoradi F. The relationship between metabolic syndrome and its components with bladder cancer: a systematic review and meta-analysis of cohort studies. *Epidemiol Health.* 2022;44:e2022.
6. Wondmkun YT. Obesity, Insulin Resistance, and Type 2 Diabetes: Associations and Therapeutic Implications. *Diabetes Metab Syndr Obes.* 2020;13:3611-6.
7. Ighbariya A, Weiss R. Insulin Resistance, Prediabetes, Metabolic Syndrome: What Should Every Pediatrician Know? *J Clin Res Pediatr Endocrinol.* 2017;9(2):49-57.
8. Lee SH, Park SY, Choi CS. Insulin Resistance: From Mechanisms to Therapeutic Strategies. *Diabetes Metab J.* 2022;46(1):15-37.
9. Petersen MC, Shulman GI. Mechanisms of Insulin Action and Insulin Resistance. *Physiol Rev.* 2018;98(4):2133-223.
10. Iftikhar IH, Donley MA, Mindel J, Pleister A, Soriano S, Magalang UJ. Sleep Duration and Metabolic Syndrome. An Updated Dose-Risk Metaanalysis. *Ann Am Thorac Soc.* 2015;12(9):1364-72.
11. Martins LM. Type B insulin resistance syndrome: A systematic review. *Arch Endocrinol Metab.* 2011;12:32-9.
12. Daut LD, Musskopf ML, Mendez M, Remonti LLR, Leitão CB, Gross JL, et al. Association between metabolic syndrome and periodontitis: a systematic review and meta-analysis. *Braz Oral Res.* 2018;32:e35.
13. Dai X. Association between serum uric acid and the metabolic syndrome among a middle- and old-age Chinese population. *Eur J Epidemiol.* 2013;28(8):669-76.
14. Johnson RJ, Perez-Pozo SE, Lillo JL, Grases F, Schold JD, Kuwabara M, et al. Fructose increases risk for kidney stones: potential role in metabolic syndrome and heat stress. *BMC Nephrol.* 2018;19(1):315.
15. Alshammary AF, Alharbi KK, Alshehri NJ, Vennu V, Ali Khan I. Metabolic Syndrome and Coronary Artery Disease Risk: A Meta-Analysis of Observational Studies. *Int J Environ Res Public Health.* 2021;18(4):1773.
16. Batista-Jorge GC, Barcala-Jorge AS, Silveira MF, Lelis DF, Andrade JMO, de Paula AMB, et al. Oral resveratrol supplementation improves Metabolic Syndrome features in obese patients submitted to a lifestyle-changing program. *Life Sci.* 2020;256:117.
17. Sáez-Lara MJ, Robles-Sanchez C, Ruiz-Ojeda FJ, Plaza-Diaz J, Gil A. Effects of Probiotics and Synbiotics on Obesity, Insulin Resistance Syndrome, Type 2 Diabetes and Non-Alcoholic Fatty Liver Disease: A Review of Human Clinical Trials. *Int J Mol Sci.* 2016;17(6):928.
18. Sooriyaarachchi P, Jayawardena R, Pavey T, King NA. Shift work and the risk for metabolic syndrome among healthcare workers: A systematic review and meta-analysis. *Obes Rev.* 2022;23(10):e13489.
19. Marcos-Delgado A, Hernández-Segura N, Fernández-Villa T, Molina AJ, Martín V. The effect of lifestyle intervention on health-related quality of life in adults with metabolic syndrome: a meta-analysis. *Int J Environ Res Public Health.* 2021;18(3):887.
20. Clifton P. Metabolic Syndrome-Role of Dietary Fat Type and Quantity. *Nutrients.* 2019;11(7):1438.

Cite this article as: Bhat RC, Santhosh T, Sudha KM. Metabolic syndrome: a comprehensive review. *Int J Basic Clin Pharmacol* 2024;13:181-3.