

The Great Inca Rebellion

Note: This program contains recreations of violent battle scenes between the Inca and the Spanish conquistadors. Please preview it to determine its appropriateness for your classroom.

PROGRAM OVERVIEW

NOVA investigates skeletal evidence that reveals a new story of the Spanish conquest of the Inca and rewrites the history laid down by the Spanish conquistadors.

The program:

- describes 21st century Lima, a bustling city of about 9 million people, beneath which lie layers of ancient Inca gravesites.
- describes several gravesites found with bodies hastily wrapped and not placed the traditional Inca way—crouched and facing east—and skeletons that revealed marks indicating violent deaths.
- presents a skeleton named Mochito that shows particularly severe injuries.
- shows how scientists use X-rays, magnetic resonance imaging, and a scanning electron microscope to examine a wounded skull.
- explains that the official version of the conquest was a dramatic story of the Spanish conquistadors written to magnify victory.
- notes that the newfound skeletons and their injuries tell a different story, including the fact that of seventy skulls examined, only three show signs of individuals being killed by the Spanish.
- introduces historical research and forensic evidence revealing a different and more accurate account of the battle between the Inca and conquistadors.
- states that for the Andean Indians to agree to assist the Spanish warriors, the Spanish probably made false promises of freedom and land but later denied the Inca all of this.
- recreates some of the battles between the Inca and the conquistadors based on what was learned from forensic and historical research, including the final battle that Mochito participated in.



BEFORE WATCHING

- 1 Make a time line of Inca civilization on the board. Have students research and plot when Inca civilization began, when it peaked, and when it fell. Then, have students find and post (above the Inca time line) information about what was going on in Europe and Asia during that time period.
- 2 Organize students into four groups. As they watch the program, have one group take notes on the how the Spanish chronicles portrayed the conquistadors overthrowing the Inca quickly and easily; a second group take notes on the types of evidence used to support or contradict the Spanish record of events; a third group take notes on a new hypothesis of the conquest that emerged; and a fourth group take notes on the techniques that each profiled expert used to obtain evidence.

AFTER WATCHING

- 1 Have students review their notes and discuss as a class how the conquistadors defeated the Inca. What did the conquistadors claim happened? How did that account change with new evidence? Which piece(s) of evidence were most compelling? Why? How confident are students in the new hypothesis?
- 2 Make a two-column chart on the board. In the first column, have students list the different careers of the experts in the program. (*These include archeologists, historians, forensic experts, and a biological anthropologist.*) In the second column, have students provide information about the evidence each expert worked with. How did the scientists work together to contribute to the new hypothesis of how the Inca were conquered?

Taping rights: Can be used up to one year after program is recorded off the air.

CLASSROOM ACTIVITY

Activity Summary

Students analyze actual data from two prehistoric communities—a hunting community and an agricultural community—to infer the impacts of diet on health.

Materials for Each Home Team

- copy of “The Tale Bones Tell” student handout
- copy of “The Two Communities” student handout

Materials for Each Expert Team Member

- copy of the “Community Demographics” student handout (Team I)
- copy of the “Skull: Porotic Changes” student handout (Team II)
- copy of the “Bones: Osteoporosis” student handout (Team III)
- copy of the “Bones: Growth Arrest Lines” student handout (Team III)
- copy of the “Teeth: Enamel Hypoplasia” student handout (Team IV)
- copy of the “Teeth: Cavities” student handout (2 pages) (Team V)

Background

Anthropologists can learn a lot about a population from the skeletal remains of its members. Skeletal analysis can provide insight to how community members lived, including the conditions they may have lived under, what the state of their health was, what contributed to their deaths, and how old they were when they died. While skeletons cannot reveal everything about the health of their former inhabitants, they can offer many clues to what people ate and some of the diseases they suffered from. A collection of skeletons can shed light on health trends and a community’s mortality patterns.

This activity provides data from prehistoric skeletal remains found at two sites in the American Midwest. Both sites are located in Kentucky and the skeletons are separated in time by about 4,000 years. The Indian Knoll skeletons belonged to members of a hunter-gatherer group who lived prior to the advent of farming in a community dated between 3300 B.C. and 2000 B.C. The site was located at the confluence of what are now called the Green and Ohio rivers in McHenry, Kentucky. The Hardin Village skeletons belonged to members of a farming community believed to have occupied their site between A.D. 1500 and A.D. 1675. The Hardin Village site was located in Eastern Kentucky. Claire Cassidy, a physical anthropologist, carefully analyzed the skeletons to determine age, sex, and evidence of pathologies.

In this activity, students will analyze actual archeological data to compare the health of hunter-gatherers to that of farmers. They will then draw inferences about the impacts of diet on health of the two communities.

LEARNING OBJECTIVES

Students will be able to:

- interpret data from skeletons of two prehistoric communities.
- draw conclusions about the health of community members based on the data.

STANDARDS CONNECTION

“The Tale Bones Tell” activity aligns with the following National Science Education Standards (see books.nap.edu/html/nses).

GRADES 5–8

History and Nature of Science

- Nature of science

GRADES 9–12

History and Nature of Science

- Nature of scientific knowledge

*Video is not required
for this activity.*

Classroom Activity Author

An archaeologist, Dr. Wilma Wetterstrom has done fieldwork in Egypt, Syria, Spain, Madagascar, and the United States. Currently an associate of the Harvard University Herbaria, she taught at MIT for nine years and has also taught at Brandeis University and Harvard University Extension School.

CLASSROOM ACTIVITY (CONT.)

