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Cholesterol-Induced Toxicity and its Dietary Links Multiple Disease: Prospective Overview

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Abstract: ***The study aims to examine the toxicological effect of dietary cholesterol and its role in the progression of multiple diseases, with particular attention to gender differences and food sources. Cholesterol plays a significant role in multiple diseases, particularly cardiovascular diseases (CVD), where elevated low - density lipoprotein (LDL) cholesterol is strongly linked to atherosclerosis and heart disease risk. Lifelong elevated LDL cholesterol is a well - established risk factor for CVD, supported by extensive genetic, clinical trial, and epidemiological evidence9. Beyond cardiovascular effects, cholesterol and its oxidized forms often generated by high - heat cooking methods may contribute such as frying or grilling - may contribute to toxicity and disease progression by promoting oxidative stress and inflammation. Dietary cholesterol from foods can influence blood cholesterol levels, but the impact varies depending on the type of cholesterol consumed and how food is prepared. Oxidized cholesterol, formed in processed or fried foods, is particularly implicated in adverse health effects. Cholesterol - induced toxicity can affect multiple organs and systems, contributing to diseases like liver toxicity and metabolic disorders, often through mechanisms involving oxidative stress and inflammation. In my view, the study offers a compelling overview of how elevated level of low - density lipoprotein (LDL) and oxidized cholesterol _particularly from processed and high heat - cooked foods - contribute to toxicity and chronic diseases. It is evident that cholesterol induced oxdative stress and inflammation are central to the development of cardiovascular, liver and metabolic disorders. This suggests that dietary habits play a key role in cholesterol regulation and disease prevention. The manage cholesterol intake through conscious food choices and preparation method to mitigate health risks. In summary, cholesterol, especially elevated LDL and oxidized cholesterol from certain foods, plays a critical role in the prevalence and progression of multiple diseases, primarily cardiovascular disease, but also liver and metabolic toxicities. Managing cholesterol intake and food preparation methods can help mitigate these risks. A clearer understanding of cholesterol is dietary pathways and disease linkages can support targeted public health interventions and guide nutritional education programs.***

Keywords: Cholesterol toxicity, LDL cholesterol, dietary fats, chronic disease, cardiovascular health

1. Overview of Cholesterol

Cholesterol is a waxy, fat - like substance found in all body cells essential for making hormones, vitamin D and bile acids that help digest food. It is produced by the liver and also obtained from animal - based foods like meat, eggs and dairy.

There are two main types of cholesterol transported in the blood by lipoproteins:

- **LDL (low - density lipoprotein):** Known as "bad cholesterol" because it can deposit cholesterol in artery walls leading to plaque buildup and atherosclerosis increasing heart disease risk.
- **HDL (high - density lipoprotein):** Known as "good cholesterol" because it helps remove cholesterol from the bloodstream and arteries reducing heart disease risk.

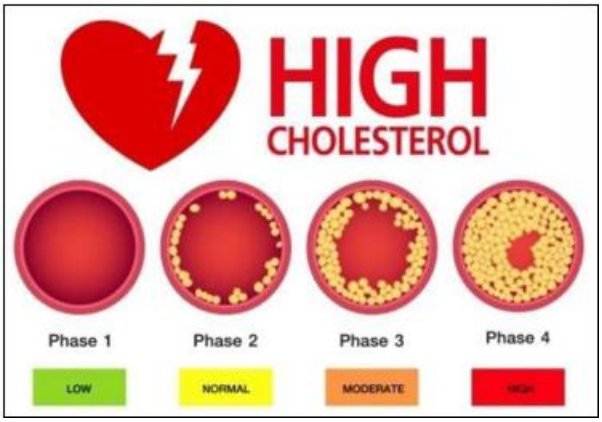


Figure 1: Phases of Cholesterol

Functions of cholesterol include:

- It is key component of cell membranes, helping maintain fluidity and cellular function.
- Precursor for steroid hormones (cortisol, estrogen, testosterone), vitamin D and bile salts.
- Part of the skin's outer layer lipid matrix helping prevent water loss. Cholesterol's chemical structure includes a sterol nucleus of four hydrocarbon rings, a hydrocarbon tail, and a hydroxyl group, making it waxy and insoluble alone in blood; thus, it travels attached to proteins as lipoproteins.

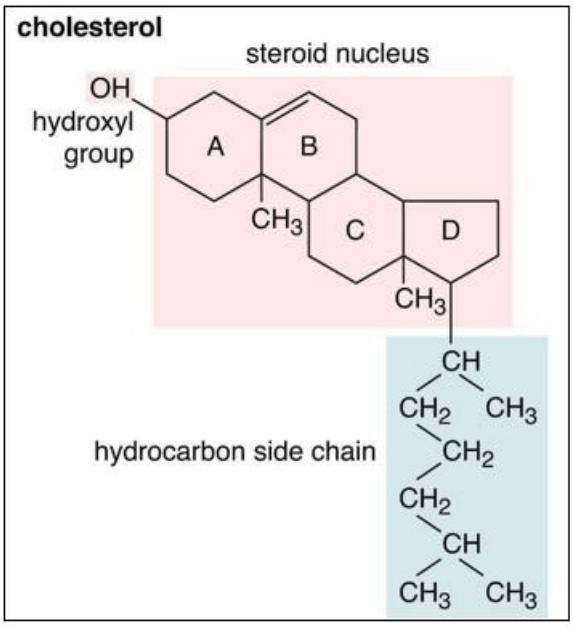


Figure 2: Structure of cholesterol

Excessive cholesterol, especially high LDL, can lead to plaque formation in arteries, causing heart attacks and strokes.

Table 1: Various details of cholesterol

Various sides	Details
Nature	Waxy, fat - like substance.
Sources	Made by liver, found in animal foods.
Types	LDL, HDL, VLDL, Triglycerides.
Functions	Cell membrane, hormone precursor, vitamin D synthesis, bile acids.
Health impact	High LDL impact on plaque, atherosclerosis, high LDL protective
Chemical structure	Sterol nucleus (4 rings), hydrocarbon tail, hydroxyl group.

Cholesterol induced toxicity multiple diseases via foods: Cholesterol - induced toxicity contributes to multiple diseases through excess accumulation and disturbed cholesterol homeostasis often influenced by dietary intake.

High cholesterol especially from foods rich in saturated fats and cholesterol leads to its buildup in tissues causing cell dysfunction and disease pathogenesis beyond just atherosclerosis.

Diseases Linked to Cholesterol Toxicity:

- **Cardiovascular diseases (CVD):** Excess cholesterol, particularly LDL cholesterol, accumulates in arterial walls forming plaques that cause atherosclerosis and increase heart disease risk.
- **Neurodegenerative diseases:** Cholesterol imbalance is involved in Alzheimer's disease and other neurological disorders.
- **Metabolic disorders:** Elevated cholesterol contributes to diabetes, non - alcoholic fatty liver disease (NAFLD), and non - alcoholic steatohepatitis (NASH)

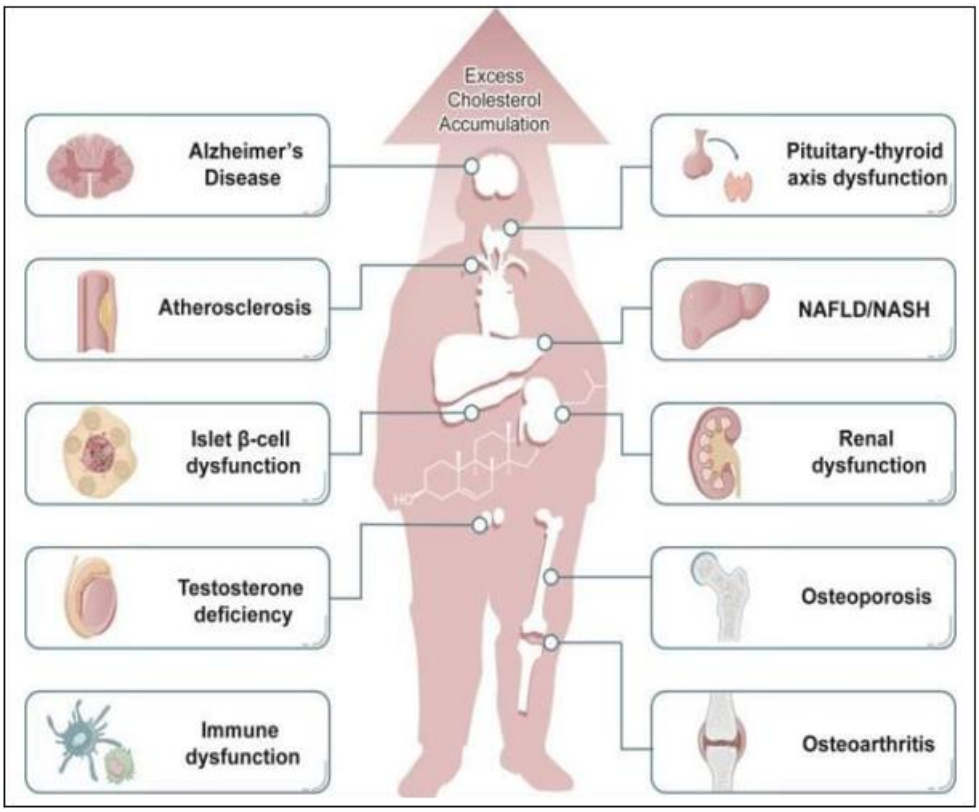


Figure 3: Multiple cholesterol diseases

Mechanisms via Foods:

- Dietary cholesterol and saturated fats increase blood cholesterol levels, disrupting homeostasis and promoting cholesterol accumulation in organs.
- Food processing can oxidize cholesterol, producing harmful cholesterol oxidation products that exacerbate toxicity.
- Phytochemicals in certain foods (e. g., flavonoids, saponins, phytosterols) can lower cholesterol absorption and oxidation, mitigating toxicity and disease risk.

