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Prevalence of Metabolic Syndrome in People with Type 2 Diabetes in Romania

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Abstract

Metabolic syndrome (MetS) has been and remains a highly controversial topic. There is a close association of (MetS) with a group of symptoms associated with diseases of the heart, blood vessels, arteries, and accelerated aging. To find out and discover whether the distribution of these associations or the totals of (MetS) components differ from one gender to another or from one ethnicity to another, 110 subjects were selected as a sample at the National Institute of Diabetes, Nutrition and Metabolic Diseases (N.C.Paulescu) In Bucharest, 110 subjects in divided between 47 Males, 63 females with an age range of 54 years for age groups 35 - 65 years. The pathological conditions in the present study were divided into 2 groups: G1: Patients who have metabolic syndrome. G2: Patients without metabolic syndrome. This study, therefore, aims to diagnose metabolic syndrome according to the criteria approved by ATP III (MetS), also known as insulin resistance syndrome or Syndrome X, which is defined as (a group of several conditions that together increase a person's risk of developing diabetes and increased heart disease), a disease that is achieved by the presence of 3 or more than 5 components that are considered as parameters or directories (MetS); such as "High level of obesity; High triglyceride levels; High blood sugar level; Decrease in HDL, or good cholesterol and High blood pressure," but not in a condition in which the person has blood pressure. To achieve this goal, a sample of 110 subjects was selected. An increase in the number of patients with metabolic syndrome at a rate of prevalence (71.1%) of type II Diabetes Patients is among those 110 diabetes patients. Especially among the large age groups, by approximately 55%, Metabolic syndrome was diagnosed in 81 patients, and an apparent increase in the number of female patients with metabolic syndrome (44 females, 37 men). Results have also shown that the metabolic syndrome criterions evolved

intrinsically among type 2 diabetes patients with high blood pressure as the highest incidence (79.01%). In contrast, the low level of the high-density lipoprotein had come as the minimal incidence (38.39%). The finding confirmed in this study the data indicates that (MetS) is expected in the category of patients with type 2 diabetes, with an estimated rate of up to 70%. In general, and for people with diabetes in particular, new lifestyles and new health interventions must be followed regarding type 2 diabetes in Romania and the world at large in order to stop or neutralize the burdens, complications, and risk of heart disease in patients with diabetes.

Keywords

Metabolic Syndrome, Type 2 Diabetic, Insulin

1. Introduction

Diabetes is considered a global epidemic with a hazardous and negative impact on human life through a negative impact on body functions in general. It is considered one of the 10 most dangerous diseases that cause death among infected people worldwide. The world deals with two types of diabetes, the most common among patients and the other types (**Figure 1**) [1]. The International Diabetes Federation has released its "Diabetes Atlas 2019" estimates on the number of people with diabetes, as there are around 537 million cases of diabetes. In addition to estimates, these people with diabetes will exceed 783 million by 2045 (**Figure 2**). Whereas type 2 diabetes is considered one of the most prevalent types of diabetes in the world, accounting for 90% of all cases of diabetes around the world, followed by type 1 diabetes, which is accompanied by other types of diabetes, which represents the remaining percentage of diabetes cases around the world [2] [3].

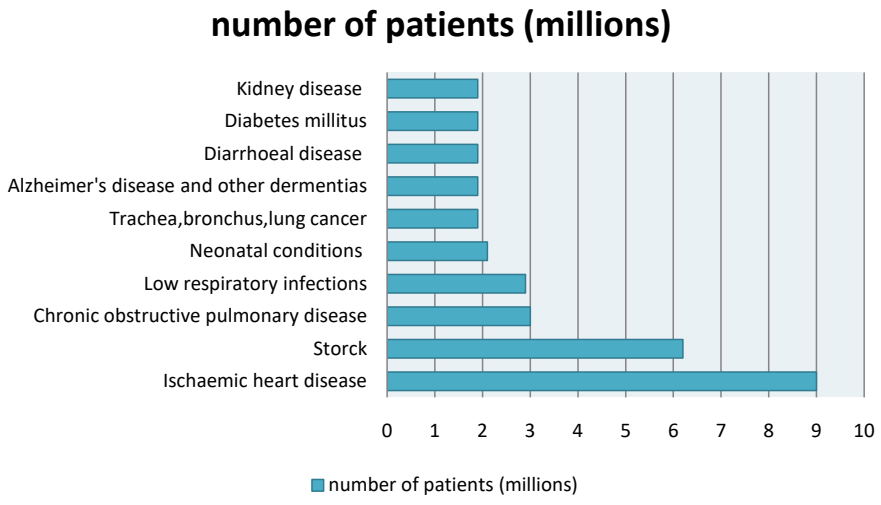

Figure 1. Globally Prevalent Death Causes. Source: WHO Global Health Estimates, Note: WORLD BANK 2020 INCOME CLASSIFICATION.

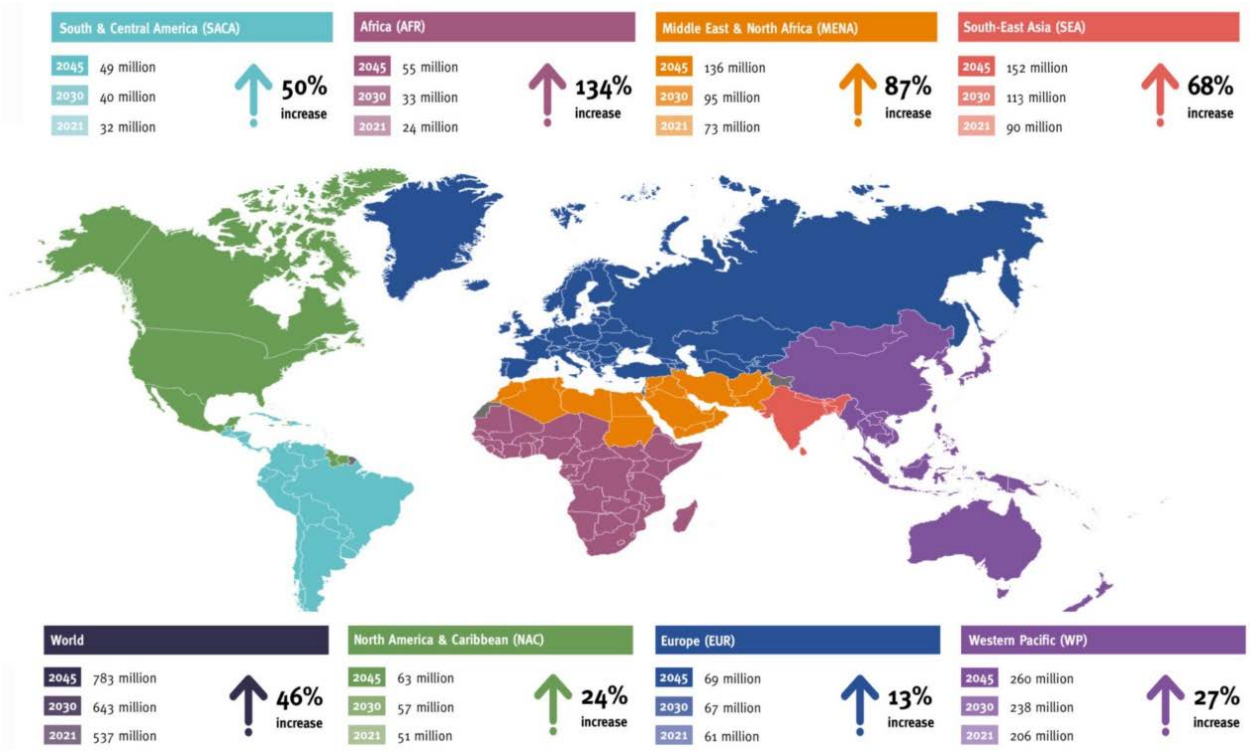

Figure 2. Estimates of comparative prevalence rates for the age group (20 - 79) in 2021 according to the 10th edition of the Diabetes Atlas.

Whereas type 1 diabetes results from attacking insulin-producing beta cells in the pancreas by the immune system in an autoimmune process. As a result, the body produces little or does not produce it at all. I believe that the explanation for this process is combining genetic susceptibility with environmental factors, which in turn lead to the formation of the "autoimmunity" [3] [4].

