Understanding Metabolic Syndrome: Causes and Prevention

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Abstract

Metabolic syndrome is a health condition involving interrelated metabolic disorders, increasing the risk of cardiovascular disease and type 2 diabetes. This condition involves central obesity, high triglyceride levels, low HDL cholesterol, hypertension, and high blood sugar levels. The increasing prevalence of metabolic syndrome in Indonesia is mainly caused by lifestyle changes, including unhealthy eating patterns and low physical activity. This research aims to identify causal factors and prevent metabolic syndrome. Literature studies were used to analyze the epidemiology, risk factors, and prevention strategies for metabolic syndrome. Prevention of this syndrome requires a comprehensive approach, including healthy lifestyle changes, such as a balanced diet, physical activity, and stress management. Modern technology and public policies that support healthy lifestyles can also strengthen these prevention efforts. With proper prevention, the risk of chronic diseases related to metabolic syndrome can be reduced, as well as improving people's quality of life.

Keywords: metabolic syndrome, obesity, hypertension, lifestyle, prevention.

Introduction

Metabolic syndrome is a condition that includes a series of interrelated metabolic disorders that increase a person's risk of developing cardiovascular disease and type 2 diabetes. This condition involves at least three of the five main components, namely central obesity (fat accumulation in the abdominal area), high triglyceride levels, low HDL cholesterol, high blood pressure, and high blood sugar levels.[1] The combination of these components creates serious health risks and makes metabolic syndrome one of the crucial health problems worldwide.

Metabolic syndrome is known as one of the early markers for cardiovascular disease and type 2 diabetes.[2] This condition often goes undetected because many people do not feel specific symptoms, even though their bodies have experienced significant changes in metabolism. Without realizing it, metabolic syndrome can develop into serious complications if not treated immediately.[3] Globally, metabolic syndrome is one of the pressing public health problems. This is because of its broad impact, not only in terms of individual health, but also in the economic burden. Diseases associated with metabolic syndrome such as heart disease and diabetes require expensive and prolonged medical care, which ultimately burdens the health system and the economy.[4] Efforts to control the prevalence of metabolic syndrome need to be optimized, especially through a preventive approach that focuses on a healthy lifestyle and early detection.

In Indonesia, the increase in cases of metabolic syndrome is a concern. A diet rich in processed foods, coupled with an increasingly sedentary lifestyle, makes people susceptible to this condition.[5] Rapid changes in lifestyle in big cities have changed the way many people live, including eating habits that rely more on fast food that is high in calories and low in nutrition. This is exacerbated by the low level of physical activity among urban communities, which further increases the risk of metabolic syndrome. Metabolic syndrome in Indonesia has become one of the most worrying health issues in recent decades. The spread of this syndrome is in line with the increasing prevalence of non-communicable diseases such as diabetes, hypertension, and cardiovascular disease.

National data and studies show that metabolic syndrome has now spread widely in various communities, both in urban and rural areas, especially as a result of unhealthy lifestyle changes. According to data from the 2018 Basic Health Research (Riskesdas), the prevalence of obesity and metabolic-related diseases in Indonesia has increased significantly. Riskesdas noted that the prevalence of central obesity in the population aged 15 years and over reached 31%, which is one of the main components of metabolic syndrome. Meanwhile, the prevalence of type 2 diabetes mellitus, which is often a manifestation of metabolic syndrome, has also increased significantly. Based on Riskesdas 2018, diabetes in the Indonesian population reached 10.9%, an increase from the previous survey. Hypertension is also an important component of metabolic syndrome which has a high prevalence rate in Indonesia. Riskesdas 2018 showed that the prevalence of hypertension in Indonesian adults reached 34.1%, which means that more than a third of the adult population in Indonesia has high blood pressure.[6]

In general, the prevalence of metabolic syndrome in Indonesia tends to be higher among women than men, mainly due to the high rate of central obesity in women. Riskesdas 2018 showed that the prevalence of central obesity in Indonesian women reached 36.3%, higher than

men which was only 26.6%. This condition puts women at higher risk for metabolic syndrome and related cardiovascular diseases. The high prevalence of metabolic syndrome in Indonesia requires serious attention from various parties, including the government, health workers, and the community.

