INVESTIGATION

22

Population Distribution *and* Survivorship

Lab

PURPOSE

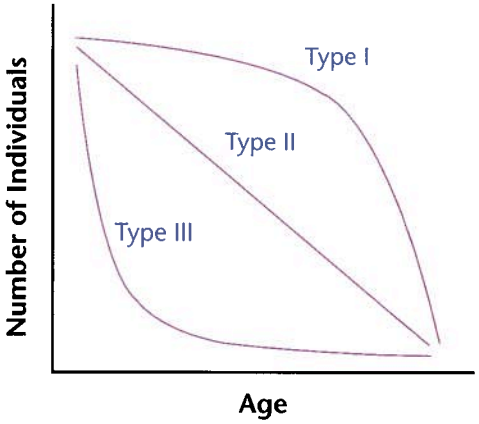
- Collect data to develop survivorship curves and age-sex population pyramids
- Predict characteristics of future populations based on sex, age, fertility, species life cycle, and other factors

INTRODUCTION

Most individuals do not reach the maximum life span of their species, and many die prematurely. The ratio of age at death to the surviving portion of a population is a function of the species and, for human populations, also of the historical period and its socio-economic conditions. A **survivorship curve** shows the probability that an individual of a particular species, age, and gender will survive to a certain age.

Fig. 22-1

Survivorship curves show variations in the relation between the age group in a population and its rate of survivorship. A Type I curve reflects most individuals surviving to maturity and beyond, while Type III curves describe very high early-life mortality followed by a steadying rate of survival.



In Part 1 of this lab you will organize actuarial data to produce survivorship curves. A survivorship curve is normally generated by plotting the logarithm of the fraction of individuals surviving against the age of the individual. In your relatively small study, logarithms will not need to be computed. It is possible and often useful to compare the survivorship of different species by

stretching or shrinking the *x*-axis so that two or more curves end at the same point, the maximum lifespan for the species. In this lab you will graph and compare the two genders of human populations, choosing one of three possible data collection methods.

In Part 2 of the lab, you will go on to make age-sex diagrams from the same data. This kind of graphing tool is useful to ecologists in predicting the trends of population growth over time.

Materials

- newspaper obituaries *or*
- cemetery access *or*
- Internet access

Optional:

- archives of 19th-century newspapers
- access to a cemetery dating to the 19th century

PART I: Producing a Human Survivorship Curve

Procedures

Method 1: Newspaper Data You will collect data on age of death from obituaries in a local newspaper. Since at least 300 individual obituaries will be needed for a proper distribution, you may start collecting a month or two before organizing the statistics and carrying out the investigation, depending on the size of the circulation area of your local newspaper. Low population areas will have fewer deaths and therefore take much longer to supply data. (Alternatively, you could collect the data by going to the web page of a newspaper covering a larger population region in your state.)

Step 1 From each obituary, record the age at death and sex:

Individual 1: Age at death _____ Sex _____

Individual 2: Age at death _____ Sex _____

Individual 3: *and so on . . .*

To save time and develop a larger sample, the data may be organized by several groups working independently. The information can be accumulated on a single data table for the class and then entered in a spreadsheet.

Step 2 Construct a table that breaks the data into age categories of five-year intervals: 0–4.9, 5–9.9, 10–14.9, etc. Follow that pattern to include the oldest individuals you find. Set up the data table to record, for each sex and age category, **Number of Deaths**, **Total Surviving** to the next age group, and **Mortality Rate**. A chart like that below gives space to record raw data and enter necessary calculations.

Fig. 22-2: Survivorship Data Table

	MALE			FEMALE		
AGE	Number of Deaths	Total Surviving	Mortality Rate	Number of Deaths	Total Surviving	Mortality Rate
20.0+						
15–19.9						
10–14.9						
5–9.9						
0–4.9						
	TOTAL			TOTAL		

Step 3 For each sex, calculate the total number of deaths you recorded.

