Integral Research
(ISSN: 3048-5991) Coden: IRABCA

Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

The Art and Science of Metabolic Syndrome: A Naturalistic Approach

[1]Prof. Mirza Sibtain Beg ✉ [2]Prof. Dilshad Husain Rizvi

[1]Department of English, Shia P.G. College, Lucknow, U.P., India.
[2]Department of Pharmacology, Era Medical College, Lucknow, U.P., India.

Metabolic syndrome is a conundrum of some metabolic conditions like hypertension, diabetes mellitus, fatty liver, hyperlipidaemia, hyperuricemia, hypertriglyceridemia and cardiovascular diseases along with apple-shaped obesity. Most of Indian people are, unfortunately, not metabolically very resilient, and abdominally obese with insulin resistance residing in visceral fat. They are unable to use insulin mellifluously secreted by pancreas because of the resistance this fat offers, consequently metabolic syndrome props up with gratuitous manifestations. Metabolic syndrome has brought cascading epidemic-affecting one fourth adult population of the world-and posing threats belligerently to health, longevity, and quality of life of the masses. The abovementioned biomarkers are linked with one another and mar the lifespan. It is lifestyle disorder, so necessitates lifestyle modifications to control its pejorative progression. If it is not redressed timely and tenuously then its volcanic wrath yields insulin resistance giving birth to deadly diseases like diabetes and hypertension. Thus, Metabolic syndrome is a foremost factor of morbidity and mortality worldwide and has become an interface to explore new vistas to tackle its menace. Though, so many pharmaceutical companies offer medicines that are proven invariably very useful. But there remains a scope in the use of nutraceuticals in the treatment of metabolic ailments. The paper is a humble attempt to explore newer therapies, and natural approaches to address metabolic syndrome. However, the paper pinpoints the importance of naturopathy and natural products to manage and manoeuvre metabolic syndrome.

Keywords: Metabolic syndrome, obesity, insulin resistance, diabetes mellitus, hyper lipidaemia, hypertension, and cardiovascular diseases.

Metabolic syndrome is a major and surging medical health challenge all across the globe springing due to distancing from nature, high calories intake, embracing obesity, and gracing sedentary lifestyle. Dr. N.M. Kaplan of Texas University, Dallas in his work "The Deadly Quartet" (1989), opined that Metabolic syndrome is the combination of upper body obesity, glucose intolerance, hypertriglyceridemia, and hypertension. However, in 1992, Metabolic syndrome was termed as "The Insulin Resistance Syndrome". In early nineties, it was prevalent more in men (39%) than in women (33%) in depending on the environment, age, and ethnicity, sedentary life, and high Basic Mass Index (BMI), and low Basal Metabolic Rate (BMR) etc. Initially, Insulin Resistance (IR) and central obesity were considered as primary causative factors, and genetics, physical inactivity, aging and inflammation were taken secondary with symptoms as enlarged waist circumference, high blood pressure, and skin tags (acanthosis nigricans) at the neck or under armpits.

Metabolic syndrome (MS) is one of the most burning issues regarding health in the present day world scenario, it has desecrated and decimated the fabric of world's population, affecting acrimoniously, at least, one out of the four people everywhere. The surge in metabolic syndrome stems from many factors, such as stress, sedentary lifestyle, sleep deprivation, high intake of carbohydrates and ultra -processed food. Metabolic syndrome has been defined and described as conglomerate of so many factors as hyperglycaemia, abdominal obesity, hypertension, hyperinsulinemia, insulin resistance, hypertriglyceridemia, low plasma high- density lipoprotein (HDL), and higher levels of low- density lipoprotein (LDL). In addition, age related things and hormonal

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

changes have been associated with the development of metabolic syndrome (Kassi et al., 2010)). Several pathological disorders closely co-related to metabolic syndrome including liver diseases as non-alcoholic fatty liver disease (NAFD), non-alcoholic steatohepatitis (NASH) (Benedict M., et al., 2017). National Cholesterol Education Programme (NCEP) Adult Treatment Panel III (ATPIII) devised a diagnostic criterion for the metabolic syndrome, and it is most widely considered criteria of metabolic syndrome hovering around measurements and pathology. This criterion includes the key factors of visceral obesity, atherogenic dyslipidaemia, hyperglycaemia, and hypertension. It emphasises that at least three of five factors that entail metabolic syndrome. It is summarised in the following table pmc.ncbi.nlm.nih.gov):

S. No.	Diagnostic Criteria	Measurements
1.	Central Obesity	waist circumference ≥102 cm (Males) ≥88 cm (Females)
2.	Hypertriglyceridemia	Triglycerides ≥ 150 mg/dl
3.	Low HDL Cholesterol (High-density Lipoprotein)	Males≤40 mg/dl Females≤50 mg/dl
4.	Hypertension (High Blood Pressure)	BP ≥130mgHg(Systolic) BP ≤ 80 mg Hg (diastolic)
5.	Hyperglycaemia (High Blood Glucose Levels)	FPG≥100mg/dl PPG≥ 140mg/dl

Factors Causing Metabolic Syndrome:

Lifestyle

The sedentary lifestyle plays important role in the prevalence and progression of metabolic syndrome, and adapting healthy lifestyle can diminish its occurrence. Those who lick to mobile phones or televisions for long hours, are found more susceptible to the syndrome. In addition, inadequate physical activity or muscular contraction seems to interfere triglyceride as well as glucose (Thorp et al.,2010). Inclusion of exercise, low calories intake, less fats especially unhealthy, and reduction in carbohydrates intake inferred good results in people grappling with metabolic syndrome.

Diet

Diet has a major role in progression of metabolic syndrome (Aron et al. ,2016). Consumption of complex carbohydrate, more fibres, limited intake of meat, vegetables and fibrous fruits cast noticeable effects. Of effect, prolonged consumption of high fat diet concentrations induces deposition of fat and fat-derived lipotoxins in liver, skeletal muscle, and pancreas which develops insulin resistance (Erion & Shuleman, 2010). It is seen that protein rich breakfast after waking up in the morning, sets off subtle and steady effects that fetches the sense of satiety whole day. It brings metabolism on the right axis, lowers insulin spikes. Weneed to avoid snaking after the meals. 25-30 g protein early in the day activates Ghrelin-the hormone of satiety, and stimulates GLP 1 that keeps hunger calm, without overwhelming the system. It slows down digestion of amino acids, and muscles store energy well.

