

# DP IB Environmental Systems & Societies (ESS): HL



Your notes

## 8.1 Human Populations

### Contents

- \* Human Population Dynamics
- \* Managing Human Population Growth
- \* Population Composition & Modelling



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## Human Population Dynamics

# Demographic Variables

## Inputs to human populations: births and immigration

- Births and immigration are inputs that contribute to the growth of a population
- **Crude birth rate (CBR):**
  - This is the number of live births per 1 000 people in a population per year
    - For example, a CBR of 15 means 15 babies are born for every 1 000 people in that population each year
  - CBR is calculated by dividing the total number of live births in a year by the total population and then multiplying by 1 000

$$CBR = \frac{\text{total number of live births}}{\text{total population}} \times 1\,000$$



### Worked Example

A country has 25 000 live births in a year, and the total population is 500 000.

Calculate the crude birth rate.

#### Answer

$$CBR = (\text{number of live births} / \text{total population}) \times 1\,000$$

$$CBR = (25\,000 / 500\,000) \times 1\,000$$

$$CBR = 50 \text{ births per } 1\,000 \text{ individuals}$$

- **Immigration rate:**
  - This is the number of immigrants per 1 000 people in a population per year

## Outputs from human populations: deaths and emigration

- Deaths and emigration are outputs that reduce the size of a population
- **Crude death rate (CDR):**



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- This is the number of deaths per 1 000 people in a population per year
  - For example, a CDR of 8 means 8 people die for every 1 000 people in that population each year
- CDR is calculated by dividing the total number of deaths in a year by the total population and then multiplying by 1 000

$$CDR = \frac{\text{total number of deaths}}{\text{total population}} \times 1\,000$$



### Worked Example

In a given year, a country recorded 15 000 deaths, and the total population is 750 000.

Calculate the crude death rate.

#### Answer

$$CDR = (\text{number of deaths} / \text{total population}) \times 1\,000$$

$$CDR = (15\,000 / 750\,000) \times 1\,000$$

$$CDR = 20 \text{ deaths per } 1\,000 \text{ individuals}$$

- **Emigration rate:**
  - This measures the number of people leaving a population per 1 000 people per year

## Quantifying population dynamics

- Population growth and decline can be quantified through several key measures:
- **Total fertility rate (TFR):**
  - This is the average number of children a woman is expected to have during her lifetime, based on current age-specific fertility rates
    - In developing countries, TFR tends to be higher (e.g. due to limited access to family planning)
  - TFR is calculated by summing the age-specific fertility rates (ASFR) and multiplying the result by five

$$TFR = \sum ASFR \times 5$$



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## Worked Example

A country has the following fertility rates per 1 000 women in each age group:

- 15–19 years: 20 births per 1 000 women
- 20–24 years: 85 births per 1 000 women
- 25–29 years: 100 births per 1 000 women
- 30–34 years: 80 births per 1 000 women
- 35–39 years: 40 births per 1 000 women
- 40–44 years: 10 births per 1 000 women
- 45–49 years: 2 births per 1 000 women

Calculate the total fertility rate.

### Answer

$$\text{TFR} = (20 + 85 + 100 + 80 + 40 + 10 + 2) \times 5$$

$$\text{TFR} = 1\,685 \text{ births per } 1\,000 \text{ women}$$

$$\text{TFR} = 1.685 \text{ children per woman}$$

This means that, on average, a woman in this country is expected to have approximately 1.69 children over her lifetime based on current fertility rates.

- **Life expectancy:**
  - This is the average number of years a person is expected to live from birth, assuming current demographic factors (such as healthcare) remain the same
- **Doubling time (DT):**
  - This is the number of years it would take a population to double in size, based on its current growth rate
  - DT is calculated using the 'rule of 70': divide 70 by the population growth rate percentage

$$DT = \frac{70}{\text{growth rate } \%}$$



## Worked Example

A population has a growth rate of 2% per year.

Calculate the doubling time.



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**Answer**

DT = 70 / growth rate

DT = 70 / 2

DT = 35 years

▪ **Natural increase rate (NIR):**

- This is the difference between the crude birth rate and crude death rate, usually expressed as a percentage or a number per 1 000.
  - If the birth rate is higher than the death rate, natural increase occurs
- NIR is calculated by subtracting the CDR from the CBR and then dividing the result by 10

$$NIR = \frac{(CBR - CDR)}{10}$$

**Worked Example**

A country has a CBR of 25 births per 1 000 individuals and a CDR of 10 deaths per 1 000 individuals.

Calculate the natural increase rate.

**Answer**

$$NIR = (CBR - CDR) / 10$$

$$NIR = (25 - 10) / 10$$

$$NIR = 1.5\%$$

**Examiner Tips and Tricks**

Make sure you can define terms like crude birth rate, fertility rate and life expectancy. These often come up in exam questions.

