

FROM THE LAND OF
THE LABYRINTH
MINOAN CRETE, 3000-1100 B.C.

ESSAYS



ALEXANDER S. ONASSIS PUBLIC BENEFIT FOUNDATION (USA)



HELLENIC MINISTRY OF CULTURE

ARCHAEOLOGICAL MUSEUMS OF CRETE

CHAPTER 15
MORBIDITY AND MEDICAL PRACTICE IN
MINOAN CRETE

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Attempts to breathe life back into Minoan civilization—its art and architecture—are futile without a consideration of the actual physical remains of the people who created it. Studies of Minoan skeletons, until recently not always retained for study, animate the canvas. They enable one to examine evidence for morbidity, which, *sensu stricto*, is a measure of the frequency of insults from diseases, or a disease, over a specific period of time. Morbidity is influenced by such factors as the standard of living: housing, nutrition, hygiene, and medical treatment.

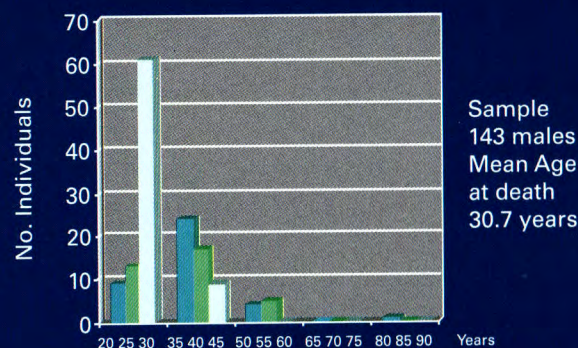
The first palace at Knossos was built on the detritus of five thousand years of earlier settlement. It was an age of unparalleled prosperity, when trade flourished and resources were seemingly limitless. Certain achievements of Minoan society during this period are startlingly modern. The plumbing, cisterns, drainage, sanitation, bathing, paving stones, and spectator sports, to name a few, all elicit from us an assured response of admiration, because the lack of some of these amenities may be reminiscent of our recent past and sometimes even of the present. Yet despite some superficial resemblances, the people of Minoan times were living under conditions quite different from those of modern society.

Longevity

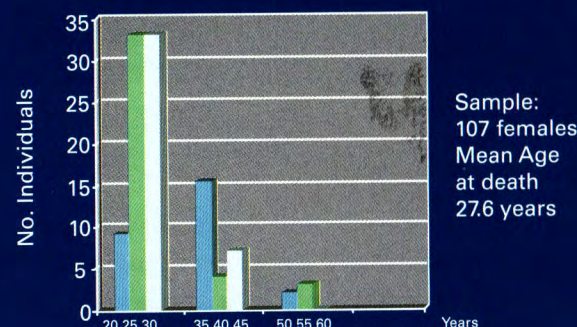
One very important difference in contemporary society is the array of medicines—especially antibiotics—diagnostic technology, and modern surgical techniques that have changed the parameters of life expectancy in Western society in the twentieth century, so that many people now live into their seventies, eighties, and even nineties. Available evidence for the Minoan period shows that even though the Minoans practiced therapeutic medicine and surgery, most men and women did not survive beyond their thirties. In other words, the life span of most Minoan inhabitants of Crete was not even half that of a modern Cretan. There were, of course, exceptions—some people who lived into their forties and fifties and occasional examples of people who lived into their eighties—but the majority of those who reached adulthood died in their twenties and thirties.

Below are histograms of a large sample of male and female skeletons excavated at the Late Minoan cemetery of Armenoi (ca. 1400–1200 B.C.), near Rethymnon, illustrating the survival statistics for adults.

Late Minoan III Armenoi: Survival statistics for men



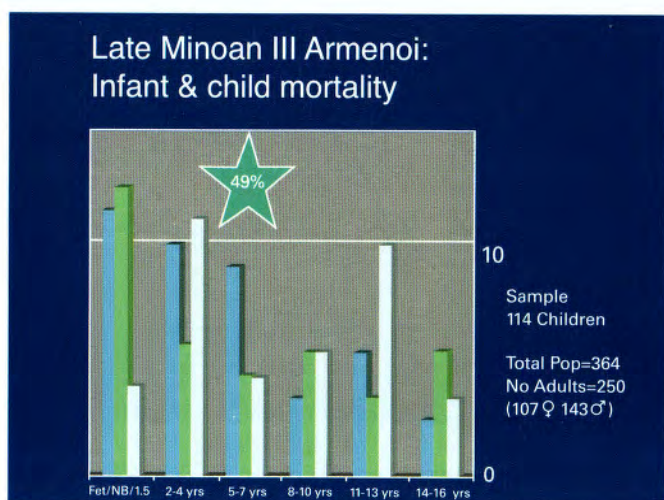
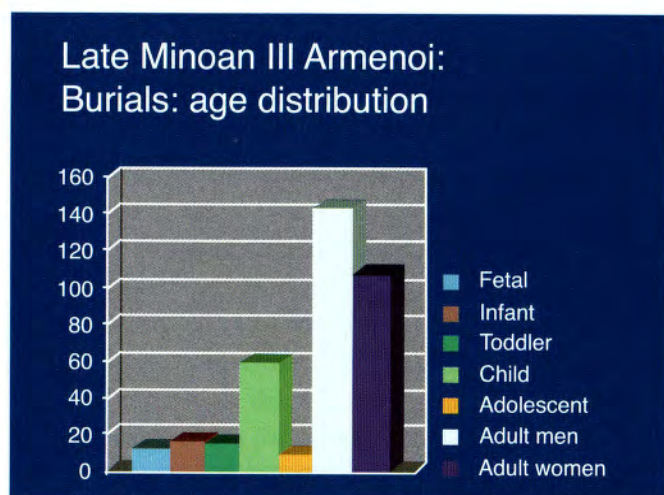
Late Minoan III Armenoi: Survival statistics for women