Received 09 January 2026; Accepted 27 January 2026. Available online: 30 January 2026. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

Smoking and Alcohol

Smoking and drinking alcohol may cause metabolic syndrome. Smoking was found to reduce the insulin insensitivity, increase cardiovascular risk factor, and upgrade the levels of triglycerides (Cena et. Al. ,2010), Extreme long use of tobacco and nicotine increase leptin hormones levels leads to more food consumption causing obesity. Prolonged consumption of alcohol increases insulin level causing fatty liver and metabolic syndrome.

Stress

Stress and sedentary life style add to ill metabolic health. High stress develops metabolic syndrome by activating hypothalamic-pituitary-adrenal (HPA) axis, giving surge to cortisol levels, and sympathetic nervous system. High levels of cortisol bring behavioural changes including craving for sugary and high carbohydrate foods, physiological pangs like insulin resistance, inflammation, weight gain and ultimately metabolic syndrome.

Inadequate Sleep

Metabolic syndrome is the progenitor of appalling diseases obesity, fatty liver, diabetes, vascular diseases, and other serious ailments. Inadequate and excessive sleep leads to increase the risk of poor metabolic health. It increases because of two processes: much rapid eye movement (REM) or not having sufficient slow wave sleep SWS). Sleep inadequacy is believed to be one of the major risk factors for the development of metabolic syndrome. Medic et. Al opined:" Long term risks of the sleep disruption include cardiovascular disease metabolic syndrome, type II diabetes mellitus, dyslipidaemia, etc. (Medic…et. al. , 2017) ". With dietary changes like low carbs, healthy fats, proteins, probiotics and supplements like resveratrol that is found in cherries, red grapes, and peanuts along with healthy life style, we can cure metabolic syndrome.

Inflammation

Various humoral substances like TNF-α, leptin, and adiponectin are produced by adipose tissue that cause inflammation leading to metabolic syndrome. Chronic inflammation is a cause and consequence of metabolic syndrome, marked by high blood pressure, high levels of sugar in blood, elevated triglycerides and excess fat in body. Excess body fat activates immune cells like monocytes and macrophages, that determines the high inflammatory substances, a causative factor of insulin resistance.

Defects in Insulin Signalling Pathway

Verily, metabolic syndrome germinates from the complex breakdown of communication and coordination between multiple signalling networks that substantiate homeostasis, inflammation and growth. Insulin initiates its action by binding to insulin receptors through two main signalling pathways- the phosphatidylinositol 3-kinase (P13K)-serine threonine kinase (AKT)/ protein kinase B (PKB), which plays a part in regulating metabolism and the RAS-mitogen activated protein kinase (MAPK) pathway, which is mainly responsible for controlling

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

cell growth and differentiation (Taniguchi CM, 2011)) The renin angiotensin aldosterone system (RAAS) in cardiovascular system instigates the metabolic syndrome. Angiotensin II and insulin signalling interact extensively in both insulin resistance and cardiovascular tissues, establishing a relationship between insulin resistance and cardiovascular disease (Kame et al., 2006)

Fatty Liver: Metabolic syndrome and hepatic steatosis are closely interlinked with each other. Excess calories intake especially carbohydrates cause deposition of fat in liver that leads to hepatic steatosis, the main precursor of metabolic diseases. Metabolic syndrome was predicted by gamma glutamyltransferase and alanine aminotransferase (Hanley et al.,2007)

Aging

Elderly people are more prone to metabolic syndrome. With increasing age, the secretion of insulin declines leading to metabolic disruption. Hyperinsulinemia, hyperglycaemia or type II diabetes, hypertension, and insulin resistance ransack the life of aging people miserably. This is associated with an increased prevalence of central obesity and increased visceral fat in the aging population (Gabriely, I. et al, 2002).

Immunocytes

Immune cells play a significant role in the prevalence of metabolic diseases. Adipose tissue has most types immune cells, which contribute inflammation due to obesity, activation and influx of pro-inflammatory immune cells in adipose tissue. Adipose tissue macrophages are of two types- M1 phenotype (pro-inflammatory), and M2 phenotype (anti-inflammatory), showing two points macrophage polarization. M1 macrophages release pro-inflammatory cytokines, such as TNF-α, and reactive oxygen species (ROS) that worsen inflammation, mast cells, neutrophils and dendrite cells directly or indirectly exacerbate IR (Orliaget L. et al., 2020)). Apart from it, complement system plays role in immune defence, promoting innate and adaptive immune responses promoting apoptosis, and eliminating dead endogenous cells.

Oxidative Stress

Oxidative stress is a phenomenon when there is ambivalence between occurrence and inactivation of reactive oxygen species (ROS). Stress in mitochondria, nucleus, and endoplasmic reticulum may also be contributing factors to metabolic syndrome (Zhou et al., 2012). In metabolic syndrome, ROS production increases due to unhealthy diet, causing cell stress and pro-inflammatory factors. ROS are crucial and when cells are under oxidative stress, they can become dysfunctional (Dandona et al., 2005). ROS ransacks lipids, protein, and even DNA, causing inflammation, insulin resistance, vascular ailments, and diabetes.

Ceramide Accumulation

Ceramides are lipids consisting of sphingosine and a fatty acid, driver of metabolic syndrome. These bioactive lipids disrupt insulin signalling, exacerbate fat accumulation in fat cells, and bring cell stress

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

and inflammation. They interfere with insulin signalling pathways, stopping muscle and fat cells to uptake glucose, leading to hyperglycaemia. Ceramides also substantiate inflammation, worsening conditions as atherosclerosis and other cardiovascular problems. The surge in levels of ceramides with specific chains of C-16, C-18, and C-24, which affect liver, pancreas and adipose tissue, initiating diabetes, cardiovascular risks, and metabolism.

Organelle Interaction

Organelle interactions at contact membrane cites (MCSs) between mitochondria, endoplasmic reticulum, and lipid droplets, are important for metabolic health; their imbalance brings lipid imbalance, oxidative stress, inflammation, and disrupting calcium signalling, causing NAFLD and T2DM. Organelles can actively communicate and cooperate with each other through vesicle trafficking pathways and membrane contact points (MCSs) to maintain cellular homeostasis, which facilitates exchange of metabolites and other information required for normal cellular physiology (Cohen S., 2018).

