A PHYSICAL ANTHROPOLOGICAL RESEARCH OF THE BEGUINES OF BREDA 1267 TO 1530 AD

F.E. Rijpma and G.J.R. Maat

BARGE'S ANTHROPOLOGICA

Nr. 11

Leiden

2005

A PHYSICAL ANTHROPOLOGICAL RESEARCH OF THE BEGUINES OF BREDA 1267 TO 1530 AD

F.E. Rijpma and G.J.R. Maat

BARGE'S ANTHROPOLOGICA

Nr. 11

Leiden

2005

Published by:
Barge's Anthropologica
Leiden University Medical Center
P.O. Box 9602
2300 RC Leiden
The Netherlands

ISBN-10: 9080645680
ISBN-13: 9789080645684

A PHYSICAL ANTHROPOLOGICAL RESEARCH OF THE BEGUINES OF BREDA, 1267 TO 1530 AD

F.E. Rijpma and G.J.R. Maat
Barge's Anthropologica, Department of Anatomy, Leiden University Medical Center

SUMMARY

A physical anthropological study was performed on the excavated remains of Beguines buried in the cemetery of the Beguinage of the City of Breda. The excavation was carried out by the *Archeologische Dienst Breda* in 1994. The skeletons were transferred to the department of Anatomy of the Leiden University Medical Center for further study. The collection of 120 skeletons dated from 1296-1535 AD. Beguines were religious women who lived together in a cluster of houses, often oriented around a courtyard (the Beguinage). To be able to enter a Beguinage a woman had to buy or build her own house and had to provide for herself. The results of the physical anthropological research showed the expected nutritional and health state of this middle class social section of the city's population. Once the beguines passed the age of 20 years, their average age at death was 43 years. Other health indicators like stature, incidence of infectious diseases, deficiency diseases and joint degeneration also supported the theory that women who entered a Beguinage were economically fairly well off.

INTRODUCTION

Beguines, a historical context

In the late 12th and early 13th century a wave of new religious enthusiasm spread all over Europe. Some new religious orders were started, for instance by Francis of Assisi, the son of a wealthy tradesman, who renounced all his wealth and founded the Franciscan Order. Many women felt attracted to these new religious ideals and some opted for a sober and chaste life without entering the secluded world of the cloisters. They lived mainly in towns and cities, alone or in groups in one house. These so-called Beguines were recognized by their simple woollen robes.

There are several theories about the etymology of the name *Beguin*. Perhaps it derived from the old Flemish word *beghen*, in the sense of 'to pray'. Or perhaps it originated from Bega, the patron saint of Nivelles, where, according to a questionable tradition, the first Beguinage was established. Another theory is that it originated from Lambert le Bègue (the Stammerer), a 12th century priest of Liège, who founded a cloister and church for the widows and orphans of crusaders in his native town.

Opinions on these women varied. The Franciscans considered them equal spirits and offered to be their confessors. The Catholic Church saw the movement as a threat, especially because women were not supposed to involve themselves with theological problems. The church felt uneasy about them because they were difficult to control. Beguines were no ordinary citizens and they were not nuns either. They could not be controlled by a regular confessor or put behind cloister walls.

Pope John XXII forbade the Beguine movement in 1318 AD. This was the end of that kind of unorganised community life; only those women who were already living together in Beguinages (*Begijnhoven*) could more or less continue their way of life. They were put under the care of a priest.

Beguinages spread widely all over Western Europe, they could be found for instance in Paris, Basel and Rome. Nowadays they have mostly disappeared. In Belgium the Beguinages developed into a town within a town. Some can still be admired in Bruges, Leuven and Diest. In the Netherlands the expansion had been more modest, and only some, such as in Amsterdam and Breda, survived after the onset of the Reformation in 1517 AD. Often only the names of streets and churches will remind us of Beguine life.

General Archaeological Introduction

The municipality of Breda set out to remodel the *Park Valkenberg* (Falcon Hill Park, see Fig. 1) as part of their programme of improvement of the historic town of Breda from March 1994 onwards. Excavations of the Beguinage churchyard started mid-November 1995, under the supervision of N. Digby, archaeologist for the municipality of Breda. In 1996 the skeletons were transferred to Barge's Anthropologica of the Department of Anatomy at the Leiden University Medical Center for further examination.

Park Valkenberg lies immediately west of the *Koninklijk Militaire Academie* (Royal Military Academy), formally the Breda Castle. The park is located within the first medieval town wall. The origin of the park is associated with the castle, which was founded in the 12th century. This area became the hunting grounds for the *Heren van Breda* (Lords of Breda) and was, at least in part, used for falconry, as suggested by the name Falcon Hill. Documentary evidence shows that a Falcon house was situated in the area by the 14th century.

In about 1267 AD the Lord of Breda donated land for establishing a Beguinage. This was one of the first to be established in the Low Countries. As part of extensive changes to the layout of the area, the original Beguinage was levelled in the 1530s and the now existing Beguinage developed. The site of the original Beguinage and its churchyard was lost.

The lost Beguinage churchyard was rediscovered during the 1995 excavations and was found to contain a large number of graves. Only six graves dating from all three church building phases were situated within the church foundations (five females: skeleton numbers 2516, 2517, 2521, 2522, 2524; one male: skeleton number 2523). The other graves clustered around the outside of the church, particularly in the area immediately west of the outline of the first brick church foundations. The distribution of the graves decreased in density further to the west and south of the church. (See Fig 2. for an overview.)

The position of the graves, while generally oriented in the usual Christian east-west direction, varied to a considerable extent. The graves could be subdivided into three groups, A, B and C, according to their orientation. The majority of graves fell into category A, i.e. parallel to the axis of the church. Since these graves had been dug in the vicinity of the church, they follow closely the line of the church walls. The graves in category B were located almost exclusively in the northwestern part of the churchyard, and were remarkable in that these graves had a west-southwest to east-northeast orientation. The third group, category C, had no consistent or dense distribution. This group was located mainly south and southwest of the church.

There were three ways in which the graves could be assigned to a particular period.
Firstly, there was a considerable variation in the depth of the bottom of each burial, the lowest at + 0.4 m NAP[1], the highest at + 1.66 m NAP, a difference of 1.26 m. This variation became clearer when the building phases were taken into account. Each new building phase was associated with a rising of the area within the Beguinage churchyard. The depth of each grave therefore reflects the phase it belongs to.

Secondly, many of the graves were filled in with grey-brown sand containing a small percentage of small brick and mortar fragments and charcoal flecks. This soil had become so disturbed that it formed an evenly mixed layer. It was noticed that the earliest graves in the sequence had fills that contained a much less even mix, with disturbed yellow sand and patches of a more brown sandy soil. There also was an absence in these graves of brick and mortar fillings, suggesting that they predated the earlier brick church, or the demolition of the first brick church.

