Population age structures

Focus question	What is an age structure diagram? How does age structure affect population growth? Why is this important in food production?
Learning target	Students analyze graphic data to make predictions about population growth.
Vocabulary	Population age structure (population pyramid), reproductive age, malnourished, undernourished, green revolution, genetic modification

MS-LS2.A: Interdependent Relationships in Ecosystems

Performance expectation MS-LS2-1	Classroom connection: Students will determine the growth of the human population through time.

Science and engineering practices

Analyzing and Interpreting Data	Classroom connection: Human population is growing. Students analyze and interpret age structure diagrams to determine which countries have the largest potential for growth.

Disciplinary core ideas

| LS2.A: Interdependent Relationships in Ecosystems	Classroom connection: Students analyze and interpret age structure diagrams to determine if access to resources is available in the countries that have the largest potential for growth.

Cross-cutting concepts

Cause and Effect	Classroom connection: Students determine which factors contribute to higher birth rates.

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Students should work individually to complete this activity. If students are struggling, they can be paired to help each other to determine the predictive nature of the age structure diagram, but all students should be encouraged to predict growth (low, medium, high or negative) from at least one age structure.

Background

A population age structure diagram is the proportion of the population (and of each gender) at each age level. (Each level in the above graphic represents an age group in increasing order—youngest at the bottom and oldest at the top.)
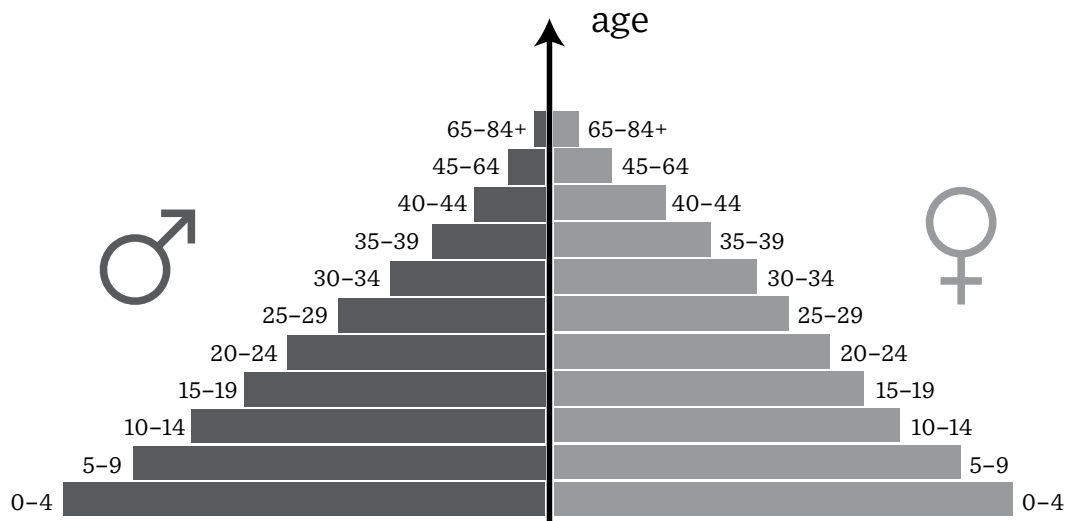
The first three levels of the pyramid encompass the pre-reproductive age group, 0–14.
The next six levels, levels four through nine, include the reproductive age group (15–44).
Above the ninth level is the post-reproductive age group (44–85+).