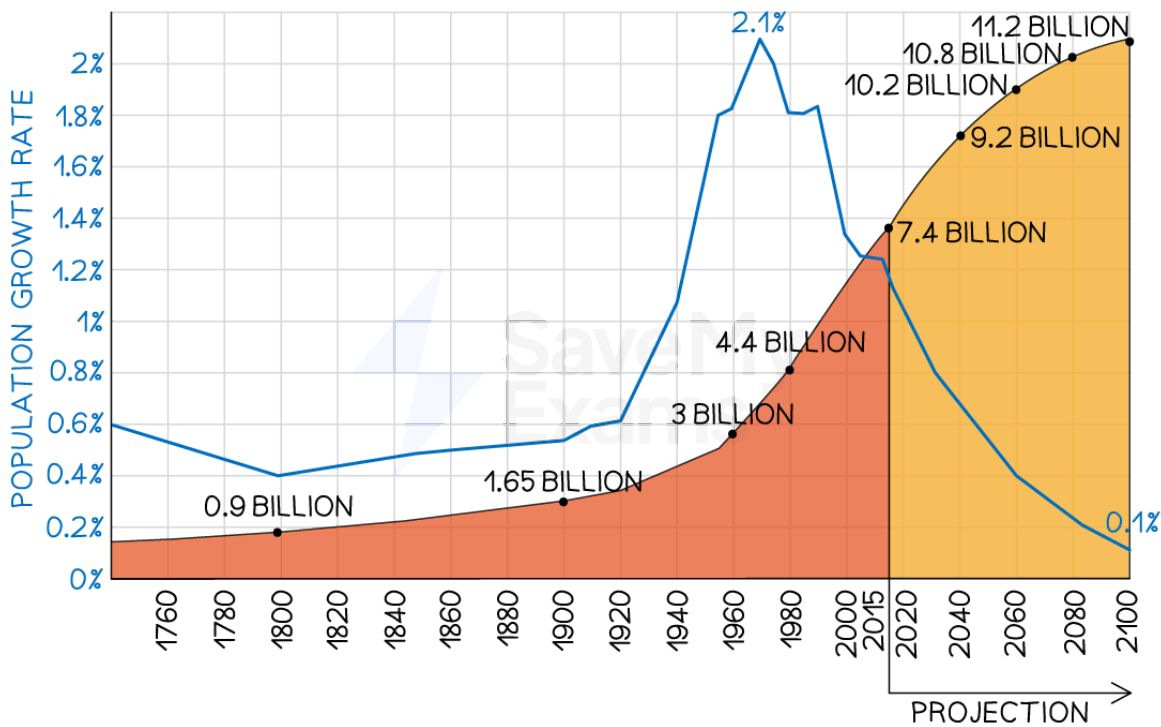
## Human Population Growth

### Rapid growth of the global human population



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- The global human population has followed a **rapid growth curve**, particularly in the past century
  - The global human population grew very slowly until 18th century
  - From 10 000 BCE to 1700 CE, the average growth rate was just 0.04% per year
  - There has been exponential growth in the global human population since the mid 18th century
  - In 1800, the world population was about 1 billion
  - By 2024, the population will have grown to over 8 billion
  - This growth is largely due to improvements in **medicine**, **agriculture** and **technology**, which have reduced death rates
- The growth rate is starting to fall again
- However, the world population is projected to continue to grow until approximately 2100, when it could reach more than 11 billion



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World population total and growth rate, 1750–2015 (with projections until 2100)

## Models to predict future global population growth

- **Population models** are used to predict the growth of the human population in the future
  - These models take into account **birth rates**, **death rates**, **fertility rates**, and **migration**
  - Models can help policymakers understand trends and make decisions about resource use, healthcare and urban planning



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## UN projection models

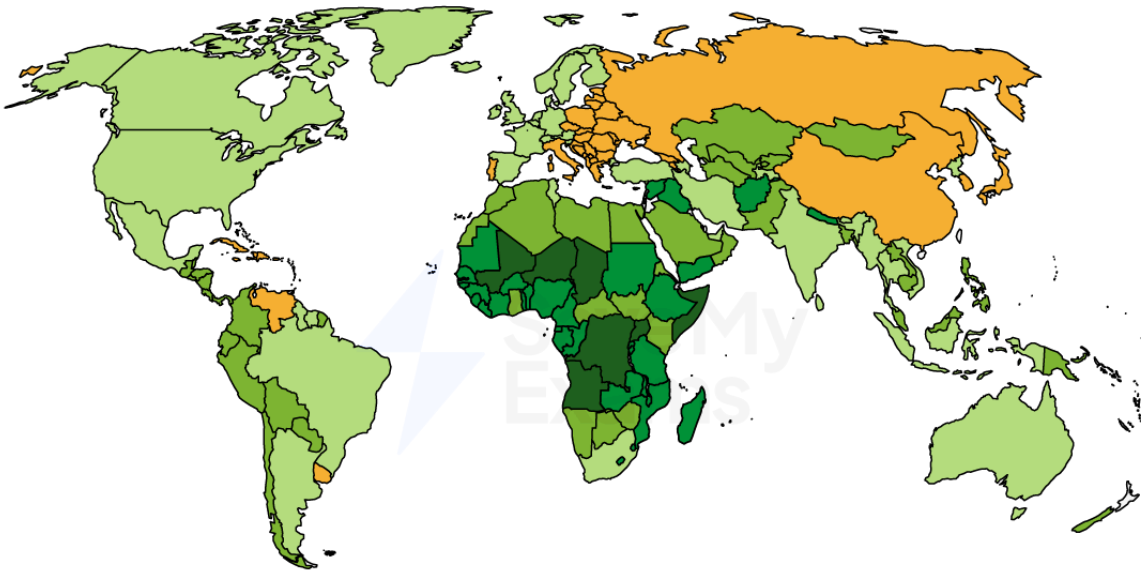
- The United Nations (UN) uses models to project future global population growth, offering **three different scenarios**:
  1. **High-fertility scenario**: assumes higher birth rates will continue, leading to a more rapid population increase
  2. **Medium-fertility scenario**: assumes a steady decline in fertility rates, leading to moderate population growth (this is the most likely scenario)
  3. **Low-fertility scenario**: assumes fertility rates will drop significantly, leading to slower growth or a shrinking population
- By 2100, the global population is projected to be around **9.7 billion** in the medium-fertility scenario