Procedure

- 1 Ask students to list some of the things they think that skeletal remains can tell us about a person. (*Students may suggest gender, age, when the person lived, and how the person may have died.*)
- 2 Tell students that they will be analyzing data from real skeletons found in Kentucky. These skeletons represent people who lived more than 1,500 years ago. Students will be looking at data about different aspects of these people and making inferences about their health.
- 3 Have students locate the general area where the skeletons were found on a U.S. map and create a time line that indicates when each of the sites were inhabited and what else was going on worldwide at that time (see Background for locations and dates).
- 4 Use a jigsaw grouping for this activity. In this cooperative learning method students will first be organized into Home Teams. Each member of a Home Team will be assigned to a particular Expert Team. Home Team students will reorganize into Expert Teams to learn information that they will teach the members of their Home Teams when they return there.
- 5 Organize students into their Home Teams in groups of five and distribute the two Home Team handouts listed in the materials section. Review the activity with students. Have each team read the information about the two communities. Once all students are done, create a two-column graph on the board that lists each community and each of the foods they relied on. As a class, identify the main food groups that each of the foods belongs to (see *Activity Answer* on page 5 for this list).
- 6 Assign Expert Team assignments to each Home Team member (I–V) and then have students reorganize into their Expert Teams.
- 7 Distribute the handouts for each Expert Team to each team member (note that Team III has two handouts and that the handout for Team V is two pages). Have students work in their Expert Teams to review, graph, and analyze the data on their handouts and answer the questions listed with each data set.
- 8 After students have completed reviewing all the data in their Expert Teams, have them return to their Home Teams. Have the “experts” report their findings to other members of their Home Team.
- 9 Summarize on the board what students learned from the data sets. Some questions to consider are:
 - How would students rate the health of the two groups?
 - What could students infer about the nature and quality of the diet of the Indian Knollers vs. the Hardin Villagers? Which might be more nutritionally balanced? Why?
 - From their analysis, can students draw any conclusions about the possible positive and negative impacts each type of diet had on the health of each community?

ADDITIONAL IMAGES

The following sites include photos, illustrations, and radiographs of some of the pathologies students are studying:

Skull Porosity

plaza.uff.edu/maurihoo/paleopathology.html

Osteoporosis

www.nof.org/osteoporosis/bonehealth.htm

nihseniorhealth.gov/osteoporosis/whatisosteoporosis/normalvsosteopopup.html

www.nlm.nih.gov/medlineplus/ency/imagepages/17156.htm

Enamel Hypoplasia

bioanthropology.huji.ac.il/knowledgebase.asp

researchnews.osu.edu/archive/neanderpics.htm

CLASSROOM ACTIVITY (CONT.)

- How much confidence do students have in their conclusions? Do they feel that the percentage of skeletons studied was sufficient to draw conclusions about the community?
- What additional data would they like to have to increase their confidence in their conclusions?

(See *Activity Answer* on page 5 for more information.)

- 10** To conclude, discuss any other interpretations students had regarding the data. Some questions to consider include:
- Were there any data that students had questions about?
 - Were there any trends or patterns that students could not explain?
 - Which data sets were more difficult to interpret? Why? What additional information would students need to be able to draw better conclusions?
 - When did the data not support the overall conclusions?
 - What might influence a scientist's interpretation of a particular set of data?
 - What would be the best way to resolve differences in opinions?
- 11** Discuss with students the nature of scientific endeavor and how it encourages scientists to evaluate each other's work and do additional studies to support or refute previous research and conclusions.
- 12** As an extension, have students prepare a news report for the people of Hardin Village. In the report ask students to contrast the Hardin Villagers health with that of their hunting and gathering ancestors at Indian Knoll.

ACTIVITY ANSWER

Food Sources

Indian Knoll		Hardin Village	
Food	Main Food Group	Food	Main Food Group
deer	protein	corn (main food source)	carbohydrate
raccoon	protein	beans	carbohydrate
beaver	protein	nuts	protein
muskrat	protein	deer	protein
otter	protein	elk	protein
wild turkey	protein	raccoon	protein
box turtle	protein	fox	protein
fish	protein	wild turkey	protein
mussels (seasonal)	protein	fish	protein
nuts	protein		
wild fruits	carbohydrate		
roots, bulbs, shoots	carbohydrate		

Key Question

What do these skeletal remains reveal about the nutritional health of each community?

These data sets reveal that the health of the Hardin Villagers (who relied mostly on a carbohydrate diet) was poor in comparison to the health of Indian Knoll community members (who relied on a mixed diet of protein and carbohydrates).

The Hardin Villagers may have eaten less protein because of depleted game supplies due to hunting. Since farming supports higher densities of population than hunting and gathering, there likely would have been more people hunting—and eating—the same amount of fish and game. In addition, farmers are less mobile and less able to extend their hunting range during the time they are producing agricultural crops.

The skeletons in the Hardin Village community members showed higher incidences of osteoporosis, enamel hypoplasia, and cavities, all disease pathologies that can result from a nutritionally poor diet that leaves members more susceptible to infection and death. Although the Indian Knoll skeletons showed a higher incidence of porotic changes, they were mild and did not likely impact the health of community members. Though less frequently occurring, the severe porotic changes seen in the Hardin Villagers likely impacted their lifespan.

The Indian Knoll skeletons showed a higher incidence of growth arrest lines, possibly due to the fact that they suffered from seasonal food shortages during times when meat and plants were scarce. However, while agricultural practices allowed communities to better store food, agricultural communities may have suffered from diets that lacked the nutritional balance necessary for good health.

ACTIVITY ANSWER (CONT.)

You may want to note to students that while this data reveals information about what affected some of the community members, scientists don't have the complete picture of these communities. Since not all food leaves an archeological record, scientists don't know what else community members may have eaten. They also don't know whether other pathologies not evident in the skeletons may have contributed to sickness and death. Studying a larger number of skeletons could increase their knowledge base and confidence in their conclusions.

Students may draw different conclusions from the data. This is true among working archeologists as well. Accept all reasonable answers.