Step 4 To calculate the **Total Surviving** for the first age group, subtract the number of deaths for 0–4.9 years from the total number of deaths for that sex. For the next higher age group, subtract the number of deaths from the number of survivors of the first age group. Continue this pattern until the number of survivors drops to zero. Do this for all the males and then for all the females.

Step 5 To calculate the **Mortality Rate** for each age group in each sex, divide the number of deaths by the total number of individuals of that sex. Note that the rate rises for the older age groups.

Step 6 Develop a survivor curve by first setting the axes: age groups on the *x*-axis and the mortality rates on the *y*-axis. (*Lab Hints:* Set your scales to spread over most of the graph paper. Also, since male and female data will be plotted on the same set of coordinates, the scales must allow for all data from both data sets.)

Step 7 Plot your data for age vs. mortality. Use separate lines of different colors and different point protectors for males and females.

Step 8 **Extension (optional)** Collect data from newspaper archives for obituaries in the 19th century. Repeat the above procedure, then compare the two curves.

Method 2: Cemetery Data This method requires permission to use a cemetery to collect data from headstones. It also requires that respect for the gravesites always be shown. Your class will need information from at least 300 stones. Because cemeteries usually fill up section by section, based on the years that deaths occur, it is important to sample a large enough area to get a representative sample. An advantage of choosing an old cemetery is that you can collect two data sets from different centuries and compare the two curves.

Step 1 Working in pairs, find the following data: year of birth, year of death, and sex. Calculate age by subtracting birth year from death year and record age and sex.

Individual 1: Age at death _____ Sex _____

Individual 2: Age at death _____ Sex _____

Individual 3: *and so on . . .*

To save time and develop a larger sample, the data may be organized by several groups working independently. The information can be accumulated on a single data table for the class and then entered in a spreadsheet.

Step 2 Construct a table that breaks the data into age categories of five-year intervals: 0–4.9, 5–9.9, 10–14.9, etc. Follow that pattern to include the oldest individuals you find. Set up the data table to record, for each sex and age category, the **Number of Deaths, Total Surviving** to the next age group, and **Mortality Rate**. (A chart like that given in **Fig. 22–2** gives space to record raw data and enter necessary calculations.)

Step 3 Calculate the total number of males and females in your class data set.

Step 4 To calculate the **Total Surviving** for the first age group, subtract the number of deaths for 0–4.9 years from the total number of deaths for that sex. For the next higher age group, subtract the number of deaths from the number of survivors of the first age group. Continue this pattern until the number of survivors drops to zero. Do this for all the males and then for all the females.

Step 5 To calculate the **Mortality Rate** for each age group in each sex, divide the number of deaths by the total number of individuals of that sex.

Step 6 Develop a survivorship curve by first setting the axes: age groups on the *x*-axis and the mortality rates on the *y*-axis. (*Lab Hints:* Set your scales to spread over most of the graph paper. Also, since male and female data will be plotted on the same set of coordinates, the scales must allow for all data from both data sets.)

Step 7 Plot your data for age vs. mortality. Use separate lines of different colors and different point protectors for males and females.

Step 8 **Extension (optional)** Collect data from grave markers for people who died in the nineteenth century and repeat the above procedure. Then compare the two curves.

Method 3: Internet Data If it is not feasible to collect obituary data or to visit a cemetery, then you can gather the required data from a number of Internet Web sites. Consider these:

- The USGenWeb Project, maintained by a volunteer group for genealogy research: http://www.rootsweb.com/~usgenweb
  The Web site has cemetery data broken down by state. From there you can search for information closer to home.

- This page is also broken down by state and includes National Cemeteries: http://www.interment.net/us/index.htm
  The main Web site has records from 7,500 cemeteries around the world. It would be a good twin project to compare survivorship curves from around the world. If interested, discuss pursuing this variation in the lab with your teacher.
- Conduct an Internet search using Google or another search engine and find your own Web sites of data, of which there are many thousands. Some sites will have the information already organized in tabular form, saving some work on your part and allowing for larger or additional samples.

