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Phytoconstituents as Potential Therapeutics in Endocrine Disorders: A Comprehensive Review

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Abstract: *The endocrine system is composed of various glands that produce and release hormones directly into the bloodstream. These hormones regulate vital functions such as metabolism, growth, reproduction, and other physiological processes. When this system is disrupted, it can lead to endocrine disorders that are associated with health problems including obesity, diabetes, cardiovascular diseases, and metabolic syndromes. Diseases such as Diabetes Mellitus, Obesity, cardiovascular diseases, are major contributors to global mortality and morbidity, having a significant impact on public health worldwide.*

Diabetes mellitus is a complex metabolic disorder caused by either a lack of insulin production or impaired insulin function. It affects a large proportion of the population in both developed and developing countries. Treatment with synthetic drugs can be expensive and often carries a significant risk of side effects.

Cardiovascular disease is a major and growing health concern in the United Kingdom, accounting for nearly one-third of all deaths and causing significant illness.

Obesity is a complex, multifaceted disease characterized by the accumulation of excess body fat, which negatively impacts overall health.

Keywords: Endocrine system , Diabetes Mellitus, Cardiovascular Disease, Obesity, Phytoconstituents, Disorder, Medicinal plants, Harmonal imbalance

I. INTRODUCTION

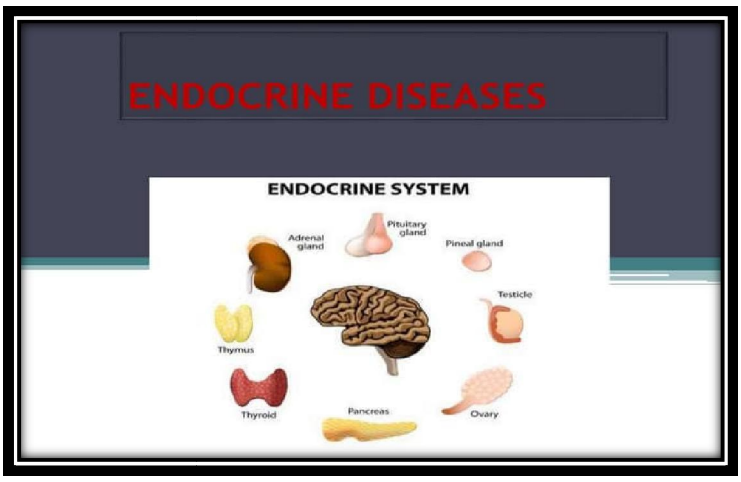

Fig: 1.1 Endocrine Disorder

The endocrine system consists of several glands, such as the pituitary gland, the hypothalamus located in the brain, and the adrenal glands situated above the kidneys. Impairment of endocrine glands and their functions can lead to various

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disorders. Common examples include diabetes mellitus, which involves abnormal insulin regulation; Addison's disease, characterised by decreased production of adrenal hormones;Cushing's syndrome, caused by excessive cortisol levels; Graves' disease, resulting from overproduction of thyroid hormones; and Hashimoto's thyroiditis, an autoimmune condition leading to hypothyroidism and reduced thyroid hormone levels.

Other related disorders include hyperthyroidism (overactive thyroid), hypothyroidism (underactive thyroid), and prolactinoma, which involves overproduction of prolactin by the pituitary gland. The endocrine system is made up of important glands such as the pituitary gland, the hypothalamus in the brain, and the adrenal glands near the kidneys. These glands release hormones that control many body functions. When any of these glands do not work properly, different health problems can occur. For example, diabetes mellitus happens due to problems with hormone production.

Addison's disease occurs when the body does not make enough hormones, while

Cushing syndrome happens when the body makes too much cortisol.

Graves' disease is caused by too much thyroid hormone, while

Hashimoto's thyroiditis is an autoimmune condition that reduces thyroid hormone levels.

Other disorders like hyperthyroidism, hypothyroidism, and prolactinoma (too much prolactin due to an overactive pituitary gland) also result from hormone imbalance. Even though these diseases are different, they all occur because the glands are not functioning correctly. Early diagnosis and treatment are important for good health. Scientists are still studying these conditions to better understand what causes them. (1)

Diabetes mellitus (DM), cancer, infections, inflammation, cardiovascular diseases (CVDs), and gastrointestinal (GI) disorders are among the conditions that continue to have a significant impact on mortality and morbidity globally.

Chronic illnesses, which are frequently linked to numerous complications, can also significantly lower quality of life. This includes causing drug interactions, having negative side effects, and/or causing hypersensitive reactions.

In ethno medicine, medicinal plants have long been used as effective therapeutic agents since they are typically regarded as safer, less expensive, and easier to obtain than synthetic medications. Over 80% of people worldwide still use traditional medicines made from plants to treat their fundamental medical needs, according to the World Health Organisation (WHO).

In order to manage diabetes mellitus, cancer, infections, inflammation, cardiovascular diseases, and gastrointestinal disorders, this review aims to investigate the most widely used medicinal plants in ethnomedicine, as well as their phytoconstituents, pharmacological characteristics, and mechanisms of action.