2. Introduction

Cholesterol is a universal component of mammalian cell membranes and plays an indispensable role in regulating their fluidity, permeability and micro - structures. It is also an important precursor for the synthesis of bile acids and steroids hormones. Systemic cholesterol excess has generally considered to be mainly hallmark of atherosclerosis a supported by the high cholesterol formations ophthalmological macrophage form cell with in the arterial walls. It is a waxy fat like substance that plays a vital role in various body function Cell membrane structure.

- Cholesterol helps maintain the integrity and fluidity in cell membrane Hormone production:
- Cholesterol is a precursor during exposure to sunlight 7 - dehydrocholesterol in the skin absorbs UV B radiation and is converted to pre vitamin D3.
- Cholesterol is converted to bile acids in the liver which acid in fat digestion and absorption.1
- The study aims to examine the toxicological effect of dietary cholesterol and its role in the progression of multiple diseases, with particular attention to gender differences and food sources.

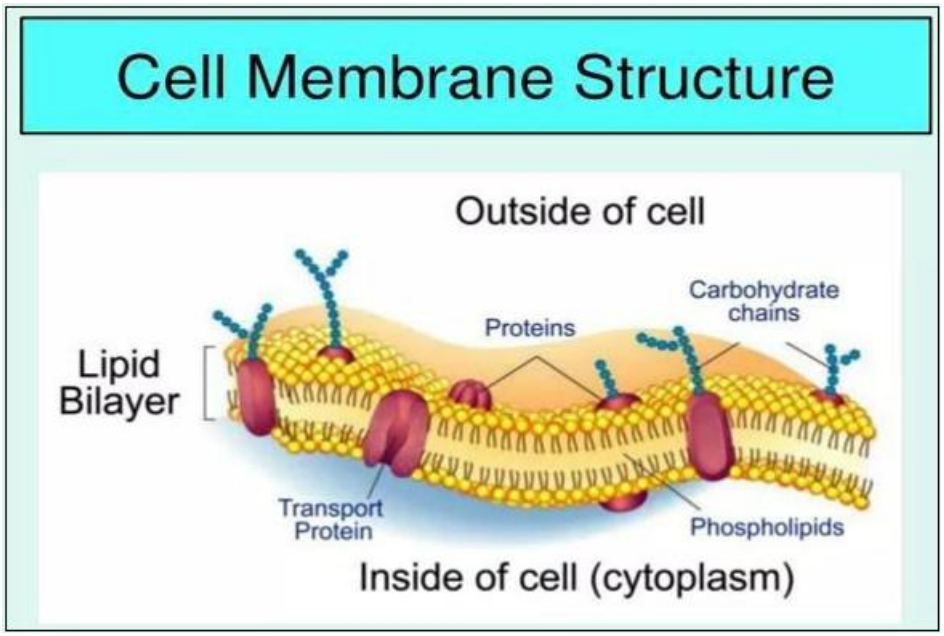


Figure 4: Cell membrane[2]

Definition:

Cholesterol is a type of fat found in the bloodstream. It plays a vital role in various bodily function such as building and maintaining cell membranes, producing hormones and facilitating fat digestion.

Types of cholesterol:

1) Low density lipoprotein [LDL]
2) High density lipoprotein [HDL]
3) very high-density lipoprotein [VLDL]
4) Triglycerides [TG]

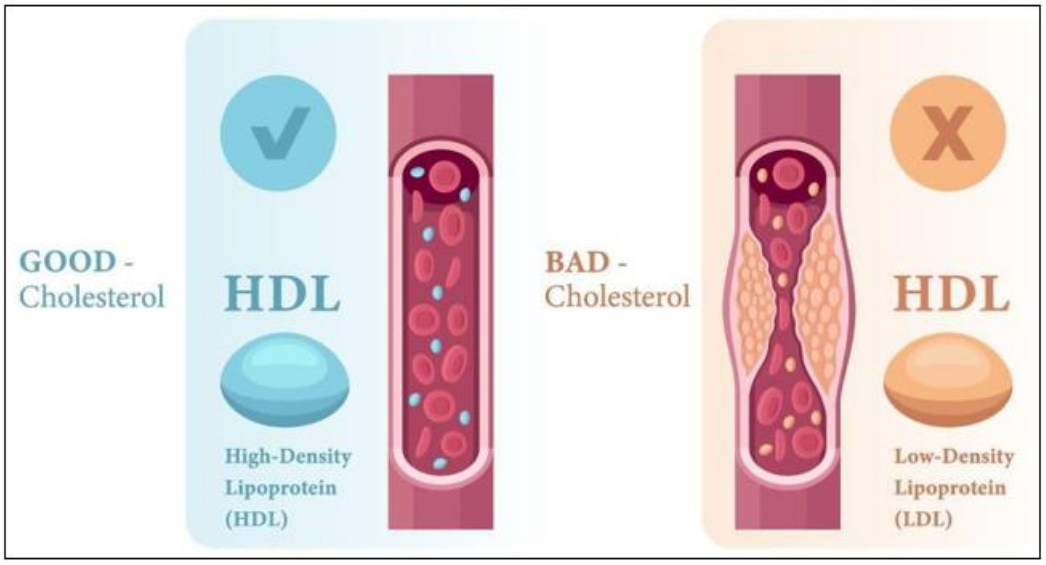


Figure 5: Good cholesterol and bad cholesterol Low density lipoprotein

LDL cholesterol is often referred to 'bad cholesterol' this is slightly oversimplified as LDL helps to deliver cholesterol to your cells which is essential health.

High density lipoprotein:
HDL cholesterol is often called 'good cholesterol' because HDL helps to return LDL cholesterol from your arteries to liver.

Very low density lipoprotein: 22
The liver produce VLDL cholesterol VLDL transport triglycerides in your blood. Body will either store the triglycerides use for energy.

Triglycerides:
Triglycerides are type of lipid in blood stream they composed of three fatty acids chains attached to glycerol molecules.3

Normal cholesterol levels:

For Adults [20 years and older]
- Total cholesterol: less than 200mg/dl
- LDL [bad] cholesterol: less than 100mg/dl
- HDL [good] cholesterol: 60mg/dl higher Triglycerides: less than 150mg/dl

For children and adolescents [0 - 19]
- Total cholesterol: less than 170mg/dl
- LDL [bad] cholesterol: less than 110mg/dl
- HDL [good] cholesterol: 45mg/dl higher
- Triglycerides: less than 75mg/dl [for children 0 - 9years] and less than 90mg/dl [for children 10 - 19years].4

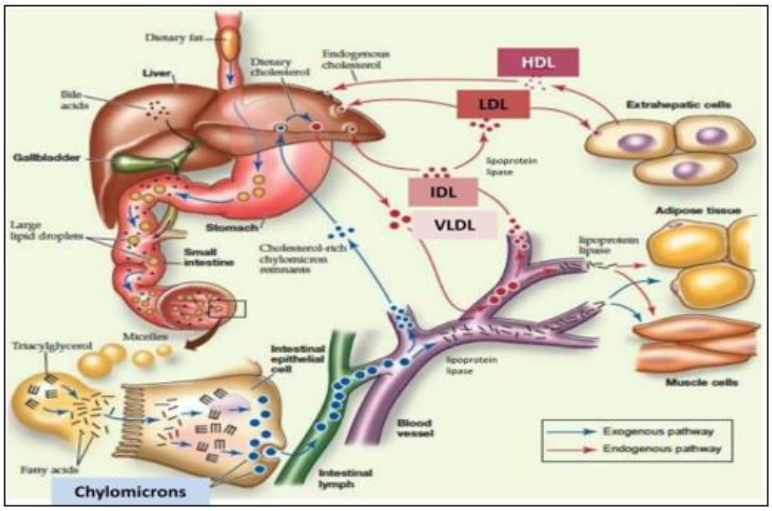
Role of cholesterol: -
Cholesterol often receives negative attention, but is also several essential roles in the several important function in the human body.

1) Cell Membrane Structure:
Cholesterol is crucial role component of cell membrane, maintaining their fluidity and structural integrity.

2) Hormone Production:
Cholesterol serves as a precursor for the synthesis of steroid hormones such as cortisol, aldosterone and steroid hormones.

3) Bile acid production:
Cholesterol is converted into bile acids in the liver which are essential for digestion and absorption.