While diabetes mellitus type 2, is the most common type of diabetes, the high level of sugar in the blood is a result of a significant and initial sign as a result of the inability of the body's cells to perform the maximum response to insulin, causing what is called "insulin resistance" so with the onset of insulin resistance, the hormone is of slight effectiveness. This leads to an increase in insulin production at the right time. Over time, beta cells become unable to meet demand due to insufficient insulin production [5].

To reduce the risk of this disease, unhealthy practices should be avoided, and irregular control of levels of carbohydrates and fats in food should be avoided, as these factors are among the most critical factors that lead to a steady rise in cases of diabetes among young people. Age groups; Also, high rates of undiagnosed diabetes cases, mainly type 2 diabetes, exceed 50%, a source of concern for society and international health organizations. Those with a cluster of cardiovascular risk factors are more likely to experience cardiovascular problems (such as a heart attack or a stroke) [6].

Metabolic syndrome is a medical term describing a set of metabolic abnormalities raising the risks of CVD and type II diabetes. Gerald Reaven, an Ameri-

can physician, first described the metabolic syndrome as "X syndrome" in 1988; the World Health Organization named her after her current name in 1999 [7]. Metabolic syndrome refers to a minimum of 3 conditions [8]: high blood pressure, low tolerance to glucose, excess body fat around the waist, above-normal triglyceride levels, and low levels of good cholesterol. If you have only one of these conditions, it does not mean you suffer from metabolic syndrome. But it means that you have a higher risk of severe disease. And if you develop several diseases in this category, the risks of complications, like type II diabetes and cardiovascular diseases, are even higher. If you suffer from metabolic syndrome or one of its components, significant lifestyle changes can delay and even prevent the development of severe health problems [9].

Dietary metabolic syndrome represents a group of dangerous factors related to cardiovascular disease. These include weight gain, central Obesity (abdominal Obesity), insulin resistance and disrupted body fat ratios, and Hypertension [10]. Dietary metabolic syndrome is a growing global problem that threatens public health not only because of the increasing population in recent years but because they are the first cause of CVD [11], the prevalence of dietary metabolic syndrome among the general public is estimated at 17% - 25% [12] [13].

A group of experts has tried to develop a uniform definition of metabolic syndrome to become more widely accepted than those presented by the WHO, which is the first organization to propose criteria for determining metabolic syndrome in 1999, where this organization in its Diagnosis required proof of either insulin resistance (IR) or Diagnosis of type II diabetes (DM2) through high fasting plasma glucose (FPG) where or reach sugar intake two hours after a glucose tolerance test or Impaired glucose torelance (IGT) or fishery glucose dysfunction Impaired fasting glucose (IFG) and at least 2 of the following 4 criteria [14]; High blood pressure, Increased level of triglycerides or lower level High-density lipoprotein (HDL), Obesity is at the waist rate, Microalbuminuria limits the rate of secretion of polyadymogen protein. The presence of 3 of the 5 symptoms shown in **Table 1** is considered a diagnostic sign (MetS) [15].

Regardless of abnormalities in glucose metabolism, people with type 2 diabetes have a significantly increased risk of developing (MetS). The presence of

Table 1. Diagnosis of metabolic syndrome (The presence of 3 of 5 symptoms) in the table [16].

Criterion	Clinical value
Abdominal obesity	**Waist circumference >40 inches for Men/>35 inches for Women**
Hypertriglyceridemia	**≥150 mg/dL**
Low HDL cholesterol	**<40 mg/dL in Men <50 mg/dL in Women**
Hypertension	**Blood pressure ≥ 130/85 mm/Hg**
High fasting glucose	**≥110 mg/dL**

(MetS) and type 2 diabetes simultaneously increases the chances of chronic disease of the heart and blood vessels, diseases of the retina, and kidney diseases [14]. Studies were conducted on metabolic syndrome in Romania, where these studies showed an increase in the number of people with MetS, especially among women; it was also noted that there was an increase in the association of (METS) with obesity and insulin resistance [17].

Prevalence studies (MetS) conducted in Romania, especially among Romanian patients with diabetes, are few, so this study evaluated metabolic syndrome in type 2 diabetes and its associated risk factors, and tried to find solutions to reduce the spread of this syndrome, especially among the elderly age group, and urging to follow natural primary treatment methods before going to drug treatment methods, which are not devoid of causing pathological complications and drug interactions that harm the person's health and cause secondary symptoms in the infected, which are indispensable.

The increasing prevalence of (MetS) makes it a fundamentally global health issue. For this reason, international organizations, conferences, and many researchers have published research and studies that contribute to increasing awareness of the importance of adhering to healthy habits and leaving unhealthy habits to neutralize and reduce factors associated with increased risk of infection of (MetS).

2. Epidemiology of the Metabolic Syndrome

In 2006, the global Prevalence of **(MetS)** was estimated at 20%. In 2007 the percentage of **(MetS)** increased to 21.6%, since the overall rate of **(MetS)** occurrence dropped slightly during the past few years, reaching about 19.5% in 2014, after which it was noted that Prevalence rose again in 2015 when the rate was 22.9%, the increase was particularly prevalent among men, from 22.5% in 2007 to 27.8% in 2018 [18] [19], The rates related to age and sex are generally shown in **Figure 3**, as the prevalence rates (MetS) are high in women over 50, while this percentage is lower in men in the same age group.

The Prevalence of **(MetS)** varies from 10.0% to 84.0% worldwide, depending on characteristics such as age and body mass index, according To previous studies and reviews published in 2014. They ranged from 10% among those aged 20-29 (eutrophic) to 45.0% among those aged 60 - 69 (obesity) [10].

(MetS) has a high incidence in Western European countries than in Eastern European countries. European study looked examined data from 8 cohorts (a total of 8200 men and 9363 women) to determine the Prevalence of **(MetS)** using WHO's criteria and then compared those results to those obtained using a different, recommended definition of **(MetS)** for those who do not have diabetes. Despite the gradual increase in proportion to the increase in age for all persons, the study showed that the prevalence rate of **(MetS)** among men is about 7% - 36%, while it decreases among women at a rate of 5% - 22% between the ages of 40 - 55 of both Genders [18].

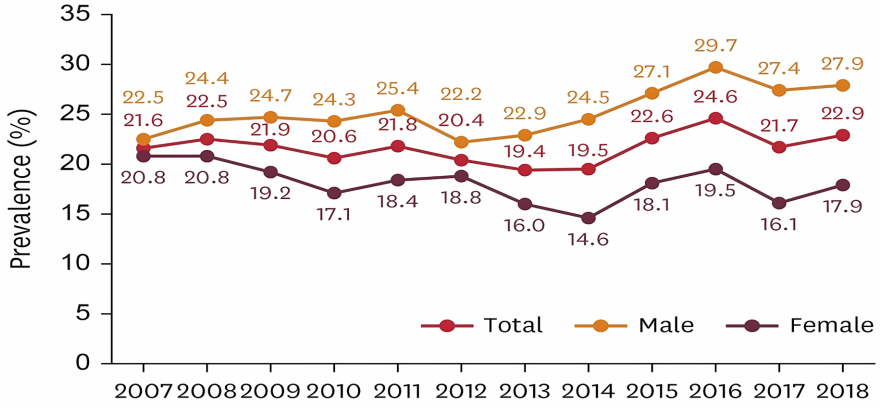

Figure 3. Prevalence rates of (MetS) by sex from 2007-2018 [20].

(MetS) They are risk factors closely related to DM2, cardiovascular disease, strokes, and kidney disease [21]. The frequency of MS in adults was briefly analyzed in a study published in NHANES 50, a survey conducted in the United States between 1999 and 2010. Changes in **(MetS)** are prominent among the population groups, including symptoms of abdominal obesity (central obesity), which indicates an increase in cases since the beginning of our study.

The Prevalence of **(MetS)** in Romania was between 32.74% - 35.66% depending on the criteria used to make the diagnosis, according to a systematic review published in 2016 [22].

3. Metabolic Syndrome and Type 2 Diabetes

Diabetes mellitus of the second type, the most prevalent worldwide, and **(MetS)** are linked to a common factor. Obesity, lack of physical activity, and an unbalanced and irregular diet are considered a factor of association between them. Studies indicate that people with **(MetS)** are 5 times more likely to develop type 2 diabetes than the average person [23] [24].

The Prevalence of DM2 is increasing at high rates in the world. High blood sugar levels and insulin resistance increase the risk of complications associated with microvascular problems and macrovascular complications. Type 2 diabetes also leads to the production of a group of different pathological disorders, including low glucose balance [25].