Gut Health

An unhealthy gut (dysbiosis) leads to bacterial fragments (endotoxins) to go in the bloodstream, causing systemic inflammation (metabolic endotoxemia) that brings insulin resistance and metabolic syndrome. Good gut health regulates appetite, and soothes glucose and fat metabolism. Probiotics and prebiotics improves gut health, diminish inflammation and eases metabolic resilience.

Autophagy

Autophagy is a process in which damaged cells and organelles recycle to give energy and cell repair to maintain homeostasis of metabolism. Impaired autophagy in muscle, liver, and fats disrupts insulin sensitivity, reduced autophagy in heart mars cardiac function, resulting metabolic syndrome. Through exercise, we can substantiate autophagy, improve insulin sensitivity, and consequently address metabolic syndrome.

Low Vitamin D Levels and of Minerals

Low vitamin D levels may lead to metabolic syndrome, and its constituents-obesity, insulin resistance, hypertension, and dyslipidaemia. Vitamin D improves glucose regulation, insulin sensitivity, and good cholesterol HDL. It has effects on skeleton system as well as pancreatic β-cells. The molecular mechanisms of Vit. D deficiency involved in the development of insulin resistance may be because it maintains normal resting levels of reactive oxygen species and calcium ions in pancreatic β-cells and also reduces the degree of insulin resistance related pathological, such as oxidative stress and inflammation (Syzmczak P. et al., 2019). Mineral like magnesium plays a very significant role in maintaining metabolic resilience, and its scarcity fetches metabolic syndrome. It is a vital cofactor involved in the smooth regulation of over 300 enzymes, improves insulin sensitivity, carbohydrate and lipid metabolism, and inflammation. Zinc is also an important micro nutrient in smoothing

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

the function of insulin, reduces inflammation and oxidative stress.

Polycystic Ovary Syndrome/Disease

This is a metabolic disorder, and its relation with metabolic syndrome is bidirectional. Factors like insulin resistance, obesity, and hormonal imbalance increases the risk of metabolic dysfunction, causing infertility both in males and females. Women with PCOS possess greater risk of developing glucose intolerance, diabetes type 2, gestational diabetes, hypertension and cardiovascular disease. Insulin resistance and its compensatory hyperinsulinemia is considered to be an important pathological basis for reproductive dysfunction (Macut D et al., 2017).

Pathophysiology:

• Insulin Resistance
• Visceral Obesity

Insulin Resistance

It is an anabolic hormone secreted by pancreas, composed of 51 amino acids having two disulphide bridges linking two polypeptide chains. It stimulates glucose utilization by various tissues mostly skeletal muscle, liver, and adipose tissue. Insulin affects metabolism of macro nutrients as carbohydrates, lipids, and synthesis of proteins in most tissues. In carbohydrate metabolism, it increases glucose leading to obesity decreases gluconeogenesis. In lipid metabolism, it inhibits lipolysis, and stimulates lipogenesis. In protein synthesis, it stimulates circulation of amino acids into cells. Insulin exacerbates glucose uptake after binding to the cell surface with GLUT 4 glucose transporter, and insulin receptor complex enters the cell by pinocytosis, producing a membrane bound vesicle. However, insulin carries out many reactions in the cell affecting biologically diversely on carbohydrate, protein, lipids, and cell replication. Insulin dependent disposal rates differ in people belonging to different ethnicity, race, environment and regions, it may be due to adiposity, inactivity, and genetics. Insulin resistance is when cells in our muscles, adipose tissue, liver and kidneys fails to respond well to insulin hormone. Insulin resistance (IR) plays a pivotal role in prevalence and progression of metabolic diseases like diabetes, hypertension, hyperlipidaemia, liver diseases, polycystic ovarian disease (POCS), and cerebrovascular diseases. Insulin resistance or hyperglycaemia is responsible for the development of diabetic cardiomyopathy by pathophysiological mechanisms including impaired insulin signalling, cardiac mitochondrial dysfunction, endoplasmic reticulum stress, impaired autophagy, impaired myocardial calcium handling, abnormal neuro humoral activation, maladaptive immune responses (Jia G. et al., 2018)

Physiological insulin mechanism regulates when insulin molecules bind to the insulin receptor, a ligand-activated tyrosine kinase. This binding of insulin to its receptor, spawns reactions that activate or deactivate key enzymes present in the cell. When insulin binds to its receptor, tyrosine phosphorylation of downstream substrates takes place, two pathways are activated: the phosphoinositide

Received 09 January 2026; Accepted 27 January 2026. Available online: 30 January 2026. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

3-kinase (P13K) pathway, and the mitogen activated protein (MAP) kinase pathway. Tyrosine phosphorylation of insulin receptor substrates (IR) stimulates P13K pathway, which activates 3-phosphoinoside- dependent protein kinase 1 (PDK1) and (Ak strain transforming) AKT kinase that is also known as Protein Kinase B. The P13K-Akt pathway is precursor of various downstream metabolic effects insulin. AKT kinase phosphorylates in vascular endothelial cells, and awakens endothelial nitric oxide synthase (eNOS). AKT kinase stimulates GLUT 4 glucose transporter to cell surface for glucose uptake in skeletal and adipose tissue.

Moreover, tyrosine phosphorylation of the Shc homology and collagen (Shc protein) stimulates the GTP exchange factor son of sevenless (SOS). Subsequently, MAP pathway involving Ras, Raf, MAP kinase (MEK) and extracellular regulated kinase (ERK). The MAP kinase pathway mediates endothelin-1 (ET-1) production, leading to vasoconstriction; expression of vascular cell adhesion molecules-1 and E-selectin, which tends more leukocyte-endothelial interactions; and growth and mitogenesis (mitosis) effects on vascular smooth muscle cells. When insulin resistance develops, then P13K-Akt pathway is affected, but the MAP kinase pathways functions well, and this results to depletion of nitric oxide in the endothelium turning it dysfunctional, inhibiting GLUT4 translocation, and reduction of glucose uptake by muscle and fat cells. But MAP kinase pathway is unaffected, and endothelin-1 productions occurs, which is a potent vasoconstrictor peptide and causes spike in blood pressure. Insulin increases local blood flow in tissues through the starvation of eNOS, leading to two separable effects (Kim et al.2006). In such a way, insulin resistance is determinant of vascular problems, and may germinate atherosclerosis.