4) Vitamin D synthesis:
Cholesterol is converted into vitamin D skin exposure to sunlight which is essential for bone health.5



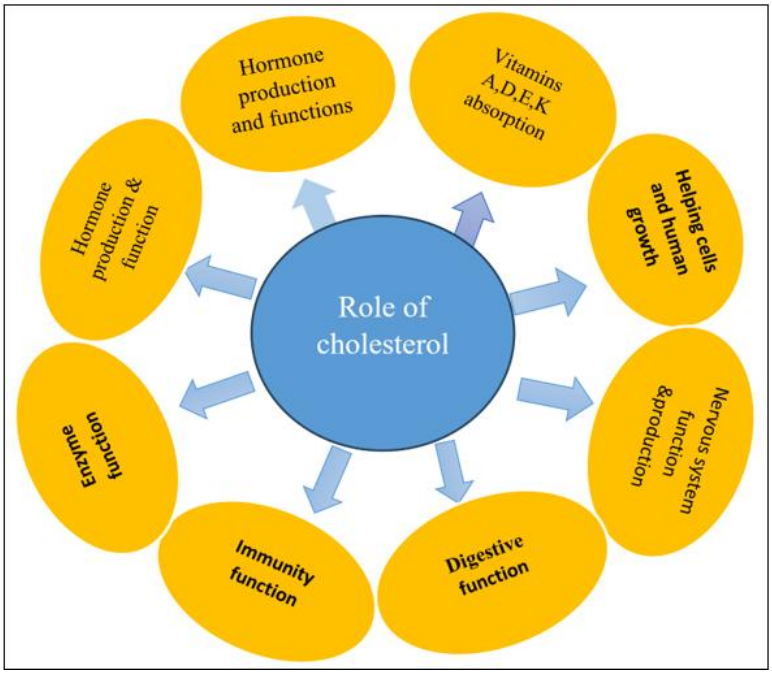


Figure 6: Role of Cholesterol

Table 2: High and low cholesterol food

High cholesterol food	Low cholesterol food
Egg: Consumption has little effect on LDL cholesterol and may actually improve HDL cholesterol levels. 	Consume foods that are naturally high in fiber especially soluble fiber. 
Grass - fed beef lean beef and chicken consumption have similar effects on plasma levels of total, LDL and HDL cholesterol and triglycerides. 	Eat 6 - 8 small meals daily instead of 1 - 2 large ones. Follow the DASH diet result.  30 minutes of moderate physical activity on most of the week.

	
Dark chocolate dark chocolate contains flavonols, which are antioxidants heart health and may reduce cholesterol levels and arterial plaque. 	Limit the amount of saturated fat you consume to no more than 5 - 6% of calories. Avoid food with added trans fat.

Causes of High Cholesterol:

1) **Genetics:** Family history can play a role in cholesterol levels.
2) **Diet:** Consuming high amounts of saturated and trans fats, cholesterol, and carbohydrates.
3) **Obesity:** Excess weight can increase cholesterol production.
4) **Lack of Exercise:** Sedentary lifestyle can contribute to high cholesterol.
5) **AGE:** Cholesterol levels tend to rise with age.
6) **Other Medical Conditions:** Certain conditions, such as diabetes, high blood pressure, and kidney disease, can increase cholesterol levels.

Symptoms:

1) **Atherosclerosis:** plaque buildup in the arteries, increasing risk of heart attack and stroke.
2) **Heart disease:** High cholesterol can contribute to the development of heart disease.
3) **Peripheral artery disease:** Narrowing of the arteries in the legs, arms and pelvis.

Diagnosis:

1) **Blood tests:** Lipid profiles measure cholesterol and triglyceride levels HDL, LDL, VLDL TG.
2) **Peripheral examination:** Healthcare providers assess overall health and look for signs of related conditions.

Treatment:

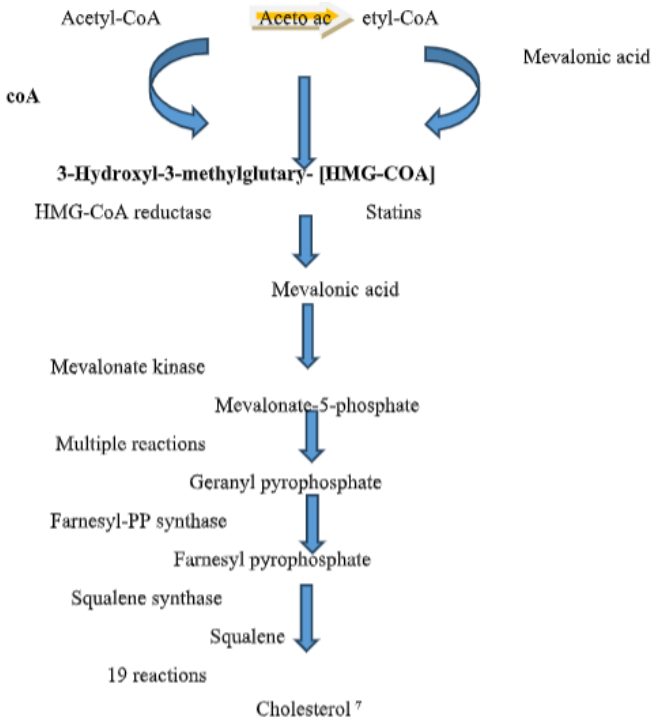
1) **Lifestyle changes:** Adopting a healthy diet, exercising regularly, quitting smoking and maintaining a healthy weight.
2) **Medications:** Statins, bile acid sequestrants and other cholesterol - lowering medications may be prescribed.
3) **Alternative therapies:** Certain supplements, such as plant sterols and stanols may help lower cholesterol levels.

Prevention:

1) **Healthy diet:** Focus on consuming fruits, vegetables, whole grains, lean proteins, and healthy fats.
2) **Regular exercise:** Engage in moderate - intensity exercise for at least 150 minutes per week.
3) **Maintain a healthy weight:** Aim for a body mass index [BMl] between 18.5 and 24.9.
4) **Don't smoke:** Quit smoking to reduce the risk of heart disease.
5) **Limit alcohol:** Consume alcohol in moderation [up to one drink per day for women and up to two drinks per day for men.6

Synthesis of Cholesterol:

Cholesterol synthesis is a complex process that occurs in the liver it involving multiple enzymes and intermediates.



Excess cholesterol and disease pathogenesis:

1) **Atherosclerosis**: High levels of cholesterol are associated with the development of atherosclerosis.[8]
2) **Multi - organ impact**: Excess cholesterol accumulation affects various tissues and organs, contributing to multiple diseases.[1]
3) **Liver diseases**: Excess cholesterol plays a role in liver disease pathogenesis.[9]
4) **Diabetes:** cholesterol accumulation contributes to diabetes development.[10]
5) **Chronic kidney disease**: Excess cholesterol affects kidney function.[11]

6) **Alzheimer's disease:** cholesterol accumulation is linked to Alzheimer's disease.[12]
7) **Osteoporosis:** Excess cholesterol affects bone health.[13]
8) **Osteoarthritis**: cholesterol accumulation contributes to joint disease.[13]
9) **Pituitary - thyroid axis dysfunction**: Excess cholesterol impacts hormone regulation.[14]
10) **10. Immune disorders**: cholesterol accumulation affects immune function.[15]

Therapeutic complications:
Cholesterol - lowering medications: Expanding therapeutic use to treat various diseases highlighting the role of excess cholesterol in multiple diseases this concept can broaden our understanding of cholesterol's toxic effects and lead to new therapeutic approaches.[1]

Importance of cholesterol homeostasis:
1) **Prevention of toxicity**: Maintaining cholesterol homeostasis prevents cellular toxicity.
2) **Regulation of cholesterol synthesis**: The SREBP2 - SCAP complex and LXR regulate cholesterol synthesis to maintain homeostasis.

Atherosclerosis pathogenesis:
1) **Lipoprotein accumulation:** Lipoproteins [mainly LDLs] accumulate in the subendothelial or intima.
2) **Modification and uptake:** Modified lipoproteins are taken up by macrophages, leading to foam cell formation.
3) **Inflammatory response**: Accumulation of cholesterol induces an inflammatory response.[1]

Key players in atherosclerosis:
1) **Macrophages:** Transform into foam cells to excess modified LDL - cholesterol uptake.
2) **HDL**: prevents cholesterol accumulation in macrophages by promoting cholesterol efflux.

Risk factors for atherosclerosis:
1) **Hypercholesterolemia**: Elevated levels of cholesterol contribute to atherosclerosis.
2) **Pro - inflammatory cytokines**: High levels of pro - inflammatory cytokines alter cholesterol efflux.
3) High blood pressure: contributes to atherosclerosis development.[8]
4) **Excess cholesterol and Renal dysfunction:**
   a) **Lpid deposition**: Excess cholesterol accumulation in the kidneys can lead to renal dysfunction.1[1]
   b) **Kidney damage**: High levels of cholesterol can cause damage to kidney cell and tissues.1[1]

Mechanisms:
a) **Inflamation**: Excess cholesterol can trigger inflammation in the kidneys leading to tissue damage.[11]
b) **Oxidative stress:** High levels of cholesterol can increase oxidative stress in kidneys, 'contributing to renal dysfunction[11].
c) **Fibrosis:** Excess cholesterol can lead to the information of scar tissue in the kidney, impairing their function[11].

Consequences:
1) **Chronic kidney diseases**: Excess cholesterol accumulation in the kidneys can be contribute to the development of chronic kidney disease[11].
2) **Kidney failure:** Un treated renal dysfunction can process to kidney failure, requiring dialysis or transplantation[11].