Women died earlier than men in Minoan times, another striking contrast with modern Europe, where women usually outlive their male counterparts by three to seven years. Most Minoan men died at about thirty or thirty-one, whereas the mean age at death of adult women was about twenty-seven. Many women died during the stage of life that coincides with peak reproductive activity, indicating that the causes of early mortality in the female population must have been partly related to the dangers and complications of pregnancy and childbirth. Teenage pregnancy was clearly a fact of life in Minoan times. The young, in addition to having immature pelvises, have a higher incidence of anemia and toxemia, which contribute to higher obstetric morbidity. High maternal mortality may have been a result of the combination of high fertility, or frequent pregnancy, which appears to have been the case, and the high risk of dying with each pregnancy.

Despite the short life span, the population increased steadily through the two millennia that encompass the Bronze Age. What was a sparsely populated island at the beginning of the Bronze Age, with small communities whose diverse burial customs probably reflect different religious beliefs and assorted geographical origins, gradually melded into a more unified cultural entity. One scholar estimates that the Early Bronze Age population grew from 75,000 to almost 250,000 inhabitants at the height of Minoan civilization. Others extrapolate a population of 217,000 for palatial Crete based on the amount of easily cultivable land.

The histograms below show the proportion of children to adults in the same cemetery and indicate that about half the children died in early infancy or in childhood before the age of five.



The causes are obvious, although they are not usually verifiable, since the duration of a disease would have been quite brief and in most cases would not leave traces on bone, normally the only evidence available. Leading causes of death in children under five would have been pneumonia, diarrheal diseases caused by tainted food or water or by bacteria from thumb-sucking, malaria spread by mosquitoes, measles and other childhood ailments, and tuberculosis. These diseases remain the major killers of children under the age of five in the less developed nations of the world today.

Occasionally, an unborn fetus has been discovered within a mother's pelvis, whereas other fetuses, possibly still-born or premature, and full-term infants who died shortly after birth, because they did not thrive or succumbed to some illness or birth injury, were probably not always buried in cemeteries. There are a few examples of infants buried under the floors of houses, which appears to be an age-old widespread custom not confined to Crete. Older children, of three or four, were sometimes buried with their toys and sometimes with their feeders, like the one from Khania illustrated in figure 1.

The timing of weaning is culturally defined and can be critical to the survival of a population's offspring. The age at which mothers stopped nursing children in the Minoan period is, of course, an unknown parameter, but it could be detected through bone chemistry analyses, since nursing infants have 2 to 4 percent higher nitrogen stable isotope values than newborn infants or adults. Weaning is a dangerous period for infants and young children, because they lose the protection of passive immunity from their mother's milk, whereas foods such as grain gruel are difficult to digest and may not meet all their nutritional requirements. At the same time, the children are exposed to new infectious agents in these foods.



Fig. 1. Thelastron/feeder buried with a three-year old child in Tomb 12 at Palama Street, Khania (ca. 1350-1300 B.C.). Khania Archaeological Museum.