Thirdly, the size and shape of the graves gave some indication of variation over time. Generally the graves were of a standard size 2.0 - 2.15 m long, about 0.5 - 0.7 m wide and tapering towards the foot. The earliest graves were substantially larger and more rectangular, being about 2.2 - 2.5 m long and 0.7 - 0.9 m wide.

Taking all these different indicators into account, each grave was assigned to one of the three time phases (Table 1). Some graves showed indicators of different phases and did not clearly fall into one particular category. In such cases graves were marked as of uncertain date. The first phase comprises

[1] NAP = Nieuw Amsterdams Peil, the Amsterdam ordnance datum

5 graves with 5 individuals. The vast majority of the graves (N= 88) containing 112 individuals, fell into the second phase, as might be expected, given the fact that during this phase the church stood for three quarters of the lifetime of the Beguinage. The third phase is represented by 4 graves with 3 individuals. The 6 individuals buried within the church walls fell into phase 2 and possibly phase 3.

MATERIALS and METHODS

A general overview of the 109 grave numbers and associated skeletons can be found in Table 3. In the text, a four digital number between brackets denotes the number of each associated skeleton. If more than one skeleton could be associated with one grave number (e.g. grave 2641), a letter was added to the original gave/skeleton number (e.g. 2509A, 2509B). If an individual was buried inside the church the letters Ch were added to the skeleton number of Table 3 (e.g. 2516 Ch). The table also shows the main demographic data of the osteological analyses.

All 120 skeletons were processed for physical anthropological and paleopathological analyses. The collection consists of 63 complete and 57 incomplete skeletons. Their degree of completeness was recorded and can be found in the individual physical anthropological departmental reports (Table 2). Some bones showed post-mortem fractures. If possible these were manually reconstructed. The texture of the bone tissue was good.

Sex, age and stature determinations and dental examinations were carried out in compliance with departmental protocols (Maat et al., 1999) and with the recommendations of the Workshop of European Anthropologists (WEA, 1980). Sex determination concerned adults only.

Analysis of the non-metrical morphological degree of sexualization of the pelvis and cranium was executed by determining the degree of feminine or masculine development by means of scoring a series of anatomical sex features (Maat et al., 1997). From the total weighted scores and their total weight factors, the quotient, the so-called 'degree of sexualization', was calculated. This degree of sexualization may range from hyper-feminine (-2), via indifferent (0) to hyper-masculine (+2).

By measuring the antero-posterior diameter of femurs and tibias with a sliding calliper, further analysis of sex development was carried out (Antero-Posterior Diameter; MacLaughlin and Bruce, 1986).

Methods for diagnosing skeletal age at death differ for various phases of aging. For children, dental development and ossification of the axial skeleton were used (Ubelaker, 1978; Maat et al., 1999). From the age of twelve years on, epiphyseal fusion of long bones was considered to be the main age indicator (Brothwell, 1981). For adults the so-called Complex Method of Acsádi and Nemeskéri (1970) was applied. In this method age characteristics are read from:

- the degree of increasing obliteration of the endocranial sutures
- the changes of the face of the pubic symphysis
- the deterioration of the spongiosa in the proximal femur
- the deterioration of the spongiosa in the proximal humerus

For reasons of computing, all individuals were assigned to a 10-year age at death interval. In general it should be kept in mind that given ages are skeletal/biological ages, not calendar ages. Both are expressed in years. They do not necessarily coincide exactly but will be mostly equivalent.

Stature of female adults was calculated after Trotter and Gleser from the length of the long bones (Trotter and Gleser, 1958; Trotter, 1970). The physiological decrease of the living height of females with aging was calculated. According to the literature the actual living height of males during life should be estimated by using the formula of Breitinger (1937). Long bone measurements were taken as defined by Knussmann (1988).

To determine the cranial index, proper measurements can only be taken from intact crania. Cranial measurements were taken as defined by Knussmann (1988), using the calculation formula: maximum skull breadth x 100 / maximum skull length. The index can be used to make a rough 'ethnic comparison' of the Beguines with other populations groups.

For the understanding and the interpretation of the dental data, the following definitions and abbreviations are relevant:

N erup	Assessed number of erupted regular teeth on the basis of the available space for socket positions in the jaws (maximum of 32; minimum of 28 in case all third molars failed to develop)
N insp	Number of inspected teeth
N miss. pos.	Number of missing jaw (socket) positions and related teeth
N ret	Number of congenitally absent or not erupted teeth
N AM loss	Number of ante-mortem losses
N PM loss	Number of post-mortem losses
N supernumerary	Number of supernumerary teeth
N caries	Number of teeth with carious lesions (NOT the total number of lesions)
N abscess	Number of abscesses
N fistulas	Number of fistulas
Alveolar atrophy	Degree of alveolar atrophy scored after Brothwell (1981)
Calculus	Degree of calculus/tartar formation scored after Brothwell (1981)
Periodontitis	Degree of periodontitis i.e., interalveolar atrophy with pitting and reactive bone/crest formation (none, light, medium and considerable)
DM(F) index= Decayed Missing (Filling) index	Percentage of decayed (AM loss), missing (PM loss) (and filled teeth).

$$\text{Ante mortem loss (\%)} = \frac{\text{AM loss} \times 100}{\text{N erup - N miss. pos.}}$$

$$\text{Post-mortem loss (\%)} = \frac{\text{PM loss} \times 100}{\text{N erup - N miss.pos - AM loss}}$$

$$\text{Caries frequency (\%)} = \frac{\text{N caries} \times 100}{\text{N insp}}$$

$$\text{Abscess frequency (\%)} = \frac{\text{N abscess} \times 100}{\text{N erup. - N miss.pos. - AM loss}}$$

$$\text{Fistula frequency (\%)} = \frac{\text{N fistulas} \times 100}{\text{N insp}}$$

$$\text{DM(F) index (\%)} = \frac{\text{N AM loss + N PM loss (+ N filled teeth)} \times 100}{\text{N insp}}$$

All percentages have been calculated from so-called 'possible cases' i.e., from examinable specimens. Only unequivocal observations were taken into account. All percentages represent 'prevalence at death'. They may differ from frequencies in the 'living population' of those days. Comparisons in the 'Discussion' chapter were only made if calculation methods used in the literature were compatible.

Paleodemographic analyses and paleopathological diagnoses were supported and confirmed by the literature (e.g. Cox and Mays, 2000; Aufderheide and Rodriguez-Martin, 1998; Haslett et al., 2004; Mays, 1998; Rogers and Waldron, 1995; Waldron, 1994; Ortner, 1985; Steinbock, 1976).

Criteria for the diagnosis of the arthropathies, vertebral- and peripheral osteoarthritis (vOA and pOA), Diffuse Idiopathic Skeletal Hyperostosis (DISH), Paget's disease, Reiter's syndrome, rickets and tuberculosis were those given by Rogers and Waldron (1995) and Haslett et al. (2004) supplemented with conditions by Maat et al. (1995). Only unequivocal cases of skeletons having adequate numbers of vertebras from all three spinal levels (cervical, thoracic and lumbar) were taken into account.