## Uncertainty of future fertility rates

- Predicting **fertility rates** is challenging, leading to **uncertainty** in population forecasts
  - Changes in **cultural norms**, **economic conditions**, and **government policies** can all influence fertility rates
- Countries that went through **Industrial Revolutions** in the 18th and 19th centuries experienced **rapid population growth**
  - Today those countries are **developed** and their growth rates have **fallen**
  - In some cases, they have fallen so much that their total populations are in **decline** (e.g. Japan)
- The fastest population **growth** today occurs in **developing** countries that are **rapidly industrialising**



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NO DATA



-4% -2% 0% 1% 2% 3% 4%



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**Global pattern of population growth rate (2021)**





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## Managing Human Population Growth

# Direct Management of Population Growth

- **Population management** involves policies aimed at influencing the size, growth and distribution of human populations
  - These policies focus on **birth rates** (pro-natalist or anti-natalist) or on **migration** (immigration and emigration).
  - Governments use these policies to address concerns such as:
    - Overcrowding
    - Economic demands
    - Ageing populations

## Anti-natalist policies

- Anti-natalist policies **reduce birth rates** in countries with high population growth
  - These policies are common in countries facing **overpopulation**, where resources are strained

## Methods used

- **Education and awareness**: promoting smaller family sizes and the benefits of fewer children
  - For example, **China's One-Child Policy** (introduced in 1979) aimed to slow population growth by limiting families to one child
- **Access to contraception**: improving the availability of birth control methods to reduce unwanted pregnancies
  - For example, in **India**, family planning campaigns have included the distribution of free contraceptives
- **Financial incentives**: offering financial rewards or penalties to influence family size
  - For example, **Vietnam's Two-Child Policy** (introduced in the 1980s) aimed to limit family size by encouraging people to have only two children
  - The policy was supported by:
    - Financial penalties for larger families
    - Incentives such as preferential housing and education benefits for those who complied

## Outcomes



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- Anti-natalist policies lead to:
  - Slower population growth
  - Reduced pressure on resources
- However, they can also cause **long-term issues**, such as an ageing population (fewer young people to support the elderly)

## Pro-natalist policies

- Pro-natalist policies encourage an **increase in birth rates** in countries with low or negative population growth
  - These policies are used in countries facing **ageing populations** or **labour shortages**

## Methods used

- **Financial incentives**: offering parents monetary support for having more children
  - For example, **France's Code de la Famille** (1939) offers cash bonuses, paid parental leave and subsidised childcare to encourage larger families
- **Parental support**: providing benefits such as **longer parental leave** or free childcare
  - For example, **Sweden** offers generous parental leave (up to 480 days shared between both parents) to support family growth
- **Cultural encouragement**: promoting family-friendly values through campaigns or media

## Outcomes

- Pro-natalist policies help to:
  - Boost population growth
  - Ensure a balanced ratio between working-age individuals and the elderly
- However, they may **take time** to show effects and could face **cultural resistance**

## Migration policies

- Migration policies manage **immigration** (inward) and **emigration** (outward) to influence population size and labour markets
  - Countries may encourage or restrict migration based on economic needs and population growth goals

## Methods used

- **Open immigration policies:** allowing more people to enter the country, particularly if there is a need for workers
  - For example, **Germany** has encouraged immigration to offset its declining population and labour shortages
- **Restrictions on immigration:** limiting the number of people who can enter a country to control population growth or preserve jobs for citizens
  - For example, **Australia** has a strict immigration policy based on points
    - This points-based system favours skilled workers
- **Encouraging emigration:** some countries promote emigration to relieve population pressure



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## Outcomes

- **Immigration** can help to:
  - Balance an ageing population
  - Provide labour
  - Diversify the economy
- **Emigration** can reduce population pressure, but may lead to a '**brain drain**', where skilled workers leave the country



### Examiner Tips and Tricks

Make sure you are aware of the potential long-term effects of anti-natalist, pro-natalist and migration policies, such as ageing populations or labour shortages.

## Indirect Management of Population Growth

- **Indirect population management** involves policies that do not directly aim to control population growth but still affect factors such as birth rates, death rates and migration
  - These policies focus on **economic, social, health and development** areas
  - These policies indirectly influence population dynamics

## Economic policies

- Economic policies influence population growth by:



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- Improving living standards
- Changing family planning decisions
- In less wealthy societies, families feel **economic pressure** to have **more children** because:
  - **Children contribute to family income:** in many rural or low-income areas, children may work on farms or help with small businesses, providing extra income for the family
  - **Lack of social welfare:** without government support like pensions or healthcare, parents may rely on their children to support them in old age
  - **Higher child mortality rates:** in areas with poor healthcare, parents may have more children to ensure that some survive to adulthood
  - **Limited access to education:** with fewer opportunities for higher education, children are often seen as a source of immediate labour and support, rather than an investment for the future
- **Wealthier societies** tend to have **lower birth rates**, as families may prefer to invest more in fewer children

## Methods used

- **Job creation and economic stability:** improved employment opportunities can reduce poverty
  - This leads to fewer children as families focus on education and careers
- **Welfare systems:** governments that provide strong social welfare systems help families feel secure with fewer children