The rising Prevalence of diabetes as a serious health issue is a cause for anxiety. Currently, diabetes affects over half a billion individuals worldwide [3] (**Figure 2**).

4. Diabetes Type 2

Type 2 diabetes is the most prevalent type among diabetics in the world, with a rate of 90% of all diabetes cases in the world. This type occurs due to problems in the process of regulating sugar in the body and using it to provide the body with energy, as this pathological condition leads to an increase in the level of sugar in the blood. As a result, the levels of sugar in the blood rise and eventually

lead to disturbances in the blood circulation, the nervous system and the immune system [26].

In type 2 diabetes, there are two main problems. The pancreas does not produce enough insulin, the hormone responsible for regulating the movement of sugar in the blood. The second problem is the weak or almost non-existent response to insulin by the cells of the body, and thus the cells obtain very small amounts of sugar [27].

4.1. Epidemiology of Diabetes

90% - 95% of non-insulin-dependent diabetes cases are attributable to type 2 diabetes [28].

Complications related to diabetes, including cardiovascular disease and stroke, are a significant cause of death worldwide. Type 2 diabetes cases are the vast majority of cases of diabetes increases [29].

Around 8.8% of adults (20 - 79) worldwide have diabetes, or about 415 million individuals, according to data from 220 nations and territories included in the updated IDF Global Atlas of Diabetes. Less than a quarter (25.0%) of those comes from developed countries, with the remainder from developing and less-developed regions. (IDF) the ninth edition of the Diabetes Atlas in 2019 predicts that more than 600 million individuals, or one in ten adults, will have diabetes by 2040 [30].

Depending at the latest statistics by the International Diabetes Federation (IFDF), there are 537 million cases of diabetes between the age group 20 - 79 years. They are expected to reach 783 million cases in 2045, with an increase in diabetes cases among middle-income countries (**Table 2**). Estimates and statistics of diabetes cases, depending on the classification of "The World Bank" [3].

Diabetes affects 18.6% of the world's population aged 60 - 79, and this age group is projected to see the most significant increase in prevalence. Quantitatively, however, the most incidences are found among those aged 40 to 59. Diabetes is more common among those of modest means. Hence its prevalence is predicted to rise at a faster rate. The prevalence of diabetes increases inversely

Table 2. Statistics of the prevalence of diabetes in the world for the years 2019, 2030, and 2045 [30].

World Bank income classification	2019		2030		2045	
	Prevalence of Diabetes (%)	Number of people with diabetes (Millions)	Prevalence of Diabetes (%)	Number of people with diabetes (Millions)	Prevalence of Diabetes (%)	Number of people with diabetes (Millions)
High-income countries	10.4 **(8.6 - 13.7)**	95.2 **(78.7 - 120.9)**	11.4 **(9.4 - 14.3)**	107.0 **(88.3 - 134.4)**	11.9 **(9.8 - 14.8)**	112.4 **(92.2 - 139.2)**
Middle-income countries	9.5 **(7.6 - 12.3)**	353.3 **(280.1 - 455.3)**	10.7 **(8.4 - 13.7)**	449.6 **(353.0 - 576.7)**	11.8 **(9.0 - 15.0)**	551.2 **(422.7 - 705.2)**
Low-income countries	4.0 **(2.8 - 6.7)**	14.5 **(10.0 - 24.3)**	4.3 **(3.0 - 7.1)**	21.9 **(15.2 - 36.4)**	4.7 **(3.3 - 7.8)**	36.5 **(25.8 - 60.2)**

with a country's GDP; in other words, in countries where people have less money, diabetes is more common [31] [32].

According to the statistics of the American Diabetes Association, 33% - 49% of people with diabetes lack control over glucose and cholesterol levels in the blood. These factors contribute to an increase in the incidence of diabetes worldwide [30]. Having two or more diseases at once, social and financial constraints, and unique obstacles to achieving the desired outcomes in diabetes therapy are all relevant considerations [33].

Treatment and prevention of diabetes complications are expected to cost $673 billion worldwide in a conservative analysis, rising to $1197 billion in a more optimistic one. According to international experts in epidemics and diseases, by 2040, treatment and prevention costs will increase to about 1425 billion dollars [32].

4.2. Pathophysiology of Diabetes

According to the latest studies and research, diabetes mellitus "type 1 and type 2" have a unique or distinctive pathophysiology. The findings of a 2013 study of the pathophysiological and pathogenic mechanisms of diabetes provide evidence that these two forms of diabetes are distinct [32] [34].

Insulin levels in the blood of people with type 2 diabetes are reliably elevated. By using the oral glucose tolerance test (OTG), we can easily describe the characteristics of **(MetS)** [34]. One can classify those with impaired or decreased glucose tolerance as a subset of the chemically diabetic population. People with diabetes with moderate fasting hyperglycemia have levels under 140 mg/dl, while those with values beyond this threshold have diabetes with apparent fasting hyperglycemia [33].

Impaired glucose tolerance and elevated blood plasma insulin levels are conclusive biochemical evidence of **(IR)**. Because insulin levels decrease in type 2 diabetes throughout the transition from intolerance to diabetes, this enhances the character of reduced insulin secretion [33] [35].

IR (mainly in the liver and muscles) and a decrease in insulin production in pancreatic beta cells play varying roles in the pathogenesis of type 2 diabetes. Both can be affected by upbringing and heredity. The pathogenesis of type 2 diabetes is complex, involving some interrelated factors. One such aspect is the dysregulation of hormone secretion in the entero-hypothalamic and entero-insular axes [36].

It is now widely known that the steady evolution of insulin resistance **(IR)** in glucose-intolerant individuals is a crucial factor in the onset of diabetes due to the beta cell's inability to respond to the rising demand for peripheral insulin. Since the Symptoms and signs of **(IR)** after onset slightly increases with time, all patients with DM2 have detectable beta cell dysfunction. However, since the progressive decline in beta cell function, the beta cells' ability to respond to treatment also declines over time [37].

Noticed rise in baseline insulin concentrations in the blood is seen in the development of **(IR)**, especially in obese people. Some people can keep this gain, while others see it disappear. The former will continue to be neither hyperglycemic nor insulin resistant, whereas the latter will inevitably lose control of their glucose levels [38].

Compared with the accumulation and evaluation of visceral fat, abdominal fat deposition "central obesity" is associated with a prognosis associated with the syndrome and plays a more significant role in the onset of (IR). This occurs when fatty muscle and liver cells' normal metabolism is disrupted. Triglyceride metabolites can stimulate hepatic gluconeogenesis and their effects on insulin signaling, glucose transport, phosphorylation, muscle glycogen synthesis, and muscle protein synthesis (**Figure 4**) [39] [40].

Sometimes **IR** is insufficient to induce type 2 diabetes effectively; while **IR** can be considered the primary cause, insulin deficiency can also be regarded as the primary cause.

Moreover, most patients diagnosed with this illness exhibit both conditions. Many people with type 2 diabetes miss it until difficulties have occurred since the disease manifests with less severe symptoms [41].

4.3. Resistance to Insulin

Among the metabolic/cardiovascular alterations linked to insulin resistance in the general population, we find systemic arterial Hypertension; Hypercholesterolemia; Obesity (including central obesity), carbohydrate intolerance, Hypercholesterolemia, arterial Hypertension, decreased HDL-c (high-density lipoproteins); Elevated LDL-c (low-density lipoproteins) and hyperuricemia in addition to cardiovascular disease and arteries [42]. The term **(MetS)** refers to these

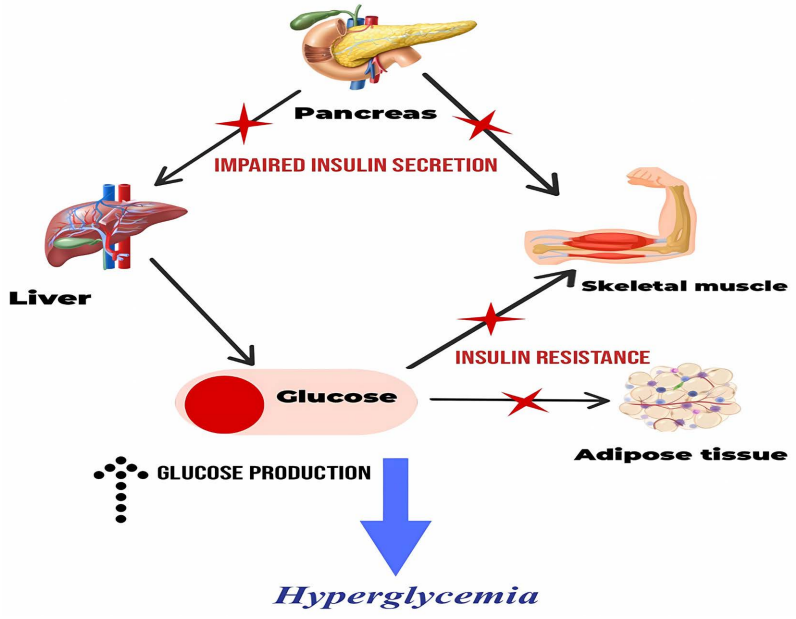

Figure 4. Pancreas and insulin production [39].

changes. Given these correlations, measuring insulin sensitivity is crucial. There are both direct and indirect measures that can be used for evaluation. The effects of injecting a known insulin dose into a human are studied using natural approaches. On the other hand, endogenous insulin's influence can be used as a proxy for insulin's efficacy, especially under homeostatic conditions [43].