Therefore, the purpose of writing this article is to find out more about metabolic syndrome, identify the factors that cause metabolic syndrome and analyze effective prevention efforts in reducing the prevalence of this condition.

Methods

The research method used in this study is a literature study or literature review, which involves the collection and critical analysis of various relevant scientific literature sources on metabolic syndrome. This approach aims to identify, analyze, and synthesize data from previous studies that discuss topics such as epidemiology, risk factors, pathophysiology, clinical manifestations, and prevention strategies for metabolic syndrome, both in Indonesia and globally. Data sources are taken from scientific journals, research reports, reference books, and publications from international health institutions such as WHO and the Indonesian Ministry of Health. Through this literature study approach, this study examines various empirical findings, and evaluates approaches that have been proposed or implemented in efforts to prevent and treat metabolic syndrome. Data analysis is carried out by comparing and integrating the results so that comprehensive conclusions are obtained regarding the problem of metabolic syndrome.

Discussion

Metabolic Syndrome

Metabolic syndrome is a group of medical conditions that occur together and increase a person's risk of developing cardiovascular disease, type 2 diabetes, and other serious health complications.[7] People with metabolic syndrome have a significantly greater risk of developing heart disease, stroke, and type 2 diabetes compared to individuals without these conditions.[8] In the modern era, with the increasing prevalence of obesity and unhealthy lifestyles, metabolic syndrome has become one of the global public health challenges.

According to the National Cholesterol Education Program (NCEP) Adult Treatment Panel III, metabolic syndrome is defined as a cluster of interrelated metabolic disturbances that, when occurring together, increase cardiovascular risk. This definition highlights the importance of viewing metabolic syndrome as an accumulation of conditions that may not be particularly dangerous individually but that, when combined, can have serious health

consequences.[9] The NCEP also states that a person is considered to have metabolic syndrome if they have three or more of the following five criteria: central obesity, high triglycerides, low HDL cholesterol, high blood pressure, and high fasting blood sugar.[10]

Central obesity is one of the main components of metabolic syndrome.[11] This condition is characterized by excessive fat accumulation around the abdomen, which is medically known as visceral obesity. Fat around the abdominal organs is more dangerous than subcutaneous fat (which is located under the skin) because it can trigger inflammation and insulin resistance. Alberti and Zimmet in their definition used by the International Diabetes Federation (IDF) emphasize that central obesity is the main marker of metabolic syndrome, which is closely related to an increased risk of type 2 diabetes and heart disease.[12] In addition to obesity, they highlight the role of insulin resistance as a key factor causing other metabolic disorders.

Insulin resistance, where the body does not respond well to insulin, is the underlying mechanism of metabolic syndrome. When the body cannot use insulin effectively, blood sugar levels rise, eventually leading to type 2 diabetes.[13] Insulin resistance also affects fat metabolism, leading to increased triglyceride levels and decreased HDL cholesterol, known as the good cholesterol.[14] Reaven, an endocrinologist, first introduced the concept of metabolic syndrome in 1988 with the term “Syndrome X,” describing the relationship between insulin resistance, obesity, and the risk of cardiovascular disease.[15] This concept was later developed into the metabolic syndrome we know today. Overall, metabolic syndrome should be understood as a multifactorial condition involving many interrelated metabolic components. It is not just about one risk factor, but about the interaction of several factors that worsen each other.