The future potential of medicinal plants for human health disorders and developments in medicinal plant research are also covered in this article. (2)

These days, endocrine disorders are a more common and complicated global health issue, and because of their severe complications, they place a greater financial strain on governments around the world.Examples of the best medicinal plants used to treat common endocrine disorders are given in this review, with special attention to green-formulated nanoparticles, which work better than crude extracts.(3)

Table: Major Classes and Representative Compounds (4)

Class	Representative Compounds	Plant Sources	Notable Activities
Alkaloids	Morphine, Berberine, Ephedrine	Opium poppy, Barberry, Ephedra	Analgesic, antihypertensive, antidiabetic
Flavonoids	Quercetin, Rutin, Catechin	Onions, Buckwheat, Green tea	Antioxidant, anti-inflammatory
Terpenoids	Artemisinin,Menthol, Ginsenosides	Artemisia, Mint, Ginseng	Antimalarial, immunomodulatory
Saponins	Dioscin, Glycyrrhizin, Ginsenosides	Yam, Licorice, Ginseng	Cholesterol-lowering, anti-inflammatory
Glycosides	Stevioside, Digoxin, Salicin	Stevia, Foxglove, Willow	Cardiac, antidiabetic
Others	Tannins, Lignans, Polyphenols	Tea, Flaxseed, Grapes	Antioxidant, phytoestrogenic

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Various Endocrine Diseases

(A) Diabetes Mellitus.

A disorder of carbohydrate, fat, and protein metabolism caused by decreased insulin production or increasing resistance to its action, diabetes mellitus is "a metabolic disorder of multiple etiologist characterized by chronic hyperglycaemia with disturbances in carbohydrate, fat, and protein metabolism resulting from defects in insulin secretion, insulin action, or both," according to the World Health Organization (WHO). Diabetes is a chronic condition brought on by either insufficient insulin production by the pancreas or inefficient insulin utilization by the body.One hormone that controls blood sugar is insulin. (5)

It is triggered by an excess of growth hormone and mostly functions via insulin signalling pathways. Insulin resistance is primarily caused by excess growth hormone (GH) through insulin signalling pathways. In addition to encouraging lipolysis and raising blood levels of free fatty acids, GH also hinders insulin's capacity to deliver glucose into cells. Hyperglycaemia results from the blood glucose level staying high as a result. Though this increased demand on β-cells can eventually lead to their malfunction, causing diabetes mellitus, particularly type 2 diabetes, hyperinsulinemia is the result of the pancreas compensating by producing more insulin. Nephropathy, neuropathy, cardiovascular disease, and retinopathy are among the effects of long-term hyperglycaemia. (1)

The most common endocrine condition in the world, diabetes mellitus is typified by abnormal glucose, protein, and lipid metabolism, impaired insulin signalling, developing insulin resistance, and B cell dysfunction. Type 1, type 2, and gestational diabetes are the three primary forms of diabetes mellitus recognized by the WHO. Approximately 90% of all cases of diabetes are type 2 diabetes mellitus, according to the International Federation of Diabetes. Late complications such as cardiovascular atherosclerosis, obesity, retinopathy, nephropathy, autonomic neuropathy, etc., develop in diabetic patients.

Diabetes mellitus was predicted to rise from 2.8% in 2000 to 4.4% in 2030 on a global scale. It is anticipated that there will be 366 million individuals with diabetes mellitus globally by 2030, up from 171 million in 2000. About 8.3% of adults worldwide, or 382 million people, have diabetes mellitus, according to the International Diabetic Federation (IDF), with 65.1 million of those individuals living in India. The number will surpass 592 million within the next 25 years. (6)

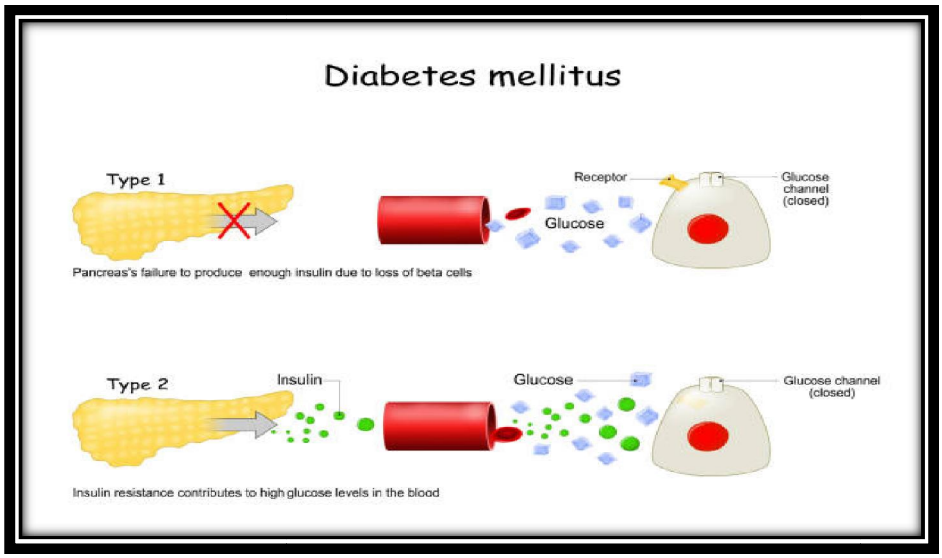

Fig: 1.2 Diabetes Mellitus

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Classification of Diabetes Mellitus