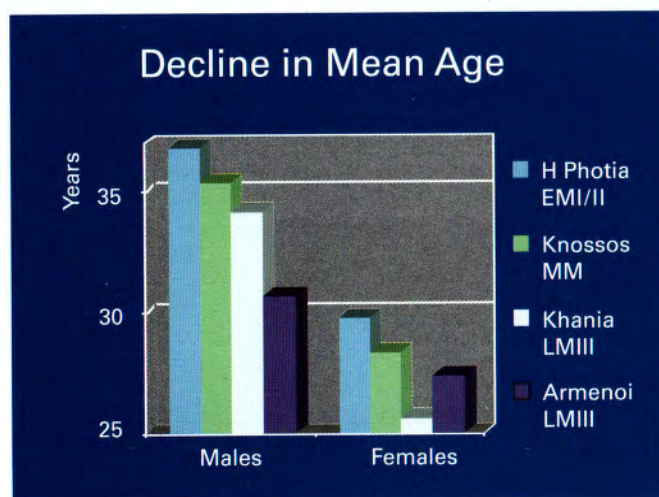
Biosocial Adaptation

Despite these dire statistics, the undeniable growth of the Minoan population is a measure of the success with which humans adapted to their island, which was richly endowed with numerous animal and plant species; there are still more than a hundred indigenous plants. However, sea-level changes, tectonic movements, climate changes (the present climate is roughly equivalent to a move of 500 kilometers south), and human agency are believed to have brought about a significant transformation of the physical environment enjoyed by the Minoan population. Animals such as red and roe deer, enchantingly portrayed by Minoan artists, once populated a more tree-filled landscape, but the deer species that formed a part of the Minoan diet had disappeared by the Byzantine period. Certain trees that are well-known sources of fodder, such as hornbeam, hazel, elm, and poplar, began to decline in the Final Neolithic, and lime had disappeared entirely by the end of the Early Bronze Age, while others such as the deciduous oak became much rarer. Tree cover was gradually diminished by clearance for cultivation or fodder, by burning for pasturage or fuel, and by the use of wood as raw material for constructing buildings, ships, tools, or artifacts and was replaced by the now typical vegetation of maquis, phrygana, and steppe terrain.

The Minoans exploited a range of herd animals, including cattle (see cat. no. 225 for an exuberant portrait of a bovid), pigs, sheep, and goats, introduced to the island by Neolithic settlers. These species were especially valuable, not only as food sources for meat, fat, milk, and such dairy products as yogurt, cheese, and butter, but also for their teeth, bones, sinews, pelts, wool, and leather. A thriving trade in leather goods developed. In Syria, for example, texts reveal that sandals were exported from Crete to Mari in the eighteenth century B.C., while Linear B tablets record various leather-working occupations, such as male and female stitchers of reins, halters, and headbands. The Knossos tablets show how the wool textile industry was of major importance, with more than thirty different occupations involved in all stages of manufacture supervised by a palace-based administration (see chap. 8, fig. 10a–b). Society gradually became more complex and increasingly layered.

Fish and fowl, including pheasant and partridge (see cat. no. 158), were also eaten. While some ceramic residue analyses have suggested that fish was not an important part of the diet, and the “fragility factor” of fish remains contributes to this impression, it is highly unlikely that marine resources were not exploited. Communities that lived next to the sea would certainly have relied on fish as a staple in their diet. Fishing requires only three to seven hours per week for a person to subsist. The work is a far less onerous and less precarious than animal husbandry or agriculture, and the food is richer in flavor and nutrition. The Late Minoan vase

painters of the Marine Style depict many kinds of fish and reveal the Minoans’ familiarity and continuing fascination with the sea and sea creatures (see cat. nos. 31–34, 237). A great variety of fish remains has been recovered in recent excavations at Palaikastro and Mochlos by water-sieving the deposits. The fish are mainly inshore species, such as red bream, blue spotted bream, red mullet, bogue, picarel, grouper, merou, and so on, which are fished in coastal waters and were evidently as popular then as they are today. Another very recent study of fish remains from Building II at Malia identified a similar range of fish species that live in coastal waters up to 100 meters deep. Moreover, eels, usually found in fresh water and available in the rainy season, were also identified, as well as eight varieties of bivalves and gastropods that live in rocky pools and marshes near the seashore. Shellfish can be cooked in steam within two or three minutes. It is highly unlikely, then, that the Minoans did not exploit rich aquatic resources that were easily accessible and provided flavorful, nutritious food that could be simply and rapidly prepared. Net-mending instruments and pictorial representations of net fishing also suggest that the sea was an important source of food, especially for communities located near the shore. Harpoons and fishhooks found in Early Minoan graves at Hagia Photia and elsewhere were used for fishing too. A barbed trident (see cat. no. 66), ostensibly a fishing tool, was recently discovered in a Late Minoan IB building at Mochlos (ca. 1525/1500–1450 B.C.).



There is archaeobotanical evidence for the cultivation or exploitation of many plants: olives probably native to Crete were cultivated in the Late Neolithic, as were grapes, figs, pears, almonds, pistachios, various greens (*chorta*) for salad, cereals (mainly wheat), and legumes, such as beans and lentils. Herbs and aromatic plants were used to produce perfumed oils, which the Minoans developed into a profitable overseas trade lasting throughout the Bronze Age. Sites where perfumed-oil containers have been found are sprinkled over

the map of the eastern Mediterranean. The earliest attestation of this trade, from an Egyptian text, dates to the Early Minoan. The Egyptians imported these oils for embalming as well as for medicinal and hygiene purposes.

