

CORRELATION OF LIPID PROFILE AND RISK OF DEVELOPING TYPE 2 DIABETES
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ABSTRACT

Diabetes is a chronic metabolic disorder characterized by elevated blood glucose levels. It is a global health concern affecting millions of individuals. One of the significant complications associated with diabetes is an alteration in lipid profile, particularly cholesterol levels. Central to the complexities of diabetes is the often observed derangement in lipid profiles, particularly in low-density lipoprotein (LDL) cholesterol. This paper explores the relationship between diabetes and cholesterol levels, shedding light on the underlying mechanisms and implications for diabetes management. Regular monitoring, another numerical component, is the linchpin that ensures the efficacy of these interventions. The recommended annual lipid profile checks, as advised by the American Diabetes Association, provide a window into the effectiveness of cholesterol management strategies. For those with poorly controlled diabetes or pre-existing cardiovascular disease, more frequent monitoring may be essential to fine-tune interventions.

INTRODUCTION

Diabetes mellitus, a multifaceted metabolic disorder, profoundly affects the body's ability to regulate blood glucose (sugar) levels. There are two primary types of diabetes: Type 1 diabetes and Type 2 diabetes. Type 1 diabetes is characterized by an autoimmune assault on insulin-producing pancreatic beta cells, leading to an absolute deficiency of insulin.^[1] In contrast, Type 2 diabetes typically arises from a combination of insulin resistance in target tissues and impaired insulin secretion by pancreatic beta cells.

Prevalence and Impact of Diabetes: Diabetes is a global epidemic, affecting millions of individuals across the world.^[2] According to the International Diabetes Federation, in 2019, there were approximately 463 million adults (20-79 years) living with diabetes, and this number is projected to increase to 700 million by 2045.^[3] In the United States, about 34.2 million people, or 10.5% of the population, had diabetes in 2020, with 90-95% of cases being Type 2 diabetes.

Complications of Diabetes: The consequences of uncontrolled diabetes are far-reaching and encompass a spectrum of complications:

Cardiovascular Disease: Cardiovascular disease is one of the most significant complications of diabetes. Adults with diabetes are two to four times more likely to die from heart disease than those without diabetes.^[4] The American Heart Association reports that 68% of people aged 65 or older with diabetes die from heart disease, and 16% die of stroke.

Nephropathy: Diabetes is a leading cause of chronic kidney disease. In the United States, diabetes is responsible for approximately 44% of all new cases of end-stage renal disease (ESRD), necessitating dialysis or kidney transplantation.

Retinopathy: Diabetic retinopathy is a microvascular complication that affects the eyes. Approximately 4.1 million Americans aged 40 and older have diabetic retinopathy, and it is the leading cause of new cases of blindness among adults aged 20-74.

Neuropathy: Diabetic neuropathy is a common complication that can lead to nerve damage. In the U.S., around 60-70% of people with diabetes have some form of neuropathy^[5], which can result in pain, tingling, and numbness in the extremities.

Cholesterol and Diabetes

Elevated cholesterol levels, especially low-density lipoprotein (LDL) cholesterol, are frequently observed in individuals with diabetes, adding another layer of complexity to diabetes management.

Numerous studies have demonstrated the strong correlation between diabetes and altered lipid profiles

Individuals with diabetes often exhibit a characteristic lipid profile with high LDL cholesterol levels and reduced levels of high-density lipoprotein (HDL) cholesterol. For example, a study published in "Diabetes Research and Clinical Practice" found that people with Type 2 diabetes had higher mean levels of LDL cholesterol and lower levels of HDL cholesterol compared to those without diabetes.

Insulin resistance, a hallmark of Type 2 diabetes, contributes to increased triglyceride levels in the bloodstream. A meta-analysis published in "Diabetes Care" in 2011 reported that insulin resistance is associated with higher triglyceride levels.

Chronic hyperglycemia, a defining feature of diabetes, can stimulate the liver to produce more cholesterol. In a study published in "Diabetes" in 2011, researchers found that elevated blood glucose levels contributed to increased hepatic cholesterol production.

Inflammation, a common feature of diabetes, can damage blood vessels and promote atherosclerosis.^[6] Atherosclerotic plaques can trap cholesterol, further narrowing blood vessels and increasing cardiovascular risk.

It is crucial to understand these relationships, as they have significant implications for the management of diabetes and its associated complications, particularly cardiovascular disease. Elevated cholesterol levels are independent risk factors for atherosclerosis and heart disease, amplifying the importance of addressing both diabetes and cholesterol levels in diabetes care.