3. RESULTS

From the 109 graves 120 individuals could be examined. Main results on the sex, age at death, stature and paleopathology of the related individuals are listed per individual in Table 3. A summary of the main demographic data for the entire collection can be found in Table 4.

Sex

Of 99 skeletons the sex could be determined. The male/female ratio was found to be 9/90 (N= 99). In 97 cases the sex of the individual could be settled by assessing the 'degree of sexualization' of the pelvis and/or cranium. An attempt was made to determine the sex of skeletons missing the pelvis and cranium by using the average antero-posterior diameter (APD) of the left and right femurs and tibias. The femoral APD-range for females was 24 to 36 mm, while the range for males was 27.9 to 32.5 mm. The tibial APD-range was 21.8 to 36 mm for females and 32.9 to 37 mm for males. This resulted in two sex diagnoses out of eight sets of femurs and nine sets of tibias from ten skeletons of unknown sex. The two extra diagnosed were found to be female (2511; 2568).

Age

For 70 of the individuals the age at death could be assigned to a specific 10-year age at death interval (e.g. interval 0 = 0-9 years, 1 = 10-19 years, 2 = 20-29 years, etc.). In de churchyard the percentage of individuals younger than 20 years of age was 5.8% (7 children), while that of those older than 20 years was 92.5% (111 adults). Two individuals could not be aged (1.7%). Ages varied from 9 - 70 years (the maximum determinable skeletal age). The average age at death of those older than 20 years, the adults, was 43.2 years i.e., 43.3 for the males (N= 9) and 43.0 for the females (N= 49).

Standing living height of adults

The stature of females and males has been calculated by means of the equations of Trotter and Gleser (1958) and Trotter (1970). The resulting average stature was 159.9 cm (s.d.[2] = 4.5 cm) for 55 females and 165.8 cm (s.d. = 5.8 cm) for 8 males. As a result the estimated sexual dimorphism (difference) in body length was 5.9 cm.

Horizontal Cranial Index

The average horizontal cranial index of the females (N= 10) was 82.4 (s.d. = 4.3). This outcome falls within the brachycranic range of 80.0 and over. Of only two males the horizontal cranial index could be measured. The average was 84.7. This outcome cannot be used for comparisons or to draw conclusions on due to small sample size.

Dental status

Dental examination was possible on the complete and incomplete jaws of 76 skeletons. A total count on their dental status is given in Table 5.

A total of 1400 teeth was inspected. Ante-mortem loss was 15.5% and post-mortem loss 36.6%. The caries and abscess frequency was 10.4% and 3.1% respectively.
Average tartar (calculus) formation was defined as light. Remarkable was a single case of heavy unilateral depositing on the left side in a 51-year-old female (2551).

Paleopathology

The general health status of this late medieval female population with related occurrences of mechanical traumas (e.g. fractures), infections, deficiency diseases, tumours, arthropathies and anomalies is reflected in the frequencies of their pathological changes. See Tables 7 to 11.

DISCUSSION

Sex

The female domination in the sex ratio of the adults as determined from their skeletons (Table 4, female : male = 90 : 9) was predictable since Beguines were by definition female. The presence of nine males can be explained by the fact that Beguines usually had to appoint a confessor for their religious community (Koorn and van der Eycken, 1987). They probably buried confessors in their own cemetery if they died during their employment. Another possible explanation for the presence of male burials could be the existence of male employees required for strenuous labour within the Beguinage (Koorn and van der Eycken, 1987).

Age at death

See Fig. 3 for a graphic visualisation. For details see Table 4. The average age at death of the deceased over 20 years of age was 43.2 years overall, 43.0 years for females (N=78) and 43.1 years for males (N=9). If compared to contemporary female populations from different cities from the same time period, the average age at death of the Beguines seemed to be relatively low (see Table

[2] Standard deviation

12). A univariate analysis of variance (General Linear Model) and an Independent Sample T-test revealed no significant difference in age between the Beguines and other populations. The presence of buried children, despite the chastity vow of the Beguines, is not unusual because widows could enter the Beguinage with their children (Koorn and van der Eycken, 1987).

Standing living height

The calculated average stature of the females after Trotter and Gleser (1958) seemed to be rather small when compared to other female populations from the same time period. A comparison was made with females from Delft, Dordrecht and Gorinchem (see Table 12). But, again a univariate analysis of variance (General Linear Model) and an Independent Sample T-test revealed no significant difference in stature.

Stature can be used as indicator of the general health status of a population. In general, growth shifts in stature over the centuries are attributed to changes in socio-economic and hygienic conditions of populations (Oppers, 1966; van Wieringen, 1979; Maat, 1984, 1993, 2003; Roede and van Wieringen, 1985; Frederiks et al., 2000). It seems acceptable to assume that the Beguines do not show major genetic differences with contemporary and present inhabitants of the Netherlands. We may then conclude that the adult female stature of 159.9 cm, when compared to that of 1997 (170.6 cm; Frederiks et al., 2000) points to a fairly low health condition during growth if compared to that of the present time.

The stature of females and males was calculated by means of the equations of Trotter and Gleser (1958) and Trotter (1970). As was stated in the results, the estimated sexual dimorphism (difference) in body length was only 5.9 cm. Taking into account the very small number of males in this sample, this result should not lead to any meaningful conclusions.

Cranial Index

The number of skulls of which the cranial index could be determined was small (N= 12). The average overall index of the females was 82.4 (s.d. = 4.3). This is within the brachycranic range of 80.0 and over according to Knussmann (1988). Brachycranic means that the skulls were relatively broad compared to their length. The index should not be interpreted as a reliable indicator of ancestry, since in studies based on huge sample sizes of immigrants from various countries to the United States during the beginning of the 20th century, skull form proved to be extremely dependent on non-genetic factors (Boas, 1912). Even after a short time span, the skull form of growing children responded strongly to a change in environment (geographical position, climate).

Teeth

For details see Tables 5 and 6.

Usually many teeth are lost while the body is lying in the grave or afterwards during excavation, cleaning and transport. Post-mortem tooth loss in the Beguinage cemetery was 36.6%. When compared to other excavations (see Table 13), this percentage is fairly high.

Ante-mortem loss, a lesion typically due to caries, was 15.5%, i.e. a little more than 3 teeth per individual. Such a value, together with a caries frequency of 10.4% (almost 2 teeth per individual) and a DM(F) index (Decayed Missing Filling index) of 22.6% is an indication that tooth decay was a moderate problem amongst the Beguines. See Table 14 for a comparison of these three values with data from other periods in the history of the Low Countries.