These diagrams help to determine how a country's population will grow. Take a look at the two structures below:
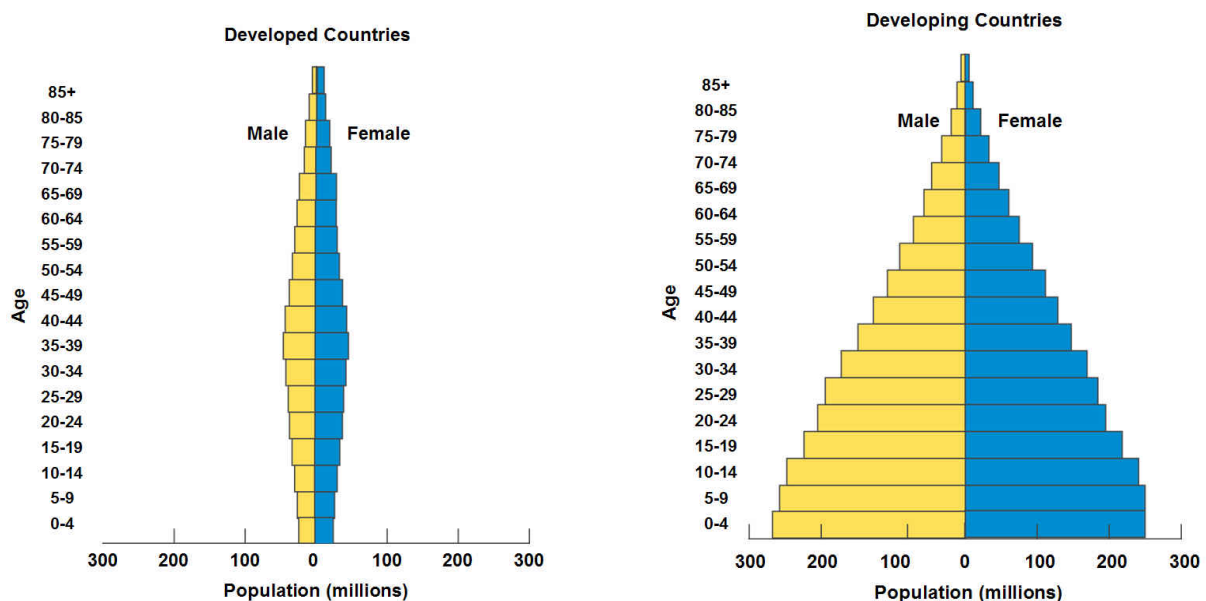
The structure on the right would indicate imminent population growth.

The percentage (or the actual number) of the population that is of reproductive age is the percentage that will be responsible for increasing population, in addition to the percentage that will be reaching reproductive age in the following years. In the diagram to the left, the reproductive population is much smaller and there are fewer children in the age categories below the reproductive age groups. As you might think, the populations of less-developed countries are increasing at a greater rate than those of developed countries. In addition, a larger number of malnourished people also live in those developing countries. Almost all the hungry people, 780 million, live in developing countries, representing 12.9 percent, or one in eight, of the population of developing countries. There are 11 million people undernourished in developed countries (FAO 2015; for individual county estimates, see Annex 1).

What are the implications of rapidly-growing populations and more malnourished people in developing countries? What might a country do to decrease population growth? What has been done (i.e. policies in China, Thailand, India)?

Possible Answers: more people in less-developed countries lead to more food insecurity, worsening health problems, more children struggling in school where education is accessible

Countries have taken various approaches to slowing population growth—China required one child for many years (1979-2015); people were penalized if they had more than one child (https://www. thoughtco.com/chinas-one-child-policy-1435466). Thailand offered birth control to their population from 1971-1992 and lowered their population growth rate from 3.2%-1.6%. (https://www.context.org/iclib/ic31/frazer/) India tried forced sterilizations in the 1970's (and still conducts sterilizations—4 million in 2013-2014) that result in many people suffering from complications related to the surgeries. (https://www.bbc.com/news/world-asia-india-30040790)

In 1798, Thomas Robert Malthus predicted that short-term gains in living standards would be undermined as human population growth outstripped food production, creating a population crash. However, we have not seen this to be the case. Over the last half-century, world population doubled while food supply tripled, even as land under cultivation grew by only 12% (FAO, 2012). Raising productivity, or getting more output from existing resources, has been driving growth in global agriculture and has proved Malthus wrong. In fact, at the global level, the long-run trend since at least 1900 has been one of increasing food abundance—in inflation-adjusted dollars, food prices fell by an average of 1% per year over the course of the 20th Century. See more at: http://www.choicesmagazine.org/choices-magazine/submitted-articles/productivity-growth-in-global-agricultureshifting-to-developing-countries#sthash.G3Uw6q0Z.dpuf