## Outcomes

- **Higher living standards** often lead to lower birth rates, as families feel less economic pressure to have many children
- **Economic development** can slow population growth as people focus more on career and lifestyle choices over family size

## Social and gender equality policies

- Policies that promote **gender equality** and **social development** indirectly reduce birth rates
  - This is because these types of policies empower women to make informed family planning decisions

## Methods used

- **Education for girls and women:** increasing access to education leads to delayed marriages and childbirth, as well as smaller family sizes
- **Workforce participation:** encouraging women to join the workforce allows them to focus on careers

- This often leads to smaller families and later pregnancies

## Outcomes

- **Improved gender equality** leads to more choices for women, resulting in lower birth rates
- Societies with **greater gender equality** have higher levels of education and economic participation, both of which can reduce population growth

## Public health and welfare policies

- Health policies affect population growth by lowering death rates and improving overall well-being
  - Both of these can influence birth rates

## Methods used

- **Improved healthcare**: providing better healthcare, especially maternal and child health services, reduces infant mortality
  - This can lead to smaller family sizes

## Outcomes

- **Better healthcare** reduces both death and birth rates, leading to more stable population growth



### Examiner Tips and Tricks

Make sure you are able to differentiate between **direct** and **indirect policies**. Direct policies, like **China's One-Child Policy**, explicitly target birth rates, while indirect policies, like **improving girls' access to education** in countries like Bangladesh, influence population growth through broader social changes.



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## Population Composition & Modelling



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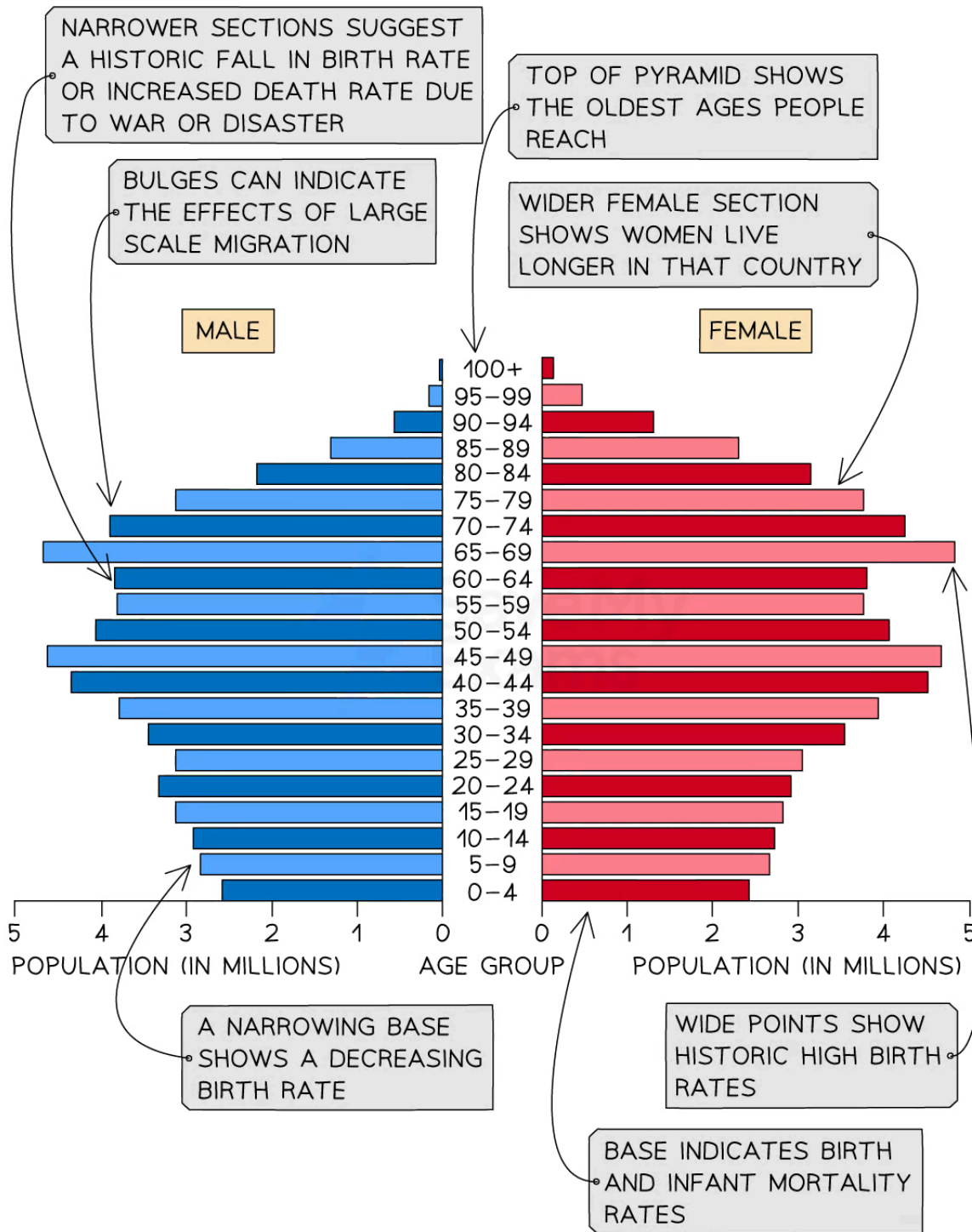
# Human Population Models

