

Health risks, evidence and treatment

Revision notes · Analysing health data, judging study design and risk perception, cholesterol and lipoproteins, reducing CHD risk, and the drugs used to treat CVD.

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Health risks, evidence and treatment Spec 1.15-1.20

Analysing data on illness and mortality Spec 1.15

Health data are usually given as **rates** so that populations of different sizes can be compared.

- **Incidence**: the number of new cases of an illness in a population in a stated time, often per 100 000 people per year.
- **Prevalence**: the total number of people with the illness at a given time, often per 100 000 people.
- **Mortality rate**: the number of deaths from a cause in a stated time, per 100 000 people (or per 1000).

Calculating a mortality rate

In one year 1500 people died from coronary heart disease in a town of 600 000 people. Calculate the mortality rate per 100 000 people.

1. Rate per 100 000 = (number of deaths ÷ population) × 100 000

2. = (1500 ÷ 600 000) × 100 000

Answer: 250 deaths per 100 000 people per year

To interpret data, describe the trend with figures from the table or graph, calculate percentage changes, and compare groups. Percentage change = (new value – original value) ÷ original value × 100.

Correlation and causation

A **correlation** is a relationship between two variables, often shown on a scatter diagram: as one rises the other rises (positive) or falls (negative). A correlation does not show that one variable **causes** the other. A third variable (a confounding variable) may be responsible for both, or the link may be due to chance.

Evidence for a causal relationship is stronger when there is a plausible biological mechanism, the effect increases with the dose of the factor, the link is found repeatedly in different studies, and intervention (removing the factor) reduces the disease.

Conflicting evidence

Studies on the same risk may reach different conclusions because they differ in sample size, the people studied, the length of the study, how data were collected and which other variables were controlled. When evidence conflicts, compare the quality of the studies and look at the overall weight of evidence.

Maths skill: Give rates with units (per 100 000 per year), and when calculating a percentage change always divide by the original value.

Exam tip: When asked why data do not prove causation, name a possible confounding variable (for example, other lifestyle differences between groups) rather than just writing 'correlation is not causation'.

Evaluating the design of studies Spec 1.16

Valid	The data measure what the study claims to measure, with other variables controlled.
Reliable	The results are consistent, and similar results would be obtained if the study were repeated.

Questions to ask when evaluating a study

Feature	What makes it better	Why
Sample selection	People who represent the whole population (age, gender, lifestyle), chosen at random	Avoids bias, so the findings can be applied to the population; volunteers may be unusually health-conscious
Sample size	Large	Reduces the effect of chance and of anomalous individuals; the results are more reliable
Control of variables	Groups matched for age, gender and other factors, with a control group	Reduces the effect of confounding variables, so any difference is more likely to be due to the factor
Data collection	Objective, measured values (blood pressure, cholesterol)	Self-reported diet and exercise rely on memory and honesty
Duration	Long enough for the disease to develop; follow people over time	CVD takes years to develop

In a **cohort study** a large group is followed over time and the rate of disease is compared between people with and without a factor. In a **case-control study** people with the disease are compared with matched people without it. Both can show a link but cannot prove a cause.

Exam tip: Do not just write 'bigger sample'. Say why: a larger sample reduces the effect of chance and anomalies, so the data are more reliable. Link bias in selection to validity.

Perception of risk Spec 1.17

The **actual risk** is the measured probability of harm, found from data. The **perceived risk** is what people think the risk is. The two often differ.

- **Overestimating**: risks that are dramatic, rare and widely reported, or outside a person's control (for example air travel).
- **Underestimating**: risks from everyday lifestyle choices whose harm builds up slowly, such as a diet high in saturated fat, little exercise and smoking. People feel healthy now, and the harm is years away.
- Reasons include media coverage, the experience of friends and family (a relative who smoked and lived to 90), the pleasure or convenience of the behaviour, believing the risk applies to others, and difficulty understanding statistics (for example confusing a large relative increase with a large absolute risk).

These differences matter because people who underestimate the risk of heart disease from diet and inactivity are less likely to change their behaviour. Health education aims to present the evidence clearly so perceived risk is closer to actual risk.

Exam tip: Use the wording 'overestimate' and 'underestimate' with a named lifestyle risk, and give a reason such as media coverage or the delay before harm appears.

Blood cholesterol, HDL and LDL Spec 1.18(i)

Cholesterol is needed to make cell membranes and some hormones, but it is hydrophobic and cannot dissolve in plasma. It is carried in blood inside **lipoproteins**: particles with a surface of phospholipid and protein around a core of cholesterol and triglyceride.

LDL and HDL		
	LDL (low-density lipoprotein)	HDL (high-density lipoprotein)
Carries cholesterol	From the liver to the body tissues	From the tissues back to the liver
Effect on arteries	Excess LDL is taken into the artery wall and contributes to plaque formation	Removes excess cholesterol from the artery wall, so protective
Effect on CVD risk	Higher level = higher risk	Higher level = lower risk

Doctors look at total cholesterol, LDL and HDL, and often the ratio of total cholesterol to HDL. The lower the ratio, the lower the risk. Typical UK guidance suggests a total cholesterol below about 5 mmol dm^{-3} and LDL below about 3 mmol dm^{-3} (you are not expected to learn these values). A diet high in saturated fat tends to raise LDL.

Exam tip: When analysing data, compare people using LDL and the total:HDL ratio, quote the values, and say a high LDL level with a low HDL level means the highest risk.