Community Demographics

Student Handout Questions: Children Demographics

- 1 What percentage of the population in Indian Knoll died before the age of 17? *44.6 percent*
- 2 What percentage of the population in Hardin Village died before age 17? *53.5 percent*
- 3 In what community and what age group was the highest mortality among children? *Hardin Village, children ages 1–3*
- 4 What conclusions could you draw from this data and the information you have been given? *Hardin Village had a higher rate of death among children. The high mortality rate of children between ages 1–3 in Hardin Village may have been because they did not get their nutritional requirements met, particularly protein requirements.*
- 5 Write down any other observations you have about this data set.
Answers will vary.

Community Demographics

Student Handout Questions: Adult Demographics

- 1 What do you notice about the longevity of males in the two communities? *Males lived longer in Indian Knoll than males in Hardin Village. More males in Indian Knoll die in the 40–49 age group than males in Hardin Village.*
- 2 What do you notice about the longevity of females in the two communities? *More females lived longer in Indian Knoll than in Hardin Village.*
- 3 What conclusions could you draw from this data and the information you have been given? *Male members of Hardin Village did not live as long as male members of Indian Knoll. Perhaps more young adult men (ages 40–49) in Indian Knoll died than same-aged men in Hardin Village because more of them were exposed to higher-risk activities, such as hunting.*
- 4 Write down any other observations you have about this data set.
Answers will vary.

ACTIVITY ANSWER (CONT.)

Skull: Porotic Changes

Student Handout Questions

- 1 What do you notice about the distribution of porotic changes in the skulls of the skeletons? *Indian Knoll remains reveal a large percentage of porotic changes in community members aged 12 and older.*
- 2 In what age groups were porotic skull changes most prevalent? *Ages 12–40+ in Indian Knoll and in ages 30–39 in Hardin Village.*
- 3 In which community were the porotic skull changes severe enough to impact the overall health of community members? *Hardin Village.*
- 4 What conclusions could you draw from this data and the information you have been given? *At first glance, it appears that young adult and adult members of Indian Knoll suffered more porotic damage to their skulls than their counterparts at Hardin Village. However, the data can be misleading if the severity of the changes are not taken into account. The porotic changes seen in Indian Knoll community members are considered insignificant; the changes seen in the Hardin Villagers are considered severe. The severity of porotic changes in Hardin Village community members may have been due to eating a low-protein diet, eating a diet heavy in corn, or a combination of both.*
- 5 Write down any other observations you have about this data set.
Answers will vary.

Bones: Osteoporosis

Student Handout Questions

- 1 How is osteoporosis distributed by age and sex in the two groups? *More women 40+ in both age groups exhibit osteoporosis. Osteoporosis is much higher in Hardin Village for all age ranges except 40+ females, where it is comparable with the incidence in the Indian Knoll community.*
- 2 How do young women in Indian Knoll compare with young women in Hardin Village? *Young women in Hardin Village have a much higher incidence of osteoporosis.*
- 3 What conclusions could you draw from this data and the information you have been given? *Both males and females in Hardin Village may not have gotten the nutrients they needed to ward off osteoporosis. Poor nutrition may have led to osteoporosis in young women who became so thin that their bodies stopped producing the estrogen necessary for proper bone maintenance. Osteoporosis in the 40+ group may have been age-related.*
- 4 Write down any other observations you have about this data set.
Answers will vary.

ACTIVITY ANSWER (CONT.)

Bones: Growth Arrest Lines

Student Handout Questions

- 1 The skeletons in both groups show growth arrest lines. What, if any, differences are there between the occurrences of these lines in the two populations? *Indian Knoll has a much higher incidence of growth arrest lines.*
- 2 What conclusions could you draw from this data and the information you have been given? *The fact that there are many lines suggests that members of Indian Knoll suffered multiple episodes of disease or starvation. This may have been due to the feast or famine cycle of the hunter-gatherer lifestyle. The fewer lines evident on the bones of the Hardin Village skeletons may be due to the fact that the villagers' ability to store agricultural products allowed them a steady supply of food year-round.*
- 3 Write down any other observations you have about this data set.
Answers will vary.

Teeth: Enamel Hypoplasia

Student Handout Question

- 1 How do the percentages of children with enamel hypoplasia compare between the two communities? *No children in the Indian Knoll community suffered from enamel hypoplasia. Children in the Hardin Village community ages 6–11 months and ages 1–5 years showed high rates of hypoplasia.*
- 2 What do you notice about the occurrence of hypoplasia among youths and adults at the two communities? *Among Indian Knoll skeletons, the incidence of the severe form of hypoplasia is higher for youths; the mild form is higher for youths at Hardin Village. However, more adult skeletons from Hardin Village show the severe form of hypoplasia than at Indian Knoll. The moderate form of hypoplasia is comparable across youths and adults at both communities.*
- 3 What conclusions could you draw from this data and the information you have been given? *The lack of hypoplasia in Indian Knoll children indicates that the community had relatively healthy mothers. The high rate of hypoplasia among children in Hardin Village suggests that their mothers were malnourished. The fact that more youths than adults in Indian Knoll died with severe hypoplasia could be due to the fact that they were weakened by repeated famine. Those that survived into adulthood with no hypoplasia may have had generally good nutrition or not suffered markedly from repeated exposure to malnutrition or disease.*
- 4 Write down any other observations you have about this data set.
Answers will vary.

ACTIVITY ANSWER (CONT.)

Teeth: Cavities

Student Handout Questions

- 1 What do you notice about the distribution of cavities in children?
Skeletons of Hardin Village children have a much higher incidence of cavities. Indian Knoll children show no incidence at all of cavities.
- 2 What do you notice about the frequency of total cavities between the two groups?
Members of Hardin Village show a significantly larger percentage of cavities than the Indian Knoll population. At Hardin Village, nearly half the children had cavities by age 5. More than 90 percent of adults had them. While it appears from the percentages that Indian Knoll adults suffered a high incidence of cavities (roughly half of the Indian Knoll adults had them) a closer look at the data reveals that there were very few cavities per mouth. Both children and adults had Hardin Village had a higher number of cavities per mouth.
- 3 What conclusions could you draw from this data and the information you have been given?
The high incidence and number of cavities at Hardin Village reflects a diet rich in carbohydrates and processed foods that tend to cling to teeth.
- 4 Write down any other observations you have about this data set.
Answers will vary.