However, due to insulin receptors' abnormalities, peripheral glucose utilization, vascular fabric and blood circulation gets marred. Same mechanisms exacerbate insulin resistance, and thereby affecting vascular function, encircling hyperglycaemia, glycation, lipid toxicity because of FFAs, visceral obesity, hyperlipidaemia, and other metabolic abnormalities that give rise to inflammation.

Visceral Obesity

Visceral obesity or abdominal obesity has rendered as global pandemic causing metabolic syndrome, it arises from genetic factors, sedentary lifestyle, ultra -processed food, energy drinks, and pro-inflammatory conditions. Visceral obesity is linked with insulin resistance, impeding glucose utilization by cells. The mechanisms for this probably involve adipocytes, which are made by adipose tissue that modulate crosstalk between metabolism and vascular function (Kershaw and Flier, 2004). Adipose tissue is an odd mix of adipocytes, stromal preadipocytes, immunocytes and endothelium, and turns adipocytes' hypertrophy and hyperplaxia. Many adipokines are secreted such as leptin, and adiponectin hormones; angiotensinogen, apelin, resistin, and peptides like plasminogen activator inhibitor (PAI)-1: inflammatory cytokines including interleukin (IL)-6, tumor

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

necrosis factor alpha (TNF α) visfatin, omentin, and chemerin. All these adipokines constitute the pathophysiology of insulin resistance and metabolic syndrome.

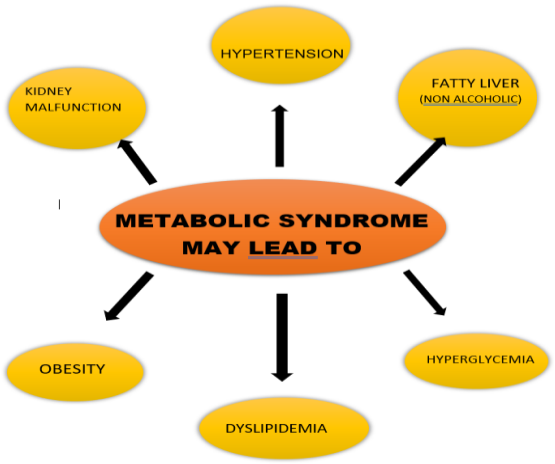
In the consequence of obesity and hypertrophic adipocytes, the blood supply to adipocytes diminishes and causes hypoxia. Hypoxia leads to necrosis and macrophages enter into adipose tissue, which substantiates the production of adipocytokines and glycerol, free fatty acids(FFA), inflammatory tumor necrosis factor alpha (TNF α) and interleukin-6 (IL-6), plasminogen activator inhibitor -1 (PAI-1) and C-reactive protein (CRP). The production of cytokines infers inflammation in the adipose tissue, and then systemic inflammation to obesity.

Atherogenic Dyslipidaemia

Atherogenic dyslipidaemia is a lethal lipid pattern characterized by high triglycerides (TG), elevated LDL cholesterol, and low HDL (good cholesterol), which gives birth to cardiovascular diseases, is considered to be linked with metabolic syndrome. The key features of atherogenic dyslipidaemia are high plasma TG levels, low HDL cholesterol level, and an increase in small dense LDL, insulin resistance and visceral obesity are associated with atherogenic dyslipidaemia (Semenkovich, 2006). Insulin resistance is the precursor of atherogenic dyslipidaemia, disruption in insulin signalling surges in lipolysis in adipose tissue, giving rise to free fatty acids levels, which convert to TGs in the liver. Free fatty acids also substantiate the formation of apoB, the chunk of VLDL, increasing the production of VLDL. Simultaneously, Insulin also disrupts apoB via P13K-dependent pathways, making more VLDL. Insulin also activates lipoprotein lipase (LPL) in adipose tissue promoting triglycerides accumulation in adipose tissue. Insulin decreases LPL (enzyme) activity in muscle causing more glucose uptake rather than fatty acid storage, which is related with insulin resistance.

Endothelial Dysfunction

An important trait of metabolic syndrome is that it mars endothelial cells power to produce nitric oxide (NO), which is a vasodilator. Endothelial dysfunction is the final common pathway between many cardiovascular risk factors and the development of atherosclerosis (Gimbrone et al., 2005). Metabolic components like insulin resistance, visceral obesity, hypertension, heart disease, and diabetes type II damage endothelium, diminishing levels NO and elevating inflammation and oxidative stress, heading towards atherosclerosis. By virtue of adopting healthy lifestyle, diet and medication, we can address it.



Received 09 January 2026; Accepted 27 January 2026. Available online: 30 January 2026. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

Diagnosis and Management of Metabolic Syndrome (Natural Approach)

Exercise

Exercise is an important step to address metabolic syndrome and associated diseases, improves insulin sensitivity, reduces atherosclerosis, and increases life expectancy. In our daily routine, we must integrate walking, resistance training, and cardiac work outs. To walk everyday briskly for at least 30 minutes proves beneficial in metabolic resilience. By walking, we don't only make our body more flexible but also better our cardiovascular system. Regular movement strengthens heart function, and facilitates blood pressure. Walking (forward and backward) helps muscle to uptake glucose from bloodstream without extra insulin, and thereby smoothing resistance, and easing arterial inflammation. Resistance training three days in a week, helps to build and maintain muscle mass, and eases out muscle contraction. Exercise helps maintaining steady blood sugar level increasing insulin resistance, lowers blood pressure, exacerbates HDL, and diminishes triglycerides. Aerobic exercises can lead to increased insulin sensitivity and enhanced glucose metabolism through a variety of different molecular mechanisms, including upregulation of insulin transporters on the cell membranes of insulin dependent cells, reduction of adipokines, normalization of redox status, improvement of βcells function, regulation of IRS-1 phosphorylation, reduction of ceramide plasma levels, and induction of angiogenesis, which may lead to a reduced incidence of diabetic complications, as well other metabolic effects (Bariyegi H. et al., 2019). After taking every meal, walking for at least 10-15 minutes is proven very handy to manage sugar spike and metabolism.