1) Insulin Dependent Diabetes Mellitus (Type1 IDDM)

Type 1 diabetes is an autoimmune disease, which means the body's immune system attacks its own cells by mistake. In this case, it destroys the pancreas cells that make insulin. Because of this, the body cannot make insulin or makes very little of it. This type of diabetes usually starts in childhood or early adulthood and can come on suddenly. People with Type 1 diabetes often need insulin injections to survive, which is why it is also called insulin-dependent diabetes. It may also occur along with other autoimmune diseases like Graves' disease, Hashimoto's thyroiditis, or Addison's disease. The exact cause of diabetes mellitus is still unknown. However, in many individuals, it is believed to be linked to an autoimmune response in which the body produces antibodies that gradually destroy the beta cells of the pancreas.

2) Non-Insulin Dependent Diabetes Mellitus (Type2 Niddm)

Type 2 diabetes mellitus, often called adult-onset diabetes, occurs when the body becomes resistant to insulin and the pancreas gradually loses its ability to produce enough insulin (American Diabetes Association, 2014). People with this condition usually do not respond properly to insulin. Over time, both type 1 and type 2 diabetes can lead to serious complications affecting the blood vessels, kidneys, eyes, and nerves, which significantly increase illness and death rates. The causes of type 2 diabetes are multifactorial. Major risk factors include obesity, a sedentary lifestyle, older age (especially in middle-aged and elderly individuals), and genetic factors (Ross and Wilson, 2010). Patients with type 2 diabetes are also at a higher risk of developing both macrovascular and microvascular complications.

3) Gestational Diabetes Mellitus

Gestational diabetes mellitus (GDM) is the term used to describe glucose intolerance that begins or is diagnosed during pregnancy. Women with undiagnosed asymptomatic type 2 diabetes mellitus that is discovered during pregnancy and those who develop type 1 diabetes mellitus during pregnancy are categorized as having gestational diabetes mellitus (GDM), which is defined as diabetes diagnosed during pregnancy that is not obviously related to diabetes. Gestational diabetes mellitus may appear during pregnancy and then go away after giving birth. Because of the effects of intrauterine exposure to hyperglycemia, children born to mothers with GDM are more likely to experience obesity and type 2 diabetes in later life.

4) Other Specific Type (Monogenic Types)

Mutations in a hepatic transcription factor called hepatocyte nuclear factor (HNF)-la on chromosome 12 cause the most prevalent type of monogenic diabetes. Another name for them is beta cell genetic defects. The early onset of hyperglycemia is a common feature of these types of diabetes. These conditions are also known as maturity-onset diabetes of the young (MODY) or maturity-onset diabetes in young people with insulin action defects, exocrine pancreatic diseases like pancreatitis or cystic fibrosis, dysfunction linked to other endocrines, and pancreatic dysfunction brought on by chemicals or medications.Some medications are used after organ transplantation or in conjunction with HIV/AIDS treatment.In a few families, genetic abnormalities that cause the inability to convert proinsulin to insulin have been found; these traits are inherited in an autosomal dominant pattern. They make up less than 10% of cases of DM. (7)

Table 1: Type 1 and Type 2 Diabetes Mellitus (6)

Age at onset	Early (below 35 years)	Late (after 40 years)
Type of onset	Abrupt and severe	Gradual and insidious
Frequency	10–20% of total diabetes cases	80–90% of total diabetes cases
Weight	Normal	Obese / Non-obese
Genetic locus	Unknown	Chromosome 6
Pathogenesis	Autoimmune destruction of β-cells	Insulin resistance and impaired insulin secretion
Blood insulin level	Decreased insulin	Normal or increased insulin
Islet cell changes	Insulitis, β-cell depletion	No insulitis; later fibrosis of islets
Clinical management	Insulin therapy and diet	Diet, exercise, oral hypoglycaemic drugs, and insulin

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Treatment

Insulin and Oral Hypoglycemic drugs:

In order to prevent hypoglycemia in between meals and limit postprandial hyperglycemia, insulin therapy should try to emulate nature. For better and safer insulin action, the site of administration is equally important. Insulin injections can be administered intramuscularly or intravenously.(8)

Herbal Treatment Of Diabetes:

As traditional medicine research has increased over the past few decades, plant-based medicines—which are eco-friendly, bio-friendly, economical, and generally safe—have risen from the periphery to the mainstream.

The most instructive review of the literature on anti-diabetic herbal agents is that of Atta-ar-Rahman, who has listed over 300 plant species that are recognized for their hypoglycemia qualities.