Risk factors:
1) **Hypercholesterolemia**: High levels of cholesterol in the blood can increase the risk of renal dysfunction.[11]
2) **Diabetes**: Diabetes is a major risk factor of kidney diseases, and excess cholesterol can exacerbate this condition.[11]
3) **Hypertension**: High blood pressure can damage kidney blood vessels increase the risk of renal dysfunction.[11]

Relationship between cholesterol and thyroid function:
1) **Hypothyroidism**: Characterized by low thyroid hormone production which can leads to increased levels of low density lipoprotein cholesterol.[14]
2) **Cholesterol metabolism**: Thyroid hormones play a crucial role in regulating cholesterol metabolism. Decreased thyroid hormones levels can impair cholesterol metabolism leading to accumulation.

Potential Mechanisms:
1) **Lipid metabolism disruption:** Excess cholesterol can disrupt lipid metabolism pathways effecting thyroid hormone production and function.
2) **Inflammation and oxidative stress:** Elevated cholesterol levels can trigger inflammation and oxidative stress further impacting thyroid function.

Clinical implications:
1) **Thyroid function tests:** Patients with hypothyroidism should undergo regular lipid profile checks to monitor cholesterol levels.[14]
2) **Cholesterol - lowering therapies**: Managing cholesterol levels through diet, exercise or medication may directions.

Excess cholesterol and osteoporosis:
1) **Bone Metabolism**: Cholesterol plays a role in bone metabolism and excess accumulation may contribute to osteoporosis.[13]
2) **Osteoporosis:** Characterized by decreased bone density and increased risk of fractures which can influenced by various factors, including cholesterol level.

Potential Mechanism:
1) **Inflammation and oxidative stress**: Elevated cholesterol levels can trigger inflammations and oxidative stress which may negatively impact bone health.[15]
2) **Hormonal regulation**: Cholesterol is involved in the regulation of hormones that influence bone metabolism such has estrogen and testosterone.
3) **Bone cell function:** Excess cholesterol may affect the function of bone cells, including osteoblasts and osteoclasts leading to an imbalance in bone remodeling

Clinical implications:

1) **Bone density monitoring:** Patients with high cholesterol levels should undergo regular bone density checks to monitor for potential osteoporosis.
2) **Lifestyle modifications:** Managing cholesterol levels through diet, exercise and lifestyle changes may help reduce the risk of osteoporosis.
3) **Therapeutic considerations:** Cholesterol - lowering medication may have a beneficial effect on bone health although further research is needed to confirm - β.

Excess Cholesterol and Alzheimer's diseases:

1) **Brain Cholesterol:** The brain is indeed highly enriched in cholesterol which plays crucial role in brain function and development
2) **Alzheimers diseases:** Characterized by progressive cognitive decline, memory loss and neuronal damage with excess cholesterol accumulation potentially contributing to disease progression[12].

Potential mechanisms:

1) **Amyloid - β accumulation:** Excess cholesterol may contribute to the accumulations of amyloid - β peptides a hallmark of Alzheimers diseases.
2) **Inflammation and oxidative stress:** Elevated cholesterol level can trigger inflammation and oxidative stress.

Clinical complications:

1) **Cognitive decline:** Patient with high cholesterol levels may be at increase the risk of cognitive decline and alzheimers disease.
2) **Life style modifications:** Managing cholesterol levels through die, exercise, and life style changes may help reduce the risk of alzheimers disease.
3) **Therapeutic consideration:** Cholesterol - lowering medication may have a beneficial effect on cognitive function.[12]

Foods that Increase LDL Cholesterol:

Unfiltered coffee:

- Unfiltered coffee can increase LDL cholesterol due to its high levels of cafestol and kahweol which may raise cholesterol levels.
- HDL and VLDL levels may raise not be significantly affected but triglycerides could potentially increase due to the coffee's impact on metabolism.

Sugar:

- High sugar intake can lead to a small increase in LDL cholesterol and triglycerides potentially due to its impact on weight gain and metabolic health.
- HDL levels may decrease and VLDL levels may increase due to the liver's increased production of triglycerides.[16]

Saturated and trans fats:

- Foods high in saturated fats such as beef, cheese and butter can increase LDL cholesterol and triglycerides.
- Trans fats, found in processed foods also contribute to higher LDL levels and lower HDL levels.
- VLDL levels may increase due to the liver's increased production of triglycerides.

Food that decreases LDL cholesterol:

Soluble fiber - rich foods:

- Oats, barley, and psyllium can help lower LDL cholesterol due to their soluble fiber content which binds to bile acids and removes them from the body.
- HDL levels may increase and VLDL and triglyceride levels may decrease due to the improved lipid profile.

Plant sterols and stanols:

- food with added plant sterols or stanols such as fortified spreads and orange juice can help reduce LDL cholesterol by inhibiting its absorption in the gut.
- HDL levels may increase and VLDL and triglyceride levels may decrease due to the improved lipid profile.

Avocados:

- Rich in mono un saturated fats, avocados can help lower LDL cholesterol while increasing HDL [good] cholesterol.
- VLDL and triglyceride levels may decrease due to the improved lipid profile[16].

Nuts and seeds:

- Almonds, flaxseeds and chia seeds are rich in healthy fats and fiber which can contribute to lower LDL cholesterol and triglycerides.
- HDL levels may increase due to the improved lipid profile.

Fatty fish:

- Fatty fish like salmon and tuna are rich in omega - 3 fatty acids, which may help lower triglycerides and reduce blood pressure.
- HDL levels may increase and VLDL levels may decrease due to the improved lipid profile.

Food that increases HDL cholesterol:

1) **Fatty fish:** Fatty fish like salmon, sardines, mackerel, and trout are rich in omega - 3 fatty acids, which can increase HDL levels. Aim for 2 - 3 servings per week.
2) **Avocados**: Rich in monounsaturated fats, avocados can help lower LDL cholesterol while increasing HDL level.1[7]
3) **Olive oil:** High in polyphenols, olive oil can increase HDL levels. Consume 4 tablespoons daily for optimal benefits.
4) **Nuts and seeds:** Almonds, walnuts, flaxseeds, chia seeds, and pumpkin seeds are rich in healthy fats and fiber, which can contribute to higher HDL levels.
5) **Berries:** Berries like blueberries and strawberries are rich in antioxidants, protecting HDL particles.
6) **Leafy greens:** Spinach and kale are packed with nutrients beneficial for heart health.
7) **Whole grains:** Oats, barley, and brown rice are rich in soluble fiber, which can help increase HDL levels.
8) **Legumes and beans:** Good sources of soluble fiber, plant sterols, and stanols, which can improve the LDL - to - HDL ratio.
9) **Soy products:** Son milk, tofu, and tempeh can help raise HDL levels when consumed in moderation.

10) **Dark chocolate:** Dark chocolate with at least 75% cocoa content can help lower LDL while boosting HDL levels.

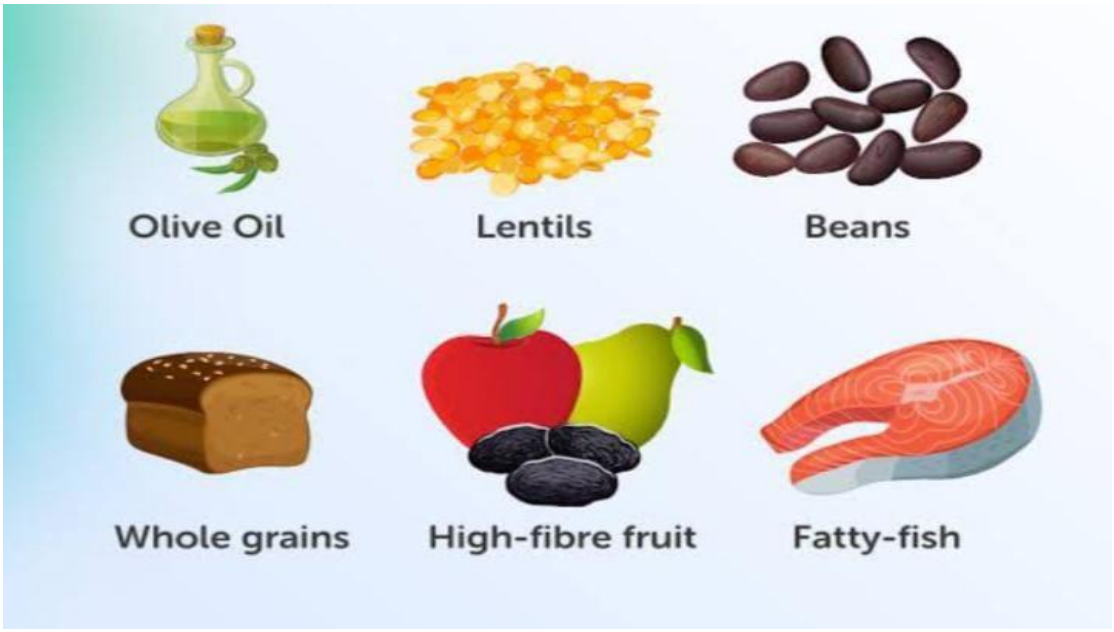


Figure 7: Food that increase good cholesterol Food that decrease HDL cholesterol

1) **Saturated and trans fats:** Food high in saturated and trans fats, such as beef, cheese, and processed foods, can decrease HDL levels.
2) **Refined carbohydrates:** Consuming high amounts of refined carbohydrates, such as white bread and sugary snacks, can decrease HDL levels.[18]
3) **Processed Meats:** Processed meats like hot dogs and sausages can decrease HDL levels due to their high sodium and preservative content.[19]
4) **Fried food:** Fried foods like French fries and fried chicken can decrease HDL levels due to high fat and calorie content.[19]

Foods that Increase VLDL Levels:

1) **Saturated and Trans Fats:** Foods high in saturated and trans fats, such as beef, cheese, and processed foods, can increase VLDL levels.
2) **Refined Carbohydrates:** Consuming high amounts of refined carbohydrates, such as white bread and sugary snacks, can increase VLDL levels.
3) **Processed Meats:** Processed meats like hot dogs and sausages can increase VLDL levels due to their high sodium and preservative content.
4) **Fried Foods:** Fried foods like French fries and fried chicken can increase VLDL levels due to their high fat and calorie content.
5) **High - Sugar Foods:** Consuming high amounts of sugar can increase VLDL levels by stimulating the liver to produce more triglycerides.