Sleep

Sleep is an important determinant of good health. Sleep deprivation or irregular sleep is considered harbinger of metabolic syndrome, a compendium of conditions like obesity, hypertension, type 2 diabetes, high triglycerides, and POCS or POCD etc. Sleep apnea and insomnia are related with the development of ill metabolic health. Sleep loss causes hormonal imbalance- leptin (satiety hormone) and ghrelin (hunger hormone) are affected, causing fat accumulation, and elevated sugar levels. Poor sleep increases systemic inflammation and oxidative stress, crippling metabolism and narrowing blood arteries. Sleep stimulates sympathetic nervous system- the 'fight or flight' response, increasing blood pressure and sabotaging metabolic resilience. During sleep, body repairs, cardiovascular system heals, blood pressure comes down, hormones find balance, brain cells clean toxins, and chances of building plaques in arteries slump. Quality sleep for at least 7-8 hours is essential for good metabolic health. Before sleep, screens should be unfriended, food intake be stopped before 2 hrs going to bed, temperature of room be diminished, noise be curtailed and LED lights be switched off for smooth release of melatonin from pineal glands of brain. Magnesium glycinate 200-400 mg may be tried before sleep if insomnia ransacks but with consultation of a physician.

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

Stress

Stress management is necessary to address metabolic syndrome, as stress if it becomes severe and chronic, it activates the HPA (hypothalamic pituitary adrenal) axis, secreting more cortisol hormone, and stimulating fight and flight response. High levels of cortisol give formation of glucose for instant energy, and causing secretion of more insulin to cope with the high sugar levels, causing insulin resistance. High levels of cortisol correspond to high secretion of glucagon, increasing visceral fat, creating more inflammation, and marring metabolic health. In our fast paced life, we are pitted against formidable stress, giving birth to inflammation, elevated glucose levels, and insulin resistance. The physiological changes that take place due to prolonged stress, becomes detrimental, causing plaque formation in arteries, and overall metabolic resilience. To lessen stress, we can opt for some exercises. Inhalation and exhalation exercises and living closely to nature helps a lot to redress the metabolic syndrome and leveraged abnormalities.

Vitamin Gratitude

Feeling of gratitude spawns better sleep, less stress, lipid lowering, promoting healthier societal relations, thereby creating low risk of metabolic diseases. Feeling of gratitude and improved societal interactions calm the nervous system (parasympathetic system), lowering cortisol levels, and diminishing inflammation (as TNF α and interleukin 6), reducing chances of heart problems. High exposure to loneliness, extrovertness, and social inactivity, cascade to lead high stress and cortisol secretion. Engaging in societal and familial meaningful interactions proves beneficial for management of stress. Social gathering and feasts are no bad to stave off tension and stress.

Diet and Nutrition

Metabolic syndrome is a dietary and lifestyle disorder. Dietary control is very conspicuous for better metabolic health. We must avoid gorging on such foods that spike blood glucose level, surge in insulin secretion, and scarring the arteries. We must be careful about the food that fall into following groups:

Sugary Foods

Sugary foods like cold drinks, desserts, energy beverages, and sweets that cause sugar levels in blood soaring high, and to cope with such spike of sugar, pancreas feels toll to secrete more insulin, and when this condition prolongs, cell becomes stagnant and decline influx of glucose into it, causing insulin resistance, the main culprit in developing metabolic syndrome. Instead of refined carbs, low glycaemic grains, vegetables, legumes, berries, fruits may be tried. To make the gut healthy, we must take fibrous food as fibre slows down glucose absorption, fetching minerals like magnesium, potassium, and antioxidants. Consumption of carbohydrates rich in dietary fibre and low glycemic index, such as whole grains, is beneficial in improving insulin sensitivity and metabolic flexibility, independent of insulin resistance (Malin S.K. et al., 2018).

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

Ultra processed Food

Ultra processed food rich in refined carbs like bread, pasta, and snacks, giving glucose insulin roller coaster rise, accumulating fat is liver and adipose tissue, inflaming vascular vessels, and inviting metabolic syndrome. We must be cautious about their intake. Instead of gorging carbohydrate rich foods, we must opt for high quality protein rich foods to better insulin sensitivity and improving metabolic resilience. Approximately, 1.0 g per kg body weight (not for kidney patients) from sources like salmon or sardine fish, poultry, eggs, and grass fed meat, and sugarless curd or yogurt.

Seed Oils: Fried food soaked in seed oils, processed and packed market food articles, and deep fryers or refrying food, turning them into trans-fat, spawning toxins that mar LDL particles, and building arterial plaques. We must avoid them profusely, opting for olive oil (extra virgin), avocado and mustard oil. Fats rich in nutrients are quintessential for better metabolism, hormone synthesis, brain health, cell repair, reduction of inflammation and maintaining absorption of fat soluble vitamins A, D, E and K inter alia. Sans healthy fats, metabolism disrupts, low energy stalls, and inflammation mars the physiology of the body, causing building of plaques in the artery. For healthy fat, we may follow the following table:

Increase in Consumption	Advantage
Extra-virgin olive oil	Rich in polyphenols that reduce oxidation and increase HDL
Egg yolks	Rich in choline that betters brain and liver health, absorption of fat soluble vitamins
Avocado, sesame oil	Improves appetite and satiety
Marine fish like Salmon, Sardines, Herring and Mackerel	Rich in omega 3s that improves heart health, decrease triglycerides, LDL and inflammation

Intermittent Fasting

Intermittent fasting has proven beneficial for treating metabolic syndrome under expert's supervision and guidance. Body is given breaks between meals, liver rests, insulin level falls, and metabolism gets flip. Several patients who were prediabetes and diabetic for 5 years, underwent intermittent fasting, and their metabolic health improved. By virtue of fasting, cutting the refined carbohydrates, body weight is reduced that also helps to treat metabolic ill health. With low insulin level, fat stored in liver and adipose tissue begins to melt, encouraging lipolysis, and demoting lipogenesis, causing better metabolic health, and to improve Homa IR (Homeostatic Model Assessment of Insulin Resistance) that should be less than 6.