Degrees of alveolar atrophy (tooth socket retraction), calculus formation (tartar) and periodontitis (inflammation of the histological attachment of teeth to the alveolar bone) were not alarming. All processes were slightly to moderately developed. When looking for a statistically significant correlation between these three aspects, an acceptable relationship between the presence of calculus and periodontitis was found. This seems to be a functional relationship, since the spread of calculus formation along the cemento-enamel junction will irritate the adjacent gingiva (gum) and periodontium to a state of chronic inflammation. In one female a dental wear channel/facet was found. In later periods these wear channels indicate smoking habits (Khudabux, 1991; Maat et al., 2002) but tobacco was not yet introduced in Europe at this time (Griep en Van Houtte, 1976). The (occupational?) cause of this wear channel is not known.

MAIN PATHOLOGIC BONE CHANGES IN ADULTS

A total count and frequency distribution of main pathologic changes are listed in Table 7.

Mechanical traumas

The number of individuals with healed fractures was 16 (N= 120). This accounted for 13% of the population. The males showed relatively more mechanical trauma (3) than the females, the three individuals accounted for 33% of the male population. Amongst the females only 13% (12 individuals) showed signs of healed mechanical traumas. A possible explanation could be that males who worked in the Beguinage might have been hired to do strenuous work. Four individuals (4%) had multiple healed fractures. An example was a 27-34 year old female who showed complex healed fractures of the elbow (Fig. 4), spine and foot. The spine showed avulsions of thoracic and lumbar vertebras and a scoliosis caused by these avulsions to the thoracic spine. The trauma was probably caused by one severe accident. The most frequent fractured bones were found to be clavicles (4 individuals) and ribs (3 individuals). Marks of a healed mechanical trauma were found on the frontal bone of one of the males (2513; see Fig. 5). A blow from, or a fall onto an object is likely to explain this trauma. Three females showed parturition scars on their pubic bone (see Fig. 6). As mentioned above, it was not unusual for females to enter a Beguinage after having given birth.

Mechanical traumas to the vertebras

The spines of this population also showed injuries. In 14 individuals avulsion injuries was diagnosed (N= 75; 18.7%). Avulsion injuries may be caused by rather insignificant accidents, such as for instance to loose one's footing (Maat and Mastwijk, 2000). Two females showed spondylolysis, a fatigue fracture separating the vertebral arch from the vertebral body (2.7%). In two females (2591, 2562) a compression fracture of complete vertebral bodies was noted. This kind of fracture is caused by unexpected axial force on the spine.

Infections

One individual (male) showed extensive changes caused by periostitis on the mandible (see Fig. 7). One individual of unknown sex had changes due to a unilateral periostitis on a fibula and one female unilaterally on a tibia. Unilateral periostitis is typical for a direct infection of the periosteal membrane due to a perforation through the skin. No cases of bilateral periostitis were found. The bilateral presence of periostitis (especially in the tibia) is a parameter of the infection pressure on a community, since it is due to a symmetrical haematogenous infection of body parts. The tibia is very vulnerable since the local slow bloodstream makes it relatively easy for microorganisms to settle down and colonize. The fact that no cases of bilateral periostitis were found seems to indicate that the population of the Beguinage was not exposed to very unhygienic circumstances, such as caused by overcrowding, urbanization and poor hygiene. Only two cases of a specific infection were found: tuberculosis in two females. The infection had caused characteristic non-reactive defects in the vertebral bodies of the spine.

Deficiency diseases

Rickets

Six individuals suffered from rickets (5%). For individual 2508 (female, 51-60 years) this probably also caused her scoliosis, secondary vertebral osteoarthritis and secondary peripheral osteoarthritis. Individual 2596 (unknown sex and age) also suffered from secondary peripheral osteoarthritis as a possible consequence of rickets. Comparing this percentage with other populations (see Table 15), we may conclude that the found frequency is not an unusual percentage. Rickets is caused by a lack of vitamin D. Vitamin D is produced by the skin with the help of sunlight. It is also found in animal fat. Vitamin D is required for the deposition of minerals in bone tissue (Haslett et al., 2004). A shortage causes the weight-bearing bones, especially the tibias and fibulas, to bend.

Osteoporosis

Two cases of serious osteoporosis were recorded. Osteoporosis has been divided into two groups (Aufderheide and Rodriguez-Martin, 1998; Haslett et al., 2004): Type 1, afflicting primarily post-menopausal women, is characterized by predominantly trabecular bone loss with fractures of the distal radius and vertebras. In the Beguine population the skeleton of a 54-year- old female (2542) showed so-called fish-vertebras of the thoracic and lumbar spine. The frequency is known to increase with age. Type 2 affects both genders above the age of 60, and features loss of both trabecular and cortical bone with hip and vertebral fractures. The other individual showing osteoporosis was a male of 67 years (2510).

Tumours

Because most tumours arise from non-osseous soft tissue of the body, only few examples of benign tumours, such as an osteoma (N= 5) and osteochondroma (N= 2) and malignant tumours, such as metastases (N= 3) were found in this collection. An osteoma is a benign tumour that affects more adult men than women. These bone-forming lesions are normally located on the outer surface of the skull and also on facial bones (Fig. 5). Other bones, such as the tibia, are only occasionally affected. The osteochondroma lesion often develops before the age of 30 years. About half of these tumours are found on the metaphyseal surfaces of the lower femur and upper tibia (Aufderheide and Rodriguez-Martin, 1998) (Fig. 8). Most malignant skeletal lesions are metastases. The most commonly affected bones are vertebras, pelvis, ribs, major long bones, sternum and skull. One female, 65 years of age (2517), showed cranial (Fig. 9) and tibial metastases. A 67-year-old male (2510) showed a cranial metastasis.

Arthropathies

A distinction has to be made between the disorders:

1. *Degenerative disc disease* (DDD), a degeneration of the intervertebral discs, and
2. *Vertebral* and *peripheral osteoarthritis* (vOA or pOA), a degeneration of the cartilage of the synovial joints of the vertebral arches (i.e. facet joints) or of peripheral bones (e.g. knees).

Degenerative disc disease or *vertebral osteophytosis* (DDD) results from the degeneration of the fibro-cartilaginous tissue of the intervertebral disc with increasing age. As a result disc tissue herniates from the original disc space and may press on passing nerve roots if directed dorso-laterally (nerve root compression syndromes). But in most cases the herniation protrudes anteriorly without nerve compression. In dry bone vertebras the pathology can be recognized by so-called Schmörl's nodules (disc material impressions in vertebral endplates) and by reactive osteophytes (bone protrusions) along the rim of vertebral bodies. The frequency of the affection in the Beguine population was 27.7 % (see Table 8). Compared to other populations this is relatively low (see Table 16).

Vertebral osteoarthritis (vOA)
This spine affection was noticed in 23.1% of 65 examined individuals (see Table 8). Compared to the frequency in other populations this is a relatively low percentage (see Table 17). In this common disease the degenerative process affects the cartilage of the vertebral facet joints of the vertebral arches. These synovial joints are positioned between the vertebral arches, behind the vertebral bodies. As a result of osteoarthritis the joint surface may show pitting, subchondral cysts, marginal osteophytes and in severe cases eburnation (bone-to-bone wear). Patients may complain of backache, start-up stiffness, pain and crepitus.