The Role of Cholesterol in the Body

Cholesterol, a waxy, fat-like substance, plays a critical role in numerous physiological functions within the human body. It is a fundamental component of cell membranes, contributing to their structural integrity and fluidity.^[7] Additionally, cholesterol serves as a precursor for the synthesis of several essential molecules, including steroid hormones (such as cortisol and sex hormones), bile acids, and vitamin D. Here, it is essential to delve into the numerical aspects of cholesterol's significance in the body.

Cell Membranes: Cholesterol is an integral part of cell membranes, where it influences membrane fluidity and permeability. Cholesterol molecules are interspersed between the phospholipids in the membrane, preventing the fatty acid chains of phospholipids from packing too

closely together. This maintains the membrane's fluidity at various temperatures, ensuring that cells remain functional even under extreme conditions.

Hormone Synthesis: Cholesterol is the precursor for the synthesis of steroid hormones. These hormones include cortisol, which regulates metabolism and immune responses^[8]; aldosterone, which regulates salt and water balance; and the sex hormones estrogen, progesterone, and testosterone. Without cholesterol, the body would be unable to produce these vital hormones.

Bile Acid Production: Cholesterol is essential for the production of bile acids in the liver, which are crucial for the digestion and absorption of dietary fats. Bile acids help emulsify fats in the digestive process, breaking them down into smaller particles that can be absorbed in the intestines.

Vitamin D. Synthesis: Cholesterol plays a pivotal role in the synthesis of vitamin D, a fat-soluble vitamin necessary for calcium absorption and bone health. When the skin is exposed to ultraviolet (UV) sunlight, cholesterol in the skin cells is converted into vitamin D, highlighting the vital role cholesterol plays in maintaining bone health.

Cholesterol is transported in the bloodstream by lipoproteins, complex molecular structures that consist of lipids (fats) and proteins. Two primary types of lipoproteins associated with cholesterol transport are low-density lipoprotein (LDL) and high-density lipoprotein (HDL).

Low-Density Lipoprotein (LDL): LDL is often referred to as "bad" cholesterol because it can contribute to the buildup of fatty deposits in the walls of arteries, a condition known as atherosclerosis. Elevated LDL levels are associated with an increased risk of cardiovascular disease. Numerically, an LDL cholesterol level below 100 mg/dL is considered optimal, while levels above 160 mg/dL are considered high and present a higher risk of heart disease.

High-Density Lipoprotein (HDL): HDL is often referred to as "good" cholesterol because it plays a protective role in cardiovascular health. HDL helps remove LDL cholesterol from the bloodstream and transport it to the liver for excretion.^[9] Higher levels of HDL are associated with a reduced risk of heart disease. An HDL cholesterol level of 60 mg/dL or higher is considered high, while levels below 40 mg/dL are considered low and pose a higher risk of heart disease.

Understanding the multifaceted role of cholesterol in the body and its transport by LDL and HDL lipoproteins provides a comprehensive view of its significance in maintaining overall health and well-being.

Diabetes and Altered Lipid Profile

Individuals with diabetes often exhibit significant alterations in their lipid profile, encompassing changes in low-density lipoprotein (LDL) cholesterol, total cholesterol, triglycerides, and high-density lipoprotein (HDL) cholesterol. These alterations have profound implications for cardiovascular health, and a more detailed examination reveals the underlying mechanisms, along with numerical data:

1. Insulin Resistance

Mechanism: In Type 2 diabetes, insulin resistance is a predominant feature. This resistance hinders the ability of insulin to facilitate glucose uptake by cells, resulting in higher blood glucose levels.^[10] Insulin resistance extends its influence to lipid metabolism, promoting increased synthesis of triglycerides in the liver and reducing the clearance of triglycerides from the bloodstream.

Numerical Insight: Research published in the "Journal of Clinical Lipidology" shows that insulin resistance is associated with elevated triglyceride levels. In patients with insulin resistance, triglyceride levels can often exceed 150 mg/dL, which is considered elevated and indicative of increased cardiovascular risk.

2. Hyperglycemia

Mechanism: Elevated blood glucose levels, a hallmark of diabetes, can stimulate the liver to produce more cholesterol. The elevated hepatic cholesterol production contributes to an increase in LDL cholesterol levels, further exacerbating the cardiovascular risk associated with diabetes.

Numerical Insight: Studies have shown that chronic hyperglycemia can lead to a considerable increase in hepatic cholesterol production, resulting in LDL cholesterol levels exceeding 100 mg/dL in individuals with uncontrolled diabetes.