## Age–sex pyramids

- The composition of human populations can be modelled and compared using **age–sex pyramids**
  - These are sometimes referred to as population pyramids, age–gender pyramids or age structure diagrams
- An age–sex pyramid is a graphical representation of a population's **age and sex structure**
  - It displays the percentage or number of individuals in each age group and gender within a given population
  - They typically show data for a particular country or region
- The age–sex pyramid is usually represented as a horizontal bar graph
  - The **age groups** are displayed along the **vertical axis**
  - The percentage or **number of individuals** in each age group is displayed along the **horizontal axis**
  - The **left** side of the graph displays the **male** population
  - The **right** side shows the **female** population
- The **shape** of the age–sex pyramid can provide **insights** into the demographic characteristics of a population
  - For example, a pyramid with a broad base and a narrow top indicates a young population with high fertility rates and low life expectancy
  - Whereas a pyramid with a narrow base and a broad top indicates an ageing population with low fertility rates and high life expectancy



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**An example of a population pyramid**

- Age–sex pyramids are used by policymakers and economists to:
  - Understand **population trends**
  - Forecast **future population growth**
  - Plan for social and economic policies
- They are also used in fields such as public health, education and social welfare to plan for the needs of specific age groups within a population
  - This means that governments can estimate and plan for spending
- An age–sex pyramid can be used to identify the following groups:
  - Young dependents
  - Old dependents
  - Economically active (working population)



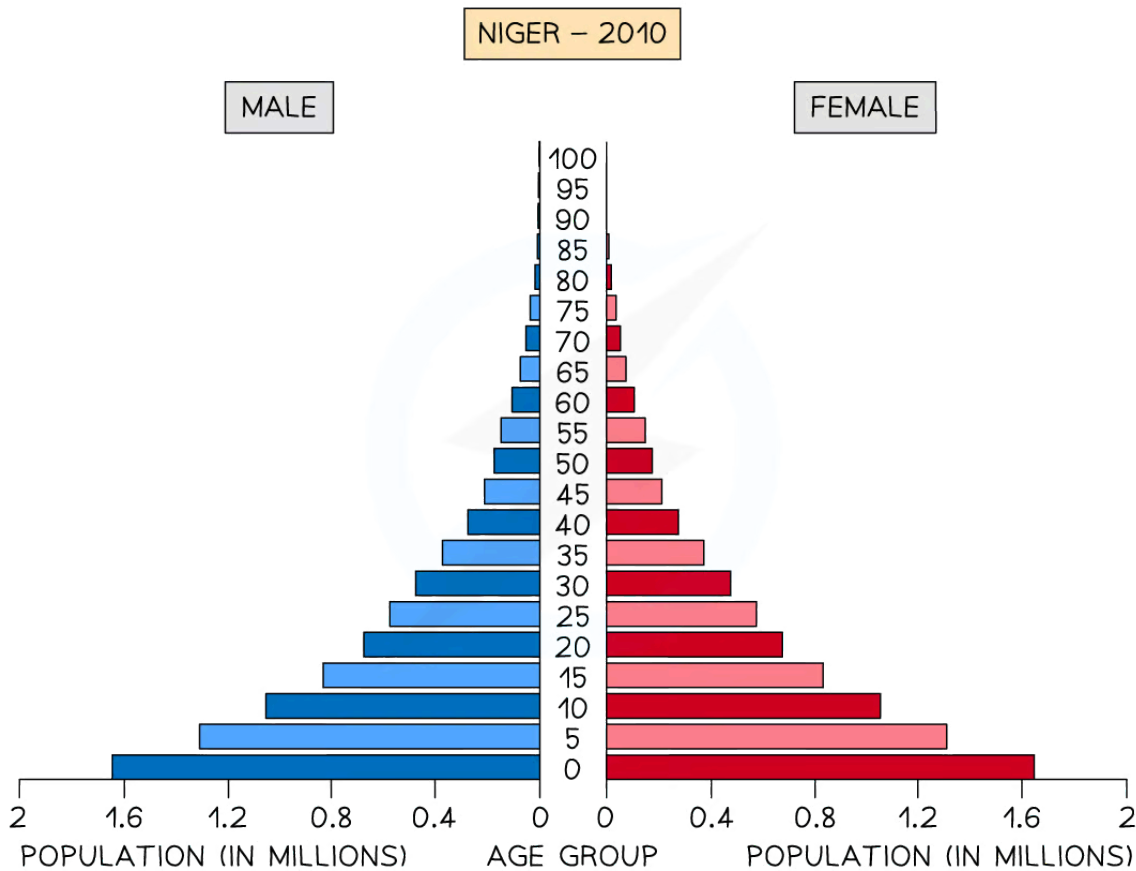
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## Population structures of LICs and HICs