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David H. Koch

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LINKS AND BOOKS

Links

NOVA—The Great Inca Rebellion

www.pbs.org/nova/inca

Presents the producer's story, describes how the Inca created such a vast empire, compares the differences between Inca and conquistador weaponry, and reveals how one bioarcheologist examined Inca finds.

The Empire of the Incas

www.millville.org/Workshops_f/Acker_Inca/inca.htm

Describes several Inca rulers and tells about the language of the Inca.

Inca

www.mnsu.edu/emuseum/prehistory/latinamerica/south/cultures/inca.html

Provides a map of Inca territory and geographical and cultural information about the Incas.

The Inca Civilization

lsa.colorado.edu/~lsa/texts/Incas.html

Includes information about Inca territory, society, and the Spanish conquest.

Books

Daily life in the Inca Empire

by Michael Andrew Malpass.
Greenwood Press, 1996.

Reconstructs the daily life of Inca people, including those outside of the ruling class.

Empire of the Inca

by Barbara A. Somervill.
Facts On File, 2005.

Presents information about the beginning of the empire, the empire at its height, and the final years of Inca rule.

The Incas

by Shirlee P. Newman.
Franklin Watts, 1992.

Describes the civilization of the Inca empire that flourished from the thirteenth to the sixteenth century and the present-day lives of the Andean people descended from that empire.

The Tale Bones Tell

Farming provided a revolutionary change in human lifestyle. Agriculture helped bring about the development of large communities and complex societies. In this activity, you will have the opportunity to assess how the shift to agriculture may have affected health.

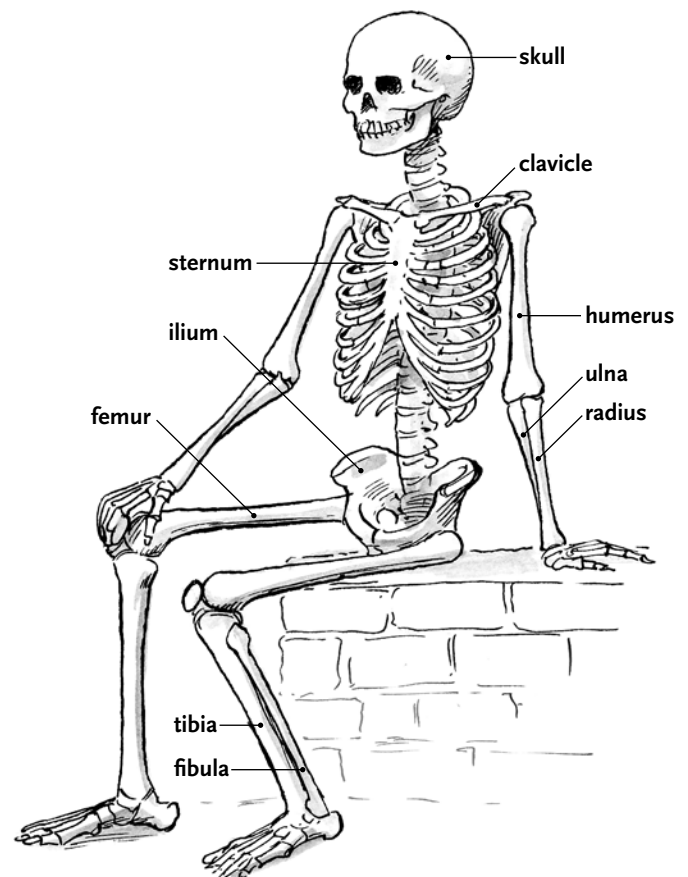
Your task is to compare the skeletal remains of two populations. Specifically, you want to determine if there are differences in the health of the two groups, especially differences that may be related to their different diets and lifestyles.

Procedure

- 1 After you have been assigned to a Home Team, read the “Two Communities” handout that provides information about each community. As a class, list and review the main foods that each community ate.
- 2 Each Home Team member will be assigned to one of the following Expert Teams:
 - Community Demographics (Team I)
 - Skull: Porotic Changes (Team II)
 - Bones: Osteoporosis and Growth Arrest Lines (Team III)
 - Teeth: Enamel Hypoplasia (Team IV)
 - Teeth: Cavities (Team V)
- 3 Your Home Team will split up and team members will reorganize into their assigned Expert Teams. Each Expert Team will be given a handout that includes data related to its topic area. Expert Team members will analyze the data together and answer the questions listed at the bottom of their handout. Team members should refer to the written information provided on each handout to help draw conclusions about the data. The key question each Home Team will be trying to answer is:

What do these skeletal remains reveal about the nutritional health of each community?

- 4 Members of each Expert Team should prepare graphs for presentation to their Home Team members. Review the data in your Expert Team to determine the most appropriate type of graph to create.
- 5 Once all Expert Teams have finished, team members will return to their original Home Teams. Each team member will prepare and share information about what was learned in his or her Expert Team, including the following:
 - description of the skeletal part(s) studied
 - nature and cause of the condition studied
 - conclusions reached about the data, including a presentation of the graphed data
- 6 After each expert has shared information, work together in your Home Team to write a short summary that answers the key question of what the skeletal remains revealed about the nutritional health of each community.