Factors Causing Metabolic Syndrome

The causative factors for metabolic syndrome are a combination of lifestyle elements, genetics, and certain health conditions that interact with each other. One of the main factors that plays a role in the development of metabolic syndrome is obesity, especially central obesity.[11] The accumulation of fat around the abdomen, known as visceral fat, is very dangerous because it directly affects the body's metabolic function. Visceral fat produces hormones and chemicals that can trigger inflammation and insulin resistance, which ultimately increases the risk of metabolic syndrome. When central obesity occurs, it becomes more difficult for the body to use insulin effectively, so blood sugar tends to increase, triggering type 2 diabetes and other metabolic disorders.[16]

In addition to obesity, an unhealthy lifestyle is one of the main causes of metabolic syndrome. A diet high in calories, saturated fat, sugar, and low in fiber greatly contributes to

the development of this condition. Fast food, sugary drinks, and processed foods that are increasingly consumed in everyday life have increased the number of people who experience obesity and resistance. In Indonesia, this trend is increasing, especially in urban areas, where people tend to choose foods that are fast and easily accessible without considering their nutritional quality. Lack of consumption of fruits, vegetables, and grains also worsens metabolic conditions because the nutrients that are important for the body are not met. Lack of physical activity is also an important factor in the development of metabolic syndrome. The increasingly sedentary modern lifestyle, with more time spent sitting in front of the computer, watching television, or using gadgets, has significantly reduced people's physical activity levels. Low physical activity causes metabolism to slow down, so that the body is unable to burn calories efficiently. As a result, excess calories are stored as fat in the body, which ultimately triggers obesity and insulin resistance. Regular physical activity is essential to improve insulin sensitivity and maintain a healthy weight, thereby reducing the risk of metabolic syndrome.

In addition to lifestyle factors, genetics also play a significant role in predisposing a person to metabolic syndrome. Some people have a genetic predisposition to insulin resistance or obesity, which makes them more susceptible to metabolic syndrome.[17] These genetic factors can be passed from parents to children, making metabolic syndrome more common in certain families. Although genetics play a role, lifestyle remains a dominant factor, and healthy lifestyle changes can help prevent or control the development of metabolic syndrome, even in individuals who are at genetic risk.[18] Aging is also a significant factor in the development of metabolic syndrome. As we age, the body naturally undergoes metabolic changes that can lead to decreased insulin sensitivity and increased body fat, especially around the abdomen. In older individuals, muscle tends to decrease, and fat tissue increases, causing metabolism to slow down. This can increase the risk of insulin resistance, hypertension, and other metabolic disorders associated with metabolic syndrome. Therefore, metabolic syndrome is more common in adults over the age of 40, although it is not uncommon in younger individuals, especially those with unhealthy lifestyles.[11]

Hormonal factors also play a role in the development of metabolic syndrome, especially in women. After menopause, women are more likely to accumulate fat in the abdomen, which increases the risk of central obesity and insulin resistance. Changes in estrogen hormones after menopause cause a redistribution of body fat, so that more fat is stored around the abdomen than in other parts of the body. This is one reason why metabolic syndrome is more common in postmenopausal women than in women who are still of reproductive age.[19] In addition, other hormonal imbalances, such as excess cortisol due to stress, can also trigger visceral fat

accumulation and insulin resistance. Chronic stress is also a contributing factor that should not be ignored. Long-term stress triggers increased production of the hormone cortisol, known as the stress hormone. Continuously high cortisol can lead to increased appetite, accumulation of fat in the abdomen, and insulin resistance.[20] Stress can also disrupt sleep patterns and influence lifestyle decisions, such as the tendency to choose unhealthy foods or avoid physical activity.

Hypertension, or high blood pressure, also often occurs in conjunction with metabolic syndrome. High blood pressure is a major component of this syndrome, which occurs due to a combination of factors such as obesity, insulin resistance, and decreased blood vessel function. Excess fat in the body, especially around the abdomen, can cause chronic inflammation and extra pressure on blood vessels, which in turn increases blood pressure. Hypertension also worsens other metabolic conditions, such as dyslipidemia (abnormal cholesterol levels) and insulin resistance, creating a vicious cycle that worsens metabolic syndrome. Dyslipidemia, which is characterized by low HDL cholesterol and high triglyceride levels, is also a key factor in metabolic syndrome. This lipid imbalance is usually caused by insulin resistance, where the body cannot properly regulate fat metabolism. High triglyceride levels and low "good" cholesterol contribute to plaque buildup in the walls of the arteries, which ultimately increases the risk of cardiovascular disease. Dyslipidemia is also closely linked to central obesity, where visceral fat produces compounds that disrupt the body's lipid balance.