Peripheral osteoarthritis (pOA)
This affection, which has the same pathogenesis as *vertebral osteoarthritis*, affects non-spinal synovial joints (shoulders, elbows, hips, knees, etc.) (see Table 8). Osteoarthritis is attributed to wear and tear of joints from excessive use, but a strong constitutional (genetic) factor is also involved in its pathogenesis (Maat et al., 1995). The presence of pOA in the hip joint is recognized in 9 individuals (N= 78). This accounted for 11.5% of the population. In the Beguine population 12 individuals (N= 79) were diagnosed with pOA of the acromio-claviculair joint. This accounted for 15.2% of the population. The costo-clavicular and sterno-clavicular joints were also affected in some individuals. The presence of pOA in the shoulder-clavicular area and hip joint is an indication that the Beguines were probably doing repetitive physical labour. Possible activities would be doing the laundry and scrubbing floors.

Scheuermann's disease

Aufderheide (1998) states that the osteochondrosis of the apophyseal rings of the vertebral bodies is the lesion unique to the condition of Scheuermann's disease. But according to Zimmerman and Kelly (1982) it is caused by hampered vascularisation of the intervertebral discs. Its onset usually occurs between the ages of 12 and 18. Usually, the apex of the kyphotic curvature falls close to the 8th-10th thoracic vertebras (Ortner and Putchar, 1985). Some skeletal collections report a male predominance, while others show no gender predilection. This rather common disease was found in a Beguine of between 35 and 55 years. In this case the main changes were anterior extensions of vertebral bodies, fragmentation of endplates, wedging of vertebral bodies and Schmörl's nodules. It should be mentioned that references to such deformities are quite rare in the paleopathological literature (Onisto et al., 1998; Ortner and Putschar, 1985). This is probably because vertebras do not preserve as well as many other parts of the skeleton. In addition, kyphosis can only be diagnosed if one takes the trouble to articulate the complete spine.

Osteochondritus dissecans

Osteochondritus dissecans (*aseptic/avascular bone necrosis*) is a benign, non-inflammatory condition of young adults characterized by the production of small, focal epiphyseal areas of necrosis on the convex surfaces of diarthrodial joints, resulting in partial or complete detachment of a segment of the subchondral bone and articular cartilage (Aufderheide and Rodriguez-Martin, 1998; Rogers and Waldron, 1995). Three cases (5%) were found (see Table 8), one in a male and two in females. This condition, with a partially genetic cause, is quite often recorded in the paleopathological literature. Usually it is more commonly seen in males than in females. The knee is the affected joint in 90% of the cases.

Reiter's syndrome

Reiter's syndrome is called a sero-negative arthropathy because it cannot be diagnosed with the help of a positive blood reaction, while at the same time the changes in the skeleton are similar to those of sero-positive arthropathies. Reiter's syndrome consists of non-specific urethritis, conjunctivitis and polyarthritis. Recently most cases have shown to be related to the bacterium *Chlamydia trachomatis*. Urethritis and conjunctivitis are direct infections by this organism, while the polyarthritis is usually sexually transmitted. It is most commonly found in men. In the Beguine population a male and female were diagnosed with having Reiter's syndrome. Their skeletons showed bilateral sacro-iliitis together with spine and arthrotic changes of the large peripheral joints (e.g. Fig. 10 and 11).

Miscellaneous pathological changes
(for details see Table 9)

Diffuse Idiopathic Skeletal Hyperostosis (DISH)

The slowly progressing disease of DISH (*diffuse idiopathic skeletal hyperostosis*; Forestier's disease) ossifies ligaments and joint capsules, muscle attachments on bones (tendon insertions) and cartilaginous structures with increasing age. It slowly makes the body more rigid. From the literature there is strong evidence that a plentiful diet is a predictive factor to develop this disease (Waldron, 1985; Rogers and Waldron, 1995; Janssen and Maat, 1999; Haslett et al., 2004). Of the 75 individuals that could be examined 28% (N= 21) suffered from DISH. Because criteria for the diagnosis differ between the various authors, an interpopulational comparison was only made of skeleton material inspected by G. Maat (see Table 18). The value of 28% is neither high nor low. This indicates that the people buried in this cemetery were from an average social class and that their nutritional state was average as well. An example of ankylosis caused by DISH is shown in Figure 12.

Paget's disease

Sir James Paget originally described Paget's disease as 'osteitis deformans' in 1877. It is a disease of considerable antiquity, usually affecting those over 40 years and most commonly over the age of 60. Although it has an unknown aetiology, it is suspected to be the result of a slow viral infection (Aufderheide and Rodriguez-Martin, 1998; Cox and Mays, 2000). According to Haslett et al. (2004) genetic factors are clearly important but, environmental factors, however, may also be important. Paget's disease affects most bones of the body. Under the microscope an irregular texture is visible. The disease results in hyper-remodelling of bone tissue. A thickening of the vault, of the pelvis as well as of the long bones is typical. Excessive bone breakdown and formation results in bone that is fragile. Complications may include arthritis, fractures, bending of limb bones and loss of hearing if Paget's disease affects the skull. Two cases of Paget's disease were diagnosed.

Hyperostosis frontalis interna

Hyperostosis frontalis interna is a peculiar thickening of the frontal bone composed of an expansion of the diploic trabecular mass budging only inwardly into the cranial cavity. It is found almost exclusively in women, only about 10% of which are less than 30 years of age (Aufderheide and Rodriguez-Martin, 1998). Within the Beguine population it was noticed in two females (2532, 2561). The origin of this change in bone structure is a matter of debate. Some possible causes are mentioned in the literature, for example: hormonal change, viral origin (Aufderheide and Rodriguez-Martin, 1998) or tumour growth (Robbins, 1968).

Allen's fossa

Femora of eight individuals showed bilateral Allan's fossae and one had Poirier's facets. An Allen's fossa is a smooth depression at the antero-superior surface of the femoral neck. It is said to develop by pressure from the tendon of the rectus femorus muscle (one of the muscles that flex the hip joint). It has been suggested that this pressure results from frequent squatting (Mann and Murphy, 1990). Maat et al. (2002) stated that this theory does not explain sufficiently the high frequency of Allen's fossa (32%) noted in the early 19th century population of 's-Hertogenbosch. There should be additional explanations. In many of their cases (19%) the anterior femoral neck also showed cribra femora. Cribra femora have a more caudal position on the femoral neck. An Allen's fossa should not be confused with a so-called Poirier's facet (Kennedy, 1989; Mann and Murphy, 1990). This is a lateral extension of the articular surface of the femoral head over the antero-superior part of the neck. Some authors suggested that these facets develop from the frequent use of very or too low seats (e.g., Kennedy, 1989).