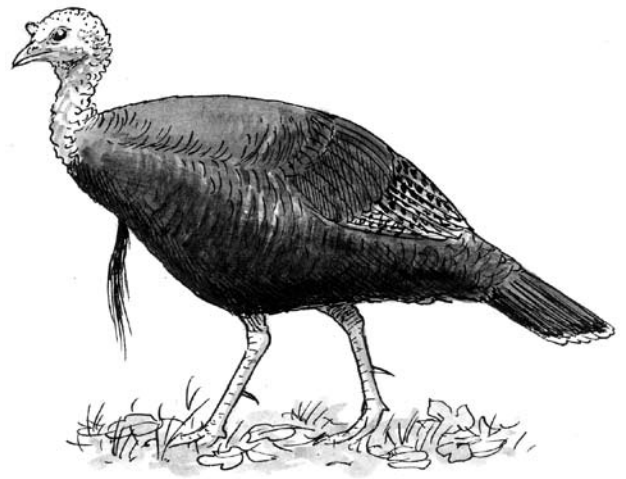
The Two Communities

The two sites in this study are Indian Knoll, located in Western Kentucky, and Hardin Village in Eastern Kentucky. The natural environments of these two areas are very similar today and probably were alike in prehistoric times as well. Four hundred and forty-five skeletons were found at Hardin Village, 296 of which were suitable for study. At Indian Knoll, 1,234 skeletons were found in or underneath the mound; a random sample of 285 was chosen for study. The data in this activity show the percentages of the population in which various pathologies were found.

Indian Knoll

Indian Knoll is a large mound, set back from the present bank of the Green River. At the time of occupation an oxbow lake or cut-off meander of the Green River bordered the Knoll and provided ideal conditions for mussel beds.

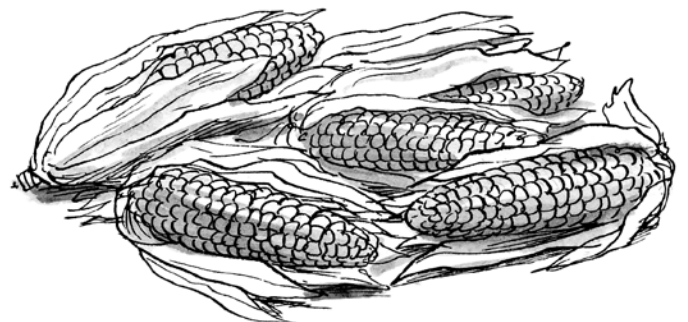
The inhabitants of Indian Knoll relied entirely on hunting and gathering for their livelihood. Local white-tailed deer, raccoon, beaver, muskrat, otter, wild turkey, box turtle, and fish provided meat. Community members also ate small mammals and large quantities of mussels during times they could be harvested. There is evidence that inhabitants



collected walnuts, acorns, hickory nuts, and wild fruits. They probably ate roots, bulbs, and shoots, but no traces of these were preserved at the archeological site. Radiocarbon dates place the occupation of Indian Knoll sometime between 3300 B.C. and 2000 B.C.

Hardin Village

The Hardin Village inhabitants were agriculturalists. Corn was likely their main source of food. They also raised some beans and gathered wild plants such as hickory nuts and black walnuts. Their mostly agricultural diet was supplemented with meat from white-tailed deer, elk, raccoon, fox, wild turkey, and fish. Although evidence of some small mammals was found, there were no indications that the Hardin Villagers ate shellfish. Carbon-14 dates indicate the site was occupied between A.D. 1500 and A.D. 1675.



Community Demographics

A high rate of deaths among newborns and infants often indicates poor care. Toddlers—children between 1 and 4 years of age—most often die from problems related to weaning, which frequently means a poor diet and infectious disease. Young children are especially vulnerable to a poor diet because their protein requirements per kilogram of body weight are higher than those of adults. Poor nutrition in children makes them especially vulnerable to infectious disease. Young children who do not get enough protein after being weaned off of their mother's milk

are more likely to die than young children whose protein requirements are met. Tables 1a and 1b show the age and gender distributions of the two populations. The number of community members listed in each age range represents the ages they were when they died.

Table 1a: Age Distribution of Children*

Ages	Indian Knoll		Hardin Village	
	Children		Children	
	# of	% of	# of	% of
Newborn	38	13.3	25	8.4
>Newborn <1 year	27	9.5	14	4.7
1–3	28	9.8	59	19.9
4–5	5	1.8	9	3.0
6–11	13	4.6	22	7.4
12–16	16	5.6	30	10.1
TOTAL	127	44.6	159	53.5

Table 1b: Age and Gender Distribution of Adults*

Ages	Indian Knoll				Hardin Village			
	Males		Females		Males		Females	
	# of	% of	# of	% of	# of	% of	# of	% of
17–19	8	2.8	13	4.6	5	1.7	5	1.7
20–24	16	5.6	14	4.9	18	6.1	21	7.1
25–29	20	7.0	10	3.5	20	6.8	14	4.7
30–39	18	6.3	13	4.6	16	5.4	21	7.1
40–49	19	6.7	14	4.9	5	1.7	9	3.0
50+	9	3.6	4	1.4	0	0	3	1.0
TOTAL	90	32.0	68	23.9	64	21.7	73	24.6

*The percentages represent what proportion of the entire population each age range represents. The combined percentages of children and adults in each community totals 100 percent of the skeletons surveyed (totals are slightly above or below 100 due to rounding errors).

Procedure

- 1 Review and graph the data.
- 2 Analyze the data for what it reveals about the health of each community.
- 3 Use the information on this page and what you have learned from the data to answer the questions listed.

Questions

Write your answers on a separate sheet of paper.

- 1 What percentage of the population in Indian Knoll died before the age of 17?
- 2 What percentage of the population in Hardin Village died before age 17?
- 3 In what community and what age group was the highest mortality among children?
- 4 What conclusions could you draw from this data and the information you have been given?
- 5 Write down any other observations you have about this data set.

Questions

Write your answers on a separate sheet of paper.