Environmental factors also play a large role in metabolic syndrome. Exposure to widely available unhealthy foods, a social climate that supports a sedentary lifestyle, and lack of access to health and exercise facilities all exacerbate the risk of metabolic syndrome. In urban areas, for example, people have easier access to fast food than healthy food, and dense environments often lack adequate open spaces for exercise. These environmental factors greatly influence people’s lifestyle choices and metabolic health.

In addition, insulin resistance as the basis of metabolic syndrome is also exacerbated by smoking. Smoking increases insulin resistance and worsens other metabolic disorders, such as dyslipidemia and hypertension. Chemicals in cigarettes can damage blood vessels, increase blood pressure, and cause fat accumulation in the body. The combination of smoking and other unhealthy lifestyles significantly increases the risk of metabolic syndrome, especially in young adults who are exposed to smoking habits from an early age. Metabolic syndrome is the result of the interaction of various causative factors including obesity, unhealthy lifestyle, genetics, aging, hormonal factors, stress, hypertension, dyslipidemia, and environmental factors. All of these factors contribute to the development of interrelated conditions and influence each other. Therefore, efforts to prevent and control metabolic syndrome must be holistic, focusing on

comprehensive lifestyle changes, stress management, and increasing awareness of the importance of a healthy diet and regular physical activity.

Metabolic Syndrome Prevention

Prevention of metabolic syndrome requires a comprehensive approach, including sustainable lifestyle changes, increased health awareness, and individual risk factor management. One of the main steps in preventing metabolic syndrome is to maintain ideal body weight, especially by reducing abdominal fat or central obesity. Excess visceral fat plays a major role in increasing the risk of metabolic syndrome, so significant weight loss will help reduce this risk.[21] A weight control program that involves dietary changes and increased physical activity is very effective in preventing fat accumulation around vital organs. A healthy and balanced diet plays a major role in preventing metabolic syndrome. Consumption of foods that are low in calories, high in fiber, and rich in nutrients, such as fruits, vegetables, whole grains, and lean proteins, is highly recommended. Reducing the intake of processed foods, saturated fat, sugar, and salt is an important strategy to reduce the risk of hypertension, obesity, and insulin resistance. The Mediterranean diet, which emphasizes the consumption of fish, olive oil, vegetables, and whole grains, has been shown to be effective in reducing the risk of metabolic syndrome because it is rich in anti-inflammatory nutrients and low in saturated fat.

Regular physical activity is also a key factor in preventing metabolic syndrome. Physical activity helps improve insulin sensitivity, burn calories, and reduce body fat, especially around the abdomen. Exercising at least 150 minutes per week at a moderate intensity, such as brisk walking, swimming, or cycling, is recommended to maintain metabolic health. In addition, strength training, such as weight lifting, can also help build muscle mass and increase body metabolism, which directly impacts the prevention of obesity and insulin resistance. In addition to diet and physical activity, it is also important to manage stress as part of efforts to prevent metabolic syndrome. Chronic stress can trigger increased production of cortisol, a hormone that can cause insulin resistance and fat accumulation in the abdomen. Stress management techniques, such as meditation, yoga, or deep breathing, are very useful in reducing the negative effects of stress on the body. In addition, maintaining a good sleep pattern is also important because lack of sleep can affect hormone regulation and increase the risk of obesity and other metabolic disorders.