Bell's palsy

A single case of heavy unilateral deposition of tartar on the left side of the jaws was noticed in a 51-year-old female (Fig. 13). A so-called Bell's palsy could have caused this. The cause is unknown but recent evidence suggests that Bell's palsy may be due to reactivation of latent herpes virus infection (Haslett et al., 2004). As a result, this individual would not have been able to use the left side of her mouth, thus resulting in heavy depositing of tartar.

Bladder stones

Bladder stones (Fig. 14) are crystal masses made from the minerals and proteins found in urine. Stones can form anywhere in the urinary system, but end up in the bladder. The most common types contain calcium salts. The causes of bladder stones are not completely understood. Diet and fluid intake appear to be important factors. There is also a strong association with poverty, malnutrition or a lack of protein and phosphate (Haslett et al., 2004). Within the Beguine population, three individuals with bladder stones were found.

Anomalies

Many anomalies were noted. See for details Table 10.

Scoliosis et causa ignota (e.c.i.)

Except for serious scoliosis, the mild form has little clinical consequences. Scoliosis illustrates human variation and flexibility in genesis. The frequency in which it was found is typical.
Scoliosis e.c.i., lateral bending of the vertebral column, was seen to a moderate degree in two (2.7%) of 75 spines. Like in most clinical cases the origin remained unknown. Rickets, a possible cause, could not be confirmed in these recorded cases (see the one case with rickets above).

Spina bifida occulta

Spina bifida occulta is a congenital defect of the spine, by which the arches of one or more vertebras did not close. Most cases of spina bifida occulta occur in the lumbosacral region. In life they are covered by skin and therefore invisible from the exterior (occulta). The frequency of this disorder in the Beguine population was 5%.

CONCLUSIONS

The study of the mainly female skeleton remains from the Beguinage cemetery of the city of Breda has produced results that are complementary to historical and archaeological observations. When compared to the physical anthropological results of other skeleton collections from various periods of other Dutch cities, we may conclude that life expectancy, stature, incidence of infectious diseases, deficiency diseases and joint degenerations show that the overall health situation in the Beguinage of Breda between 1296 and 1535 was very reasonable. That seems only possible if this female community was capable of sustaining themselves economically. Nevertheless it would be very interesting to compare the health situation of different Beguine populations in the Low Countries.

ACKNOWLEDGEMENTS

We wish to thank G. van der Eynde, N. Digby and their team of archaeologists and amateur archaeologists, at the time associated with the *Archeologische Dienst Breda*, for their careful excavation and cleaning of the human skeletons. We would also like to acknowledge the Department of Anatomy of the Leiden University Medical Center for the allocation of space and the opportunity to examine the skeletons over a period of five years. We especially wish to thank J.H. Lens for the photography and R.W. Mastwijk and R. Panhuysen for their advice. We also wish to thank S. Rijpma and Kelly Fennema for correcting the English manuscript.

REFERENCES

Acsádi, G. and Nemeskéri, J. History of human life span and mortality. Hungarian Academic Society, Budapest, 1970.

Aten, N. 'Het onderzoek van de skeletten. De geslachtsdiagnose en de leeftijdsdiagnose'. In: De doden vertellen. Opgraving in de Broerenkerk te Zwolle 1987-1988 (Clevis, H. and Constandse-Westermann, T., eds.). Stichting Archeologie IJssel/Vechtstreek, 67-97, 1992.

Aufderheide, A.C. and Rodriguez-Martin, C. The Cambridge encyclopedia of human paleopathology. Cambridge University Press, Cambridge, 1998.

Baetsen, S. 'Graven in de Grote Kerk'. Rapporten over de Alkmaarse Monumentenzorg en Archeologie, No. 8., with an English summary (Baetsen, S. and Bitter, P.). Municipality of the city of Alkmaar, 2001.

Boas, F. Changes in the bodily form of descendants of immigrants. American Journal of Physical Anthropology NS., 14: 530-562, 1912.

Breitinger E. Zur Berechnung der Köperhöhe aus den langen Gliedmassenknochen. Anthropologische Anzeiger 14: 249-274, 1937.

Brothwell, D.R. Digging up bones. 3rd ed. British Museum. Oxford University Press, Oxford, 1981.

Cox, M. and Mays, S. Human Osteology In Archaeology and Forensic Science. Greenwich Medical Media Ltd., 2000.

Digby, N. Preliminary Excavation Report, Park Valkenberg, Breda, n.d.

Frederiks, A.M., Buren, S. van, Burgmeijer, R.J.F., Meulmeester, J.F., Beuker, R.J., Brugman, E., Roede, M.J., Verloove-Vanhorick, S.P., Wit, J.-M. Continuing positive secular growth change in the Netherlands 1955-1997. Pediatric Research 47: 316-323, 2000.

Griep, Jac. L en Houtte, J.A. van (red.). De Grote Oosthoek. Encyclopedie en woordenboek. Zevende uitgave, 1976- , Utrecht, 1976.

Haslett, C., Chilvers, E.R., Boon, N.A., Colledge, N.R., Hunter, J.A.A (eds.). Davidson's. Principles and Practice of Medicine, 19th edition. Churchill Livingstone, Edinburgh, 2004.

Janssen, H.A.M. and Maat, G.J.R. Canons buried in the 'Stiftkapel' of the Saint Servaas Basilica at Maastricht, 1070-1521 AD. A physical anthropological study. Leiden, Barge's Anthropologica 5: 1-40, 1999.

Knussmann, R. Anthropologie. G. Fischer, Stuttgart, New York, 1988.

Koorn, F. and van der Eycken, M. Begijnen in Brabant: de begijnhoven van Breda en Diest, Esso uitgave, Breda and Antwerpen, 1987.

Khudabux, M.R. Effects of life conditions on the health of a Negro community in Suriname. With reference to similar aspects in local pre-Columbian Amerindians. Thesis, Leiden University, Leiden, 1991.

Lonnée, H.A. and Maat, G.J.R. Inhumations in a Roman cemetery at Valkenburg-Marktveld (Zuid-Holland) in The Netherlands. Leiden, Barge's Anthropologica 3: 1-50, 1998

Maat, G.J.R. A search for secular growth changes in The Netherlands preceding 1850. In: Human Growth and Development. Borms, J., Hauspie, R., Sand, A., Susanne, C., Hebbelinck, M. (eds.). New York, Plenum Press, 185-191, 1984.

Maat, G.J.R., Hanveld, G.T., Brink, M.R.M. van en, and Mulder, W.J. A quantitative study on pathological changes in human bones from the 17th and 18th centuries excavated in the "Hoogland Church", Leiden. In: Proceedings Paleopathology Association, 4th European Meeting Middelburg/Antwerpen, 1982 (Haneveld, G.T., Perizonius, W.R.K. and Janssens, P.J., eds.). Utrecht, Paleopathology Association, 82-93, 1984

Maat, G.J.R. and Van der Velde, E.A. The caries attrition competition. International Journal of Anthropology 2: 281-92, 1987.