Foods that Decrease VLDL Levels:

1) **Omega - 3 Fatty Acids:** Fatty fish like salmon, sardines, and mackerel are rich in omega - 3 fatty acids, which can decrease VLDL levels.[20]
2) **Fiber - Rich Foods:** Foods high in soluble fiber, such as oats, barley, and fruits, can decrease VLDL levels by binding to bile acids and removing them from the body.[21]
3) **Nuts and Seeds:** Almonds, walnuts, and chia seeds are rich in healthy fats and fiber, which can contribute to lower VLDL levels.
4) **Avocados:** Rich in monounsaturated fats, avocados can help lower VLDL levels.[17]
5) **Green Tea:** Green tea has been shown to decrease VLDL levels due to its high antioxidant content.[22]

Foods that Increase Triglyceride Levels

1) **Saturated and Trans Fats:** Foods high in saturated and trans fats, such as beef, cheese, and processed foods, can increase triglyceride levels.
2) **Refined Carbohydrates:** Consuming high amounts of refined carbohydrates, such as white bread and sugary snacks, can increase triglyceride levels.
3) **Processed Meats:** Processed meats like hot dogs and sausages can increase triglyceride levels due to their high sodium and preservative content.
4) **Fried Foods:** Fried foods like french fries and fried chicken can increase triglyceride levels due to their high fat and calorie content.
5) **High - Sugar Foods:** Consuming high amounts of sugar can increase triglyceride levels by stimulating the liver to produce more triglycerides.

Foods that Decrease Triglyceride Levels

1) **Omega - 3 Fatty Acids:** Fatty fish like salmon, sardines, and mackerel are rich in omega - 3 fatty acids, which can decrease triglyceride levels.
2) **Fiber - Rich Foods:** Foods high in soluble fiber, such as oats, barley, and fruits, can decrease triglyceride levels by binding to bile acids and removing them from the body.
3) **Nuts and Seeds:** Almonds, walnuts, and chia seeds are rich in healthy fats and fiber, which can contribute to lower triglyceride levels.

4) **Avocados:** Rich in monounsaturated fats, avocados can help lower triglyceride levels.
5) **Green Tea:** Green tea has been shown to decrease triglyceride levels due to its high antioxidant content.
6) **Fatty Fish Oil Supplements:** Fish oil supplements can decrease triglyceride levels by providing a concentrated source of omega - 3 fatty acids.[23]

3. Mechanism of Action

a) **Statins:**
- **HMG - COA reductase inhibition:** Statins blocks the enzyme HMG - COA reductase reduce cholesterol production in the liver.
- **Increased LDL receptors expression:** Statins increase the expression of LDL receptors on liver cells enhancing LDL cholesterol clearance from the bloodstream.

b) Bile Acid Sequestrants:
- **Bile acid binding:** These medications binds to bile acids in the intestine, preventing their reabsorption.
- **Increased bile acid production:** The liver converts more cholesterol into bile acids reducing lipid metabolism.

c) Fibrates:
- **PPAR - alpha activation:** Fibrates activate PPAR - alpha a nuclear receptor that regulates lipid metabolism.
- **Increased lipoprotein lipase activity:** Fibrates enhance lipoprotein lipase activity improving triglyceride clearance.

d) Medications:
- **Ezetimibe:** Inhibits intestinal cholesterol absorption reducing cholesterol delivery to the liver.
- **PCSK9 inhibitor:** Block PCSK9 a protein that degrades LDL receptor increasing, LDL receptor density and LDL cholesterol clearance.[24]

Adverse reactions:

1) **Statins:**
a) **Muscle pain and weakness:** Myalgia, myopathy and rhabdomyolysis.
b) **Liver enzyme elevation:** Increased liver enzyme potentially leading to liver damage.
c) **Cognitive impairment:** Memory loss, confusion and cognitive decline.

2) High cholesterol:
a) **Cardiovascular diseases:** Increased risk of heart attack, stroke and peripheral artery diseases.
b) **Atherosclerosis:** Plaque buildup in arteries potentially leading to cardiovascular event.

Assessment of Cholesterol Health Screening:
The primary method for cholesterol assessment is a lipid panel blood test which measures LDL (bad) cholesterol, HDL (good) cholesterol, triglycerides, and total cholesterol here a breakdown.

Standard Blood Test

Procedure: a blood sample is drawn from a vein (typically in the arm) and analysed in a lab.

Key Metrics:
- LDL: Optimal: <100 mg/dl
  High risk: ≥ 160 mg/dl
- HDL: Ideal: (≥ 60mg/dl ideal)
  Low risk < 40mg/dl (men) / <50 mg/dl (women).
- Triglycerides: Normal<150mg/dl
  High ≥ 200mg/dl
- Total cholesterol: Desirable < 200 mg/dl
  High ≥ 240 mg/dl

Body – Based Visual Clues (Not Blood Test Visual;
1) **XANTHELASMA:** Yellowish cholesterol deposits around eyelids.
2) **CORNEAL ARCUS:** Gray/white rings around the cornea.
3) **ERUPTIVE XANTHOMAS:** Red - yellow bumps on skin (linked to high triglycerides).
4) **LEG DISCOLORATION:** Pale / purplish skin on legs during activity.

Figure 8: Eruptive xanthomas

Figure 9: Xanthelasma

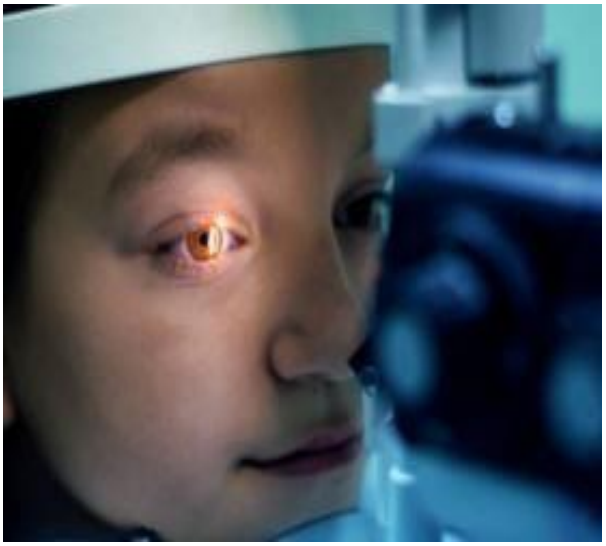


Figure 10: Corneal arcus

Treatment of Cholesterol Induced Toxicity of Multiple Diseases Via Foods:

Treatment of cholesterol - induced toxicity in multiple diseases via foods focuses on dietary strategies that lower LDL ("bad") cholesterol reduce inflammation and improve heart and vascular health. key dietary approaches include:

Foods That Help Lower Cholesterol and Reduce Toxicity:

Soluble fiber - rich foods: Oatmeal, oat bran, barley, legumes (kidney beans, lentils, chickpeas), fruits (apples, pears, bananas) and vegetables (Brussels sprouts) contain soluble fiber that reduces LDL cholesterol by limiting its absorption in the bloodstream.

Fatty fish:

Salmon, mackerel, sardines and other fish high in omega - 3 fatty acids help lower triglycerides reduce inflammation and improve heart health though they do not lower LDL directly.

Nuts:

Almonds, walnuts, pistachios and other nuts provide unsaturated fats and fiber that help lower LDL cholesterol and improve lipid profiles**.**

Whole grains:

Brown rice, quinoa whole wheat bread and steel - cut oats reduce cholesterol absorption and support heart health**.**

Fruits and vegetables:

High in fiber, antioxidants and plant sterols they help reduce cholesterol and inflammation**.**

Soy products:

Tofu, soy milk and soy yogurt can modestly reduce LDL cholesterol**.**

Healthy fats:

Olive oil, canola oil and avocado oil provide unsaturated fats that replace harmful saturated and trans fats improving cholesterol levels**.**

Foods to Limit or Avoid

- Saturated fats from red meat, butter, cheese and full - fat dairy raise LDL cholesterol**.**
- Trans fats found in processed foods, margarine and baked goods increase cholesterol and should be avoided**.**
- Fried foods, pastries and high - fat processed snacks contribute to cholesterol toxicity and cardiovascular risk**.**
- Dietary changes should be combined with lifestyle modifications like regular exercise and weight management for best results.
- In some cases, medications may be necessary alongside diet especially if cholesterol levels remain high or if there is significant cardiovascular risk.
- In a heart - healthy diet rich in soluble fiber, omega - 3 fatty acids, nuts, whole grains, fruits and vegetables while limiting saturated and trans fats is effective in treating cholesterol - induced toxicity across multiple diseases by lowering LDL cholesterol reducing inflammation and protecting vascular health.