Glycaemic Control

Glycemic index measures how fast food raises blood glucose, and glycaemic load describes how much blood glucose raises at a normal portion size of a particular food. If we consume foods having low glycaemic index under 40, and keep glycaemic load under 25 during a day, then it yields better dividends.

Natural Approaches for the Management of Metabolic Syndrome

Whole Grains

Whole grains like barley, pearl millet, amaranth, brown rice, and quinoa etc. help for the prevention and management of the

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

metabolic diseases. They are rich in fibre, protein, minerals, vitamins, and antioxidants, helping to reduce triglycerides and cholesterol, offering satiety and fullness, feeding gut bacteria, and increasing insulin sensitivity.

Vegetables: Lush leafy green vegetables like spinach, kale, asparagus, cabbage, cauliflower, broccoli, carrots, cucumber, reddish, tomato, eggplant, coloured bell pepper, pumpkin, beet roots, and bitter gourd etc. are loaded with nutrients, antioxidants, anti-inflammatory phytonutrients having low glycaemic load, help to manage metabolic diseases well. Bitter gourd are rich alkaloids, peptides that resemble insulin, and triterpenoids, addressing insulin function, glucose spike, LDL, and triglycerides etc (Chaturvedi, 2005).

Fruits

Like vegetables, fruits too offer benefit to stave off metabolic syndrome. They provide fibre, antioxidants, minerals, vitamins, phytonutrients, flavonoids that play significant role in lowering inflammation, blood pressure, and strengthens insulin function. Blueberries rich in polyphenols, which have a high antioxidant capacity more than ascorbic acid, and vitamin E, lower glucose levels, blood pressure and increase insulin sensitivity (Shaughnessy et al., 2009). Avocados are also rich in fatty acids, minerals, vitamins, phenolic, and carotenoids, address insulin sensitivity, LDL, Triglycerides, and sugar spike (Tabeshpour et al., 2017). Guava, apples, pears, kiwi and citrus fruits are of great use to improve gut health, rich in fibre, and substantiate insulin sensitivity.

Legumes

Legumes are of great worth when it comes to treat and prevent metabolic syndrome, for they are laden with protein, fibre, minerals, antioxidants, which manage blood sugar spike, hyperlipidaemia, gut health, slow digestion, and soothe metabolism. Black beans, soy, chickpeas, peanuts, and lentils contain nutrients, fibre, protein, isoflavones, and impart enzymes like nattokinase to manage metabolic health.

Syzygium Cumini or Eugenia Jambolana

Syzygium cumini or black plum are rich source of flavonoids, polyphenols, antioxidants, and minerals like iron and ascorbic acid. Mulkalwar S. et al opines: "In comparison to traditional antidiabetic medicine metformin, one such promising chemical of jamun (syzigium cumini), has an anti-hyperglycemic action (Mulkawlar, 2021). 2 to 3 g of syzigium seeds powder with luke warm water has good hypoglycaemic effect.

Fenugreek Seeds (Trigonella foenum-graecum): They are rich in fibres, and alkaloids like trigonelleine, and steroidal saponins, that lower glucose levels. Srinivasan et al. considers that fenugreek seeds improve insulin sensitivity, lower glucose level, triglycerides and LDL. (Srinivasan, P. et al, 2018). 5 g seeds soaked in water are beneficial to manage metabolic resilience.

Curcumin

Turmeric (Curcuma Longo) is a rich source of curcumin, which improves βcells function, and regulates fat metabolism. It is loaded with phenolics, terpenoids, curcuminoids including curcumin, demethoxy

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

curcumin and bisdemethoxy curcumin. If 100-200 mg of curcumin is taken for three months, then it is seen to improve insulin sensitivity, HbA1C, lowering elevated glucose levels and triglycerides (Bulboaca et al., 2016).

Bitter melon (Memordica Charantia)

It is replete with alkaloids, steroidal saponins, peptides like insulin, and triterpenoids. It lowers elevated glucose level, triglyceride, LDL, and improves insulin sensitivity.

Ginger and Garlic

Ginger and garlic possess therapeutic uses specially to treat obesity, high glucose, cholesterol and triglycerides. Ginger contains terpenes and oleoresin that lowers blood pressure, low density cholesterol and increased glucose level (Rahmani and Ali, 2012). Garlic is a rich source of allicin, allylcysteine, ethylcysteine, and propylcysteine. These biochemicals treat glucose, lower density cholesterol and triglycerides (Hosseini et al., 2015). If they are used together, they create a synergistic response.

Ginseng and Berberine Ginseng and berberine are powerful natural medicines, and are great use to treat metabolic syndrome. They substantiate blood glucose level and regulate fat metabolism. Ginseng (panax ginseng) is loaded with chemicals like ginsenosides that has shown remarkable hypoglycaemic effect and in reducing hyperlipidaemia, and hypertension. On the other hand, berberine is a plant derived alkaloid that activates the enzyme to treat metabolism- AMPK (adenosine monophosphate activated protein kinase). It also reduces inflammation and weight. Berberine dose is 500mg twice in a day or as suggested by physician.

Flax, Chia and Pumpkin Seeds

All flax, chia and pumpkin seeds manage metabolic ailments efficiently well by reducing lipids, inflammation and improving insulin sensitivity. They are rich source of fibres, minerals, antioxidants, and omega 3 and omega 6 fatty acids (ALA, EPA, DHA, and oleic acid). They increase good cholesterol like HDL, lower LDL, and better heart health. They reduce oxidative stress and inflammation specially C-reactive protein CRP), TNF-α, and IL-6., which play potential role in developing metabolic syndrome.

Cinnamon (Cinnamomum Cassia)

Cinnamon barks (of ceylon) can improve metabolic syndrome, lower blood glucose, blood pressure, and hyperlipidaemia. It is replete with biochemical like cinnamaldehyde and polyphenols that improves insulin sensitivity, lowers LDL and triglycerides (Anderson E. et al., 2009). It works as an antioxidant and anti-inflammatory agent, and helps to reduce oxidative stress. It inhibits cholesterol synthesis by blocking HMG-CoA reductase enzyme in liver, and increases lipolysis. Initial dose is 0.3-1 g or as suggested by physician with warm water in the morning as it interacts with certain medications. It is used as an alternative medicine.