- 1 What do you notice about the longevity of males in the two communities?
- 2 What do you notice about the longevity of females in the two communities?
- 3 What conclusions could you draw from this data and the information you have been given?
- 4 Write down any other observations you have about this data set.

Skull: Porotic Changes

Porotic changes are spongy holes that appear in the normally dense bone in the top of the skull and the orbits. They are linked to iron-deficiency anemia. Rather than a sign of inadequate amounts of iron in the diet, this type of anemia can be indicative of poor absorption of iron, or heavy iron losses from the body. Diets low in protein can result in poor iron absorption.

The porotic changes seen in Indian Knoll community members were considered mild, suggesting that the changes would not have had an ill effect on the health of the Indian Knoll people. Changes seen in the skulls of the Hardin Village community members, however, were severe. These changes very likely impacted their health.

The number and percentages of skulls found with porotic changes is shown in Tables 1a and 1b.

Procedure

- 1 Review and graph the data.
- 2 Analyze the data for what it reveals about the health of each community.
- 3 Use the information on this page and what you have learned from the data to answer the questions listed.

Questions

Write your answers on a separate sheet of paper.

- 1 What do you notice about the distribution of porotic changes in the skulls of the skeletons?
- 2 In what age groups were porotic skull changes most prevalent?
- 3 In which community were the porotic skull changes severe enough to impact the overall health of community members?
- 4 What conclusions could you draw from this data and the information you have been given?
- 5 Write down any other observations you have about this data set.

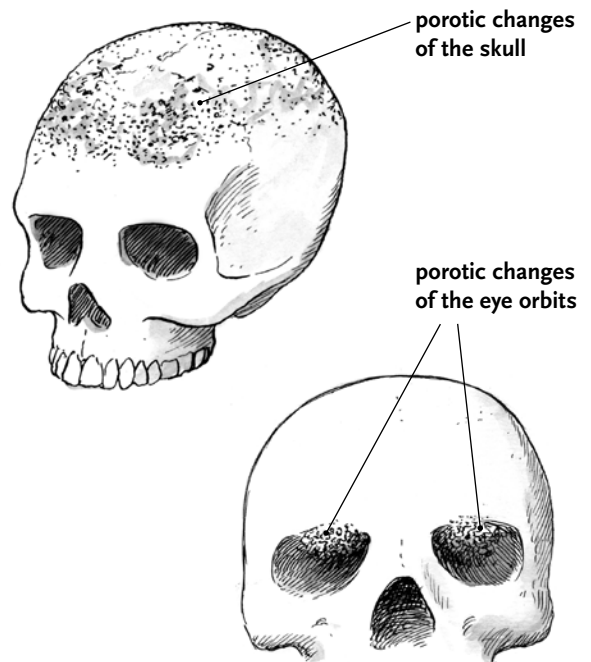


Table 1a: Porotic Changes in Children

Ages	Indian Knoll Children			Hardin Village Children		
	#w	#w/o	% with	#w	#w/o	% with
0–5	3	94	3.1	12	95	11.2
6–11	2	11	15.4	1	21	4.5
12–16	8	7	53.3	1	22	4.3

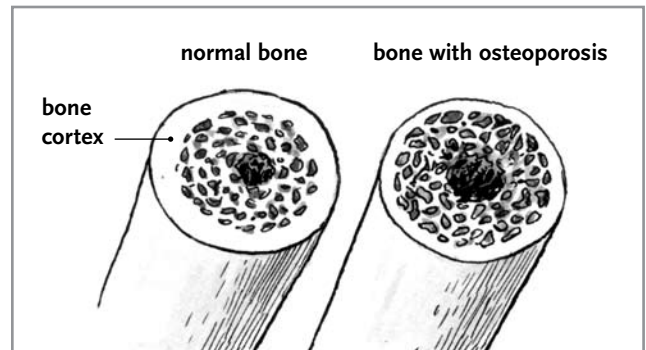
Table 1b: Porotic Changes in Adults

Ages	Indian Knoll						Hardin Village					
	Males			Females			Males			Females		
	#w	#w/o	% with	#w	#w/o	% with	#w	#w/o	% with	#w	#w/o	% with
17–29	13	13	50.0	15	13	53.6	2	25	7.4	1	25	3.9
30–39	10	9	52.6	4	6	40.0	0	19	0	3	11	21.4
40+	19	27	41.3	16	14	53.3	1	20	4.8	3	30	9.1

Bones: Osteoporosis

Osteoporosis

Osteoporosis is a severe loss of mineral from the bone. The cortex, which contains most of the bone’s minerals, becomes very thin and fractures easily. It seems to be associated with aging and with malnutrition. In modern Western populations osteoporosis is a common problem in women after menopause and in men after they reach age 60. In some societies where nutrition is poor osteoporosis is a serious problem for young women. Childbearing apparently drains the mineral reserves from their bones. In addition, young women who become very thin—to the point where their body fat drops below a certain level—stop producing the hormone estrogen that plays a role in bone turnover; these young women may later exhibit osteoporosis. Table 1 shows the number and percentages of individuals who suffered from osteoporosis.



Procedure

- 1 Review and graph the data.
- 2 Analyze the data for what it reveals about the health of each community.
- 3 Use the information on this page and what you have learned from the data to answer the questions listed.

Questions

Write your answers on a separate sheet of paper.

- 1 How is osteoporosis distributed by age and sex in the two groups?
- 2 How do young women in Indian Knoll compare with young women in Hardin Village?
- 3 What conclusions could you draw from this data and the information you have been given?
- 4 Write down any other observations you have about this data set.