Tests such as "Oral Glucose Tolerance Test, Fasting Blood Insulin, Homeostatic Model Assessment (HOMA), and QUICKI (Quantitative Insulin Sensitivity Screening Box)" are considered methods for measuring insulin resistance [44].

There are also several other methods for assessing levels of insulin resistance, including measurement of ATIC (means internal carotid artery thickness), clotting factors, enzymes, and hormones [45].

4.4. Complications of Diabetes

Many disorders in the organs and tissues, in addition to those disorders associated with diseases of the heart, blood vessels, eyes, nerves, and kidney diseases, these disorders are all linked to diabetes, for example, "retinopathy, amputation of the lower limbs, which results in physical disability" [45].

Hypoglycemia is one of the severe consequences and complications of diabetes, and it is common for people with diabetes, but sometimes it can also affect people without diabetes, as hypoglycemia is less than 70 mg/deciliter, while when blood sugar levels drop to less than 40 mg/deciliter, this is called an acute hypoglycemic crisis, which in this case leads to deaths, this disorder is more common in patients with type 1 diabetes [46].

Diabetic retinopathy, a microvascular consequence popular in type 1 and 2 diabetes, is a leading cause of blindness in adults and has been linked to factors like diabetes duration, Hypertension, hyperglycemia, and nephropathy [30].

Kidney failure is another frequent consequence, and its prevalence in people with diabetes facilitates their clinical progression to dialysis. The most common cause of kidney failure is diabetes, which leads to the condition known as diabetic kidney disease (DKD). The albumin-to-creatinine ratio is a potent cardiovascular risk factor and a DKD marker in type 2 diabetes [28] [29].

Some complications and disorders, such as "gum disease, Non-Alcoholic fatty liver disease, hearing loss, depression, erectile dysfunction, and fertility problems," are all related to diabetes [41].

Every diabetic patient has some metabolic hazards that change in lifestyle or medication must address. NCEP ATP III (National Cholesterol Education Program) and the International Diabetes Federation (IDF) include hyperglycemia, characterized by diabetes glucose levels, as 1 of 5 criteria associated with **MetS** diagnosis. Most persons with DM2 also meet of criteria for **(MetS)** [23] [29].

5. Material and Method

The practical part of research has been carried out at **The National Institute of Diabetes, Nutrition, and Metabolic Diseases "N.C.Paulescu"**, where Samples

(blood and urine) for people with type II diabetes and randomly, and the use of a carnation Dipstick for microscopic polyproline, kitlegas, lipid profile, and level Blood sugar and pressure system.

The Diagnosis of T2D had been made based on criteria by American Diabetologists Association. All subjects who visited the clinic for 18 months and were diagnosed with T2DM were initially registered. However, for current analysis, only patients for whom all data were available were retained clinical, anthropometric, and biochemical.

Measurements and Tests

We collected blood samples from diabetics during the fasting period and before breakfast, where we pulled 5 ml of blood after sterilization of the drag area; the models drawn from the blood were then placed in sterile, dry, and clean plastic tubes. We left it for half an hour at room temperature, and then we separate the serum from the clotted part with the centrifuge at 3000 cycles/minute and for 10 minutes.

1) Measuring the level of glucose in fasting serum; After fasting 12 hours of fasting according to the principle of enzyme oxidation with Glucose-Oxidase (GOD) enzyme and pink color, there was a fit for this color with the concentration of glucose in the blood serum after measuring absorption at a wavelength of 505 nanometers at a temperature of 21˚C [47].

2) Measuring triglyceride level TG in fasting serum; After 12 hours of fasting by the Enzymatic Hydrolysis principle after enzyme oxidation, Triglycerides with Lipoprotein Lipase enzyme and the reaction continued until a pink color commensurate with the concentration of triglycerides in the serum after absorption at a wavelength of 505 nanometers at temperature 21˚C [48].

3) Measuring the level of HDL in blood serum is well-known; LDL, very low-density lipoprotein VLDL, and chylomicrons are found in the blood serum, where laboratory activities in isolation and separation processes are performed carried out by adding chemicals as a solution (Phosphotungstic Acid) which contains magnesium ions; where after the centrifuge procedure, we observe the concentration of cholesterol in HDL and then the separation of these concentrations to precipitate within the laboratory sample, and then the concentration is determined after the measurement of absorption along a specific wavelength of 500 nanometers and at 21˚C [49].

4) Measuring systolic blood pressure level and diastolic blood pressure; By Rossmax, measurement took place 10 minutes after the patient sat on the backward-based seat and placed the upper limbs to the same level as the heart after which the belt was attached to the hand (above the elbow) and then pressed the operating key as the countdown began to measure the value of systolic and diastolic pressure (mmHg) and its appearance on the device screen.

5) Measuring the level of urinary microscopic protein; Urine samples were taken from people with diabetes in the morning after fasting for 8 - 12 hours

(first urine sample). In a 50 ml plastic cup, then dip the screening tape for measuring polycarbonate protein in the insertion to the middle of the indicator mark on the tape for 5 seconds, and then it is taken out and left for a minute, and compare the color in the tape with the colors on the case and read the result with (mg/L).

6) Measurement of Body Mass Index (BMI); Weight (kg) and length (m^2) have been measured for each person, after which the BMI has been estimated based on the following formula: weight (kg)/height (m^2) [50] [51].

6. Results

Results have shown that the number of people who have metabolic syndrome increased for women compared to other patients without syndrome; the total number of patients who have type II diabetes, DM2, (100%) is 110, Males 49 (44.54%) females 61 (55.46%) and an average age of 54 for age groups ranging from between (65 - 35) Year (when whose definition is applied), where the number of patients with metabolic syndrome was 81 (73.63%), 37 males (45.76%), 44 females (54.34%), while the number of those without metabolic syndrome was 29 (26.36%), 11 males (37.93%), female 18 (62.07%) (**Figure 5**, **Figure 6**).

The results also showed an increase in the number of people with metabolic syndrome among the large age groups in diabetes/type 2. The number of people who have metabolic syndrome increased from 12 (14.81%) among the age group (35 - 45 years) to 39 (48.14%) among the age group (55 - 65 years) (**Table 3**, **Figure 7**).

Through this study, we have 5 criteria for metabolic syndrome:

1) High-level of fasting glucose sugar;
2) High systolic blood pressure;
3) High BMI;
4) High-level TG triglycerides or low-level HDL lipoprotein;
5) High-level of urinary protein.

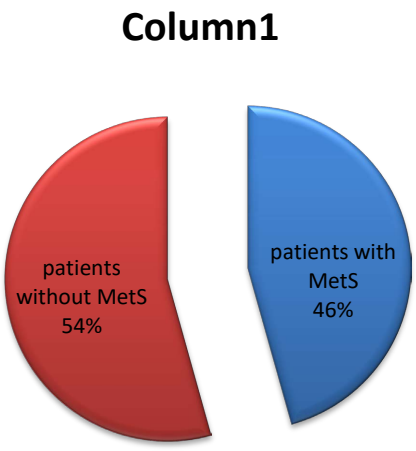

Figure 5. Showing the number and incidence of metabolic syndrome among type 2 diabetics (for all patients).