Plants have been categorized in this review based on their botanical name, country of origin, parts used, and active agent type. Momordica charantia (Family: Cucurbitaceae) is one such plant.(8)

High dosages of a typical hypoglycemic medication are administered as part of the treatment to overcome the underlying cause. When the condition is under control, the demand for hypoglycemic agents returns to normal.(9)

Causes

1. Decreased number of insulin receptors, decreased sensitivity of peripheral tissues to insulin, and down-regulation of insulin receptors. Despite having normal glycemic levels, many people are hypersensitive and hyperinsulinemic, and they also have dyslipidemia, hyperuricemia, and abdominal obesity. Relative insulin resistance is thus present, especially at the liver, muscle, and fat levels. It has been suggested that hyperinsulinemia causes angiopathy.

2. Overproduction of glucagon, a hyperglycemic hormone, etc. Relative insulin deficiency results from obesity because the B cells fall behind. Two hypotheses have shown that abnormalities in nitric oxide metabolism lead to nerve damage and altered perineural blood flow.

3.Type 3 diabetes due to certain genetic defects, such as "maturity onset diabetes of young" (MODY) and other endocrine disorders, is another uncommon form of diabetes mellitus. Mellitus gestational diabetes mellitus and pancreatectomy

4.In diabetes mellitus, certain receptors may be out of balance. A few examples of particular receptors include the beta3 adrenergic receptor, the glucagon-like peptide-1 (GLP-1) receptor, the peroxisome proliferator-activated (y) receptor (PPARy), and certain enzymes such as glycosidase and dipeptidyl peptidase IV enzyme.

5. Protein kinase C, the polyol pathway, oxidative stress, and advanced glycation end products are the main topics of current research on diabetic neuropathy.(7)

Sign And Symptoms

Polyuria(Frequent Urination)
Polydipsia(Increased Thirst)
Inexplicable weight loss,
Polyphagia(Increased Hunger)
Dry mouth
Blurred vision
Fatigue Weakness (8)

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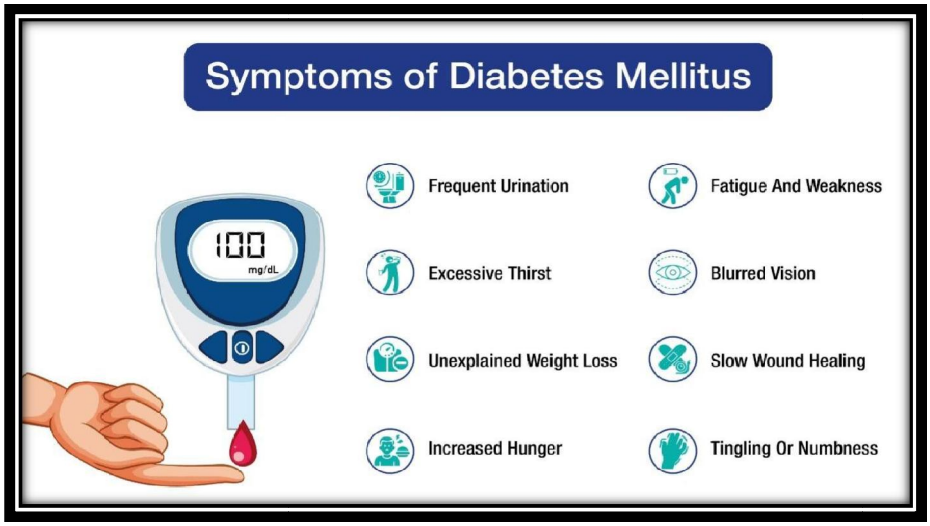

Fig: Symptoms of Diabetes Mellitus

Role of medicinal plants in the management of diabetes mellitus

Since the beginning of time, people have utilized herbal remedies to treat illness. These plants' capacity to restore pancreatic cell function by increasing insulin secretion, reducing intestinal glucose absorption, or enabling molecules in insulin-dependent activities was thought to be the cause of their anti-hyperglycaemic qualities.

The WHO has recommended medicinal herbs as the primary source of medical care due to their accessibility, affordability, social acceptability, and people's trust in them.(10)

Since the beginning of time, medicinal plants have been used to treat human illnesses. These plants' capacity to restore the function of pancreatic tissues through increased insulin production, inhibition of intestinal glucose absorption, or facilitation of metabolites in insulin-dependent processes is thought to be the cause of their antihyperglycemic effects.

Since traditional medicines are easily accessible, reasonably priced, culturally acceptable, and widely trusted, the WHO has recommended them as the main source of healthcare.

