High Cholesterol

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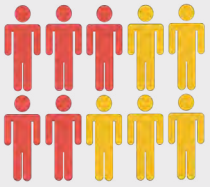
Cholesterol is a fat-like substance found in the blood and every cell of the body.

Cholesterol is required by the body to make cell membranes, steroid hormones, vitamin D and bile acids, which help digest and absorb dietary fat.

How is cholesterol made?

The liver produces most of the body's cholesterol required to stay healthy. The remaining cholesterol comes from dietary sources, mainly **animal products** including **meat**, **fish**, **dairy foods** and **eggs**.

Half of all adults in the UK have high cholesterol levels[1].



Types of cholesterol

Cholesterol is transported through the bloodstream **packaged in lipoproteins**. The main types relevant to **cardiovascular health** include:

Low-Density Lipoprotein (LDL-C)

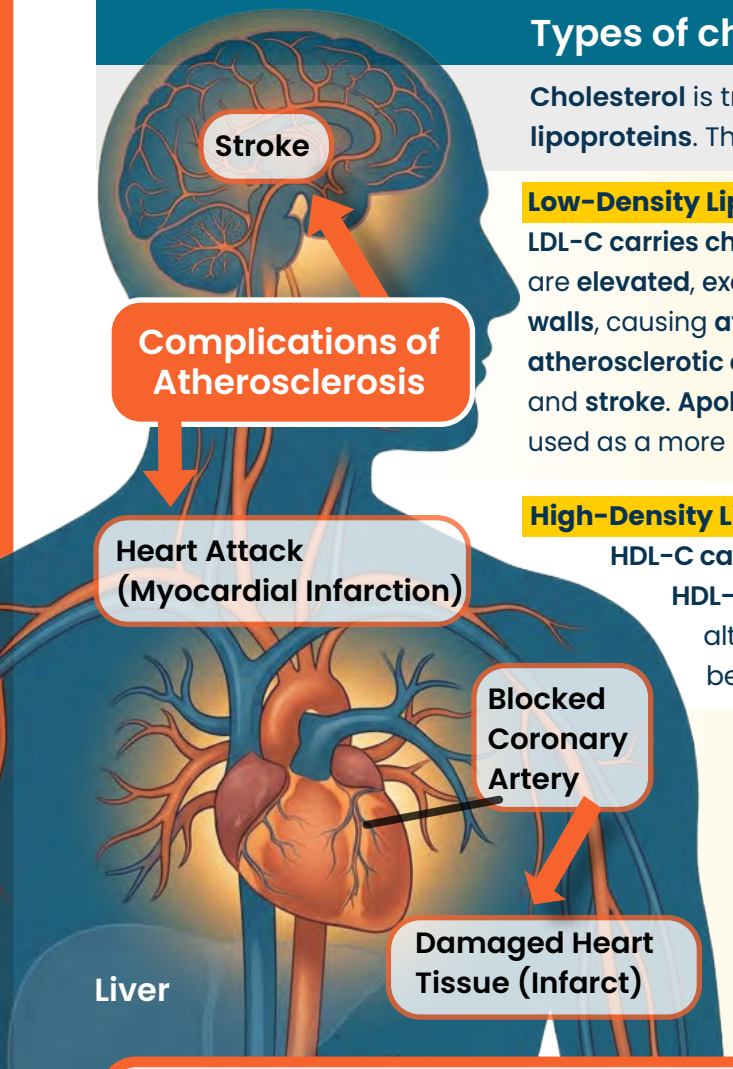
LDL-C carries cholesterol from the liver to **peripheral tissues**. When levels are **elevated**, excess cholesterol can **deposit** in the **inner lining of artery walls**, causing **atherosclerotic plaques** to form. This **increases the risk** of **atherosclerotic cardiovascular disease**, often resulting in a **heart attack** and **stroke**. **Apolipoprotein B** is the main protein found in **LDL-C**, sometimes used as a more specific **marker** for **assessing heart disease risk**.

High-Density Lipoprotein (HDL-C)

HDL-C carries cholesterol back to the **liver** for **excretion**. **Higher HDL-C levels** have been historically **linked** with **lower CVD risk**, although **current evidence** shows that **HDL-C function** may be **more important** than **levels of circulating HDL-C alone**[2].

Non-HDL Cholesterol

Non-HDL, the **total cholesterol minus HDL-C includes** the cholesterol carried by other **plaque-promoting particles**. These include **Lipoprotein (a)**, a **genetically-inherited** particle, **Very-Low-Density Lipoprotein** and **remnant lipoproteins**. **Non-HDL-C** is often used as a more **comprehensive marker** of **CVD risk** than LDL alone[3].