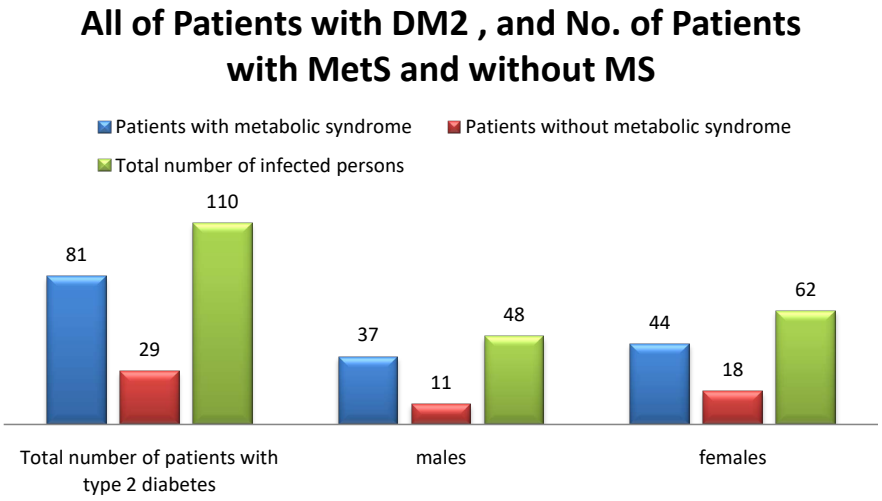

Figure 6. Total number of Patients who have DM2, and the number of Patients who have MetS and without MetS.

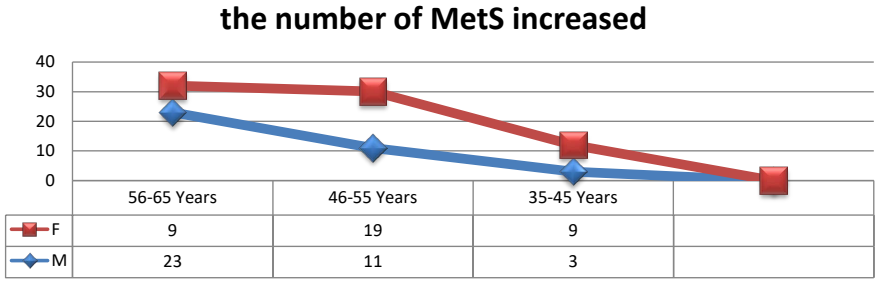

Figure 7. Increase in the number of people with metabolic syndrome among the large age groups in diabetes/type 2.

Table 3. Age groups of patients who have the metabolic syndrome among people with DM2 (male & female).

Age groups (1yr)	Number of males (No = 37)	Number of females (No = 44)	Total syndrome (%) (No = 81)
35 - 45	3 (25%)	9 (75%)	12 (14.81%)
46 - 55	11 (36.66%)	19 (63.34%)	30 (37.03%)
56 - 65	23 (58.97%)	16 (41.03%)	39 (48.14%)
Total	37 (45.67%)	44 (54.33%)	81 (100%)

These results came in various numbers and ratios, with the first order being the standard (Hypertension) of the most significant percentage of metabolic syndrome, where the infection rate was the highest at 79.01% (64 patients) divided into 29 males by 45.31% and 35 females by 54.69%, after the high level of glucose in the blood during Diagnosis because all patients with metabolic syndrome are diabetic/type 2 patients where the infection rate was 100% (81 patients), the total number of people with the syndrome, 37 males at 45.76% and 44 females at 54.34%, (High level of urinary protein) second to infect 62.96% (51 patients) divided into 29 males by 56.86% and 22 by 43.24% followed by the

same standard (high level of TG triglycerides) also represents an estimated 62.96% injury to (51 patients) divided into 28 males by 45.90% and 23 females by 54.10%, and in third place was the standard (BMI rise) of 60.49% for (49 patients) divide to 20 males and 29 females by 40.81 percent and ranked fourth standard. High-density lipoprotein HDL level reduced by 38.36% for (23 patients) divided into 10 males by 43.47% and 13 females by 56.53%, which is considered as a single criterion side by side (high level of TG triglycerides) in Diagnosing the metabolic syndrome based on WHO's definitions of metabolic syndrome. Where lowering the level of HDL has been the lowest ratio among the metabolic syndrome criteria; At the same time, we note that high blood pressure was the highest standard among metabolic syndrome criteria after the high blood glucose standard as the general standard in all patients with DM2; We note as well that the criterion of high BMI was an essential criterion in women compared to males in good male compared to women was the criterion of a high level of urinary protein. The results also showed a low probability of moral differences at probability levels ($P > 0.05$) in each of the metabolic syndrome diagnosis criteria between males and females (Table 4).

Results obtained through measurements of blood samples of patients with metabolic syndrome also showed no moral differences in serum glucose levels compared to people without metabolic syndrome.

Results for people with metabolic syndrome showed that there were moral differences in systolic blood pressure levels compared with those without the metabolic syndrome, as there has been an honest increase in systolic blood pressure levels at a level of ($P < 0.01$). Compared to people without the syndrome as well as results for people with metabolic syndrome showed moral differences in diastolic blood pressure levels compared to people without metabolic syndrome.

7. Discussion

Based on our findings as defined by WHO, we note an increase in the number of

Table 4. Preparation and reporting of Metabolic Syndrome Criteria for DM2 (Males & Females).

Metabolic syndrome criteria	Males syndrome criteria (%)	Females syndrome criteria (%)	Total syndrome criteria (%)	Moral Differences
High-level glucose fasting serum (MML/L)	37 (45.67)	44 (54.33)	81 (100)	($P > 0.05$)
High blood pressure level (mmHg)	29 (45.31)	35 (54.69)	64 (79.01)	($P > 0.05$)
High urinary microscopic protein (mg/L)	29 (56.86)	22 (43.14)	51 (62.96)	($P > 0.05$)
High TG triglycerides in fasting blood serum (MML/L)	23 (45.10)	28 (54.90)	51 (62.96)	($P > 0.05$)
High body mass index (BMI) (kg/m^2)	20 (40.81)	29 (59.19)	49 (60.49)	($P > 0.05$)
Low high-density lipoprotein HDL in fasting blood serum (Mall/L)	10 (43.47)	13 (56.53)	23 (38.39)	($P > 0.05$)

*($P > 0.05$) There are no moral differences between the male and female groups in metabolic syndrome diagnosis criteria.

people with metabolic syndrome amongst DM2 patients, increasing the prevalence of non-communicable disorders like cardiovascular disease [26] when applying metabolic syndrome definitions across other international organizations (Although Western societies differ from Eastern, these definitions have been relied upon for lack of definitive evidence for each society). These ratios vary by community, where an Increase in the number of individuals who have metabolic syndrome amongst people with DM2 for the Caucasian society among 70% - 80% while found [52]. In his study, the number of people with metabolic syndrome among people with DM2 has increased by a 75%.

The results showed a prevalence of metabolic syndrome amongst the women compared to men. These results have been consistent with other studies in several societies in Asia, such as Iran and Pakistan [30] [45]. In contrast, other studies showed a different effect of sex among metabolic syndrome patients such as [30] in the US that had shown a prevalence of metabolic syndrome among white American males compared to white American women.

The prevalence of metabolic syndrome amongst females compared to males may be due to the rapid development of diabetes complications among women, especially in the large age groups after the interruption of the menstrual period and the disruption of female hormone ratios with a lack of physical activity and eating food with high-calorie levels and its impact on weight gain (high BMI) hence low levels of HDL lipoproteins and estradiol levels [46]. As a result of our findings and other studies conducted by other researchers, metabolic syndrome levels increase with age.

The results of the diagnostic criteria for metabolic syndrome also showed that high blood pressure had been the maximum ratio of metabolic syndrome after the standard of high fasting glucose sugar as a general criterion for all metabolic syndrome patients, followed by a high level of the UCP and high level of TG triglycerides and then high body mass index and finally the low level of HDL. The cause of Hypertension in diabetes patients is insulin resistance, as it contributes to the expansion of the size of the nearby tube. Therefore, insulin enhances the reabsorption of sodium from the nearby tube [48].

The high level of urinary microscopic protein among males compared to women is probably due to female sex hormones and their role in protecting against the development of complications of kidney disease, especially in women in the fertility period [50].

Diabetic nephropathy and high level of protein are directly associated with lipid deficiency, including high levels of TG triglycerides and LDL lipoproteins and low HDL levels among type 2 diabetics due to an imbalance in the metabolism among diabetes patients.