Paradoxically, with the increased density of population over time, it appears that the mean age at death of males and females actually *decreased* rather than increased, graphically illustrated by the histogram above. The mean age of males fell from about thirty-seven in the Early Minoan to thirty-one years in the Late Minoan, while that of females fell from about thirty to twenty-seven years or less. In towns and villages, larger and denser concentrations of populations, in conjunction with poor hygiene conditions, would have been ideal hosts for epidemic diseases such as cholera and other communicable illnesses. Highly contagious diseases, such as tuberculosis (before antibiotics, mortality from tuberculosis was 50 percent), and chronic diseases, such as brucellosis, which must have taken a heavy toll on the population, were transmitted to humans by farm animals, either through airborne transmission, contact with infected animals, or the ingesting of tainted milk or dairy products.

Diminished Lifespan, Dietary Factors, and Dental Disease

Diet and nutritional factors play a vital and determinative role in susceptibility to dental disease and to diseases in general and these, in turn, ultimately influence life span. In the Minoan Bronze Age, the decreased life span of people observed through time is paralleled by an increase in dental disease. Women, whose age at death is consistently lower than that of men, also experienced a higher incidence of dental disease than men. At Early Minoan Haghia Photia, where the highest mean age at death has been observed, the population also had a relatively low incidence of dental disease and must have had access to a much more varied and nutritious diet of fresh food, probably including fish, from consistently available sources than did later populations. It is probable that numerically larger groups with more complex social organization became increasingly dependent on storable foods, such as beans and lentils. A characteristic of these foodstuffs is that they have a high carbohydrate content, which is one of the main factors implicated in dental disease.

This hypothesis of deterioration in quality of diet is also based on evidence for dental disease. Although there is only a small sample from Early Minoan Haghia Photia (106 teeth/sockets examined), caries appears to have nearly as high a frequency there (8.3 percent compared to 9 percent) as at Middle Minoan Knossos (1,352 teeth/sockets examined), but antemortem tooth loss is far lower (1.9 percent compared to 13.7 percent). In the Late Minoan at Armenoi (4,074 teeth/sockets examined) both caries (17.7 percent) and antemortem tooth loss (28.6 percent) are roughly twice as high as

at Knossos. In the Late Minoan at Khania (282 teeth/sockets examined) caries incidence is 36.9 percent and antemortem tooth loss 13.1 percent.

The mean age of men and women at Haghia Photia compared with Knossos shows a decrease of 1.5 years, which, in proportion to the life span of those times, is significantly lower. This downward trend appears with even greater clarity in the samples from Armenoi and Khania. At Armenoi the mean age at death was the lowest for men, 30.7 years. These figures must have been influenced by the health problems posed to people living and working in close contact with animals and participating in the infection chain, which would have led to greater exposure to diseases shunted in both directions. At Khania the average ages of men and women declined by 1.25 and 2.28 years, respectively. The mean age for women, 25.6 years, was the lowest of all. This sample is dated to the time following the establishment of a Mycenaean military presence on the island; recent excavations of warrior graves in the Khania cemeteries indicate that by Late Minoan III Khania was a town that presumably had a garrison attached to it, while other evidence indicates it was a commercial center with extensive overseas contacts, a place where people of multiple "ethnicities"—different religions, cultures, languages, scripts and cuisines—mingled.

Overall, the decrease in life span must have been influenced not only by dietary factors and problems of access to adequate sources of fresh nutritious foods but also by the density of the urban population. A densely populated setting would provide a larger number of hosts—and therefore greater potential for the spread of epidemic diseases—and, of course, a greater vulnerability to deprivations caused by famine in times of crop failure or by social disorganization following natural disasters, such as earthquakes or the volcanic eruption of Thera. Finally, another influencing factor may have been vulnerability to new pathogens introduced from overseas.

Evidence of Disease and Medical Practice

According to the Persians, there were three kinds of healers in Greece before the first millennium B.C.: those who cured with plants, those who used magic words, and those who used the knife. Indeed, there is evidence to confirm that the Minoans used all three methods. The export of medicinal oils to Egypt is documented in the Ebers Papyrus and corroborated by ceramic finds of Minoan perfumed-oil jars throughout the eastern Mediterranean. There is also evidence in the London Medical Papyrus dated to about 1400 B.C. that the Egyptians, the most ancient civilized people in the Mediterranean, who were celebrated for their medical knowledge, used miracle-invoking religious incantations in



Fig. 2. Votives from the Traostalos and Petsofas peak sanctuaries.

the Minoan language to cure disease. (This is hardly surprising, since there are areas today where Christians and Muslims prefer religious incantations to conventional Western medicine.) Finally, we now have indisputable skeletal evidence that the Minoans practiced very advanced surgical techniques, as we shall see below.

The Greek word *i-ja-te* (doctor) is recorded on a Linear B tablet from Pylos, indicating that the profession existed in the thirteenth century B.C. From Crete there is evidence that allows us to infer the association of priests and priestesses (*i-je-re-ja*) with the curing of disease. Anathematic votives that portray limbs and parts of the human body obviously suffering from pathological conditions have been found at Middle Minoan sanctuaries on the loftiest mountain peaks (fig. 2). These are undoubtedly the prototypes of similar votives found in the Asclepeia in the Classical period and of the *tamata* of the Greek Orthodox Church today, which are supplications, or donations, in gratitude for cures. We may hypothesize that peak sanctuaries functioned in a similar way. It is possible that priests and priestesses exercised the function of healers by virtue of the divine authority invested in them. We must, however, turn to the skeletal evidence to

verify the existence both of specific diseases and of surgeons who used the knife.