Step 1 Go to the Web site you selected and record age at death and sex for at least 300 individuals, about one-half male and one-half female.

Step 2 Construct a table that breaks the data into age categories of five-year intervals: 0–4.9, 5–9.9, 10–14.9, etc. Follow that pattern to include the oldest individuals you find. Set up the data table to record, for each sex and age category, the **Number of Deaths, Total Surviving** to the next age group, and **Mortality Rate**. (A chart like that given in **Fig. 22–2** allows space to record raw data and enter necessary calculations.)

Step 3 Calculate the total number of males and females in your class data set.

Step 4 To calculate the **Total Surviving** for the first age group, subtract the number of deaths for 0–4.9 years from the total number of deaths for that sex. For the next higher age group, subtract the number of deaths from the number of survivors of the first age group. Continue this pattern until the number of survivors drops to zero. Do this for all the males and then for all the females.

Step 5 To calculate the **Mortality Rate** for each age group in each sex, divide the number of deaths by the total number of individuals of that sex.

Step 6 Develop a survivorship curve by first setting the axes: age groups on the *x*-axis and the mortality rates on the *y*-axis.
(*Lab Hints*: Set your scales to spread over most of the graph paper. Also, since male and female data will be plotted on the same set of coordinates, the scales must allow for all data from both data sets.)

Step 7 Plot your data for age vs. mortality. Use separate lines of different colors and different point protectors for males and females.

Step 8 **Extension (optional)** Many Web sites have data for the nineteenth century. Use this information to plot similar curves for populations from those times. Then compare the curves.

Questions

1. Compare the survivorship curves for males against those for females.

   a. Explain the differences and why they occur.

   b. Give details of possible biological and social/historical causes. For example, evolutionary theory implies that females in the child-bearing years suffer higher mortality from childbirth deaths. How and in what periods do your data reflect this tendency?

   c. Describe changes in mortality for males as a result of wars.

2. Analyze and compare the mortality rates for the older age groups.

   a. In general, why should these rates be higher than the average?

   b. If you did not make a survivor curve for a nineteenth-century population, predict how it would differ in three ways from the more recent population data you did plot.

c. If you did plot an additional curve from the nineteenth century, describe and explain how it differs in three ways from the other one you plotted.

3a. How would the survivorship curves of a developed country compare to those of a less developed one?

b. How could survivorship curves be used to make judgments about environmental and health conditions in each of the countries?

4. Humans are generally classified as forming a Type I survivor curve.

a. What does this fact imply for humans?

b. Name some other organisms that are generally Type I.

c. What are the distinguishing characteristics of Type I organisms?

Questions

5a. What does it mean to have a Type II survivorship curve?

b. Give two examples of organisms that are generally Type II.

c. Describe how an organism could show characteristics of both Type I and Type II as a reaction to environmental conditions.

6a. What does it mean to have a Type III survivorship curve?

b. Give two examples of organisms that are generally Type III.

c. Describe how an organism could show characteristics of both Type II and Type III as a reaction to environmental conditions.

Questions

7. If necessary, review the meaning of the terms ***r-strategist*** and ***K-strategist***.

a. How are the life cycles of these strategists different?

b. Describe what type of survivorship curves the two should have. Why?

c. Why do we use the symbols "r" and "K" for these strategies?

d. Briefly describe an experiment to determine whether an organism is an r- or a K-strategist.

e. Describe how plants are categorized. How can some be K-strategists? Give an example.