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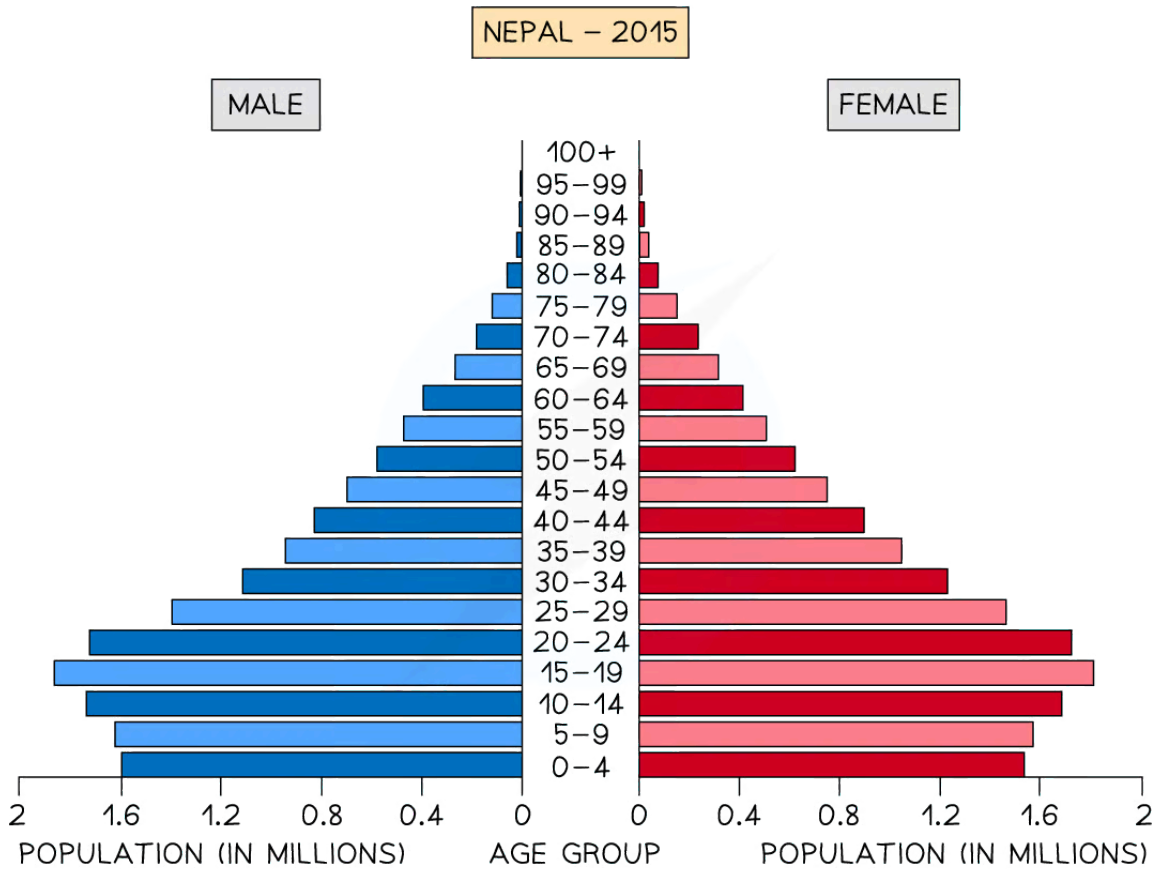


**Age-sex pyramid for Niger**

- **Low-income countries** (LICs) like Niger typically have a concave pyramid shape
- This indicates:
  - High birth rate
  - Low life expectancy
  - High death rate
  - High infant mortality rate
  - Young dependent population dominates



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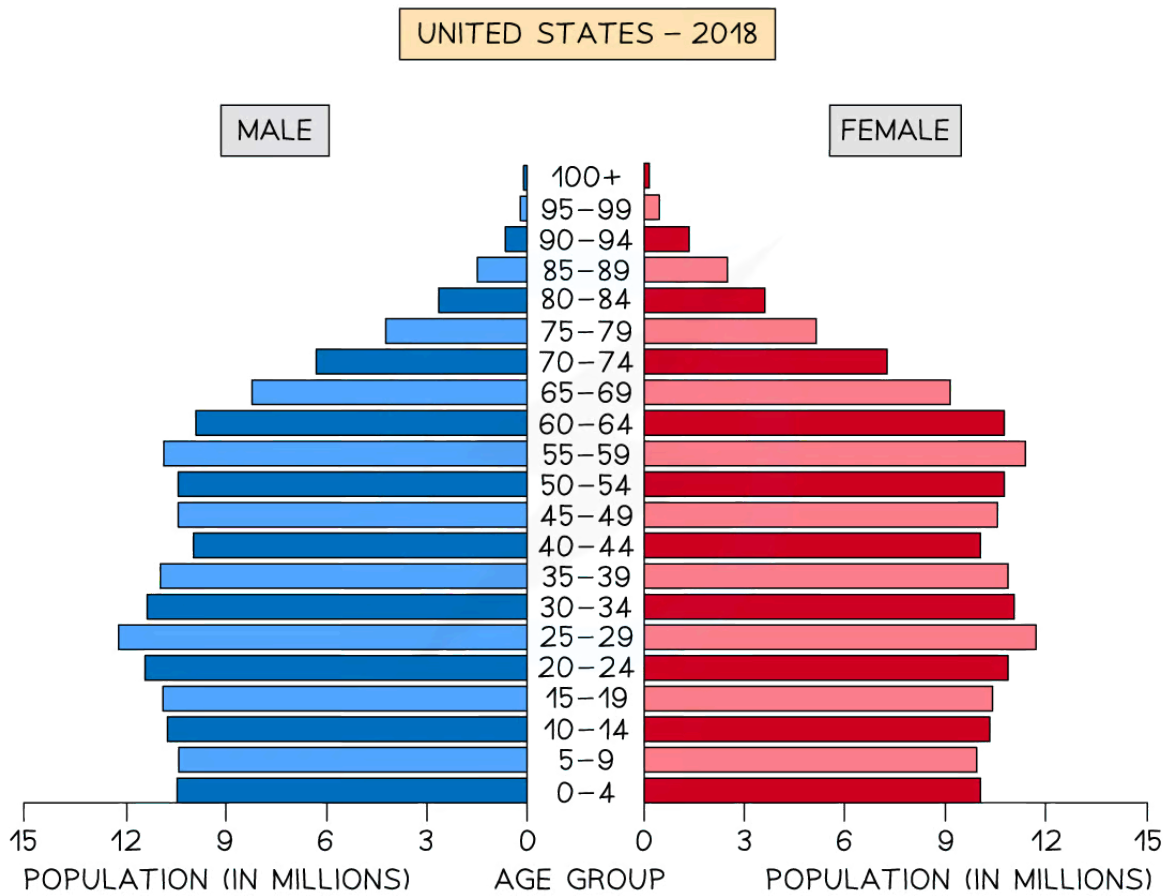