Not all diseases leave their imprint on skeletal remains, but studies of skeletal material from a large number of burials, though unevenly spread over time and space and representing only a fractional sample of the populations they are supposed to represent, do give at least some indication of the diseases people suffered from and how these were dealt with. The study of many thousands of bones from recent Greek-American excavations at the Early/Middle Minoan cave ossuary at Haghios Charalambos Lasithi is now under way and is providing a wealth of new data to complement earlier studies of material excavated in the 1970s and 1980s, when skeletons found in excavations had only just begun to be retained. In the Late Minoan cemetery at Armenoi, Rethymnon, the burials of 364 men, women, and children were studied; 6,325 bones were examined clinically; and 1,074 were examined radiologically for pathology. At Palama Street, Khania, there are about thirty burials. Any human remains from sites excavated before these almost invariably consist of a selection of the best-preserved crania.



Fig. 3. Healed fractures of tibia and fibula from Armenoi, Tomb 89.

Fractures and dislocations were fairly common, observed in 5.2 percent of the population at Armenoi (fig. 3). Among men the fractures involved predominantly legs, whereas among women fractures involved mostly arm bones. These were probably the result of accidents and occupational hazards and perhaps warfare or, in the case of women, beatings. Some of these fractures must have been reduced and immobilized, since they could not have healed otherwise. One imagines that treatments may have originated empirically, possibly by adopting the techniques used by shepherds in tending animals with broken limbs.

Post-traumatic arthritis affecting hip, knee, and particularly ankle joints appears to have been a common complaint in the Armenoi population. A few cases involved shoulder or elbow joints and vertebrae. In all probability,



Fig. 4. Clay hand from the Petsofas peak sanctuary next to a modern text book illustration of osteoarthritis.

people's occupations caused recurrent injury to these particular joints. Injury to the ankle joints was far more frequent among men than women (a fact that is paralleled by the fracture data), perhaps as a result of walking or running over stony ground. Arthritis is a chronic disease, usually correlated with age, which affects one in five people in contemporary populations. In particular occupations, excessive use or weight-bearing on particular joints increases the likelihood of injury; for example, farmers are ten times more likely to suffer from osteoarthritis of the sacroiliac joint after ten years' work than people with sedentary occupations (figs. 4, 5).

In contrast, all but one of thirteen cases of osteoporosis affected women aged between twenty-three and fifty years. Most cases of osteoporosis were probably not menopausal, as they are today, but due to secondary causes. There was one man, aged about forty, with osteoporosis of vertebrae and a metatarsal, attributed to disuse atrophy. An inverse relationship between the calorific requirements of women as mothers and their calorific intake, or the kind of nourishment generally allotted to women, is in most cases the probable explanation for the dramatic contrast in the incidence of osteoporosis among the female population as compared to the male.

There are two cases of avitaminosis in children aged eight and six. The first perhaps resulted from a dietary lack of vitamin C, which was not as readily available then as it is today. Maternal milk is a source of vitamin C (5–7 mg per 100 ml) but would not have been an adequate source for children of poorly nourished mothers, even if the child was still nursing at that age. Poor calcium absorption caused by chronic sprue, which is characterized by malabsorption and intolerance to gluten, is a likely diagnosis in the case of the younger child, given the noticeable enamel hypoplasia or defects in the enamel of the child's permanent molars.

Evidence for infectious diseases of viral etiology includes one possible case of poliomyelitis and twenty cases of



Fig. 5. Knee and toe bones from Early/Middle Minoan Haghiros Charalambos with arthritic changes.

osteomyelitis caused by bacterial infections. There are two possible cases of brucellosis that had caused ankylosis of vertebrae through the fusion of the spinous processes and posterior half of the vertebral body. There are three strains of *Brucella*, but *Brucellosis melitensis* is the most common form in Greece.

Brucellosis is also known as undulant fever because it recurs in cycles or as "Cretan Fever" because of its frequency there. It is an occupational disease of people who are engaged in animal husbandry. It may be transmitted through the milk of cows, sheep, or goats and their products, such as yogurt or cheese; it is also carried by swine. The microorganisms attack tissues of the reticuloendothelial system, such as



Fig. 6. Fused lumbar vertebrae: possible case of brucellosis from Early/Middle Minoan Haghighos Charalambos.

bone marrow, lymph nodes, liver, spleen, and kidneys. In the chronic form, symptoms of fever, weakness, aches, and pains may persist for months or years.