Evidence linking cholesterol and CVD Spec 1.18(ii)

- **Correlation** in large population studies: groups with higher total and LDL cholesterol have more cardiovascular disease.
- **Genetic evidence**: people with inherited conditions that cause very high LDL cholesterol develop atherosclerosis and CVD at a young age.
- **Mechanism**: LDL cholesterol is found in plaques; oxidised LDL is taken up by macrophages to form foam cells.
- **Intervention trials**: lowering LDL cholesterol with statins and diet reduces the number of heart attacks and strokes.
- Laboratory studies: animals fed high-cholesterol diets develop atherosclerosis.

Not every piece of evidence is consistent. Some people with normal cholesterol develop CVD and some people with high cholesterol do not, because CVD has many risk factors. Studies of drugs that raise HDL have not always shown reduced CVD. Overall the weight of evidence from several different kinds of study supports a causal role for high LDL.

Exam tip: Strong answers use more than one type of evidence (population, genetic, mechanism, intervention) and mention that CVD is multifactorial, which is why correlation alone is not proof.

Using scientific knowledge to reduce the risk of CHD Spec 1.19

Lifestyle changes and why they reduce risk

Change	Scientific reason
Eat less saturated fat	Lowers LDL cholesterol, so less atheroma forms
Eat less salt	Lowers blood pressure, so less endothelial damage
Eat more fruit, vegetables and fibre	Antioxidants and fibre; helps control weight and cholesterol
Take regular exercise	Lowers blood pressure, raises HDL, helps control body mass
Stop smoking (or never start)	Removes carbon monoxide, nicotine and chemicals that damage the endothelium and raise clotting
Keep to a healthy body mass	Obesity is linked to high blood pressure and raised LDL

Obesity indicators

body mass index (BMI) = mass (kg) ÷ height² (m²)

waist-to-hip ratio = waist circumference ÷ hip circumference

A BMI under 18.5 is classed as underweight, 18.5 to 24.9 as healthy, 25 to 29.9 as overweight and 30 or over as obese. BMI is simple to calculate but does not distinguish muscle from fat, so a muscular person can have a high BMI without being unhealthily fat. Waist-to-hip ratio shows fat distribution: a high ratio means more fat stored around the abdomen, which is linked to a higher risk of CVD (commonly used thresholds for higher risk are above 0.90 in men and above 0.85 in women).

Calculating BMI and waist-to-hip ratio

A man has a mass of 80 kg and a height of 1.75 m. His waist is 92 cm and his hips are 102 cm. Calculate his BMI and waist-to-hip ratio.

1. $\text{BMI} = 80 \div 1.75^2 = 80 \div 3.0625 = 26.1$ (to 3 s.f.)
2. $\text{Waist-to-hip ratio} = 92 \div 102 = 0.90$ (to 2 d.p.)

Answer: BMI 26.1 kg m⁻² (overweight); waist-to-hip ratio 0.90

Maths skill: Square the height before dividing in BMI, and use the same units for waist and hip. BMI is expressed in kg m⁻² and waist-to-hip ratio has no units.

Treatments for cardiovascular disease Spec 1.20

Drug treatments for CVD			
Drug	How it works	Benefits	Risks
Antihypertensives (for example beta blockers, ACE inhibitors, calcium channel blockers, diuretics)	Lower blood pressure, by relaxing artery walls, slowing the heart or reducing blood volume	Less damage to the endothelium and less strain on the heart; lower risk of stroke and heart attack	Dizziness or fainting if blood pressure falls too far, tiredness, and other side effects specific to the drug type
Statins	Reduce the liver's production of cholesterol (by inhibiting an enzyme), so the liver removes more LDL from the blood	Lower blood LDL; slow atheroma formation; lower risk of heart attack and stroke	Muscle pain, digestive upset, rarely liver damage
Anticoagulants (for example warfarin, heparin)	Interfere with the clotting cascade, so less fibrin is made	Reduce the risk of clots forming, for example after a previous clot or in people at risk	Bleeding and bruising, which can be serious; dose needs monitoring
Platelet inhibitors (for example aspirin)	Stop platelets sticking together and to damaged vessel walls	Reduce the risk of clots in arteries, so lower risk of heart attack and stroke	Bleeding, and irritation or ulcers in the stomach

These drugs treat risk factors or reduce the effects; they do not cure atherosclerosis. Treatment is chosen by weighing the likely benefit against the risk of side effects for the individual, and is used together with lifestyle changes. Anticoagulants and platelet inhibitors act at different points: anticoagulants affect the clotting cascade, whereas platelet inhibitors stop platelets aggregating.

Exam tip: For 'evaluate' or 'discuss' questions on drugs, give at least one benefit and one risk for each drug named, and conclude with who is most likely to benefit.

Quick check

1. How do you calculate a mortality rate per 100 000?
2. What is the difference between valid and reliable data?
3. What does LDL do?
4. Give the formula for BMI.
5. How do statins reduce the risk of CVD?

Quick check answers

Health risks, evidence and treatment

1. $(\text{Number of deaths} \div \text{population}) \times 100\,000$.
2. Valid data measure what the study claims to measure; reliable data are consistent and repeatable.
3. It carries cholesterol from the liver to the body tissues; high levels raise the risk of CVD.
4. $\text{Mass in kg} \div (\text{height in m})^2$.
5. They lower blood LDL cholesterol by reducing cholesterol production in the liver.