**Age-sex pyramid for Nepal**

- **More developed LICs** like Nepal typically have a pyramid shape with a taller base, like the one shown above
- This indicates:
  - Decreasing birth rate
  - Increasing life expectancy
  - Decreasing death rate
  - Decreasing infant mortality
  - Decreasing young dependents and increasing economically active population



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**Age-sex pyramid for USA**

- **High-income countries** (HICs) such as the USA typically have a column shape
- This indicates:
  - Low birth rate
  - High life expectancy
  - Low death rate
  - Low infant mortality
  - Large working age population



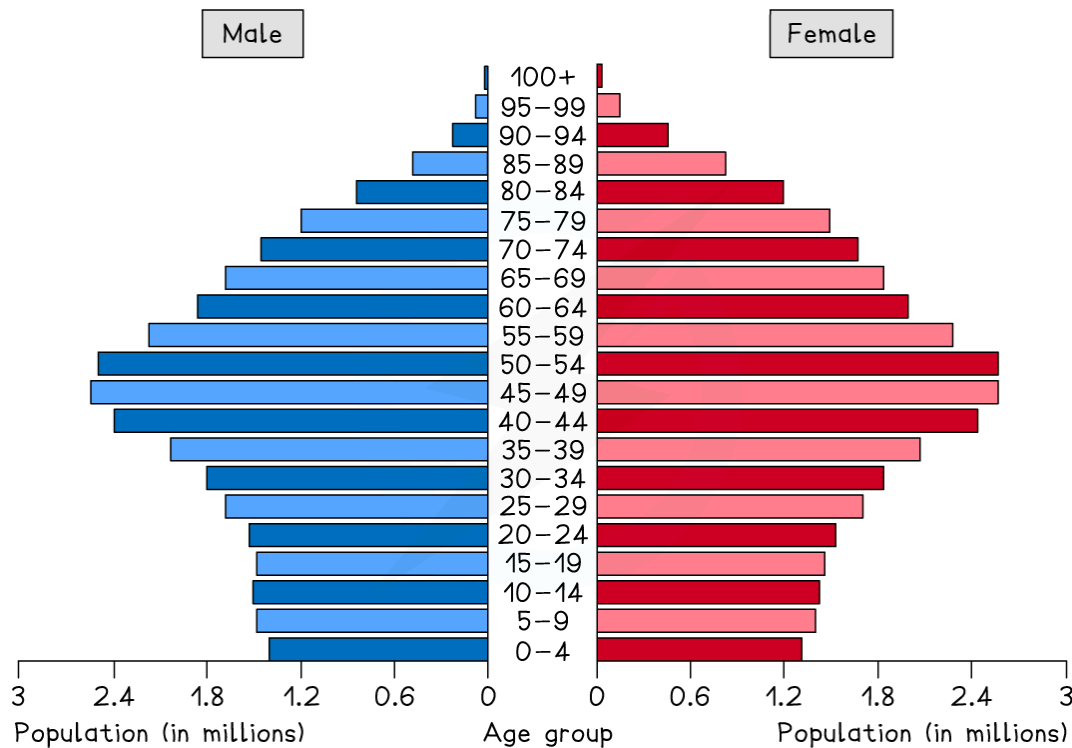


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## Worked Example

An age–sex pyramid is shown below.

What does the shape of the pyramid tell you about the population structure of the country?



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## Answer

- The narrow base means a low birth rate
- A low birth rate means a low number of young dependents
- A reasonably broad top means high life expectancy
- The majority of the population is between 40 and 60
- This means there will be a large number of elderly dependents in the future