Reducing alcohol intake and quitting smoking are also important in preventing metabolic syndrome. Excessive alcohol consumption can increase blood pressure, triglyceride levels, and fat in the liver, all of which contribute to the development of metabolic syndrome. Smoking, on the other hand, can cause blood vessel damage and increase the risk of insulin

resistance. Therefore, quitting smoking and reducing alcohol consumption are important steps to improve metabolic health and prevent metabolic syndrome. Regular health checks are also an important part of the metabolic syndrome prevention strategy. Conducting health checks such as measuring blood pressure, blood sugar levels, lipid profiles (cholesterol and triglycerides), and measuring waist circumference regularly can help detect the risk of metabolic syndrome early. By conducting these checks, individuals can find out their metabolic health condition and take immediate action if an increased risk is found, for example by consulting a doctor for further treatment.

Public education and awareness about metabolic syndrome are essential in preventing this condition. Health education and programs that emphasize the importance of a healthy lifestyle, weight control, a balanced diet, and the importance of physical activity need to be expanded, especially in urban communities that tend to be at higher risk.[22] Health campaigns that focus on the dangers of metabolic syndrome and how to prevent it should be integrated into national health programs, to increase public understanding and participation in maintaining their health. In this modern era, technology can be used to help prevent metabolic syndrome. Health applications that monitor physical activity, food intake, and weight can be useful tools for individuals to track their progress in maintaining a healthy lifestyle. Wearable technology, such as smartwatches, can also help users monitor daily activity, heart rate, and sleep quality, all of which contribute to metabolic health. With this technology, individuals can be more easily motivated to implement necessary lifestyle changes.

In addition, prevention can also be done through public policies that support a healthy lifestyle. The government and related institutions need to adopt policies that promote access to healthy foods, increase sports facilities, and increase campaigns against excessive consumption of processed foods and sugar. These policies, if implemented well, will help people more easily access healthier options in their daily lives. Behavioral change is also important in preventing metabolic syndrome. This requires a long-term commitment to maintaining a healthy lifestyle. Many people who have successfully lost weight or started an exercise program have difficulty maintaining these changes.

Therefore, motivation, family support, and consistency are essential for individuals to maintain a lifestyle that supports metabolic health throughout their lives. Finally, preventing metabolic syndrome benefits not only individuals, but also society as a whole. By preventing metabolic syndrome, the risk of cardiovascular disease, diabetes, and other complications requiring long-term care can be reduced. This will ultimately reduce the burden on the health system, as well as improve the quality of life of people at the national level. Effective

prevention requires collaboration between individuals, communities, and governments to achieve optimal results.

Conclusions

Metabolic syndrome is a cluster of interrelated metabolic disorders, such as central obesity, hypertension, insulin resistance, and dyslipidemia, that increase the risk of cardiovascular disease and type 2 diabetes. The causative factors include a combination of genetics, unhealthy lifestyle, obesity, and aging. In Indonesia, metabolic syndrome is increasingly becoming a serious public health problem, mainly due to an unbalanced diet and low physical activity, which are exacerbated by modern lifestyle changes. Efforts to prevent metabolic syndrome require a comprehensive approach that includes healthy lifestyle changes, such as maintaining ideal body weight, consuming nutritious foods, and exercising regularly. Regular physical activity, a balanced diet, and stress management are key to preventing this condition. Modern technology also plays an important role in helping individuals track their health through health applications and wearable devices, making it easier for people to maintain their metabolic health. Controlling risk factors such as hypertension, dyslipidemia, and insulin resistance through regular health checks and appropriate treatment is also essential. Community-based approaches and public policies that support healthy lifestyles, such as providing access to healthy foods and sports facilities, will strengthen efforts to prevent metabolic syndrome at the community level. Thus, collective action from individuals to the government is needed to address this condition comprehensively.

Overall, metabolic syndrome is a preventable condition through a combination of lifestyle interventions, technology, and health policies. Awareness of the importance of early prevention, public education, and access to adequate health services are important factors in reducing the prevalence of metabolic syndrome in the future. By implementing comprehensive preventive efforts, the community can reduce the risk of chronic diseases associated with metabolic syndrome, as well as improve quality of life and overall health.

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