LDL Cholesterol Accumulation

Increased plasma LDL cholesterol

Increased saturated fat intake

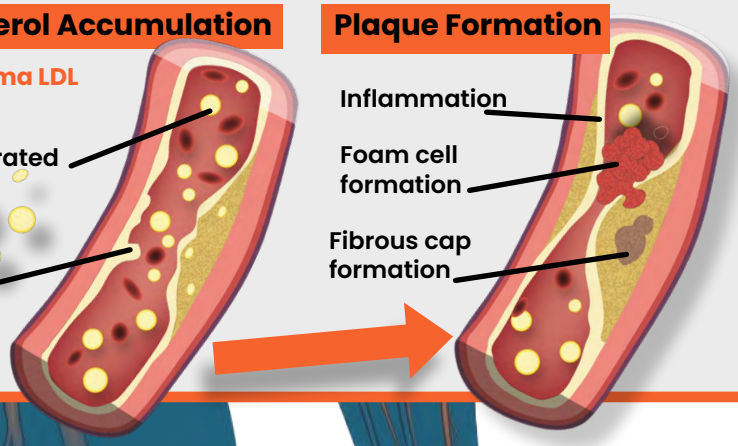
Endothelial dysfunction

Plaque Formation

Inflammation

Foam cell formation

Fibrous cap formation



Having high blood cholesterol is a **major risk** for **developing heart disease**. It causes **atherosclerotic plaques** in arteries to form, causing them to **narrow** and **increases the risk** for a **heart attack** and **stroke**.

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Causes of high cholesterol

1 Dietary factors

The **primary cause** of high cholesterol is **diet-related** and therefore the **main modifiable risk factor.** These include:



Saturated fat: found predominantly in **fatty meat** and **chicken**, **dairy products** such as **cheese**, **butter**, **cream**, **lard**, **ghee** and **tropical plant oils** including **coconut** and **palm oil**. Saturated fat **raises LDL-C** primarily by **lowering LDL receptor activity** in the **liver**, **reducing** its **clearance** from the body[4,5].

Trans fatty acids (TFAs): occur naturally in **meat** and **dairy products**, **fried foods** and in some **industrial food products** such as **baked** and **pre-packaged snacks**. TFAs **raise LDL-C levels** similar to **saturated fat**.



Ultra-processed foods: including **refined carbohydrates** and **free sugars** found in foods such as **sugar-sweetened beverages**, **cakes** and **pastries** contribute to **raised triglycerides (blood lipids)** and **LDL-C**[6,7].

Dietary cholesterol: found exclusively in **animal-based foods**, like **egg yolks**, **meat**, **offal** and **shellfish**. **Dietary cholesterol** has a more **modest effect** on raising LDL-C compared to saturated fat[8], yet has a **significant impact** on **CVD risk**[9].

2 Modifiable lifestyle factors

Physical inactivity: linked to **increased LDL-C and triglycerides**.

Excess weight: Carrying **excess body weight**, **visceral** or **abdominal fat** significantly **raises LDL-C** and **triglycerides**.



Alcohol consumption: **Alcohol** is **converted** to **triglycerides** and **cholesterol** by the **liver**, significantly **raising levels** in the **bloodstream**.





Smoking: **increases oxidative damage** to **arterial walls**, **raising modified (oxidised) LDL-C**. The **toxins** in **cigarettes** cause **micro-injuries** and **inflammation** inside the **arteries**, providing **places** for cholesterol to collect and **form arterial plaque**.

Stress and poor sleep: both associated with **higher cholesterol levels** and **atherosclerosis**[10,11].

3 Genetic and disease-related factors

Familial hypercholesterolaemia is a **genetic condition** caused by **mutations** in the **LDL receptor**, **ApoB**, or **PCSK9 genes**, significantly **elevating LDL-C from birth** and **increasing CVD risk** if untreated.