Etiology of cholesterol:

Genetic factors

1) **Familial hypercholesterolemia (FH):** A genetic disorder caused by mutations in the LDLR gene leading to very high levels of LDL cholesterol.
2) **Genetic Variants:** Several genetic variants such as those affecting the APOE, LDLR and PCSK9 gene can contribute to high cholesterol levels.
3) **Polygenic Inheritance:** High cholesterol can result from the combined effects of multiple genetic variants rather than a single genetic mutation.

Impact of Genetic Factors on Cholesterol Levels

1) **Increased LDL Cholesterol:** Genetic factors can lead to increased levels of LDL cholesterol which can increase the risk of cardiovascular disease.
2) **Decreased HDL Cholesterol:** Some genetic variants can also lead to decreased levels of HDL cholesterol further increasing cardiovascular risk.
3) **Polygenic Inheritance:** High cholesterol can result from the combined effects of multiple genetic variants rather than a single genetic mutation.

Etiology of Cholesterol:

Dietary Factors Contributing to High Cholesterol

1) **Saturated Fats:** Consuming high amounts of saturated fats found in foods like red meat full - fat dairy products processed meats can increase LDL cholesterol levels.
2) **Trans Fats:** Consuming trans fats found in processed and fried foods can increase LDL cholesterol levels and decrease HDL cholesterol levels.
3) **Dietary Cholesterol:** Consuming high amounts of dietary cholesterol found in foods like egg meats can increase LDL cholesterol levels in some individuals.
4) **Refined Carbohydrates:** Consuming high amounts of refined carbohydrates such as white bread and sugary snacks can lead to increased triglyceride levels and decreased HDL cholesterol levels.

Dietary Factors that Can Help Lower Cholesterol

1) **Soluble Fiber:** Consuming soluble fiber rich foods, like oats, barley and fruits can help lower LDL cholesterol levels.
2) **Omega - 3 Fatty Acids:** Consuming omega - 3 fatty acids found in fatty fish like salmon and sardines can help lower triglyceride levels and improve heart health.
3) **Plant Sterols and Stanols:** Consuming plant sterols and stanols found in fortified foods like spreads and orange juice can help lower LDL cholesterol levels.
4) **Healthy Fats:** Consuming healthy fats such as monounsaturated and polyunsaturated fats, found in foods like nuts, seeds, and avocados can help lower LDL cholesterol levels and improve heart health.

Etiology of Cholesterol:

Protein and Fat

1) **Dietary Fats:** Saturated and trans fats increase LDL cholesterol.
2) **Protein Sources:** Plant - based proteins (e. g., legumes & nuts) may help lower cholesterol.
3) **Animal Proteins:** Some animal proteins (e. g., red meat & full - fat dairy) may increase cholesterol due to saturated fat content.

Figure 11: Protein and fat source

A clearer understanding of cholesterol is dietary pathways and disease linkages can support targeted public health interventions and guide nutritional education programs

Epidemology

- An integrated view of the role of cholesterol in multiple diseases" (2021) which reviews how excess cholesterol accumulation contributes to the pathogenesis of various diseases including liver disease, diabetes, kidney disease, Alzheimer's, osteoporosis, immune disorders and COVID - 19. This article highlights the ubiquitous toxic effects of excess cholesterol and suggests broadening therapeutic approaches using cholesterol - lowering medications.
- Additionally review "The role of cholesterol oxidation products in food toxicity" discusses how cholesterol derivatives formed in foods can contribute to toxicity linking dietary cholesterol and its oxidation products to adverse health effects.
- For epidemiological insights on cholesterol abnormalities linked to environmental and dietary factors the article "High Cholesterol Levels And chronic exposure to toxigenic Molds in Damp Buildings.
- A High Risk For Cardiovascular Diseases and Stroke" explores how chronic exposure to mycotoxins from molds may disrupt cholesterol metabolism, increasing risks of cardiovascular and neurological diseases.
- These references collectively provide a detailed epidemiological and mechanistic understanding of cholesterol - induced toxicity related to diet and environmental exposures.

Aim and Objectives

Aim:

The main aim is A study on cholesterol induced toxicity in multiple diseases via food in gender.

Objectives:

1) Gender differentiation between dietary intake of cholesterol levels.
2) Impact of vegetarian, non vegetarian.
3) Impact of vegan diet.
4) Identifying the high - risk foods in cholesterol.
5) Developing dietary guidelines creating recommendations for cholesterol intake to minimize health risks.
6) Preventing cardiovascular diseases reducing the risk of heart diseases and stroke.
7) Promoting public health like educating the public about the importance of healthy cholesterol levels and dietary choices.

4. Methodology

Cholesterol plays a vital role in various bodily functions but excessive levels can lead to toxicity and contribute to multiple diseases.

Diseases associated with high cholesterol:

a) **Atherosclerosis:** Plaque buildup in article increasing the risk of art attack and stroke.
b) **Cardiovascular diseases:** High cholesterol contributes to the development of heart disease.
c) **Kidney diseases:** High cholesterol can damage kidneys and increase the risk of kidney diseases.
d) **Pancreatitis:** High triglyceride levels causes inflammation of the pancreas.

Food choices that contribute to high cholesterol:

a) **Saturated and trans fats:** Consuming foods high in saturated and trans fats such has processed meat. fried foods and baked goods.
b) **Cholesterol - rich foods:** Consuming foods high in cholesterol such has egg, yolks and organ meats.
c) **Refined carbohydrates:** Consuming foods high in refined carbohydrates white bread and sugary snacks.

Methodology for reducing cholesterol - induced toxicity:

a) **Healthy diet:**
- Focus on consuming fruits, vegetable, s whole grains, lean proteins healthy fats.

b) **Regular exercise:**
- Engage in moderate - intensity exercise for at least 150mins per week.
- Maintain a healthy weight to reduce the risk of high cholesterol.

c) **Stress management:**
- Practice stress - reducing techniques like medication or yoga.

Specific foods that can help reduce cholesterol - induced toxicity:

a) **Oatmeal:** Rich in soluble fiber which can help lower LDL cholesterol.
b) **Fatty fish:** Fatty fish like salmon and tuna are rich in omega - 3 fatty acids which can help lower triglycerides.
c) **Nuts and seed:** Almonds, walnuts and chia - seeds are rich in healthy fats and fiber.
d) **Plant sterol and stanols:** Foods fortified with plant sterol and stanols can help lower LDL cholesterol.

Study Design: A observational study on cholesterol. Include a subsection on ethical consideration.
Briefly describe how data was analyzed
Clarify participant section (random sampling, convenience sampling, etc)

Study Duration: 4 Months.

Study Period: The present study was carried out for a period of four months from 23 - Dec - 2024 to 8 - may - 2025.

Study Site: The present study was conducted in Vijaya hospital Nellore and community in Nellore.

Sample Size: During the study period of four months of this study the total sample size was 150; whereas 127 samples was collected.

Inclusion Criteria:
- Patient who are above 25 and older are included.
- Patient with elevated cholesterol levels.
- Patient diagnostic marks.

Exclusion Criteria:
- Patient with medica conditions like secondary causes of high cholesterol, liver disease, kidney disease.
- Patients are included demographic and lifestyle factors are age and sex restrictions.

5. Plan of Work

1) Introduction:
- Background on cholesterol and its importance.
- Overview of cholesterol induced toxicity.

2) Literature review:

a) **Cholesterol metabolism and diseases.**
- Role of LDL and HDL cholesterol.
- Impact on cardiovascular health.

b) Foods contributing to high cholesterol.
- Saturated and trans fats.
- Dietary cholesterol.

c) Mechanism of cholesterol - induced toxicity.
- Oxidative stress
- Inflammation.

3) Foods impacting cholesterol levels:

a) Foods increasing cholesterol.
- Red meet.
- Full - fat dairy products.
- Processed foods.

b) Foods increasing cholesterol.
- Fruits and vegetables.
- Whole grains.
- Omega - 3 rich foods.

4) Diseases implications:

a) **Cardiovascular diseases.**
- Atherosclerosis.
- Heart attacks and strokes.

b) **Other health implications.**
- Alzheimer's diseases.
- Kidney diseases

5) Conclusion
- Summary of key findings.
- Importances of dietary choices in managing cholesterol levels.