Many medicinal plants have been used throughout the world in traditional medicine systems to treat diabetes and avoid long-term complications. (6)

(B) Cardiovascular Disease

The term cardiovascular disease (CVD) refers to a group of related conditions that are commonly referred to as coronary heart disease (CHD), cerebrovascular disease, peripheral arterial disease, congenital and rheumatic heart diseases, and venous thromboembolism. According to WHO estimates, more than 75% of premature CVD can be avoided, and lowering risk factors can lessen the increasing burden of CVD on patients and healthcare professionals.(11) The most prevalent cardiovascular diseases (CVDs) are the result of long-term processes that involve complex interactions between risk factors that are both modifiable and unmodifiable. Since modifiable risk factors account for the majority of CVD cases, they should be regarded as preventable.(12)

Cardiovascular disease (CVD) is a major cause of death and morbidity worldwide, accounting for an estimated 16.7 million deaths (30% of all deaths). One American passes away from CVD every 36 seconds, and the disease was the cause of 74.255 deaths in North America in 2003 (33% of all deaths) .

In addition, CVD places a significant financial strain on health care systems through direct costs (such as hospital stays, rehabilitation services, doctor visits, and medications) and indirect costs related to mortality and morbidity (such as decreased productivity because of early mortality and short-term Jung-terra disability).(13)

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Depression and cardiovascular disease (CVD) are currently the two leading causes of disability in high-income nations, and by 2030, they are predicted to overtake all other nations in this regard. The main economic and health system indicators associated with depression and CVD show increased use of health services, lost productivity, and growing medical expenses.(14)

Cardiovascular diseases (CVD) are conditions affecting the heart and blood vessels. The most common underlying cause of this group of diverse diseases is atherosclerosis. CVDs are chronic illnesses that develop gradually over the course of a person's life and often show no symptoms. Symptoms typically appear only when the disease is advanced, though sudden death may be the first sign.(15)

Classification of Cardiovascular Disease

They are primarily classified into the following categories. (16)

Table:2 Classification of Cardiovascular Disease (17)

Sr.No	Cardiovascular Disease Category	Description
1	Coronary Artery Disease (CAD)	Caused by atherosclerosis, leading to reduced blood flow to the heart. Includes angina, myocardial infarction, ischemic cardiomyopathy.
2	Cerebrovascular Disease	Diseases of blood vessels supplying the brain, including ischemic and hemorrhagic stroke, transient ischemic attacks (TIAs).
3	Peripheral Arterial Disease (PAD)	Affects blood vessels supplying the limbs, causing claudication and ischemia.
4	Heart Failure	Syndrome where the heart cannot pump enough blood to meet the body's needs.
5	Cardiomyopathies	Diseases of the heart muscle impairing pumping ability.
6	Cardiac Arrhythmias	Abnormal heart rhythms, e.g., atrial fibrillation, ventricular tachycardia.
7	Valvular Heart Disease	Malfunction of heart valves, leading to stenosis or regurgitation.
8	Congenital Heart Diseases	Structural heart defects present from birth.
9	Rheumatic Heart Disease	Damage to heart valves due to rheumatic fever following streptococcal infection.
10	Inflammatory Heart Diseases	Includes myocarditis, endocarditis, and pericarditis.
11	Other Vascular Diseases	Includes aortic aneurysms, renal artery stenosis, thromboembolic diseases.

Treatment

Major Treatment in Cardiovascular Disease

1) Hypertension and Risk Reduction

Treatment is guided by major practice guidelines, with common initial medications including ACE inhibitors or ARBs, thiazide diuretics, and calcium channel blockers. Therapy is individualized based on patient comorbidities such as diabetes, chronic kidney disease, and heart failure. Practical protocols are detailed in the 2023 ESC Guidelines and WHO HEARTS technical package for primary care.

2. Ischemic Heart Disease and Secondary Prevention

Secondary prevention relies on antiplatelet therapy (aspirin or P2Y12 inhibitors) combined with lipid-lowering agents like statins, with options for ezetimibe or PCSK9 inhibitors as needed. Revascularization procedures (PCI or CABG) are chosen based on coronary anatomy, clinical symptoms, and risk stratification. Comprehensive recommendations are available in ESC ischemic heart disease guidelines and global management handbooks.

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3. Heart Failure Management

Standard care includes ACE inhibitors or ARNIs, beta-blockers, mineralocorticoid receptor antagonists, SGLT2 inhibitors, and diuretics. Device therapies such as cardiac resynchronization therapy (CRT) or implantable cardioverter-defibrillators (ICDs) are considered when indicated. Treatment details are provided in 2023 ESC Guidelines and American ACC/AHA guidelines.

4. Arrhythmia Treatment

Management of atrial fibrillation focuses on stroke prevention with anticoagulation, rate or rhythm control approaches, and procedural options like catheter ablation in selected patients. ESC and ACC/AHA atrial fibrillation guidelines offer evidence-based treatment algorithms.

5. Valvular and Congenital Heart Disease

Treatment ranges from medical management to surgical or transcatheter interventions tailored to severity and clinical presentation. Detailed guidance is present in ESC and surgical society guidelines.

6. Prevention and Lifestyle Modifications

Key strategies include tobacco cessation, dietary improvements, regular physical activity, weight control, and optimization of blood pressure, lipid levels, and diabetes management. WHO cardiovascular risk assessment tools and HEARTS program materials support effective risk reduction.(18)

Causes

major causes and risk factors for cardiovascular disease (CVD) include several behavioral, environmental, biological, and socio-economic factors:

Behavioral Factors: Unhealthy diet, lack of physical activity, tobacco use, and harmful alcohol consumption are key contributors to CVD risk.