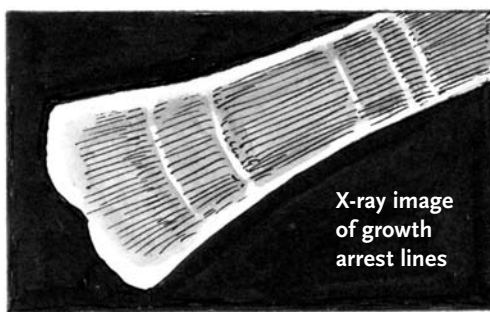
Table 1: Osteoporosis

Ages	Indian Knoll						Hardin Village					
	Males			Females			Males			Females		
	#w	#w/o	% with	#w	#w/o	% with	#w	#w/o	% with	#w	#w/o	% with
17–29	1	25	3.8	1	27	3.6	3	24	11.1	3	23	11.5
30–39	0	19	0	0	10	0	6	13	31.6	2	12	14.3
40+	5	41	10.9	16	14	53.3	7	14	33.3	16	17	48.5

Bones: Growth Arrest Lines

Growth arrest lines, also known as Harris lines, show up on X-rays of long bones as traverse lines (i.e. perpendicular to the long axis of the bone). They mark points at which the bone's growth was resumed after it had stopped; normally long bones grow continually through childhood until the ends fuse. But when the child is malnourished and the body does not have enough nutrients to go around, bones stop growing. When the crisis is over bone starts to grow again. A line forms as the bone starts to lay down mineral material again. Therefore, growth arrest lines point to short episodes of malnutrition—caused either by infection, poor diet, or starvation—followed by better conditions. An individual who is chronically ill or malnourished would probably have fewer lines than someone who suffered repeated short episodes of disease or starvation. Table 1 shows the number of growth arrest lines seen on the tibias of members of the two populations.

The Indian Knoll community relied on hunting meat and gathering fruits and nuts and other edible plants. If the Indian Knollers couldn't find food in the winter, they likely suffered seasonal food shortages. The Hardin Village community raised corn and other agricultural crops and supplemented these products with meat. Because agricultural products could be stored, the Hardin Villagers were more likely to have a regular supply of food year-round.



Procedure

- 1 Review and graph the data.
- 2 Analyze the data for what it reveals about the health of each community.
- 3 Use the information on this page and what you have learned from the data to answer the questions listed.

Table 1: Growth Arrest Lines

	Indian Knoll	Hardin Village
Average number growth arrest lines in lower leg bone (tibia)*	11.3	4.1

* Ages and sexes are combined.

Questions

Write your answers on a separate sheet of paper.

- 1 The skeletons in both groups show growth arrest lines. What, if any, differences are there between the occurrences of these lines in the two populations?
- 2 What conclusions could you draw from this data and the information you have been given?
- 3 Write down any other observations you have about this data set.

Teeth: Enamel Hypoplasia

Enamel hypoplasia is a defect that occurs when dental enamel doesn't form completely, usually because of malnutrition or disease. Enamel hypoplasia is identified as a horizontal line, a series of pits or grooves along the outer surface of the tooth. These lines mark points at which the bone's growth was resumed after it had stopped. The degree of hypoplasia is proportional to the length of time the growth was arrested. Hypoplasia does not form in individuals who are chronically ill or malnourished; it only occurs in healthy individuals.

Hypoplasia is most common in the permanent, or adult, teeth and represents episodes of arrested growth in infancy or childhood while these teeth were still developing. Once the enamel forms, it can no longer be affected.

Hypoplasia in deciduous or baby teeth is extremely rare since the fetus is usually well nourished in the womb. A case of hypoplasia in the baby teeth is generally a sign that the baby was born prematurely or was nurtured in the womb of a very sick woman. Hypoplasia in young children's teeth is usually an indication that the mother was malnourished while

pregnant or nursing. Table 1 shows the incidence of enamel hypoplasia of baby teeth, denoting episodes of growth arrest before birth and in early infancy. Table 2 shows the incidence and severity of enamel hypoplasia in permanent teeth of adults.

Procedure

- 1 Review and graph the data.
- 2 Analyze the data for what it reveals about the health of each community.
- 3 Use the information on this page and what you have learned from the data to answer the questions listed.

See tables below

Questions

Write your answers on a separate sheet of paper.

- 1 How do the percentages of children with enamel hypoplasia compare between the two communities?
- 2 What do you notice about the occurrence of hypoplasia among the youths and adults in the two communities?
- 3 What conclusions could you draw from this data and the information you have been given?
- 4 Write down any other observations you have about this data set.

Table 1: Enamel Hypoplasia in Children*

Indian Knoll			Hardin Village								
Children 6–11 months 0			Children 1–5 years 0			Children 6–11 months 16			Children 1–5 years 50		
#w	#w/o	% with	#w	#w/o	% with	#w	#w/o	% with	#w	#w/o	% with
0	0	0	0	0	0	3	13	18.8	9	41	18.0

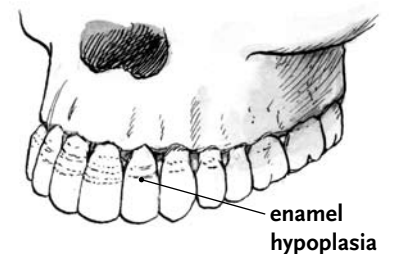


Table 2: Enamel Hypoplasia in Adults**

Degree of Hypoplasia	Indian Knoll						Hardin Village					
	Adult Males 47		Adult Females 43		Youths* 16		Adult Males 37		Adult Females 37		Youths* 23	
	N	%N	N	%N	N	%N	N	%N	N	%N	N	%N
Mild	28	59.6	23	53.5	5	31.3	14	37.8	13	35.1	12	52.2
Moderate	18	38.3	13	30.2	7	43.8	15	40.5	13	35.1	9	39.1
Severe	1	2.1	1	2.3	3	18.8	5	13.5	3	8.1	1	4.3
None	5	10.6	6	13.9	1	6.3	3	8.1	8	21.6	1	4.3

* Sexes are combined.