6. Result and Discussion

Table 3: Age criteria

S/NO	Age	Male	Female	Total
1	24 - 34	12	14	26
2	35 - 44	27	16	43
3	45 - 54	13	21	34
4	55 - 65	11	13	24

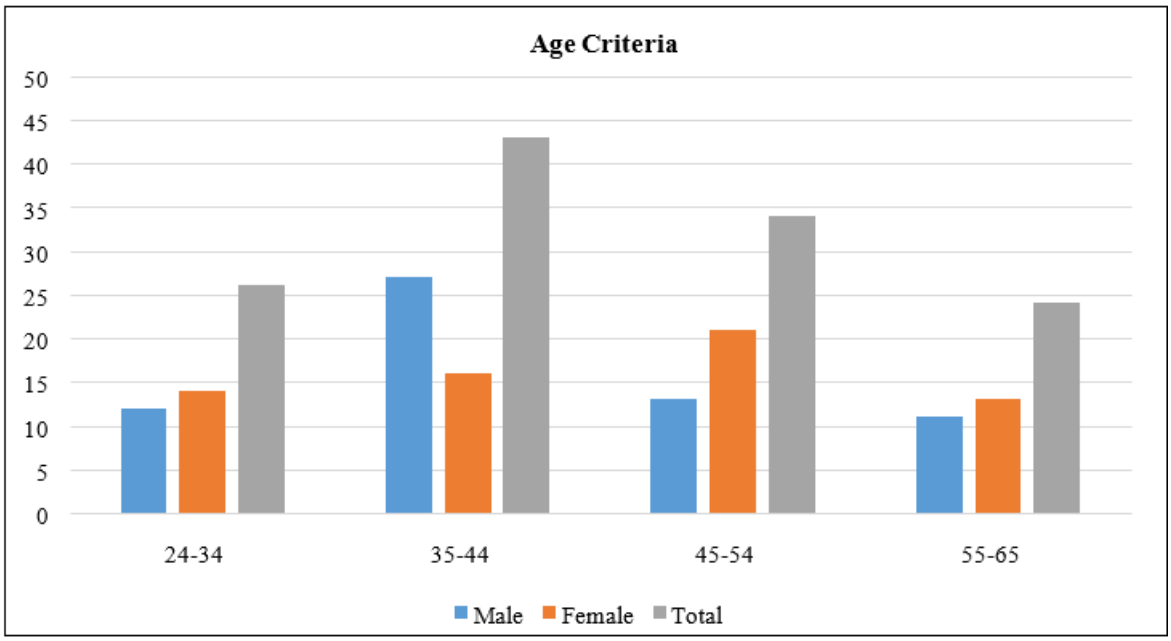


Figure 12: Age criteria

From the above table it can be inferred that 26 people respondents are age group of 2434 years, 43 people respondents are age group of 35 - 44 years, 34 people are respondent 45 - 54 years age group and 24 people are respondents to 55 - 65 age group.

Table 4: Male and female intake of vegetarian and non vegetarian

Male food intake		Female food intake	
Non vegetarian	Vegetarian	Non vegetarian	Vegetarian
8	3	9	5
16	17	9	7
10	3	13	8
6	5	7	6

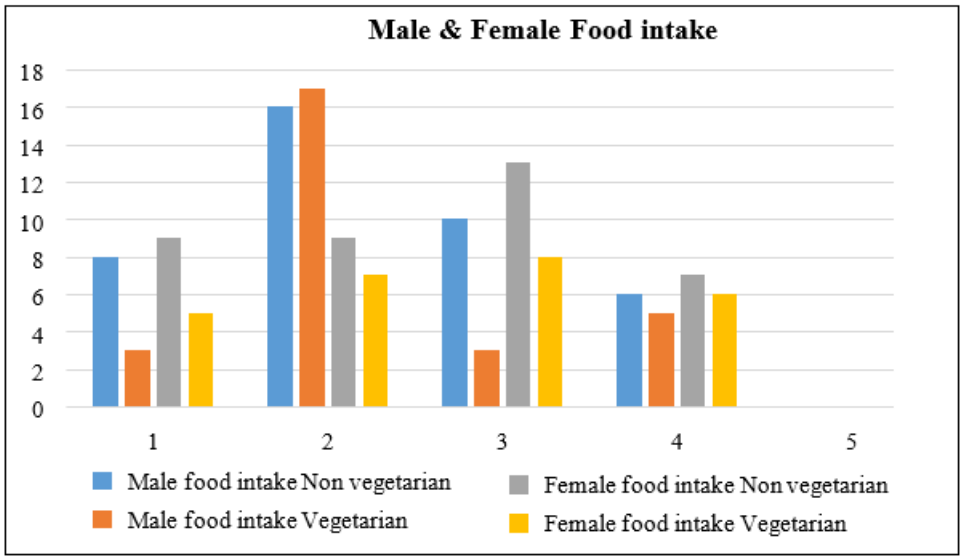


Figure 13: Male and female food intake

From the above table can inferred that 63 male respondents are taken for vegetarian and non - vegetarian.64 female respondents are taken for vegetarian and non - vegetarian.

Table 5: Female food intake with percentage

S/NO	Age	Female	Percentage
1	24 - 34	14	21.8%
2	35 - 44	16	25%
3	45 - 54	21	32.8%
4	55 - 65	13	20.8%
5	Total	64	100%

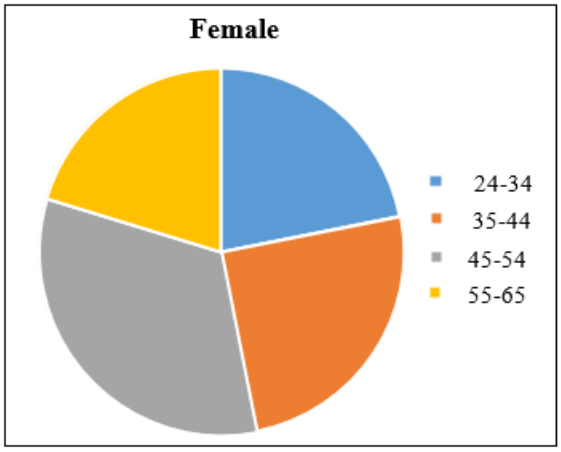


Figure 14: Female food intake

From the above table it can be inferred that 21.8% of response are age group 24 - 34 years, 25% of response are age group 35 - 44 years, 32.8% of response are age group 4554 years, 20.8% of response are age group 55 - 65 years Female response.

Table 6: Male food intake with percentage

S/NO	Age	Male	Percentage
1	24 - 34	12	19.04%
2	35 - 44	27	42.8%
3	45 - 54	13	20.63%
4	55 - 65	11	17.4%
5	Total	63	100%

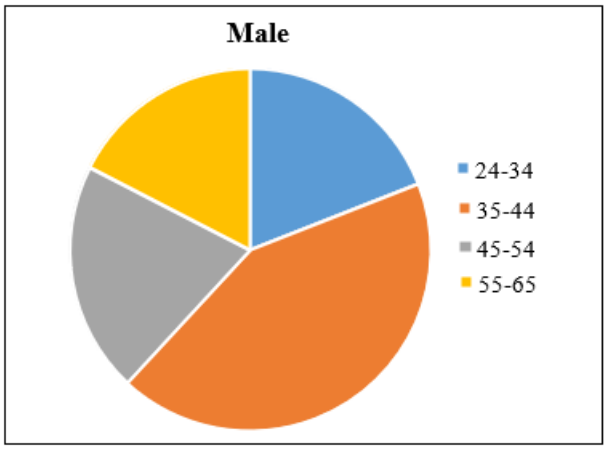


Figure 15: Male food intake

From above table it can be inferred that 19% of people are response in age group 2434years, 42% people are response in age group 35 - 44 years, 20% people are response in age group 45 - 54 years, 17% of people are response in age group 55 - 65 years male response.

Table 7: Female and male choice to food intake

S/NO	Age	Female			Male		
		Sometimes	Rarely	Often	Sometimes	Rarely	Often
1	24 - 34	5	5	4	4	6	2
2	35 - 44	10	10	6	12	12	3
3	45 - 54	10	10	1	5	6	2
4	55 - 65	5	5	3	6	3	2
5	Total	30	30	14	27	27	9

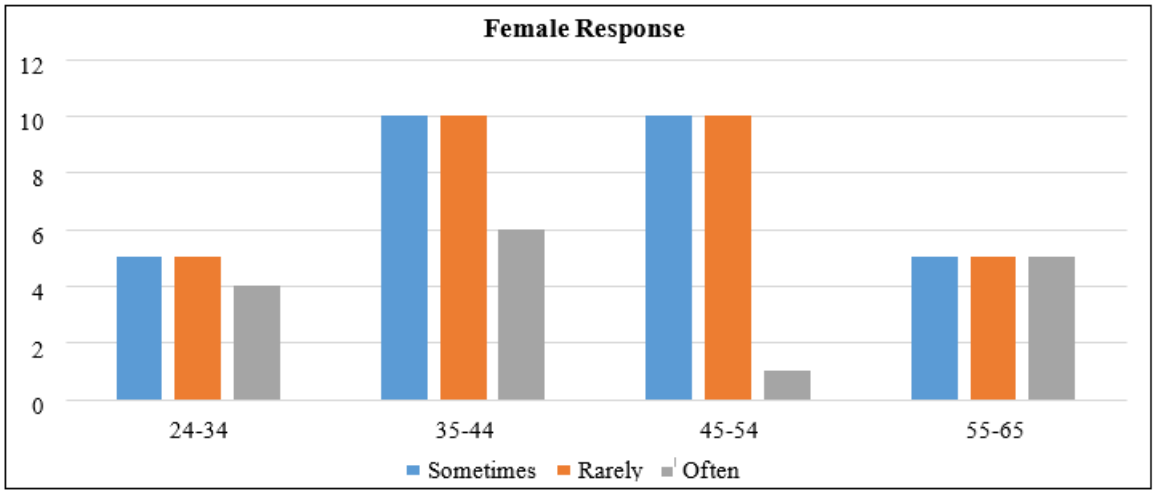


Figure 16: Female response

30 members of people said sometime they are agree that choice that take good foods like fruits and vegetables, 30 people are rarely and 14 people are often it is inferred that majority of people sometime and rarely that prefer to take foods female response.