Nuts

Received 09 January 2026; Accepted 27 January 2026. Available online: 30 January 2026. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

Nuts are very beneficial to treat metabolic syndrome as they are source of fibre, healthy fats, minerals, and antioxidants, which help to manage blood sugar, blood pressure, triglycerides, and increase HDL. A fistful of nuts thrice in a week including almonds, walnuts, hazelnuts, pistachios, and peanuts etc. have yielded better results.

Beet Roots

Beet roots manage metabolic syndrome as it improves blood pressure, lipids (visceral fat) and liver health. It is replete with nitric oxide and betalains, which reduces inflammation and oxidative stress. Nitric oxide facilitates blood circulation, and decreases blood pressure. Recommended dose 3-5 g dried beet powder with water or as suggested by medical expert.

Spirulina

Spirulina, a mediterranean micolga, possesses phycocyanin, γ-linolenic acid, and many antioxidants that manage metabolic diseases. It treats blood pressure (diastolic), LDL, triglycerides, and also regulates fasting glucose levels. 1g to 5g is a recommended dose daily or as suggested by health-care provider.
Gudmar (Gymnema Sylvestre): Gudmar is also termed as 'sugar destroyer', loaded with compounds like saponins, flavonoids, and tannins, which manages elevated blood glucose level, oxidative stress and inflammation. Recommended dose is 0.3-0.5 g under the supervision of health expert.

Dark Chocolate

Dark chocolate loaded with 70% cocoa, potentially smoothens metabolism, improves insulin sensitivity, lowering cortisol, and strengthens gut health. Flavnoids in cocoa improves metabolism, and help in burning the calories. But they are high in calories, so must be taken moderately with nuts like pistachio and walnuts. Maximum dose is about 40 g in day for a shorter period of time or as suggested by physician.

Supplements and Micronutrients:

S.No	Name	Metabolic Effect	Doses
1.	Zinc	It activates enzymes required for various metabolic functions-vitamin D synthesis, prevents insulin resistance and cell damage.	8-10 mg daily or as recommended by physician.
2.	Alpha-lipoic acid (ALA)	Helps enzymes in glucose metabolism, reduces oxidative stress.	600mg daily or as suggested.
3.	Vitamin D (cholecalciferol)	Helps insulin secretion, controls blood glucose.	600-2000 IU or as suggested by physician.
4.	Magnesium	Activates enzymes that regulate various chemical reactions-metabolises vitamin D, and improves insulin sensitivity, lowers inflammation.	200-400 mg daily as per suggestion of the medical expert.
5.	Selenium	Rich in selenoproteins which	55 mcg daily or as

Received 09 January 2026; Accepted 27 January 2026. Available online: 30 January 2026. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

		neutralizes free radicals, saves cells from oxidative stress.	suggested by physician.
6.	Vitamin C (Ascorbic Acid)	Reduces inflammation, neutralizes free radicals, helps to produce vitamin E.	500-1000mg daily or as suggested by medico.
7.	Vitamin B12 (Cobalamin)	Deficiency may trigger insulin resistance, high triglycerides, low HDL, important for DNA synthesis, and lipid regulation	2.4-15 mcg daily or as prescribed by physician.
8.	CoQ10	Potent antioxidant essential for energy production in the form of ATP, regulates blood sugar , improves insulin sensitivity	100mg daily as prescribed by a qualified medico.
9.	Quercetin	Rich antioxidant , reduces lipid peroxidation , motivates antioxidant enzymes as glutathione peroxidase, catalase to improve metabolism.	500mg twice a day along with vitamin C as per suggestion of medical pr actitioner.
10.	Chromium	Improves insulin sensitivity, addresses diabetes type 2, and better cardiovascular health.	35 mcg (Males); 20 mcg(Females) or as prescribed by medical practitioner.
11.	Vitamin E	Useful for better metabolic health , gene expression, cell signalling, and lipid synthesis.	15mg or as prescribed by physician.

In conclusion, we may say that the diagnosis of metabolic syndrome entails at least three of the five components-visceral obesity, insulin resistance, non-alcoholic fatty liver, hyperglycaemia, and hypertension. All these conditions are interconnected, sharing common pathways and pathophysiological mechanism. If it persists and prevails for a long time, it may fetch type II diabetes, which is mother of various ailments-neuropathy, nephropathy, hyperuricemia, high triglycerides, high LDL, low HDL, and atherogenic vascular diseases inter alia. Sedentary lifestyle, wrong nutrition, scorching stress, scarce sleep, family history and environmental factors may lead to metabolic syndrome. By adopting healthy life style, reducing weight, right nutrition, sound sleep, slashing stress, meditation, and medication, we may reverse it. We must not let it progress and prolong for years, reducing at least 10% of body weight, harping on less carbs, impinging on proteins and healthy fats proportionately 50 % carbs {preferably complex, 25 % proteins, and 25 % fats MUFA &PUFA} - we may curtail its scourging effect on our body and soul. We must walk at least for 10-15 minutes after every meal, and engage in physical activity for whopping 150 minutes a week. If we follow a six months' plan of exercise and nutrition, it'll unleash wonderful results. Natural ingredients extracted from plants, herbs, spices, oils and supplements, have

Received 09 January 2026; Accepted 27 January 2026. Available online: 30 January 2026. Published by SAFE. (Society for Academic Facilitation and Extension)

Integral Research
(ISSN: 3048-5991) Coden: IRABCA
Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 01, January. 2026

shown imparting shield and immunity can keep dreadful diseases like diabetes, obesity, hypertension, fatty liver, and dementia etc. at bay. Word worth's call to return to nature is very prophetic and therapeutic in its own way. Mark the following lines by Wordsworth of the poem "Composed upon Westminster Bridge, September 3, 1802):

> In his first splendour, valley, rock, or hill,
> Never saw I, never felt, a calm so deep!
> The river glideth at his own sweet will,
> Dear God! the very houses seem sleep,
> And all that mighty heart is lying still
>
> (Joseph de Roche, 1975).

References:

1, Kassi, E et al., Metabolic Syndrome: Definitions and Controversies. BMC Med., 2011, p-9, 48.