Environmental Factors: Air pollution significantly increases cardiovascular risk.

Biological (Intermediate) Factors: Elevated blood pressure, high blood glucose, raised blood lipid levels, overweight, and obesity are measurable indicators that increase the chance of heart attacks, strokes, heart failure, and related complications.

Other Determinants: Social and economic changes such as globalization, urbanization, aging populations, poverty, stress, and genetic predispositions also influence cardiovascular risk.

Chronic Conditions: Diseases such as hypertension, diabetes, and dyslipidemia require effective medical management to reduce cardiovascular events.(19)

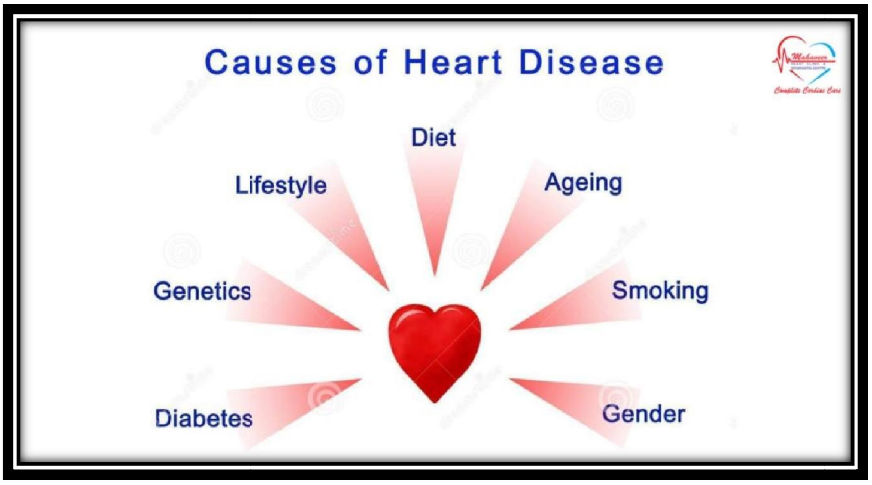

Fig: Causes Of Cardiovascular Disease

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Signs And Symptoms

Chest Pain (Angina)
Shortness of Breath
Palpitations
Fatigue and Weakness
Swelling (Edema)
Dizziness or Syncope
Other symptoms: Sweating, nausea, anxiety, and paleness often accompany acute events like myocardial infarction.(20)

Role of Cardiovascular Disease

Cardiovascular disease (CVD) continues to be a leading contributor to global sickness and death, primarily driven by an aging population together with persistent metabolic, behavioral, and environmental risk factors. Although advances in medical treatment have lowered age-standardized death rates, the absolute burden of CVD—in terms of prevalence and fatalities—is expected to increase substantially from 2025 to 2050. Ischemic heart disease and stroke are the predominant causes of CVD mortality, with raised systolic blood pressure identified as the top underlying risk factor. Considerable geographic disparities exist, with Central and Eastern Europe and Central Asia experiencing the highest standardized mortality rates. The growing rates of obesity, hypertension, diabetes, and tobacco use add to this burden, posing significant challenges to healthcare systems worldwide. Addressing these issues requires tailored, region-specific strategies guided by the latest epidemiologic data and risk factor profiles to enhance prevention and treatment effectiveness.(21)

Diagnosis of Cardiovascular Disease

Diagnosis of cardiovascular disease (CVD) involves a thorough clinical assessment supported by various blood tests and advanced imaging techniques to evaluate heart function and detect abnormalities:
Blood Tests: These include checking cholesterol, blood sugar, and high-sensitivity C-reactive protein (CRP) to evaluate inflammation and risk factors. Cardiac biomarkers such as troponins are crucial in detecting heart muscle injury.
Echocardiography: Uses ultrasound to create moving images of the heart, showing its structure, valve function, and blood flow dynamics.
Stress Tests: Assess heart performance under exercise or pharmacologic stress to reveal ischemia or arrhythmias not evident at rest.
Imaging: Cardiac computed tomography (CT) and magnetic resonance imaging (MRI) offer detailed anatomical and functional views, including blockage detection and evaluation of myocardial damage.
Cardiac Catheterization: An invasive but gold-standard test where a catheter delivers contrast dye to coronary arteries for X-ray visualization of blockages and allows simultaneous treatment interventions.(22)

(C) Obesity

Obesity is when a person has too much body fat, which can harm their health. It is a long-lasting and complex condition that increases the chance of problems like type 2 diabetes, heart disease, and certain cancers. Doctors often use a measurement called body mass index (BMI) to classify obesity; a BMI of 30 or higher usually means the person is obese. Having obesity can affect not just physical health but also mental well-being and quality of life. The primary cause of obesity is a chronic energy imbalance between caloric expenditure and intake.Obesity is a chronic, multifaceted condition that presents serious health risks due to excessive fat accumulation. With a sharp increase in prevalence, it has spread throughout the world, impacting millions of people and significantly raising healthcare expenses.(23)