Contact with animals was probably responsible for tuberculosis, another serious infectious disease at Armenoi. The remarkable number of fifteen cases of possible tuberculosis suggests that it was the chief scourge of the population. Eleven of these cases affected people who were buried in four tombs—that is, members of the same family—emphasizing the highly contagious nature of this disease. It is a disease that has a long duration, with surges and remissions. It is highly debilitating and, in the absence of an effective treatment, is fatal in the long term. (Before the development of an effective therapy, vertebral tuberculosis developed during first decade of life in 50 to 70 percent of tuberculous children and usually appeared nine months to two years after the primary infection. In older individuals, although the disease was contracted early in life, immune response could subdue the bacillus Kochi and healing would occur.) This disease was known to physicians in the Classical era as *phthisis*, the wasting disease. Today, five different strains of tubercle bacilli have been described: two are pathogenic for man (fig. 7). The human strain causes lung tuberculosis, while the bovine variety causes tuberculosis of the bones. But TB may spread through the blood stream to bones from a primary lung infection in the advanced stages of its development. Consequently, it is not possible to know with certainty which mycobacterium caused the disease merely from examining bone changes.

At Armenoi there were a large number of individuals (>10 percent), both male (17) and female (9), with anatomical variations of the lumbar and sacrum—that is, both partial and complete sacralization of the fifth lumbar (uniting of the fifth lumbar to the sacrum), or lumbarization (separation) of the first sacral vertebra. It is probable that these variations would have been asymptomatic; they occur in 17 percent of the contemporary Greek population and are usually detected accidentally in radiographs. But it is possible in cases of neoarthrosis (lumbarization), that lumbago/sciatica was experienced when movements required hyperextension or



Fig. 7. Thoracic vertebra: possible case of tuberculosis, severe rarefaction of the vertebral body from Early/Middle Minoan Haghighos Charalambos.

lifting of heavy objects. Sacral spina bifida, which also could have been asymptomatic, may have been accompanied by a dermal cyst with a tuft of hairs and hairy pores, which could have exposed them to meningococcal or other viral infections.

There were several cases of possible congenital dislocation of the hip (CDH). Four cases were femurs with a short anatomical neck, a flat mushroom-shaped head, and exostoses on the surgical neck, one in conjunction with exostoses around the acetabulum, which was disproportionately large and suggestive of forward displacement of the hip. A fifth case, with exostoses within the acetabulum, was also suggestive of the possibility of CDH. In Greece today, congenital dislocation of the hip occupies a primary position among congenital deformities and affects the left femur three times more often than the right and females six to eight times more often than males; in Crete CDH has an endemic character; its occurrence at Armenoi may be indicative of an endogenous community.

There is a case of an adult male with a leftward displacement of the nasal diaphragm, perhaps due to a fall or knock, and enormously enlarged frontal sinuses.

There are two cases of hydrocephaly in children aged two and a half and three years. In both cases the X rays show a remarkable disproportion between the size of the facial and cerebral cranium and profound impressions of the cerebral cortex and arteries on the inner table, caused by intracranial pressure. In the first case a blockage of the aqueduct of the fourth ventricle due to a tumor is hypothesized; in the other case, a possible tumor (not necessarily malignant) may have resulted in hormone disturbances, defects of vision, and headaches.

There are two probable cases of Paget's disease from Early/Middle Minoan contexts. One is an example of a tibia with thickening and distortion of the compact cortical bone below the middle of the diaphysis. Disturbance of the direction of the bone trabeculae in relation to the force lines of the bone and zones of increased and decreased radiographic shadow are noted. This may be an osteogenic sarcoma or, more likely, Paget's disease, which usually affects individuals over forty and males more frequently than females in a ratio



Fig. 8. A femur from Haghios Charalambos with Paget's disease.

of 4:3. Some studies have linked Paget's disease to cohabitation with domestic pets; it is quite probable that people sometimes sheltered with their herd animals, perhaps for practical purposes such as warmth.

From the recent excavations at Haghios Charalambos Cave, a femur with the distal end of the shaft significantly enlarged has a similar radiographic appearance (fig. 8). The internal structure of the bone has been altered: the cortex has been replaced by spongy bone that has expanded and destroyed the medullary cavity. There is coarsening of trabecular bone in the outer layers, while the outer surface of the bone is a mere skin of "compact" bone. In Paget's disease, bones of the axial skeleton are most often affected (for example, the sacrum in 57 percent of cases), whereas the femur is affected in 46 percent and the tibia in 11 percent of cases.

At Armenoi a forty-five-year-old man had a right ulna with a bulky distal diaphysis (bone shaft) enclosed in a thin layer of periosteum (outer fibrous layer of bone), which could be Paget's disease with a pathological fracture and secondary callus or an osteoblastic type of neoplasia (cancerous tumor)—for example, osteoblastic sarcoma. The compact bone cortex of his large tibia appears thicker in places and could be a metastasis of the ulna sarcoma. Metastases from the ulna to the vital organs would have caused his death.