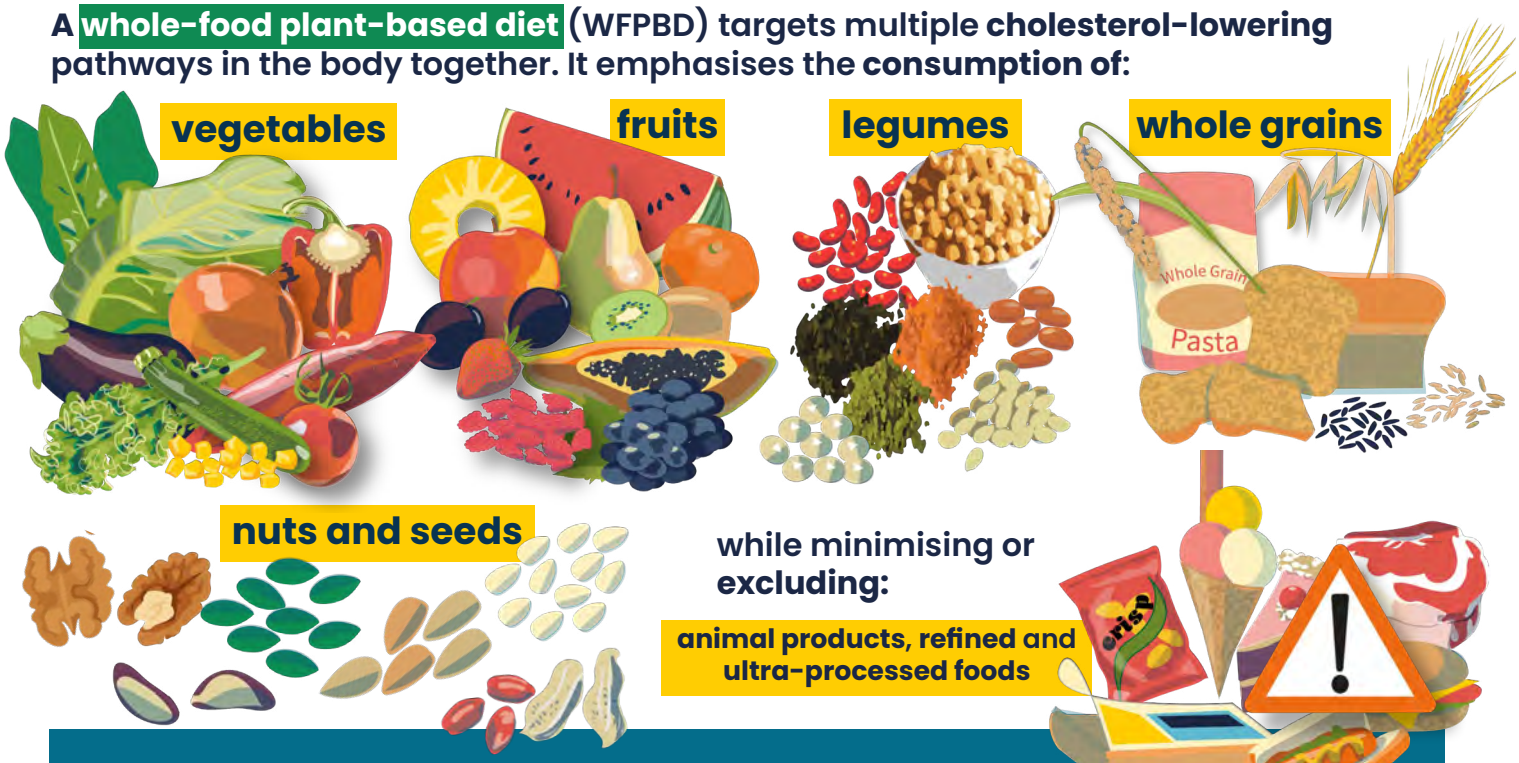
Diseases of the **kidney** and **liver**, **diabetes**, **hypothyroidism** and **Polyendocrine Metabolic Ovarian Syndrome (PMOS)** also **raise LDL-C** and **increase CVD risk**.

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How a plant-based diet reduces cholesterol

A **whole-food plant-based diet** (WFPBD) targets multiple **cholesterol-lowering** pathways in the body together. It emphasises the **consumption of:**



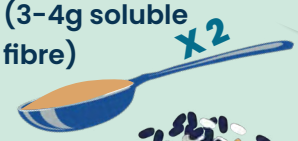
while minimising or **excluding:**

animal products, refined and ultra-processed foods

The Portfolio Diet

The **Portfolio diet** is the **leading dietary strategy for lowering cholesterol** through **diet alone**[12]. It is a portfolio of plant-based foods, each independently lowering LDL-C and total cholesterol.