Read the three statements below:
- Agriculture employs over 1.3 billion people throughout the world, or close to 40 percent of the global workforce.
- In about 50 countries, agriculture employs half of the population, and even 75 percent in the poorer nations.
- Agriculture is the world's largest provider of jobs. `momagri.org/UK/agriculture-s-key-figures/With-close-to-40-%25-of-the-global-workforce-agriculture-is-theworld-s-largest-provider-of-jobs-_1066.html`

In light of the predictions of Malthus, the realities of food production since 1900, including the Green Revolution and new technologies which include genetic modification of various types, and precision agriculture techniques, what is your prediction about food production in the next 30 years? What strategies can we continue to use, or develop, to meet the needs of growing populations and changing demographics?

Possible Answers: food production will get more efficient; there is a movement in developed countries to go back to smaller-scale farming and locally-sourced food; economies of scale may be applied to developing countries as they are in developed countries; Infrastructure needs to be improved; distribution networks need to be developed; vertical gardens could be employed where feasible

Additional resources

- Hans Rosling: Religion and babies
  ted.com/talks/hans_rosling_religions_and_babies
- Hans Rosling - Global Population Growth
  ted.com/talks/hans_rosling_on_global_population_growth

Student handout

Reflection

1. Looking at the countries that have the largest potential for population growth, what are the causes of their large population growth?

Possible Answers: more people in the reproductive age groups, lack of education of women, infant and child mortality, lack of access to contraception

2. Are these causes related to resource availability?

Possible Answers: Yes, resources including health care, education, technology, etc.

3. What are the ecosystem limits?

Possible Answers: We may not know until it is too late (Collapse by Jared Diamond: "Twilight at Easter"); it is difficult to predict because we have not exceeded the limits but we can see the signs of overgrazing, soil salinization, desertification.

4. What can humans do to address those limitations?

Possible Answers: technology that allows for growing food in non-native environments; genetic modification; precision farming methods that help to lessen the impact on ecosystems while still growing food

Differentiation

Other ways to connect with students with various needs:
- **Local community:** Students may investigate the population age structures in their town, city, state or home country (U.S.: `census.gov` Access Local Data).
- **Students with special needs (language/reading):** Structures may be increased in size for easier determination of numbers in each age group.
- **Extra support:** Video: `youtu.be/RLmKfXwWQtE` Population pyramids: Powerful predictors of the future - Kim Preshoff This video helps to combine this lesson and the following one on Demographic Transition. There is also a lesson plan here: `ed.ted.com/lessons/population-pyramids-powerful-predictors-of-the-future-kim-preshoff`
- **Extensions:** Students can research previous events that have affected the population changes (i.e. World War II, changing cultural norms in a country, etc.).

Assessments

How well do age structure diagrams predict growth of populations within countries? Are there other models that would work as well or better? What factors do age structure diagrams take into account? Are these factors always going to be predictive of population growth?

Rubric for assessment

Skill	Beginning	Satisfactory	Exemplar
Use mathematical representations (population age structures) to identify and predict changes over time in the numbers of humans within the countries.	Unable to read and interpret the mathematical representation (age structure diagram)	Able to read, analyze and interpret the meaning of an age structure diagram; ability to predict population growth	Able to read, analyze and interpret the meaning of the diagram; ability to make prediction from the diagram and identify the limitations of the predictive ability.

Rubric for self-assessment

Skill	Yes	No
I can read an age structure diagram.		
I can predict human population growth using an age structure diagram.		
I can list the limitations of an age structure diagram to predict human population growth		