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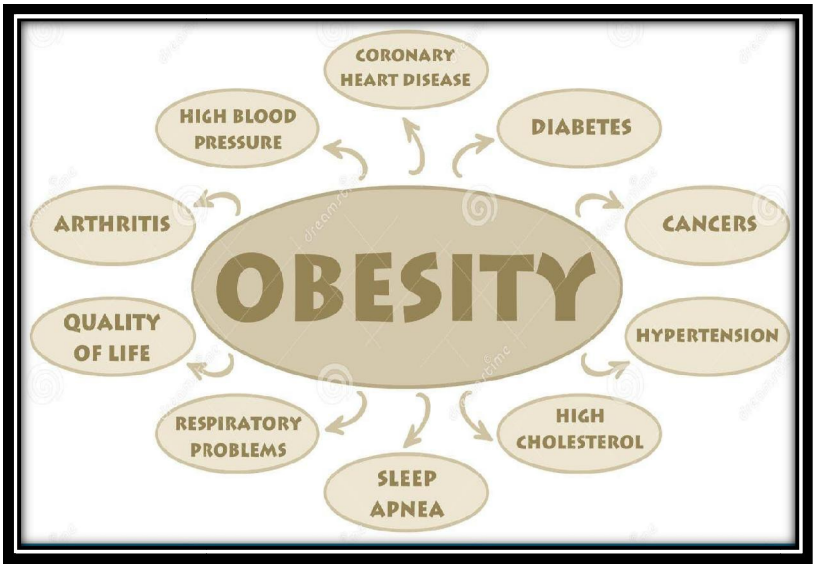

Fig: Obesity

Classification Of Obesity

Overweight: BMI between 25 and 29.9
Class 1 Obesity: BMI between 30 and 34.9
Class 2 Obesity: BMI between 35 and 39.9
Class 3 (Severe) Obesity: BMI of 40 or higher. (24)

Treatment of Obesity

Changing habits: People work on eating healthier, becoming more physically active, setting goals, and tracking progress. Support like stress management and talking with specialists (like therapists) can make these changes easier.
Healthy diet: Eating fewer calories and choosing nutritious foods is important. Diet plans should be personal and realistic for long-term success.
Regular exercise: Most people are advised to get at least 150 minutes of moderate activity (like brisk walking, cycling, or swimming) every week.
Medications: If weight loss isn't achieved by lifestyle changes, doctors may prescribe medicines such as GLP-1 agonists or naltrexone-bupropion to help people lose weight.
Weight loss surgery: For those with severe obesity, surgical procedures like gastric bypass or sleeve gastrectomy can be considered. These surgeries help people lose a significant amount of weight and may improve health problems associated with obesity.(25)

Causes Of Obesity

Obesity is caused by a mix of factors, including genetics, environment, lifestyle choices, and medical conditions.
The main reason is that people consume more calories than they burn, leading to excess fat storage.
Genetic factors can influence how the body regulates appetite, fat storage, and energy use.
Poor eating habits, lack of physical activity, inadequate sleep, and stress are key behavioral factors that contribute to obesity.
Additionally, medical conditions like certain syndromes and medications can predispose individuals to weight gain.(26)

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Fig: Causes Of Obesity

Symptoms Of Obesity

1) Noticeable weight gain, usually measured as a Body Mass Index (BMI) of 30 or higher.
2) Higher risk of chronic diseases like heart disease, stroke, type 2 diabetes, and some cancers.
3) Breathing problems such as sleep apnea, where breathing stops and starts during sleep.
4) Joint pain, especially in knees, hips, and lower back, making movement difficult.
5) Skin problems from irritation in areas where skin folds.
6) Feeling tired or fatigued frequently.
7) Psychological effects such as depression and anxiety.(27)

Diagnosis Of Obesity

Calculate Body Mass Index (BMI); a BMI of 30 or more indicates obesity.
Measure waist circumference; high risk is above 90 cm in men and 85 cm in women.
Conduct a physical exam including height, weight, blood pressure, and medical history.
Assess for related health problems like diabetes, high blood pressure, and heart disease.
Use additional tests if needed, like waist-to-hip ratio or body fat percentage measurements.
Apply clinical staging tools such as the Edmonton Obesity Staging System to evaluate severity and plan treatment.(28)

Role Of Obesity

Obesity is a major risk factor for many chronic diseases including heart disease, stroke, and type 2 diabetes.
It causes metabolic problems and contributes to high blood pressure and abnormal cholesterol levels.
Excess fat tissue promotes chronic inflammation that harms organ function.
Obesity increases the risk of certain cancers and respiratory issues like sleep apnea.
It also leads to joint problems such as osteoarthritis, and liver and kidney diseases.
The high prevalence of obesity heavily burdens healthcare systems worldwide.
Effective prevention and treatment can reduce the risk and severity of these obesity-related health problems.(29)

Mechanism of Action

Phytoconstituents can copy or change hormone activity by attaching to hormone receptors like estrogen receptors, helping keep hormone levels balanced.
Many act as antioxidants to lower harmful oxidative stress and inflammation that can hurt hormone functions.