How to reduce cholesterol levels with the Portfolio diet

Portfolio Component	Target portions (aim for)	How it works	Cholesterol-lowering effect
Soluble (viscous) fibre: **Oats, oat bran, barley, psyllium, beans, pulses, aubergine, okra, apples, oranges** and **berries**.	≥20g/day: **Half a cup** of **oats, beans** and **berries** (5-6g soluble fibre)  **2 tablespoons** of milled **chia seeds** or **flax seeds** (3-4g soluble fibre) 	Viscous fibre lowers LDL-C by forming a thick, **gel-like substance** in the **colon** that **traps excess LDL-C**, excreting it in stool. **Beta-glucans** found in **oats, oat bran** and **barley** are particularly good at binding to **bile acids** and **cholesterol** and **excreting** them.	**Reduces LDL-C by 5–10%**[13]

cont.....

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How a plant-based diet reduces cholesterol

How to reduce cholesterol levels with the Portfolio diet cont....

Portfolio Component	Target portions (aim for)	How it works	Cholesterol-lowering effect
Plant proteins: Soya & pulses **Tofu, edamame, soya milk, tempeh, beans, lentils** and **chickpeas**.	**50g/day:** **4 heaped tablespoons** of **legumes, pulses,** and **soya mince.** **Half the palm** of **tofu/tempeh** **2 large glasses** of unsweetened **soya beverage**	The structure of **soya protein increases** the number of **LDL receptors** within the **liver**, so **more cholesterol** is **removed** from the body. **Beans, lentils** and **chickpeas** contain **significant amounts** of **viscous fibre**.	**Reduces LDL-C and total cholesterol by ~10%**[14]
Phytosterols (stanols and sterols)* Naturally found in **nuts, seeds** and **legumes**. Predominantly found in **fortified** or **stanol-enriched** food products and certain **supplements**.	**2g/day:** **Two to three portions** of added **plant-based stanol-enriched foods** per **day**: **Two teaspoons (10g) fortified spread** **One stanol- enriched yoghurt** **Plant-sterol supplement** (taken with meals)	Similar chemical structure to human cholesterol. They **compete** for and **block** cholesterol from entering the bloodstream, allowing the body to **remove dietary** and **liver-secreted cholesterol**. ** **Not suitable** during pregnancy or breastfeeding and those with Sitosterolaemia.*	**Reduces LDL-C by ~12%**[15]
Nuts **Unsalted almonds, walnuts, cashews, pistachios** and **peanuts**.	**42g/day:** **One third of a cup** or a **handful** of **nuts**	Contain **soluble fibre, unsaturated fats** and **phytosterols** that work together to **remove excess LDL-C** and **lower triglycerides**.	**Reduces LDL-C by ~10%**[16]
Unsaturated Fats **Avocados, olive oil** and **rapeseed oil**.	**1-2 teaspoons** of **oil**	Both **monounsaturated** (MUFAs) and **polyunsaturated** (PUFAs) such as **omega-3 increase** LDL receptor activity in the liver, **promoting clearance** of LDL-C from the blood.	**Reduces LDL-C by ~8% to 15%**[17]

Quantities given per **2,000 calories** intake

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How a plant-based diet reduces cholesterol

Portfolio diet

The Evidence:

When all components are **followed closely**, the **Portfolio diet** **reduces** **LDL-C** up to **30%** for those who **follow closely** and **17%** for **overall heart disease risk**[18].

30% less LDL-C

Did you know?



Regularly consuming other foods such as **tomatoes**, **turmeric**, **black cumin seeds**, **sumac spice**, **garlic**, **ginger** and beverages such as **green tea** show **modest cholesterol-lowering** benefits as part of an **overall WFPBD**[19-22].

Cholesterol-lowering food-swap guide

Instead of...	Choose The Plant-Based Alternative
Butter/ghee, lard or coconut oil for cooking	**Small amounts (1-2 teaspoons)** of **olive oil, rapeseed oil** or **stanol-enriched plant-based spreads.**
Whole dairy milk	**Unsweetened fortified plant-based milk alternatives** such as **soya** or **oat drink (it adds more beta-glucans to your diet).**
Cheese (high saturated fat)	**Nutritional yeast** as a **flavour enhancer** or **small amounts** of **fermented cashew-based cheese.**
Red meat (beef, lamb and pork) and chicken	**1 cup of lentils, chickpeas, black beans, tofu or tempeh.**
White bread and refined grains	**¾ of a cup** of **whole oats** for **porridge** or **oat bread, barley, wholegrain rye bread, pasta and couscous.**



Swap





Swap





Swap





Swap







Swap



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Cholesterol-lowering food-swap guide cont.