Maat, G.J.R. Growth changes in bones. A means of assessing health status and the relative position of secular growth shift in stature. In: E. Iregren and R. Liljekvist (eds.). Populations of the Nordic Countries. Human population biology from the present to the Mesolithic. Lund, Institute of Archaeology report Series 46: 88-93, 1993.

Maat, G.J.R., Mastwijk, R.W. and Van der Velde, E.A. Skeletal distribution of degenerative changes in vertebral osteophytosis, vertebral osteoarthritis and DISH. International Journal of Osteoarchaeology 5: 289-298, 1995.

Maat, G.J.R., Mastwijk, R.W. and Van der Velden, E.A. On the reliability of non-metrical morphological sex determination of the skull compared with that of the pelvis in The Low Countries. International Journal of Osteoarchaeoloy 7: 575-580, 1997.

Maat, G.J.R., Mastwijk, R.W. and Sarfatij, H. A physical anthropological study of burials from the graveyard of the Franciscan Friary at Dordrecht, circa 1275-1572. Rapportage Archeologische Monumentenzorg 67. State Archaeological Service (ROB), Amersfoort, 1998.

Maat, G.J.R., Panhuysen, R.G.A.M. and Mastwijk, R.W. Manual for the Physical Anthropological Report. Leiden, Barge's Anthropologica 6: 1-50, 1999.

Maat, G.J.R. and Mastwijk, R.W. Avulsion injuries of vertebral endplates. International Journal of Osteoarchaeology 10: 142-152, 2000.

Maat, G.J.R., Mastwijk, R.W. and Jonker, M.A. Citizens buried in the 'Sint Janskerkhof' of the 'Sint Jans' Cathedral of 's-Hertogenbosch in the Netherlands ca. 1450 and 1830-1858 AD. Leiden, Barge's Antropologica 8: 1-28, 2002.

MacLaughlin, S.M. and Bruce, M.F. A simple univariate technique for determining sex from fragmentary femora: its application to a Scottish short cyst population. American Journal of Physical Anthropology 67: 413-417, 1986.

Mann, R.W. and Murphy, S.P. Regional atlas of bone disease. A guide to pathologic and normal variation in the human skeleton. Ch.C. Thomas, Springfield, 1990.

Mays, S. The archaeology of human bones. Routledge, London, 1998.

Onisto, N., Maat, G.J.R. and Bult, E.J. Human remains from the infirmary "Oude en Nieuwe Gasthuis" of the City of Delft in the Netherlands 1265-1652 AD. Leiden, Barge's Anthropologica 2: 1-43, 1998.

Ortner, D.J. and Putschar, W.G.J. Identification of pathological conditions in human skeletal remains. Smithsonian Institution Press, Contribution Nr. 28, Washington, 1985.

Rogers, J. and Waldron, T. A field guide to joint disease in archaeology. Wiley and Sons, Chichester, 1995.

Steinbock, R.T. Paleopathological Diagnosis and Interpretation. C. Thomas, Springfield, 1976.

Trotter, M. and Gleser, G.C. Estimation of stature from the long bones of American whites and Negroes. American Journal of Physical Anthropology NS 10: 463-514, 1952.

Trotter, M. and Gleser, G.C. A re-evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death. American Journal of Physical Anthropology NS 16: 79-123, 1958.

Trotter, M. Estimation of stature from intact limb bones. In: Personal identification in mass disasters (Steward, T.D., ed.), National Museum of History, Washington, 1970.

Ubelaker, D.H. Human skeletal remains. Excavation, analysis, interpretation. Taraxacum, Washington, 1978.

Waldron, T. DISH at Merton Priory : evidence for a 'new' occupational disease? British Medical Journal 291: 1762-1763, 1985.

Waldron, T. Counting the dead. The epidemiology of skeletal populations. Chichester, New York, Wiley, 1994.

Workshop of European Anthropologists, Recommendation for age and sex diagnosis of skeletons. Journal of Human Evolution 9: 517-549, 1980.

Zimmerman, M.R. and Kelly, M.A. Atlas of Human Paleopathology. Praeger, New York, 1982.

OTHER VOLUMES OF THE SERIES "BARGE'S ANTHROPOLOGICA"

Janssen, H.A.M. and G.J.R. Maat
Kanunniken begraven in de Stiftskapel van de Sint Servaas te Maastricht, 1070-1521 na Chr. Een paleopathologisch onderzoek. 2de druk. Leiden, Barge's Anthropologica 1: 1-40, 1998.
ISBN: 90-806456-5-6

Onisto, N., Maat, G.J.R. and E.J. Bult
Human remains from the infirmary "Oude en Nieuwe gasthuis" of the City of Delft in The Netherlands 1265-1652 AD. Leiden, Barge's Anthropologica 2: 1-43, 1998.

Lonnée, H.A. and G.J.R. Maat
Inhumations in a Roman cemetery at Valkenburg-Marktveld (Zuid-Holland) in The Netherlands. Leiden, Barge's Anthropologica 3: 1-50, 1998.

Maat, G.J.R. and J.-J. Verlaan
The search for Willem Barentsz. Report on the International Nova Zemble Expedition 1998. 2nd edition. Leiden, Barge's Anthropologia 4: 1-22, 2001.
ISBN: 90-806456-1-3

Janssen, H.A.M. and G.J.R. Maat
Canons buried in the "Stiftskapel" of the Saint Servaas Basilica at Maastricht, 1070-1521 AD. A paleopathological study. Leiden, Barge's Anthropologica 5: 1-40, 1999.

Maat, G.J.R., Panhuysen, R.G.A.M. and R.W. Mastwijk
Manual for the Physical Anthropological Report. 3rd edition. Leiden, Barge's Anthropologica 6: 1-50, 2002.
ISBN: 90-806456-2-1

Maat, G.J.R., van den Bos, R.P.M. and M.J. Aarents
Manual for the preparation of ground sections for the microscopy of bone tissue. 2nd print. Leiden, Barge's Anthropologica 7: 1-18, 2002.
ISBN: 90-806456-6-4

Maat, G.J.R., Mastwijk, R.W. and M.A. Jonker
Citizens buried in the 'Sint Janskerkhof' of the 'Sint Jans' cathedral of 's-Hertogenbosch in The Netherlands, ca. 1450 and 1830-1858 AD. Leiden, Barge's Anthropologica 8: 1-62, 2002.
ISBN: 90-806456-3-X

Van den Bos, R.P.M. and G.J.R. Maat
Cremated remains from a Roman burial site in Tiel-Passewaaij (Gelderland). Leiden, Barge's Anthropologica 9: 1-37, 2002.
ISBN: 90-806456-4-8

Maat, G.J.R., Aarents and N.J.D. Nagelkerke
Age prediction from bone replacement. Remodeling of circumferential bone tissue in the anterior cortex of the femoralshaft of the present Dutch population. Leiden, Barge's Anthropologica 10: 1-44, 2003.
ISBN: 90-806456-7-2