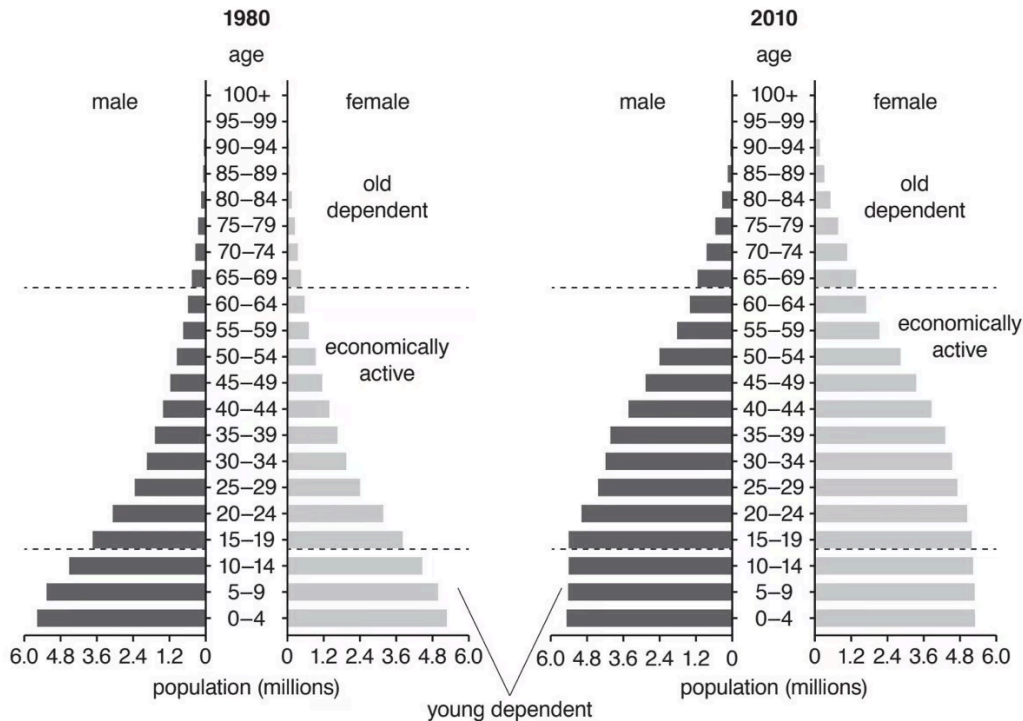
## Worked Example

The figure below shows age–sex pyramids for Mexico in 1980 and 2010.

Describe the changes in Mexico's population structure between 1980 and 2010.



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### Answer

- In 2010 there are:
  - More economically active / working / 15–64 year-olds
  - More elderly / old dependents / 65+ year-olds
  - More young dependents in total / bands up to 19 become more even



### Examiner Tips and Tricks

Remember—when interpreting an age–sex pyramid, you need to look at four key areas:

- Younger population - is the birth rate high or low?
- Working population - are there enough people of working age to support the young and old dependents?
- Elderly population - is it large or small? (if it is large, then life expectancy is high)

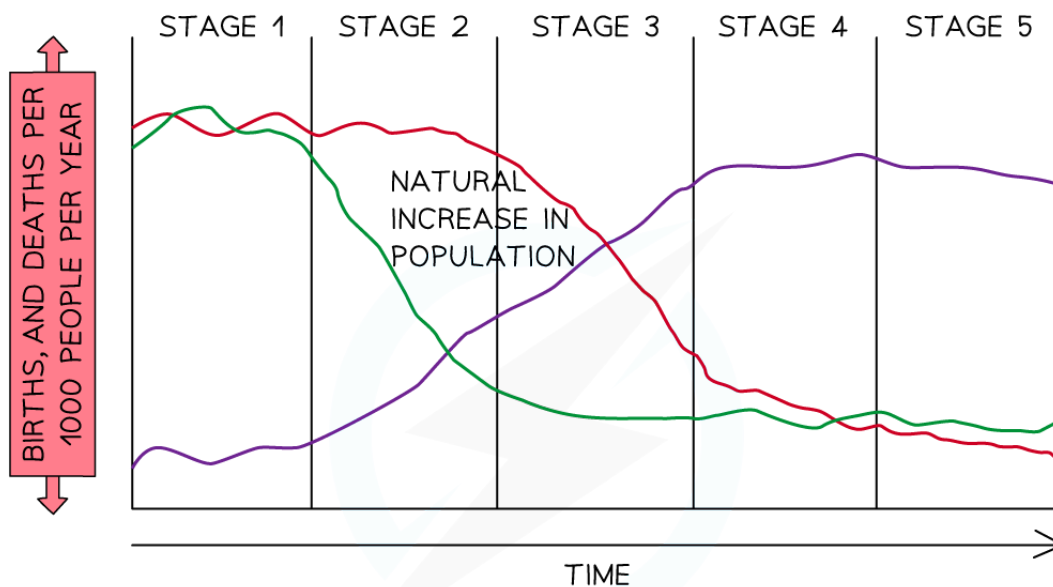


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
- Male/female split - are there any noticeable differences between the numbers of males and females?

## Demographic transition model (DTM)

- The DTM is a model that shows how a population transitions over time:
  - From a **pre-industrial stage**, with high crude birth rates and high crude death rates
  - To an **economically advanced stage**, with low or declining crude birth rates and low crude death rates
- The DTM illustrates **five generalised stages** that countries pass through as they develop
- It shows how the birth and death rates change and how this affects the overall population of the country



**KEY:**

	= TOTAL POPULATION
	= BIRTH RATE
	= DEATH RATE

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### The Demographic Transition Model



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## Stage 1

- The total population is low
- High birth rates due to lack of contraception and family planning
- High death rates due to poor healthcare, poor diet and famine
- High infant mortality, which leads people to have more children so that some children survive to adulthood

## Stage 2

- The total population starts to rise rapidly
- Birth rates remain high as people continue to have large families
- Death rates decrease as a result of improved diets, better healthcare, lower infant mortality and increased access to clean water

## Stage 3

- The total population continues to increase but the rate of growth begins to slow
- Birth rate begins to fall rapidly due to increased birth control, family planning, increased cost of raising children and low infant mortality rate
- Death rate still decreasing but at a slower rate as improvements in medicine, hygiene, diet and water quality continue

## Stage 4

- The total population is high and is increasing slowly
- Birth rate is low and fluctuating due to accessible birth control and the choice of having fewer children as well as delaying the age women start to have children
- Death rate is low and fluctuating

## Stage 5

- The total population starts to slowly decline as the death rate exceeds the birth rate
- Birth rate is low and slowly decreasing
- Death rate is low and fluctuating