Instead of...	Choose The Plant-Based Alternative
Butter on bread or toast	nut butter on toast
Creamy sauces (butter or cream)	plant-based sauce
Crisps or salty snacks	hummus crackers
Ice cream or dairy desserts eg. chocolate banana nice cream	Soya or oat yoghurt or frozen dessert or banana 'nice cream'.
Coconut milk (high saturated fat)	Light coconut milk sparingly, or replace with blended cashew milk.
Egg omelette or scramble	Scrambled silken tofu, chickpea flour omelette with added turmeric (for greater cholesterol-lowering benefits). eg. chickpea omelettte
Unfiltered coffee	Filtered coffee or coffee substitutes such as chicory and barley coffee or tea such as green tea.
Refined sugary breakfast cereals	Porridge oats with ground flaxseed and berries (rich in soluble fibre and omega-3 fats).
Salad dressings with cream	1-2 teaspoons of tahini dressing, olive oil & lemon, or miso-vinegar dressing.
Fizzy or sugary drinks	Sparkling water with fruit, unsweetened coconut water, cold-pressed veggie-fruit juice blends or unsweetened fruit iced tea.

Palm oil-free nut butter (peanut, almond cashew) or stanol-fortified spread on wholegrain toast provides a source of MUFAs, stanols and plant protein.

Cashew cream, blended silken tofu, or blended legume-based sauces (e.g. blended butter beans).

One handful of unsalted mixed nuts (almonds, walnuts, cashews) or hummus with oat or wholegrain crackers.

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Lifestyle strategies to reduce cholesterol

Exercise regularly

Regular exercise enhances the liver's ability to remove LDL-C particles from the bloodstream[23].



Aerobic exercise such as **walking, running** or **swimming** in particular uses **more circulating fats** for energy, leaving **fewer** available to **convert into cholesterol. Resistance exercise** can also modestly **reduce LDL-C.**

Aim for 150 minutes of moderate activity or 75 minutes of vigorous activity per week.

Managing weight



Losing a modest amount of body weight (5–10%) if overweight or obese can meaningfully **lower** LDL-C and triglycerides levels[24].

Sustainable weight loss can be achieved by combining a **high fibre WFPBD** with regular **exercise** and reducing intakes of **saturated fats** and **refined sugars.**

Quit Smoking



Stopping smoking immediately reduces oxidative stress linked to causing **oxidised LDL-C** and **vascular inflammation. Improvements** in the **immune system** also occur when **quitting** that helps **clear cholesterol** from the body, **reducing plaque formation.** Contacting an **NHS stop smoking service** can help you quit.

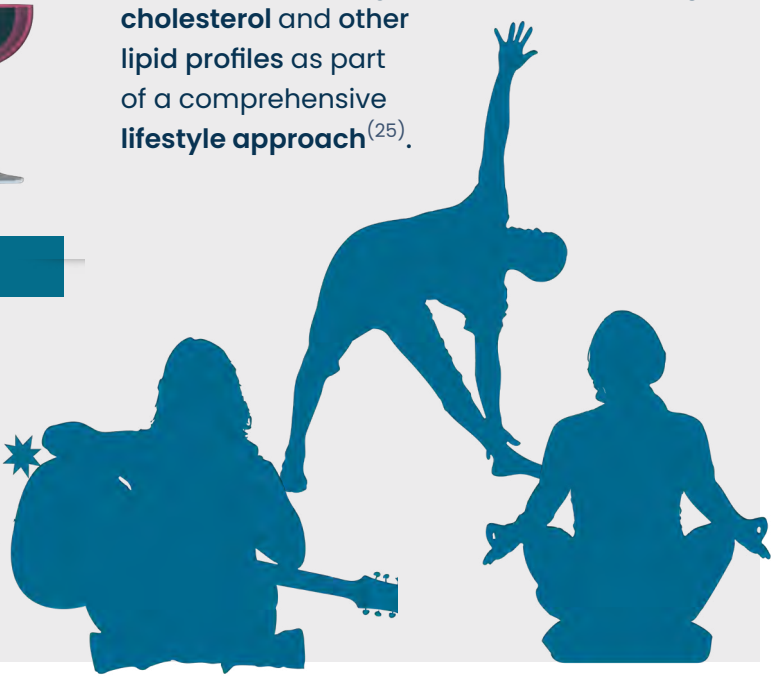
Eliminate Alcohol



Even **small amounts** of **alcohol** can **raise triglycerides**, resulting in **high blood cholesterol.** Excluding alcohol from the diet **reduces blood lipids** and allows the **liver** to better function at **removing cholesterol** from the body.