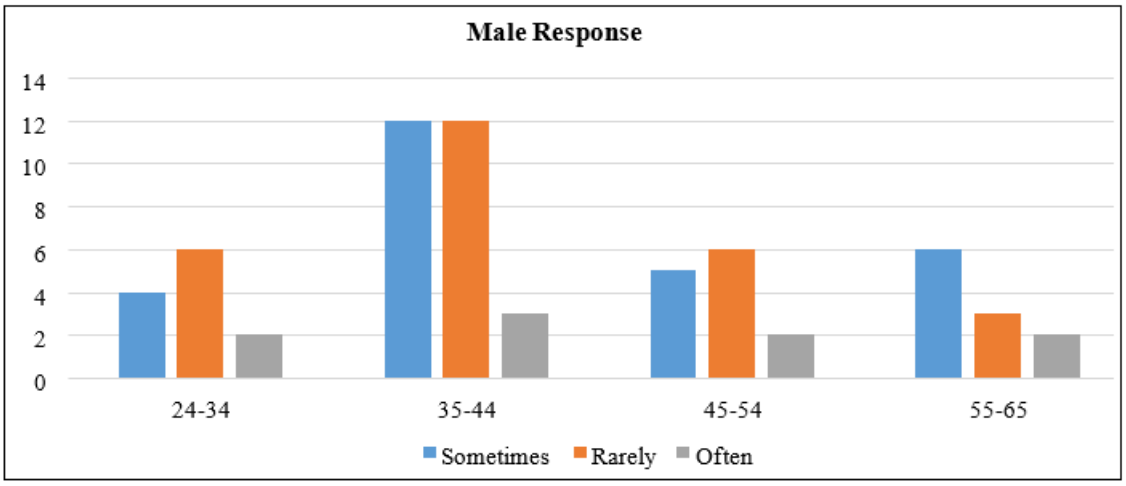


Figure 17: Male response

27 members of people said sometime they agree that choice that take good foods like fruits and vegetables, 27people are rarely and 9 people are often it is inferred that majority of people sometime and rarely that prefer to take foods male response.

Table 8: Red meat intake

S. NO	Gender	Beef intake meat	Meat intake	Chicken intake	Fish intake
1	Male	13	12	19	19
2	Female	10	12	20	22
3	Total	23	24	39	41

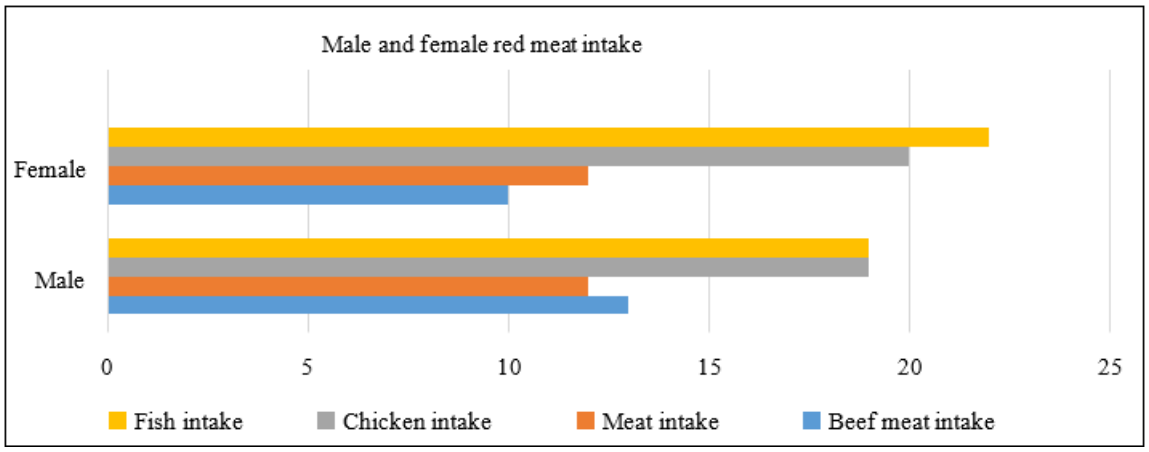


Figure 18: Male and female red meat intake

From the above table 23 people are intake of beef meat, 24 people are intake of meat 39 people are intake of chicken and 41 people are in take of fish.

Table 9: Genetic family history of hyperlipidemia

S/NO	Gender	Yes	No
1	Male	34	29
2	Female	36	28
3	Total	70	57

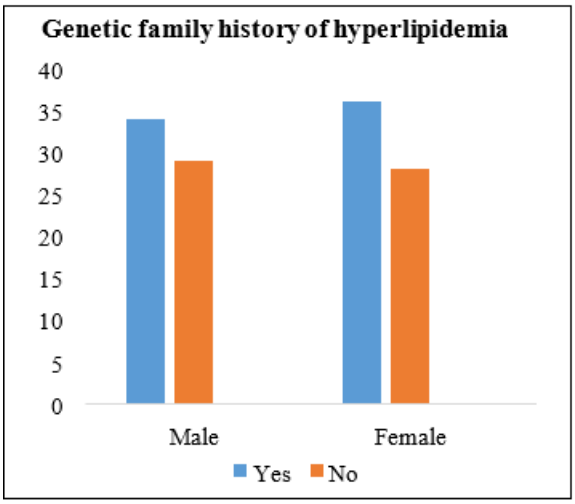


Figure 19: Genetic family history of hyperlipidemia

Frome the above table response of male and female history of hyperlipidemia.

Table 10: Clinical checkup

S/NO	Gender	Patient Clinical checkup once in 5 months	Patient Clinical checkup once in 6 months
1	Female	34	30
2	Male	29	34
3	Total	63	64

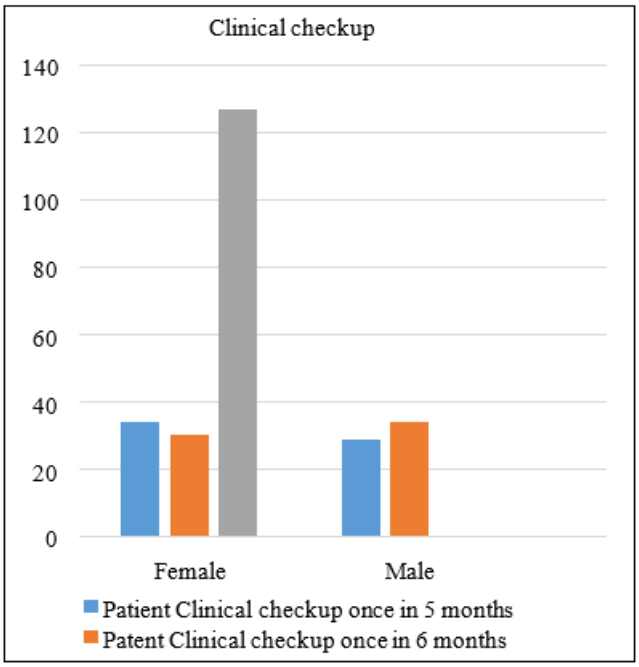


Figure 20: Clinical checkup

Frome the above table it can be inferred that patient clinical check up in 5months and 6 months once.

7. Conclusion

This study concludes that cholesterol - induced toxicity differs between males and females due to hormonal and metabolic variations. Elevated LDL levels and oxidized dietary cholesterol significantly contribute to cardiovascular and mrtabolic diseases. The data reinforces the importance of dietary regulation gender - sensitive health care strategies, and early cholesterol screening in minimizing disease risk interactions and gut microbiota effects. Men tend to have peak total, LDL and non - HDL cholesterol levels earlier (ages 30–39) than women (ages 50–59) while women consistently have higher HDL across all age groups.

Females exhibit higher total and primary serum bile acids which influence lipid metabolism differently than in males partly due to gut microbiota interactions that modulate cholesterol and bile acid pathways in a sex - specific manner.

Moreover excess cholesterol can affect hormone levels differently for instance it may induce testosterone deficiency in males impacting metabolic and disease processes. Women have a higher rate of cardiac deaths related to coronary artery disease despite different cholesterol profiles suggesting sex - specific responses to cholesterol toxicity and treatment.

Overall these differences arise from complex interactions among reproductive hormones lipid metabolism genes bile acid regulation and gut microbiota composition resulting in distinct cholesterol toxicity mechanisms and disease risks between males and females.

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Cholesterol Induced Toxicity Via Food

Cholesterol: It is a fatty substance used by the body to create cells, hormones, bile acids, vitamin D and other substances that circulates blood and performs a number of important functions.

Types 1) HDL (High density lipoprotein) 2) LDL (Low density lipoprotein) 3) VLDL (Very low density lipoprotein) 4) Triglycerides	

Choices you can make to lower the risk of heart Attack and Stroke

High cholesterol food		Low cholesterol food	
 Popcorn	 Fried Foods	 Salmon	 Nuts
 Egg yolk	 Ice cream	 Avocado	 Sweet potato
 Stop smoking	 Make heart healthy	 Weight Loss	 Medications