** %N represents what proportion of the each group (males, females, youths) exhibited each level of severity of enamel hypoplasia. For example, of all the Indian Knoll adult males who exhibited hypoplasia (47), 59.6 percent of them (28) had mild hypoplasia.

Teeth: Cavities

Caries, better known as cavities, is one of the most common diseases of the teeth. The calcified tissue becomes demineralized, resulting in a cavity. In severe cases the tooth's pulp is exposed and sometimes it becomes infected or abscessed.

The factors responsible for caries are not well understood but soft foods and carbohydrate-rich diets have been implicated. Apparently foods that stick to the teeth, particularly processed carbohydrates (like corn that has been ground and cooked), encourage certain bacteria to flourish and produce acids that break down the tooth. Tables 1a and 1b (on the second page of this handout) show the number and percentages of children, adolescents, and adults by the type of cavities they had.

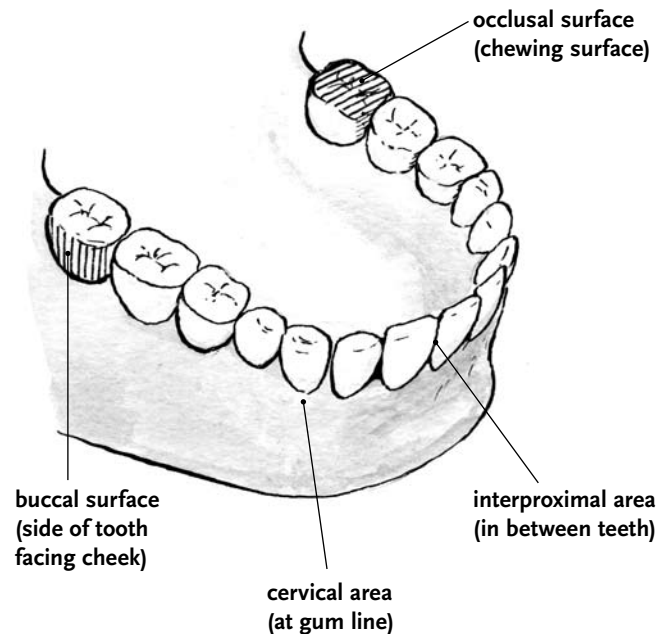
Procedure

- 1 Review and graph the data.
- 2 Analyze the data for what it reveals about the health of each community.
- 3 Use the information on this page and what you have learned from the data to answer the questions listed.

Questions

Write your answers on a separate sheet of paper.

- 1 What do you notice about the distribution of cavities in children?
- 2 What do you notice about the frequency of total cavities between the two groups?
- 3 What conclusions could you draw from this data and the information you have been given?
- 4 Write down any other observations you have about this data set.



Teeth: Cavities (cont.)

Table 1a: Frequency of Cavities in Children by Type*

	Indian Knoll								Hardin Village							
	Children 6–11 months 0				Children 1–5 years 0				Children 6–11 months 18				Children 1–5 years 59			
	#C	%C	#N ₁	% N ₁	#C	%C	#N ₁	% N ₁	#C	%C	#N ₁	% N ₁	#C	%C	#N ₁	% N ₁
Occlusal	0	0	0	0	0	0	0	0	19	27.1	7	38.9	55	39.9	21	35.6
Interproximal	0	0	0	0	0	0	0	0	18	25.7	7	38.9	6	4.3	4	6.8
Cervical	0	0	0	0	0	0	0	0	16	22.9	5	27.8	10	7.2	5	8.5
Buccal	0	0	0	0	0	0	0	0	17	24.3	7	38.9	67	48.6	14	23.7
Total #C	0				0				70				138			

* Sexes are combined.

Table 1b: Frequency of Cavities in Adults by Type

	Indian Knoll											
	Adult Males 89				Adult Females 68				Adolescents* 16			
	#C	%C	#N ₁	% N ₁	#C	%C	#N ₁	% N ₁	#C	%C	#N ₁	% N ₁
Occlusal	26	40.0	9	10.1	15	24.2	10	14.7	0	0	0	0
Interproximal	10	15.3	8	9.0	16	25.8	8	11.8	0	0	0	0
Cervical	21	32.3	10	11.2	23	37.1	9	13.2	1	12.5	1	6.3
Buccal	8	12.4	6	6.7	8	12.9	4	5.9	7	87.5	4	25.0
Total #C	65				62				8			

	Hardin Village											
	Adult Males 55				Adult Females 57				Adolescents* 23			
	#C	%C	#N ₁	% N ₁	#C	%C	#N ₁	% N ₁	#C	%C	#N ₁	% N ₁
Occlusal	92	24.8	36	65.5	125	25.8	30	52.6	53	61.6	13	56.5
Interproximal	64	17.3	28	50.9	112	23.1	41	71.9	9	10.5	5	21.7
Cervical	153	41.2	31	56.4	135	27.8	38	66.6	2	2.3	2	8.7
Buccal	62	16.7	22	40.0	113	23.3	33	57.9	22	25.6	7	30.4
Total #C	371				485				86			

* Sexes are combined.

Key

#C represents the occurrence of each type of cavity out of the total number of cavities for each group. For example, of all the cavities that occurred in Hardin Village adult males (371), 92 of those cavities were occlusal.

%C represents the percentage of each type of cavity in relation to the total number of cavities for each group. For example, of all the cavities that occurred in Hardin Village adult males (371), 24.8 percent of them (92) were occlusal.

#N₁ represents the number of individuals with each type of cavity. For example, of all the Hardin Village adult males who had cavities (55), 36 individuals had occlusal cavities.

%N₁ represents the percentage of individuals who had each type of cavity in relation to all individuals in that group. For example, of all the Hardin Village adult males who had cavities (55), 65.5 percent of them (36 individuals) had occlusal cavities.