There is one spectacular case of probable metastatic cancer to bone (fig. 9). The radiographic image of the sacrum of a middle-aged male burial has diffuse sclerosis, which could be the result of a metastasis to the bone of a malignant neoplasia or Paget's disease, which, as already mentioned, most often affects the axial skeleton. The lumbar vertebrae, particularly the last three but also half of the first lumbar, also appear dense. This suggests the hypothesis of metastatic(?) neoplasia. Practically any tumor, with the exception of the primary tumors of the central nervous system, may occasionally metastasize to bone, but this phenomenon is highly characteristic of cancers of the breast and prostate—from one half to two-thirds of these carcinomas metastasize to bones. The lumbar and sacral vertebrae together with the pelvic bones are usually the ones affected in carcinoma of the prostate. While it is true that most metastatic carcinomas

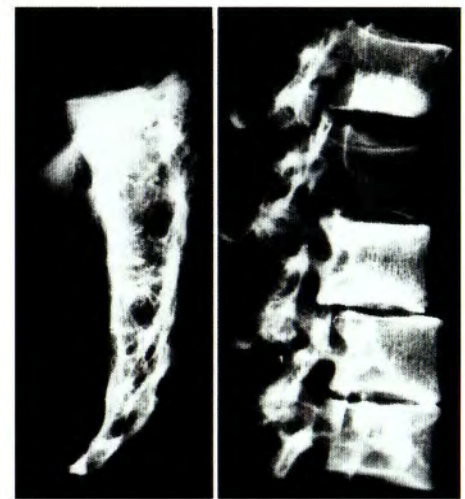


Fig. 9. Sacrum and lumbar vertebrae from Armenoi, Tomb 103 Δ.

cause bone destruction, pain, and pathological fracture, any cancer that destroys a considerable amount of bone may initiate osteoblastic reparative (bone growing/repairing) activity. This is particularly true of prostate cancer, which is often of the osteoblastic or sclerosing type. The osteoblastic response of a metastatic prostate tumor radiographically presents areas of opacification that are homogeneous but fuzzy in outline, as in the present case. This man probably had a painful end caused by prostate cancer.

Finally, at Armenoi, where there are several "warrior-type" burials, there are three cases of head injuries involving depressed fractures on the left parietal. The first case is that of a thirteen-year-old child with depressed fractures on the left parietal and frontal and a traumatic perforation of the roof of the left orbit, which may have been the portal of entry for bacteria causing the child's death. In the second case, a twenty-three-year-old woman has a shallow depression 10.6 millimeters in diameter on the left parietal. In the third case, a thirty-five-year-old man has a depression 16.2 millimeters in diameter on the left parietal; incidentally, he was buried in the same tomb as a warrior who had been literally hacked to pieces. In all three cases, blows to the left side of the head could have been inflicted at close range by a right-handed attacker; alternatively, they may have been caused by missiles, such as sling-stones.

There are about fifteen cases of head injury among the Early Minoan III–Middle Minoan IIB (ca. 2300–1700 B.C.) burials at Haghios Charalambos. The casualties were mostly men; a few women and one child are represented. Those with multiple injuries, such as the case illustrated in figure 10 cannot have been accidents but must have been acts of aggression. Lesions were caused by various weapons—one by a bladed weapon probably in hand-to-hand combat, another by a blunt weapon with a wooden handle—but most were small circular depressions, similar to those seen at Armenoi,



Fig. 10. Adult male skull with three traumas to the left side of his head.

which may have been caused by stones from a slingshot. Launched from a distance, they could impact a skull at a velocity of more than one hundred miles per hour. The symptoms resulting from such head injuries might range from simple headaches or blurred vision to paralysis of the limbs or the entire side of the body opposite whichever brain hemisphere sustained the pressure of a subdural hematoma caused by the injury, which it would have been imperative to relieve.

In fact, three of the crania from Haghios Charalambos bore evidence of skull trephination in conjunction with a head injury (fig. 11) and prove that surgeons in the nineteenth century B.C. were already practicing the protocols described in written sources dating to the third century B.C., although attributed to Hippocrates who lived and worked in the fifth and fourth centuries B.C.

From the Haghios Charalambos discoveries, it is clear that surgeons already knew when to avoid invasive surgery, as in the case of injuries to the temporal bone, since it could cause spasms. In one case, a very large area of the braincase had been removed yet, miraculously, the patient had survived (fig. 12). Without a doubt, the Minoans' knowledge of anatomy was far more profound than they have been given credit for until now. Surgeons knew that the brain floated in liquid and that it was important not to damage the meninges. Trephination was probably more commonplace than we imagine, as the physician or surgeon had none of the diagnostic techniques that we have today and thus was obliged to investigate directly, as delay could be fatal.