2. Benedict, M. et al., Non-alcoholic Fatty Liver Disease: An Expanded Review. World J. Hepatol 2017, 9, p-715

3.Thorp, A.A. et al., Delirious Associations of Sitting Time Television Viewing Time with Cardiometabolic Riskbiomarkers: Australian Diabetes, Obesity and Lifestyle Study, Diabetes Care, 33(2)(, p-334.

4. Aron-Wisnewsky et al., The Gut Microbiome, Diet, Links to Cardiometabolic and Chronic Disorders. Nature Reviews Nephrology, 12(3), 2016, p-169.

5. Erion, D.M, & Shulman, G.I.: Diacylglycerol Mediated Insulin Resistance. Nature Medicine, 16(4), p-402.

6. Cena, H. et al., Relationship between Smoking and Metabolic Syndrome, Nutrition Reviews, 69(12), 2011, p-745.

7. Medic, G. et al.. Short-and Long-Term Consequences of Sleep Disruption. Nat. Sci. Sleep ,9, 2017, p-156

8. Taniguchi C,M. et al., Critical Signalling Pathways Insights into Insulin Resistance, Nature Reviews Molecular Cell Biology, 7(2), 2006, p-85.

9. Kamei, N et al., Overexpression of Monocyte Chemoattractant Protein-1 in Adipose Tissues Causes Macrophage Recruitment and Insulin Resistance. Journal of Biological Chemistry, 281(36), 2006, p-10.

10. Hanley, N. et al., Liver Marker's and Development of Metabolic Syndrome: The Insulin Resistance Atherosclerosis Study. Diabetes., S 4(1), 2005, p-40.

11. Gabriely I. et al. Removal of Visceral Fats Prevents Insulin Resistance and Glucose Intolerance of Aging: An Adipokine Mediated Process?. Diabetes, 51(10), 2007, p-8.

12. Orliaguet I. et al. Mechanisms of Macrophage Polarisation in Insulin Signalling and Sensitivity. Front Endocrinal (Lausanne), 2020, p-11.

13. Zhou, M.S. et al. Links between the Renin-Angiotensin System and Insulin Resistance: Implications of Cardiovascular Disease. Vascular Medicine, 12 (5), 2012, p-334.

14. Dandona, P. et al. Metabolic Syndrome: A Comprehensive Perspective based on interactions between Obesity, Diabetes, and Inflammation. Circulation., 111(11), p-1448.

15. Cohen, S. et al. Interacting Organelles. Curr Opin Cell Biology, 20 (8), p-53.

16. Azymczak, P. et al. Analysis of Association of Vitamin D Deficiency and Insulin Resistance. Nutrient, 11(4), 2019, DOI10.3390nu/1040757.

17. Macut D. et al. Insulin and the Polycystic Ovary Syndrome, Diabetes. Res Clin Pract, 130, 2017, p-163.

18. Jia G. et al. Diabetic Cardiomyopathy: A Hyperglycemic and Insulin Resistance Induced Heart Disease. Diabetologia, 61 (1), 2018, p-21.

19. Kim J.A. Et al. Reciprocal Relationships Between Insulin Resistance and Endothelial

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)

Dysfunction: Molecular and Pathophysiological Mechanisms, Circulation, 113, 2006, p-1888.

20. Kershaw E.E. et al. Adipose Tissue as an Endocrine Organ. J. Clin Endocrinol Metab, 89, 2004, p-2548.

21. Semenkovich C.F. et al. Insulin Resistance and Atheroscleorosis. J Clin Invest, 116, 2006, p-1822.

22. Baribegi H. et al. Molecular Mechanisms by Which Aerobic Exercise Induces Insulin Sensitivity. J Cell Physiology, 234 (8), 2019, p-12385.

23. Malin S.K. et al. A Whole Grain Diet Reduces Peripheral Insulin Resistance and Improves Glucose Kinetics in Obese Adults: A Randomised Controlled Trial. Metabolism, 82, 2018, p-111.

24. Chaturvedi, P. Memordica Charantia in Maintaining the Normal Lipids and Glucose in diabetic Rats Fed in High-Fat and Low Carbohydrate Diet. British Journal of Biomedical Science, 62(3), 2005, p-124.

25. Shaughnessy, K.S. et al. Diets Containing Blueberry Extract Lower Blood Pressure in Spontaneously Hypertensive Strke Prone Rats. Nutrition Research, 29(2), 2009, p-130.

26. Tabeshpour J. et al. Effects of Avocado on Metabolic Syndrome A Comprehensive Systemic Review, Phytotherapy Research, 31(6), 2017, p-819.

27. S. Mulkawalar S. et al. Antihyperglycemic Activity of Syzijium Cumin (Jamun) in Diabetic Rats, J. Pharm Research, 33, 2921, p-12.

28. Srinivasan P. et al. Antibiotic Activity of Quercetin Extracted from Phyllanthus Emblica L. Fruit: In Silico and In Vivo Approaches. Journal of Pharmaceutical Analysis, 8(2), 2017, p-557.

29. Bulboaca, A. et al. Protective Effect of Curcumin in Fructose Induced Metabolic Syndrome in and Streptozotocin Induced Diabetes in Rats, Iranian Journal of Basic Medical Sciences, 19 (6), 2016, p-585.

30. Rahmani, A.H., & Aly, S.M. Active Ingredients of Ginger as Potential Candidates in the Prevention and Treatment of Diseases via Modulation of Biological Activities. International Journal of Physiology, Pathophysiology and Pharmacology, 6 (2), 2010, p-125.

31. Hosseini A et al. A Review of on the Effects.of Allium Sativum (Garlic) in Metabolic Syndrome. Journal of Endocrinological Investigation, 38 (11), 2015, p-1147.

32. Anderson, E.J. et al. Mitochondrial H2 O2 Emission and Cellular Redox State Link Excess Fat Intake to Insulin Resistance in Both Rodents and Humans. Journal of Clinical Investigation. 119 (3), 2009, p-573.

33. Joseph de Roche. The Heath Introduction to Poetry. Toronto, 1975, p-163.

Received **09 January 2026**; Accepted **27 January 2026**. Available online: **30 January 2026**. Published by SAFE. (Society for Academic Facilitation and Extension)