Reducing Stress

Mindfulness-based techniques such as **meditation** and **yoga** may benefit **lowering cholesterol** and other lipid profiles as part of a comprehensive **lifestyle approach**[25].



Improving sleep hygiene

Aiming for **7 to 8 hours** of **quality sleep** directly **reduces the risk** of CVD and may **improve lipid profiles** linked to heart health[26].



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Answers to common cholesterol questions

Q Is **saturated fat** really **harmful** for **heart health**, or has the evidence changed?



A The **scientific consensus** has **remained** remarkably **consistent**: **replacing saturated fat with unsaturated fats reduces LDL-C and CVD risk.**

The **greatest benefits** occur when saturated fats from **butter, processed and fatty meats** are **replaced** with **whole-plant foods** and heart healthy oils such as **olive oil**.



Q Does **dietary cholesterol** affect everyone's **cholesterol levels** the same way?

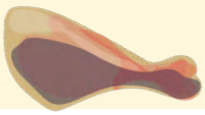


A Individuals **vary** in their **response** to dietary cholesterol.

Some people, known as **"hyperresponders"**, **absorb more cholesterol** from the **intestine** and **excrete less** in bile, resulting in a **greater rise** in **blood LDL-C after consuming cholesterol-rich foods** such as **eggs**. For individuals with **heart disease** or **diabetes**, **swapping** high cholesterol foods for **low-cholesterol foods** is advisable as part of an overall **heart-healthy** dietary pattern.

Q Is it **healthier** to eat **chicken** or **lean meat** for cholesterol?





A While **red meat** was thought to be much worse, **white meat** and **red meat** have **similar, detrimental effects** on **blood cholesterol** when consumed in **equal portions**[27].

Q Do **ketogenic diets improve** markers of **heart health**?

A Some people following **ketogenic diets** can experience **short-term improvements** in **body weight, blood glucose** and **triglycerides**. However, most experience **substantial increases** in **LDL-C levels**[28]. **LDL-C does not become harmless** simply because **other markers** of **heart health improve**. Current guidelines **do not support** the use of **ketogenic diets** for **lowering cholesterol** and **CVD.**

Q Can people of **normal body weight** have **high cholesterol**?



People of **any body type** can have **high cholesterol.** Being **overweight** can **increase** your chances but being of a **regular body weight does not prevent high cholesterol** and **heart disease risk**. Current guidelines **recommend lowering elevated LDL-C** even in those of **regular body weight.**

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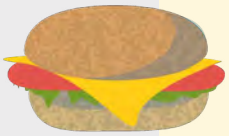
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Answers to common cholesterol questions

Q Is high cholesterol just a concern for **older adults**?

A **High cholesterol** can **begin in childhood**, sometimes due to **inherited conditions** as well as **consuming diets high in animal foods** and **low** in **whole plant foods** or through exposure to **high maternal cholesterol** in the **womb.**

Atherosclerotic plaques can start **forming** in **childhood increasing their future risk** of **CVD**[29].









Q What about **diets** and **people** with **familial hypercholesterolaemia (FH)**?

A Emerging research has shown that a **WFPBD** can also help **lower LDL-C** in people with **genetic FH**[30]. Most people with **FH** will also require **cholesterol-lowering medication.** It is **important** to **discuss with your healthcare provider** when making any **dietary changes.**

Q Do **plant-based meat alternatives** raise **LDL-C?**



A **Plant-based meat alternatives do not** generally **increase LDL-C, unless** they are **high** in **coconut oil** or **palm oil.**

In fact, **replacing animal-based meats** with **plant-based meat substitutes** is **linked to significant reductions** in **LDL-C, total cholesterol,** and **TMAO (a heart disease related compound)**[31].



Q Can **coffee** increase **cholesterol levels?**



A **Unfiltered coffee** (e.g. **French press, cafetière** and **Turkish coffee**) can **raise LDL-C** due to **naturally occurring compounds**[32], whereas **filtered** and **instant coffee** have more **minimal effects** on **cholesterol levels.**

Choose paper-filtered coffee or **swap** to **green tea** as part of a **heart-healthy dietary pattern.**



Additional resources

Portfolio diet infographic

Plant-based recipes and meal plans

Portfolio diet app

Portfolio diet for health professionals

Download the Portfolio diet app

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