3. Inflammation

Mechanism: Chronic low-grade inflammation frequently accompanies diabetes. This inflammation can damage blood vessels, increasing the risk of atherosclerosis.^[11] Atherosclerotic plaques, formed as a result, can trap cholesterol, leading to the narrowing and obstruction of blood vessels.

Numerical Insight: Inflammatory markers, such as C-reactive protein (CRP), are often elevated in individuals with diabetes and are associated with a higher risk of atherosclerosis and heart disease. Elevated CRP levels, over 3 mg/L, indicate a heightened inflammatory response.

4. Medications

Mechanism: Medications used to manage diabetes can have varying effects on lipid profiles. Some antidiabetic drugs, such as thiazolidinediones, can lead to an increase in LDL cholesterol levels.

Numerical Insight: Studies have indicated that thiazolidinediones, which improve insulin sensitivity,

may cause LDL cholesterol levels to increase by approximately 10-15 mg/dL.

Understanding the intricacies of these mechanisms and their associated numerical data underscores the importance of managing both diabetes and lipid profiles. Comprehensive care is crucial for individuals with diabetes to mitigate the risk of cardiovascular complications resulting from alterations in their lipid profiles.

Clinical Implications

Understanding the clinical implications of altered lipid profiles in individuals with diabetes is crucial for effective management and prevention of cardiovascular complications. Detailed information and numerical data illustrate the significance of these implications:

Cardiovascular Risk

Association with Diabetes: The relationship between diabetes and altered lipid profiles significantly elevates the risk of cardiovascular diseases. Individuals with diabetes are two to four times more likely to die from heart disease compared to those without diabetes.

Numerical Insight: According to the American Heart Association, about 68% of people aged 65 or older with diabetes die from heart disease. This underscores the magnitude of the association between diabetes and heart disease risk.

Lipid-Lowering Interventions

Managing Cholesterol Levels: Effective management of cholesterol levels is paramount for preventing cardiovascular complications in individuals with diabetes. Various interventions are available:

Lifestyle Modifications: Dietary changes and regular physical activity play a crucial role in managing cholesterol levels. The American Heart Association recommends a diet low in saturated and trans fats, with a focus on fruits, vegetables, whole grains, and lean protein sources. Engaging in at least 150 minutes of moderate-intensity aerobic activity per week is recommended for cardiovascular health.

Medications: In some cases, lifestyle modifications may not be sufficient, and medications may be prescribed to control cholesterol levels. Statins, a class of drugs commonly used to lower LDL cholesterol, have proven effective in reducing cardiovascular risk.

Numerical Insight: Statins have been shown to reduce LDL cholesterol levels by an average of 30-50%, depending on the specific drug and dosage used. This reduction is associated with a significant decrease in cardiovascular events.

Monitoring

Essential for Assessment: Regular monitoring of lipid profiles is essential for individuals with diabetes. Monitoring allows healthcare providers to assess the effectiveness of interventions and make necessary adjustments to reduce cardiovascular risk.

Numerical Insight: Monitoring typically involves assessing LDL cholesterol, HDL cholesterol, and triglyceride levels. The American Diabetes Association recommends that individuals with diabetes have their lipid profiles checked at least annually. For those with poorly controlled diabetes or pre-existing cardiovascular disease, more frequent monitoring may be necessary.

Comprehensive care that includes lifestyle modifications, appropriate medications, and regular monitoring is critical for individuals with diabetes. By actively managing cholesterol levels, the risk of cardiovascular complications can be significantly reduced, leading to better health outcomes for those living with diabetes.

CONCLUSION

In the intricate interplay between diabetes and altered lipid profiles, a comprehensive understanding emerges, shedding light on the multifaceted nature of this relationship. Diabetes, with its two primary forms, Type 1 and Type 2, is a global health challenge affecting millions. This metabolic disorder unleashes a cascade of complications, encompassing cardiovascular diseases, nephropathy, retinopathy, and neuropathy. Central to the complexities of diabetes is the often observed derangement in lipid profiles, particularly in low-density lipoprotein (LDL) cholesterol.

Regular monitoring, another numerical component, is the linchpin that ensures the efficacy of these interventions. The recommended annual lipid profile checks, as advised by the American Diabetes Association, provide a window into the effectiveness of cholesterol management strategies. For those with poorly controlled diabetes or pre-existing cardiovascular disease, more frequent monitoring may be essential to fine-tune interventions.

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