Conclusion

Morbidity in the Minoan population—how often people fell ill and from what causes—is unknowable in a contemporary statistical sense. On the one hand, we have only small and uneven samples of the population widely separated in time, and, on the other, only a small percentage of diseases in the population are due to illnesses that leave traces on bone. In other words, it is impossible to identify the large number of diseases that leave no traces on bone and may have afflicted the Minoans, causing illness or death on a huge scale. To



Fig. 11. A frontal trephination with smooth beveled edge, next to a trauma.

give a historical illustration of the point, it is estimated that in the seventeenth century A.D., 11 percent of the world's population died of smallpox, an epidemic disease that leaves no diagnostic trace on bone. Actually, smallpox is believed to have existed in Egypt in the twelfth century B.C. and could have been one of many pathogens introduced to Crete from overseas. Thus it is not possible to obtain a true "disease profile" for the Minoan population.

Traces of pathology in bone may be nonspecific, or characteristic of more than one disease. For example, there is frequent evidence of porotic hyperostosis observed macroscopically on the cranial vault and in the roof of the orbits, characteristic of chronic and relatively serious anemias, such as thalassaemias or deficiency anemias. At Armenoi, such changes occurred in 83 percent of crania and 6.25 percent of orbits. Cranial vault lesions affected males (88 percent) more frequently than females (77 percent), but orbital lesions appeared twice as frequently in females (8.7 percent) as in males (4 percent). It must be borne in mind that similar changes to the bones of the skull occur with all anemias. In children such lesions may occur when the iron content of the diet is inadequate. A high frequency of iron deficiency anemia at this phase of bodily and physical growth is hardly surprising in Minoan times, since it is a serious problem today.

Can one make an assessment of morbidity using stress indicators? Radiographic screening of one hundred tibias (sixty-one men and thirty-nine women) for Harris Lines, or lines of arrested growth, which indicate nutritional deficiencies or febrile infectious diseases, revealed them in 88.5 percent of male and 82 percent of females. A repetition of insults was observed in 57 percent of individuals, whereas regular distances every two millimeters occurred in 40.8 percent of individuals. These lines of arrested growth, the majority of which are near the epiphyseal plates, must be interpreted as signs of interrupted development between the ages of fourteen and eighteen. At this period the tibia grows about five millimeters per year. It is concluded that the majority of the population suffered from some febrile disease, which arose periodically at intervals of one to four months. Diseases that are periodic

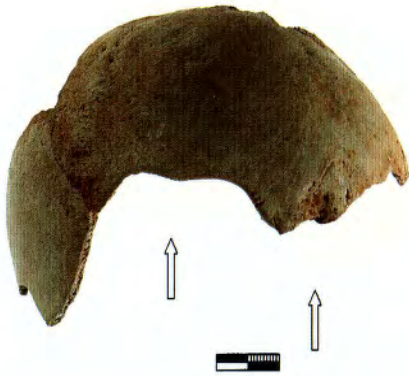


Fig. 12. This patient survived the removal of a large area of the skull.

repetitive fevers, recurring at similar intervals, are malaria, salmonellosis, and, more rarely, brucellosis and relapsing fever.

Differences between the Minoan period and contemporary times in social gender, nutrition, hygiene, medicine, medical knowledge, and technology are vast. Accidents, minor by modern standards, would have cost lives in the past. In the world before penicillin, one could be perfectly healthy and sustain a slight wound and one's life was at risk; one might

Haghios Charalambos, which date to the nineteenth century B.C., are unequivocal proof that the Minoans had advanced in the field of clinical medicine just as they had in other areas of technology, culture, and social life. One could claim that by the early second millennium B.C. the Minoans had established at least some of the foundations of Hippocratic medicine, which continued to be practiced and embellished for another fifteen hundred years until the Byzantines passed it to the Sassanian Persians and Arabs. After cross-fertilization with the medicine of Egypt, Sumeria, Assyria, and Babylon, it was transmitted back again to medieval Europe by Avicenna (Ibn Sina) and taught in the newly established universities.

Piecing together fragments of information, we are beginning to understand a little better the daily life of the people who created Minoan civilization. Despite the accumulation of a century's worth of evidence, it is still difficult to truly visualize Minoan society, for in the absence of literature and historical documents, their tensions, jealousies, scandals, dramas, court intrigues, and conspiracies will remain beyond our reach forever.



Fig. 13. "The Gossiping Ladies."
Part of the "Grandstand Fresco"
(ca. 1600–1500 B.C.).
Herakleion Archaeological Museum
(see chap. 9, fig. 9).

die of an infection within days. Hippocrates (*Epidemics*, III.4) records that when wounds were neglected in many cases what followed were infection, fever, and death. Herodotus (III.37) passes down the story of the death of Cambyses from a self-inflicted wound to his thigh caused by the tip of his sword, which accidentally became unsheathed as he mounted his horse. He died from an infection three weeks later.

This makes one marvel all the more at the evidence for cranial surgery performed by the Minoans, in addition to the ample evidence for the practice of fracture reduction and tooth extraction. The recently discovered trephinations at

Selected Bibliography

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