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Some control important enzymes and pathways to improve insulin use and blood sugar control, helping manage diabetes.
Certain compounds turn on key molecules like AMPK and Nrf2, which help cells produce energy and get rid of toxins.
Others block inflammation-related signals (such as NF-κB), reducing ongoing inflammation tied to hormone and metabolic problems.
They may help regrow insulin-producing cells in the pancreas and increase insulin release.
They also influence enzymes involved in making hormones, which is important for conditions like PCOS and thyroid problems.(30)

Limitation

Their composition varies significantly among different plant sources, making it hard to standardize doses and effects.
There is limited clinical data on their effectiveness and long-term safety.
Some phytochemicals can act as endocrine disruptors, potentially causing hormonal imbalances or reproductive toxicity.
Dosage formulation is challenging due to differences in how these compounds are absorbed and metabolized.
They may interact with conventional endocrine drugs, requiring careful monitoring.
More detailed toxicological and pharmacokinetic studies are needed to ensure their safe and effective use.(30)

Safety And Toxicity

Phytoconstituents from plants, such as flavonoids and isoflavones, are promising for treating endocrine disorders because they generally have lower toxicity and fewer side effects than synthetic drugs. However, some natural compounds can disrupt hormonal balance, potentially causing reproductive toxicity or increasing cancer risk in certain individuals.
The toxic effects depend on dosage, exposure duration, and individual sensitivity. Some phytoestrogens show both beneficial and harmful effects depending on dose and patient risk, emphasizing the need for cautious use and further research.
Comprehensive safety testing through laboratory and clinical studies is necessary to determine safe doses and minimize risks. Additionally, monitoring for adverse interactions with conventional endocrine therapies is important to ensure safe use.(31)

Future Prospects

The future of phytoconstituents as therapeutic agents for endocrine disorders is highly promising. Their ability to act on multiple targets, combined with favorable safety profiles and suitability for long-term use, makes them attractive options. Advances in fields such as phytochemistry, network pharmacology, metabolomics, and molecular docking are enhancing the precise identification of bioactive plant compounds that can modulate hormone pathways, receptor sensitivity, and metabolic balance. This multidisciplinary approach is expected to lead to improved therapies that effectively regulate endocrine functions and maintain metabolic homeostasis.
Recent research has highlighted the therapeutic potential of various phytoconstituents including flavonoids, alkaloids, terpenoids, polyphenols, and saponins in modulating key endocrine functions.
These natural compounds have shown the ability to regulate insulin signaling, thyroid hormones, reproductive hormones, and adrenal steroid production. Such properties make them promising candidates for the treatment of diabetes, polycystic ovary syndrome (PCOS), thyroid dysfunction, and adrenal disorders.
These phytochemicals may act by mimicking or modulating hormone activity and influencing metabolic pathways, offering alternative or complementary options to conventional therapies with potentially fewer side effects.
Nanotechnology-based delivery systems are poised to improve the bioavailability and stability of phytoconstituents that have poor solubility. By enhancing these properties, nanotechnology can significantly boost their clinical effectiveness,

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allowing for better therapeutic outcomes. These advanced delivery methods, including nanoparticles, liposomes, and nanoemulsions, protect phytochemicals from degradation, improve absorption, and enable targeted release at the desired site of action, thus overcoming limitations of traditional formulations.

II. CONCLUSION

Phytoconstituents such as flavonoids, alkaloids, polyphenols, and various naturally occurring compounds have shown significant potential as therapeutic agents for managing endocrine disorders including , diabetes, obesity, and Cardiovascular disease. These natural compounds demonstrate beneficial effects by modulating hormone levels, improving insulin sensitivity, reducing oxidative stress, and dampening inflammation.

Compared to synthetic drugs, phytochemicals generally have fewer adverse effects, enhancing their appeal as treatment options. Moreover, these compounds are increasingly valued not only for their individual therapeutic properties but also for their synergistic effects when used in combination with conventional medicines or as part of poly-herbal formulations. This integrative approach enhances treatment efficacy and provides a complementary strategy for endocrine disorder management.

These include improving their bioavailability, ensuring safety, standardizing formulations, and conducting rigorous clinical validation. Ongoing research focused on understanding molecular mechanisms, developing advanced drug delivery systems such as nanocomposites, and personalizing treatments will be essential to unlocking the full therapeutic potential of these natural compounds for endocrine health.

Phytoconstituents have significant promise as complementary or alternative therapies for managing endocrine disorders. To fully realize their clinical value, ongoing interdisciplinary research combined with well-designed clinical trials and advanced drug-delivery strategies is crucial. Such efforts will help transform these natural compounds into reliable, effective, and scientifically validated treatment options for endocrine-related conditions.

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