The low level of high-density lipoprotein HDL directly accelerates the process of atherosclerosis amongst people with DM2 by transferring cholesterol from the walls of the arteries to the liver to subtract and dispose of it. So it is called benign or good cholesterol for being rich in protein molecules called apolipoprotein

(Apo A-1). Other molecules protect against atherosclerosis and are inversely proportional to TG triglycerides and LDL levels of lipoprotein called bad or malignant cholesterol because it is also rich in protein molecules called apolipoprotein (Apo B), which is a cause of atherosclerosis and when classifying the risk of CVD between the general public and people with diabetes based on acceptable risk scores, edge and high levels of lipid levels in the serum. Most TG and HDL lipoprotein levels for metabolic syndrome patients ranged from risk scores (low risk) to high risk at the edge (medium risk) [51].

The absence of moral differences in fasting serum glucose levels between the group with the metabolic syndrome and those without it may be because the two groups are type 2 diabetics (Males and Females). Levels of fasting serum glucose for patients with FBS diabetes were the largest or equal to 7 ml/L according to WHO's Diagnosis of DM2 in patients with the metabolic syndrome [52]. The presence of insulin resistance (IR) by target cells has been defined as the primary cause of hyperglycemia in DM2 patients. Insulin deficiency by beta cells in the pancreas leads to high blood sugar. When there is insulin resistance by the target cells, this results in a decrease in the amount of glucose consumed by the cells and an increase in glucose production in the liver in the middle of the glycogen degradation process [53] [54].

Persistent deterioration in the function of insulin-producing cells is frequently observed in DM2 patients due to a potential role of oxidative stress, which diabetes patients experience daily due to chronic elevations in blood glucose, resulting in disease development and its increased complications [55] [56].

There are moral differences in the systolic blood pressure levels and diastolic blood pressure compared to people without the syndrome, perhaps because most of the individuals with the metabolic syndrome, most of whom had no hypertension, among people with DM2.

Diabetes patients have a higher likelihood of developing high blood pressure than non-diabetes. This interconnectedness increases as the patient ages and the more prolonged diabetes is developed, and hypertension cases increase in developing countries.

High blood pressure levels are strongly related to insulin resistance, even in the case of non-diabetes. At the same time, 40% - 70% of people with DM2 develop high blood pressure due to insulin resistance [57] [58] [59]. Metabolic syndrome is a source of serious threat to the world at present because it represents a condition associated with several serious pathological factors, in addition to being closely associated with people with type 2 diabetes and because of the widespread prevalence of this disease, which was estimated by the International Diabetes Federation (IDF) through the Diabetes Atlas 2019, the percentage of people with diabetes will rise to 700 million people around the world by the year 2045 [60].

8. Conclusions

Our study's factor analysis results argue that the relationships between the va-

riables that classically compose **MetS** are best explained through the prism of multiple physiological processes. At the same time, identified factors do not fully explain the pathogenesis of **MetS**, requiring further studies and, perhaps, introducing new components or markers to explain the phenomenon comprehensively. Our results play a role in better understanding the pathophysiology of **MetS** in T2DM patients, which could translate into practice through the development of prevention and treatment strategies that target mechanisms responsible for the simultaneous occurrence of several **MetS** components.

Increase the **MetS** prevalence amongst people with DM2, especially the large age groups, especially women. Most metabolic syndrome patients have high blood pressure, high urinary protein, high triglyceride levels, and high BMI (obesity). Furthermore, low levels of high-density lipoprotein after having DM2 thus contribute to each of the syndrome criteria to increased heart and vascular disease risks related to high mortality among metabolic syndrome patients.

Improving lifestyle and lifestyle remains the most appropriate and best solution. The initial treatment measures for those with **MetS** are following specific diet and exercise recommendations and controlling behavioral practices, emphasizing medication use for people with **MetS** who have not had apparent progression. Improve when these measures are followed.

For example, the person's immediate surroundings (housing or geographical location) may encourage this disorder. Factors like labor and working conditions, sanitation, and social norms, to name a few, might be considered alongside environmental factors.

Socioeconomic status is associated with an increase or decrease in the prevalence of **(MetS)**, diabetes mellitus, and cardiovascular disease, as well as the pathological complications associated with these diseases.

There was a wide range of approaches to assessing **(MetS)** in many systematic reviews. One of them created a hierarchical classification of these techniques according to their usefulness, with the NCEP ATP III (2001) at the top, followed by the modified 2005 (AHA/NHLBI) version, then the WHO (1998) version, and finally the modified WHO (1998) version (1999). According to the findings, the high degree of variability between type 2 diabetes and **(MetS)** may be attributable to the similarity in diagnostic criteria between the two diseases.

Obesity, Hypertension, uncontrolled hyperglycemia, high triglyceride and LDL-c levels, and low HDL-c levels are more common in women than men when comparing **(MetS)** components in a sample of people with type 2 diabetes. According to the same scientists, these changes tend to worsen with age in this population and could contribute to cardiovascular risk.

It has been noted worldwide that a comprehensive and integrated approach is necessary to effectively address not only diabetes but also the spectrum of comorbidities such as **(MetS)** that may coexist with it.

To review and evaluate the surrounding health conditions, epidemics, and diseases, it is advised that more studies be developed on this topic, comparable

to those made in eastern and developing countries. It would be fascinating to analyze how the cultural norms of each continent's people might affect the spread of the disease, (MetS) has not been recorded in young age groups and children, and this path allows us to carry out prevention and focus therapeutic steps in the stages of childhood and adolescence to avoid the occurrence of this syndrome and its associated risk factors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Ritchie, H., Spooner, F. and Roser, M. (2018) Causes of Death. Our World in Data.

[2] Sun, H., Saeedi, P., Karuranga, S., Pinkepank, M., Ogurtsova, K., Duncan, B.B. and Magliano, D.J. (2022) IDF Diabetes Atlas: Global, Regional and Country-Level Diabetes Prevalence Estimates for 2021 and Projections for 2045. *Diabetes Research and Clinical Practice*, **183**, Article ID: 109119. https://doi.org/10.1016/j.diabres.2021.109119

[3] Ogurtsova, K., Guariguata, L., Barengo, N.C., Ruiz, P.L.D., Sacre, J.W., Karuranga, S. and Magliano, D.J. (2022) IDF Diabetes Atlas: Global Estimates of Undiagnosed Diabetes in Adults for 2021. *Diabetes Research and Clinical Practice*, **183**, Article ID: 109118. https://doi.org/10.1016/j.diabres.2021.109118

[4] Unnikrishnan, R., Pradeepa, R., Joshi, S.R. and Mohan, V. (2017) Type 2 Diabetes: Demystifying the Global Epidemic. *Diabetes*, **66**, 1432-1442. https://doi.org/10.2337/db16-0766

[5] Berbudi, A., Rahmadika, N., Tjahjadi, A.I. and Ruslami, R. (2020) Type 2 Diabetes and Its Impact on the Immune System. *Current Diabetes Reviews*, **16**, 442-449. https://doi.org/10.2174/1573399815666191024085838

[6] Chawla, R., Madhu, S.V., Makkar, B.M., Ghosh, S., Saboo, B., Kalra, S. and RSSDI-ESI Consensus Group (2020) RSSDI-ESI Clinical Practice Recommendations for the Management of Type 2 Diabetes Mellitus 2020. *Indian Journal of Endocrinology and Metabolism*, **24**, 1-122. https://doi.org/10.4103/ijem.IJEM_225_20

[7] O'Neill, S. and O'Driscoll, L. (2015) Metabolic Syndrome: A Closer Look at the Growing Epidemic and Its Associated Pathologies. *Obesity Reviews*, **16**, 1-12. https://doi.org/10.1111/obr.12229

[8] Alberti, K.G.M.M., Zimmet, P. and Shaw, J. (2006) Metabolic Syndrome—A New World-Wide Definition. A Consensus Statement from the International Diabetes Federation. *Diabetic Medicine*, **23**, 469-480. https://doi.org/10.1111/j.1464-5491.2006.01858.x

[9] Watanabe, K. and Cho, Y.D. (2014) Periodontal Disease and Metabolic Syndrome: A Qualitative Critical Review of Their Association. *Archives of Oral Biology*, **59**, 855-870. https://doi.org/10.1016/j.archoralbio.2014.05.003

[10] Kaur, J. (2014) A Comprehensive Review on Metabolic Syndrome. *Cardiology Research and Practice*, **2014**, Article ID: 943162. https://doi.org/10.1155/2014/943162

[11] Balakumar, P., Maung-U, K. and Jagadeesh, G. (2016) Prevalence and Prevention of Cardiovascular Disease and Diabetes Mellitus. *Pharmacological Research*, **113**, 600-609. https://doi.org/10.1016/j.phrs.2016.09.040

[12] Ahmed, N., Ahmad, T., Hussain, S.J. and Javed, M. (2010) Frequency of Metabolic Syndrome in Patients with Type-2 Diabetes. *Journal of Ayub Medical College Abbottabad*, **22**, 139-142.