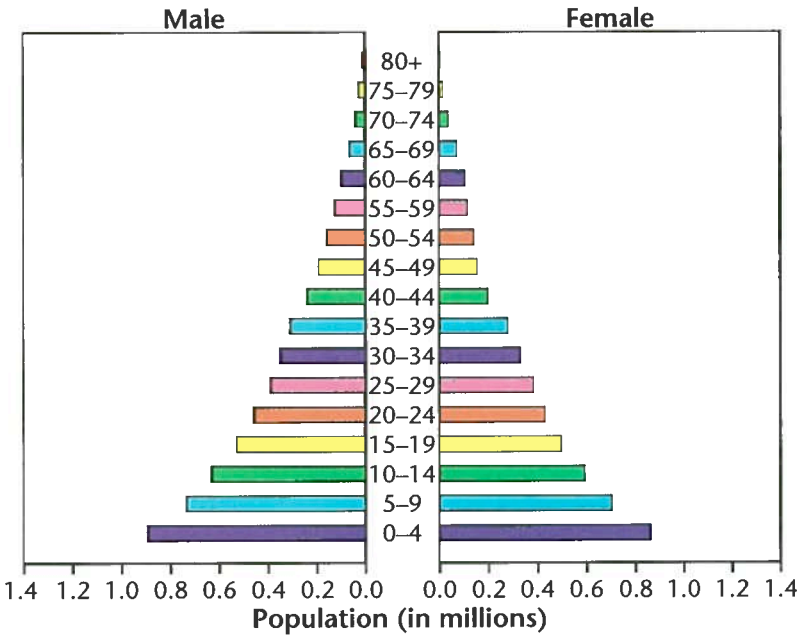
Questions

PART 2: Producing Age-Sex Diagrams

Population pyramids, or **age-sex diagrams**, illustrate the number of people of each sex in a specific five-year age group that are living at a given date. They plot, in bar graph form, the number of males and females in each age group for the total population. Population pyramids are an important model in predicting the future growth of a population. (If you have not carried out Investigation 21, on Global Population Trends, you may wish to review it now for further experience with population pyramid models.)

Fig. 22-3

The overall shape of the bars in an age-sex diagram gives you an image of whether a population is growing, shrinking, or stable at a particular point in time.



At this point in the investigation you will use the actuarial figures from your survivorship research to draw a population pyramid.

Procedure

Step 1 Using your data table from Part 1, take the number of male and female survivors for each age group. This value represents the number of males and females alive in that age group.

Step 2 Age-sex diagrams have a horizontal axis that plots males on the left side and females on the right side. The vertical axis, with age brackets, normally rises between, although it may be easier to place the scale on the far left. Scale the vertical axis to include all the 5-year age groups for which you collected data in Part 1.

Step 3 Plan the scale of your horizontal axis to match the population data you collected, then plot the data. This scale may represent either the percent of the total population in each group or, as you will give in this case, the absolute population count of the group.

Step 4 The data are plotted out from the middle as a bar graph, one bar per group, as seen in **Fig. 22–3**. You may wish to use color to better distinguish the groups.

1. What pattern of growth does your population pyramid for the more recent data suggest for the future? What evidence makes you formulate that prediction?

2. Analyze how your population pyramid would change in shape if the government built a large military base in the community.

   a. Which age groups would you expect to change the most? Explain.

   b. Describe two economic impacts the base would have.

   c. Give two examples of stress on the local environment.

3. Analyze how the pyramid for a large retirement village would look compared to your pyramid.

   a. What would the differences be? Explain.

Questions

b. Draw what you think the retirement village diagram would look like.

c. How would that retirement population change over time?

d. How would the birth rate and death rate compare to those of your sample?

e. Explain how such a population could remain constant over long periods of time.

Questions

4. How would an increase in the fertility rate alter the shape of your pyramid? Why?

5a. Draw a typical population pyramid for a developed country, a developing country, and an underdeveloped country.

b. Describe what type of population change each country could expect over the next 25 years.

c. Explain what the expected quality of life would be in each of those countries if they grew as predicted.

Questions

6a. Analyzing the pyramid given in **Fig. 22–3**, predict what will happen to the population of that country over the next 25 years if current trends continue.

b. Why will it change that way?

c. Explain in simple terms if you think such a trend could continue indefinitely.

d. Is this country an economically developed one? Why or why not?

e. What would you predict about this country's use of nonrenewable resources? Why do you postulate that?

f. Comment on the likely situation for employment and education of women in that country.

Questions