[13] Belete, R., Ataro, Z., Abdu, A. and Sheleme, M. (2021) Global Prevalence of Metabolic Syndrome among Patients with Type I Diabetes Mellitus: A Systematic Review and Meta-Analysis. *Diabetology & Metabolic Syndrome*, **13**, Article No. 25. https://doi.org/10.1186/s13098-021-00641-8

[14] Bhowmik, B., Munir, S.B., Hossain, I.A., Siddiquee, T., Diep, L.M., Mahmood, S. and Hussain, A. (2012) Prevalence of Type 2 Diabetes and Impaired Glucose Regulation with Associated Cardiometabolic Risk Factors and Depression in an Urbanizing Rural Community in Bangladesh: A Population-Based Cross-Sectional Study. *Diabetes & Metabolism Journal*, **36**, 422-432. https://doi.org/10.4093/dmj.2012.36.6.422

[15] Wahab, K.W., Sani, M., Gbadamosi, M. and Yandutse, M. (2008) Frequency and Determinants of the Metabolic Syndrome in Apparently Healthy Adult Nigerians. *Tropical Doctor*, **38**, 224-226. https://doi.org/10.1258/td.2007.070335

[16] Christian Flemming, G.M., Bussler, S., Körner, A. and Kiess, W. (2020) Definition and Early Diagnosis of Metabolic Syndrome in Children. *Journal of Pediatric Endocrinology and Metabolism*, **33**, 821-833. https://doi.org/10.1515/jpem-2019-0552

[17] Albu, A., Radian, S., Fica, S. and Barbu, C.G. (2015) Biochemical Hyperandrogenism Is Associated with Metabolic Syndrome Independently of Adiposity and Insulin Resistance in Romanian Polycystic Ovary Syndrome Patients. *Endocrine*, **48**, 696-704. https://doi.org/10.1007/s12020-014-0340-9

[18] Huh, J.H., Kang, D.R., Kim, J.Y. and Koh, K.K. (2021) Metabolic Syndrome Fact Sheet 2021: Executive Report. *CardioMetabolic Syndrome Journal*, **1**, 125-134. https://doi.org/10.51789/cmsj.2021.1.e15

[19] Beltrán-Sánchez, H., Harhay, M.O., Harhay, M.M. and McElligott, S. (2013) Prevalence and Trends of Metabolic Syndrome in the Adult US Population, 1999-2010. *Journal of the American College of Cardiology*, **62**, 697-703. https://doi.org/10.1016/j.jacc.2013.05.064

[20] Piko, P., Dioszegi, J., Kosa, Z., Sandor, J., Moizs, M. and Adany, R. (2021) Changes in the Prevalence of Metabolic Syndrome, Its Components, and Relevant Preventive Medication between 2011 and 2018 in the Northeast Hungarian Roma Population. *Journal of Personalized Medicine*, **11**, Article No. 595. https://doi.org/10.3390/jpm11070595

[21] Silveira Rossi, J.L., Barbalho, S.M., Reverete de Araujo, R., Bechara, M.D., Sloan, K.P. and Sloan, L.A. (2022) Metabolic Syndrome and Cardiovascular Diseases: Going beyond Traditional Risk Factors. *Diabetes/Metabolism Research and Reviews*, **38**, e3502. https://doi.org/10.1002/dmrr.3502

[22] Popa, S., Moța, M., Popa, A., Moța, E., Serafinceanu, C., Guja, C. and Mihai, B. (2016) Prevalence of Overweight/Obesity, Abdominal Obesity and Metabolic Syndrome and Atypical Cardiometabolic Phenotypes in the Adult Romanian Population: PREDATORR Study. *Journal of Endocrinological Investigation*, **39**, 1045-1053. https://doi.org/10.1007/s40618-016-0470-4

[23] Saeedi, P., Petersohn, I., Salpea, P., Malanda, B., Karuranga, S., Unwin, N. and IDF Diabetes Atlas Committee (2019) Global and Regional Diabetes Prevalence Estimates for 2019 and Projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas. *Diabetes Research and Clinical Practice*, **157**, Article ID: 107843. https://doi.org/10.1016/j.diabres.2019.107843

[24] Garvey, W.T., Ryan, D.H., Henry, R., Bohannon, N.J., Toplak, H., Schwiers, M. and Day, W.W. (2014) Prevention of Type 2 Diabetes in Subjects with Prediabetes and Metabolic Syndrome Treated with Phentermine and Topiramate Extended Release. *Diabetes Care*, **37**, 912-921. https://doi.org/10.2337/dc13-1518

[25] Amaral, M.O.P., de Matos, N.A.M., Veiga, N.J. and de Matos, D.S.M.P. (2020) Problemas experienciados pelo cuidador informal de pessoa idosa em situação de dependência. *Archives of Health Sciences*, **27**, 37-41. https://doi.org/10.17696/2318-3691.27.1.2020.1710

[26] Liu, Y.K., Ling, S., Lui, L.M., Ceban, F., Vinberg, M., Kessing, L.V. and McIntyre, R.S. (2022) Prevalence of Type 2 Diabetes Mellitus, Impaired Fasting Glucose, General Obesity, and Abdominal Obesity in Patients with Bipolar Disorder: A Systematic Review and Meta-Analysis. *Journal of Affective Disorders*, **300**, 449-461. https://doi.org/10.1016/j.jad.2021.12.110

[27] Hodgson, S., Cheema, S., Rana, Z., Olaniyan, D., O'Leary, E., Price, H. and Dambha-Miller, H. (2022) Population Stratification in Type 2 Diabetes Mellitus: A Systematic Review. *Diabetic Medicine*, **39**, e14688. https://doi.org/10.1111/dme.14688

[28] Regufe, V.M., Pinto, C.M. and Perez, P.M. (2020) Metabolic Syndrome in Type 2 Diabetic Patients: A Review of Current Evidence. *Porto Biomedical Journal*, **5**, e101. https://doi.org/10.1097/j.pbj.0000000000000101

[29] Leon, B.M. and Maddox, T.M. (2015) Diabetes and Cardiovascular Disease: Epidemiology, Biological Mechanisms, Treatment Recommendations and Future Research. *World Journal of Diabetes*, **6**, 1246-1258. https://doi.org/10.4239/wjd.v6.i13.1246

[30] Atlas, D. (2015) IDF Diabetes Atlas. 7th Edition, Vol. 33, International Diabetes Federation, Brussels, 2.

[31] Atlas, D. (2019) IDF Diabetes Atlas. 9th Edition, International Diabetes Federation, Brussels. http://www.idf.org/about-diabetes/facts-figures

[32] Guariguata, L., Whiting, D.R., Hambleton, I., Beagley, J., Linnenkamp, U. and Shaw, J.E. (2014) Global Estimates of Diabetes Prevalence for 2013 and Projections for 2035. *Diabetes Research and Clinical Practice*, **103**, 137-149. https://doi.org/10.1016/j.diabres.2013.11.002

[33] Baynes, H.W. (2015) Classification, Pathophysiology, Diagnosis and Management of Diabetes Mellitus. *Journal of Diabetes & Metabolism*, **6**, Article No. 541.

[34] Ozougwu, J.C., Obimba, K.C., Belonwu, C.D. and Unakalamba, C.B. (2013) The Pathogenesis and Pathophysiology of Type 1 and Type 2 Diabetes Mellitus. *Journal of Physiology and Pathophysiology*, **4**, 46-57. https://doi.org/10.5897/JPAP2013.0001

[35] Bello-Chavolla, O.Y., Almeda-Valdes, P., Gomez-Velasco, D., Viveros-Ruiz, T., Cruz-Bautista, I., Romo-Romo, A. and Aguilar-Salinas, C.A. (2018) METS-IR, a Novel Score to Evaluate Insulin Sensitivity, Is Predictive of Visceral Adiposity and Incident Type 2 Diabetes. *European Journal of Endocrinology*, **178**, 533-544. https://doi.org/10.1530/EJE-17-0883

[36] Sanches, J.M., Zhao, L.N., Salehi, A., Wollheim, C.B. and Kaldis, P. (2023) Pathophysiology of Type 2 Diabetes and the Impact of Altered Metabolic Interorgan Crosstalk. *The FEBS Journal*, **290**, 620-648. https://doi.org/10.1111/febs.16306

[37] Pjanic, M. (2017) The Role of Polycarbonate Monomer Bisphenol-A in Insulin Resistance. *PeerJ*, **5**, e3809. https://doi.org/10.7717/peerj.3809

[38] Šestan, M., Marinović, S., Kavazović, I., Cekinović, Đ., Wueest, S., Wensveen, T.T.

and Polić, B. (2018) Virus-Induced Interferon-γ Causes Insulin Resistance in Skeletal Muscle and Derails Glycemic Control in Obesity. *Immunity*, **49**, 164-177. https://doi.org/10.1016/j.immuni.2018.05.005

[39] Wamberg, L., Kampmann, U., Stødkilde-Jørgensen, H., Rejnmark, L., Pedersen, S.B. and Richelsen, B. (2013) Effects of Vitamin D Supplementation on Body Fat Accumulation, Inflammation, and Metabolic Risk Factors in Obese Adults with Low Vitamin D Levels—Results from a Randomized Trial. *European Journal of Internal Medicine*, **24**, 644-649. https://doi.org/10.1016/j.ejim.2013.03.005

[40] Caprio, S., Perry, R. and Kursawe, R. (2017) Adolescent Obesity and Insulin Resistance: Roles of Ectopic Fat Accumulation and Adipose Inflammation. *Gastroenterology*, **152**, 1638-1646. https://doi.org/10.1053/j.gastro.2016.12.051

[41] Hogrebe, N.J., Maxwell, K.G., Augsornworawat, P. and Millman, J.R. (2021) Generation of Insulin-Producing Pancreatic β Cells from Multiple Human Stem Cell Lines. *Nature Protocols*, **16**, 4109-4143. https://doi.org/10.1038/s41596-021-00560-y

[42] Petrie, J.R., Guzik, T.J. and Touyz, R.M. (2018) Diabetes, Hypertension, and Cardiovascular Disease: Clinical Insights and Vascular Mechanisms. *Canadian Journal of Cardiology*, **34**, 575-584. https://doi.org/10.1016/j.cjca.2017.12.005

[43] Kullmann, S., Heni, M., Hallschmid, M., Fritsche, A., Preissl, H. and Häring, H.U. (2016) Brain Insulin Resistance at the Crossroads of Metabolic and Cognitive Disorders in Humans. *Physiological Reviews*, **96**, 1169-1209. https://doi.org/10.1152/physrev.00032.2015

[44] Geloneze, B., Vasques, A.C.J., Stabe, C.F.C., Pareja, J.C., Rosado, L., Queiroz, E.C.D. and Tambascia, M.A. (2009) Índices HOMA1-IR e HOMA2-IR para identificação de resistência à insulina e síndrome metabólica: Estudo Brasileiro de Síndrome Metabólica (BRAMS). *Arquivos Brasileiros de Endocrinologia & Metabologia*, **53**, 281-287. https://doi.org/10.1590/S0004-27302009000200020

[45] National Center for Health Statistics (US) (2015) Health, United States, 2014: With Unique Feature on Adults Aged 55-64.

[46] American Diabetes Association (2015) 13. Diabetes Care in the Hospital, Nursing Home, and Skilled Nursing Facility. *Diabetes Care*, **38**, S80-S85. https://doi.org/10.2337/dc15-S016

[47] Burits, C.A. and Ashwood, E.R. (1999) Methods for the Determination of Serum Iron, Iron Binding Capacity, and Transferrin Saturation. In: *Tietz Textbook of Clinical Chemistry*, 3rd Edition, AACC, Washington DC, 1701-1703.

[48] Fossati, P. and Prencipe, L. (1982) Serum Triglycerides Determined Colorimetrically with an Enzyme That Produces Hydrogen Peroxide. *Clinical Chemistry*, **28**, 2077-2080. https://doi.org/10.1093/clinchem/28.10.2077

[49] Lopes-Virella, M.F., Stone, P., Ellis, S. and Colwell, J.A. (1977) Cholesterol Determination in High-Density Lipoproteins Separated by Three Different Methods. *Clinical Chemistry*, **23**, 882-884. https://doi.org/10.1093/clinchem/23.5.882

[50] Nuttall, F.Q. (2015) Body Mass Index: Obesity, BMI, and Health: A Critical Review. *Nutrition Today*, **50**, 117-128. https://doi.org/10.1097/NT.0000000000000092

[51] Herpertz, S.C. and Sass, H. (2000) Emotional Deficiency and Psychopathy. *Behavioral Sciences & the Law*, **18**, 567-580. https://doi.org/10.1002/1099-0798(200010)18:5<567::AID-BSL410>3.0.CO;2-8

[52] Mayneris-Perxachs, J., Sala-Vila, A., Chisaguano, M., Castellote, A.I., Estruch, R., Covas, M.I. and PREDIMED Study Investigators (2014) Effects of 1-Year Intervention with a Mediterranean Diet on Plasma Fatty Acid Composition and Metabolic

Syndrome in a Population at High Cardiovascular Risk. *PLOS ONE*, **9**, e85202. https://doi.org/10.1371/journal.pone.0085202

[53] Köken, Ö.Y., Kara, C., Yılmaz, G.C. and Aydın, H.M. (2020) Prevalence of Obesity and Metabolic Syndrome in Children with Type 1 Diabetes: A Comparative Assessment Based on Criteria Established by the International Diabetes Federation, World Health Organisation and National Cholesterol Education Program. *Journal of Clinical Research in Pediatric Endocrinology*, **12**, 55-62. https://doi.org/10.4274/jcrpe.galenos.2019.2019.0048

[54] Mogre, V., Salifu, Z.S. and Abedandi, R. (2014) Prevalence, Components and Associated Demographic and Lifestyle Factors of the Metabolic Syndrome in Type 2 Diabetes Mellitus. *Journal of Diabetes & Metabolic Disorders*, **13**, Article No. 80. https://doi.org/10.1186/2251-6581-13-80

[55] Li, Y., Zhao, L., Yu, D., Wang, Z. and Ding, G. (2018) Metabolic Syndrome Prevalence and Its Risk Factors among Adults in China: A Nationally Representative Cross-Sectional Study. *PLOS ONE*, **13**, e0199293. https://doi.org/10.1371/journal.pone.0199293

[56] Zhou, M.S., Wang, A. and Yu, H. (2014) Link between Insulin Resistance and Hypertension: What Is the Evidence from Evolutionary Biology? *Diabetology & Metabolic Syndrome*, **6**, Article No. 12. https://doi.org/10.1186/1758-5996-6-12

[57] Tagi, V.M., Mainieri, F. and Chiarelli, F. (2022) Hypertension in Patients with Insulin Resistance: Etiopathogenesis and Management in Children. *International Journal of Molecular Sciences*, **23**, Article No. 5814.

[58] Kostapanos, M.S. and Elisaf, M.S. (2014) High Density Lipoproteins and Type 2 Diabetes: Emerging Concepts in Their Relationship. *World Journal of Experimental Medicine*, **4**, 1-6. https://doi.org/10.5493/wjem.v4.i1.1

[59] Tsuboi, K., Mizukami, H., Inaba, W., Baba, M. and Yagihashi, S. (2016) The Dipeptidyl Peptidase IV Inhibitor Vildagliptin Suppresses Development of Neuropathy in Diabetic Rodents: Effects on Peripheral Sensory Nerve Function, Structure and Molecular Changes. *Journal of Neurochemistry*, **136**, 859-870. https://doi.org/10.1111/jnc.13439

[60] Pitocco, D., Tesauro, M., Alessandro, R., Ghirlanda, G. and Cardillo, C. (2013) Oxidative Stress in Diabetes: Implications for Vascular and Other Complications. *International Journal of Molecular Sciences*, **14**, 21525-21550. https://doi.org/10.3390/ijms141121525