Table 1.
SKELETON IN RELATION TO THE BUIDLING PHASES OF THE BEGUINE CHURH

Skeleton Nr.	Inside Church	Phase	Skeleton Nr.	Inside Church	Phase	Skeleton Nr.	Inside Church	Phase
2501		2	2549		2	2594		2
2502		2	2550A		2	2595		2 (1)
2503		2	2550B		2	9501		2
2504		2	2550C		2	9503		2
2506		2	2551		2	9505		1
2508		2	2552		2 (1)	9506		1
2509B		2	2553		1 (2)	9507		2
2511		2	2555		2	9508		2
2512		2	2556A		2	9509		2
2514		2	2556B		2	9510		2
2515		2	2557		2	9511		2
2516	Yes	2 (3)	2558		2	2507		2
2517	Yes	2 (3)	2559		2	2510		3
2518		2	2560		2	2513		2
2519		2	2561		2	2523	Yes	2 (3)
2520		2	2562		2	2527		2
2521	Yes	2 (3)	2563		2	2588		2
2522	Yes	2 (3)	2564		2	9502		2
2524	Yes	2 (3)	2565		2	9504		2
2526		2	2566		2	2500		3
2529		2	2568		2	2505		2
2530A		2	2569		2	2509A		2
2530B		2	2571A		2	2525		3
2531		2	2571B		2	2541B		2
2532		2	2572		2	2548		2
2533		2 (1)	2573		2	2554		2 (1)
2534		2	2574		2	2567		2
2535		2	2575		2	2570		2
2536		2	2577		2	2571C		2
2537		2	2578		2	2576		2
2538		2	2580		1	2579A		2
2539		2	2582		1	2579B		2
2540		2	2584		2 (1)	2581		2
2541A		2	2585		2	2583		2
2542		2	2587		2	2586		2
2543		2	2589		2	2596		2
2544		2	2590		2 (1)	2597		2
2545		2	2591		2	2598		2
2546		2	2592		2	2599		2
2547		2	2593		2	9500		2

Table 2. TOTAL COUNT OF MAJOR BONES FROM ADULTS
(120 individually distinct, but incomplete, skeletons)

Bone	N with Right & Left	N with Right or Left	Total
Cranium			87
Mandible			79
Atlas			56
Spine*			80
Spine**			75
Clavicle	63	17	143
Humerus	69	24	162
Radius	62	22	146
Ulna	62	23	147
Femur	75	15	165
Tibia	76	10	162
Fibula	71	14	156

*= vertebras present
**= most vertebras present
N = number of individuals

Table 3. MAIN DEMOGRAPHIC DATA PER INDIVIDUAL (1296-1535 AD) (120 individually distinct, but incomplete, skeletons)

Skeleton Nr.	Grave Nr.	Cranial Index	Pelvis (1)	Pelvis (2)	Cranium (1)	Cranium (2)	Sex (3)**	Age Min.(4)	Age Max. (5)	Interval (6)	Trotter (cm;'58,'70)	Main pathology (7)
2502	**2630**		**-0.89**	**19**	**-1.63**	**32**	**1**	43.33	49.33	4	159.31	metopic suture
2503	**2635**		**-1.17**	**12**	**-1**	**30**	**1**	21.00	24.00	2	160.40	
2504	**2634**		**-1.45**	**11**			**1**	51.00	66.00	5	161.29	DISH;pOA (Fig. 15); vOA; sternal foramen
2506	**2638**	**72.58**	**-1.08**	**12**	**-1**	**31**	**1**	38.33	44.33	4	156.40	DISH; vOA; sacralization L6; Allen's fossa; acromion trauma (Fig. 16)
2508	**2639**		**-1.3**	**12**			**1**	51.00	60.00	5	168.00	Rachitis + secondary scoliosis, vOA and pOA
2509B			**-1.27**	**12**	**-1.41**	**20**	**1**	18.00	25.00	1	150.51	DDD; DISH
2511	**2643**						**1**	18.00	19.00	1		avulsion Th10
2512	**2644**		**-1.17**	**11**	**-0.85**	**25**	**1**	48.00	57.00	4	165.79	DISH; vOA; pOA; osteochondritis dissecans
2514	**skull**				**-1.15**	**20**	**1**	34.00	60.00			
2515	**skull**				**-1.2**	**15**	**1**	40.00	80.00			
2516Ch	**2618**		**-1.3**	**10**	**-1.5**	**20**	**1**	30.00	36.00	3	169.44	pOA; DDD; avulsion
2517Ch	**2621**		**-1**	**12**	**-1.46**	**26**	**1**	62.50	67.50	6	160.21	DISH; avulsion; foramen olecrani; fracture of costa; bladder stones; metastases
2518	**2642**		**-1.75**	**8**	**-0.73**	**22**	**1**	40.00	49.00	4	152.65	
2519	**2646**	**88.02**	**-1.25**	**12**	**-0.73**	**30**	**1**	28.33	34.33	3	164.15	os epiptericum
2520	**2647**				**-1.24**	**25**	**1**	23.00	34.00	2		
2521Ch	**2607**		**-0.75**	**12**	**-1.24**	**17**	**1**	30.00	36.00	3	163.35	pOA; Poirier's facet; periostitis; osteoma; tuberculosis
2522Ch	**2608**		**-1.3**	**10**	**-1**	**18**	**1**	34.00	58.00		159.95	pOA; avulsion; hyperostosis frontalis interna; facial infection
2524Ch	**2628**				**-0.55**	**11**	**1**	40.00	80.00			
2526	**2651**		**-1**	**12**	**-1.22**	**18**	**1**			3	153.76	fracture of clavicle and femur
2529	**2650**				**-1.63**	**8**	**1**	34.00	40.00	3		
2530A	**2653**				**-1**	**20**	**1**	23.00	34.00	2		
2530B			**-1.5**	**6**			**1**					
2531	**2658**				**-1.68**	**31**	**1**	41.00	58.00		157.76	DISH; pOA
2532	**2657**	**83.3**	**-1.28**	**18**	**-1.03**	**32**	**1**	43.33	49.33	4	149.20	Paget's disease; spina bifida occulta S3, S4, S5

Skeleton Nr.	Grave Nr.	Cranial Index	Pelvis (1)	Pelvis (2)	Cranium (1)	Cranium (2)	Sex (3)**	Age Min.(4)	Age Max. (5)	Interval (6)	Trotter (cm;'58,'70)	Main pathology (7)
2533	**2654**				**-0.33**	**9**	**1**	23.00	40.00			
2534	**2659**				**-1.71**	**7**	**1**	23.00	40.00			
2535	**2700**				**-1.44**	**27**	**1**	40.00	80.00			
2536	**2704**		**-1.08**	**12**	**-0.72**	**18**	**1**	53.33	59.33	5	156.94	pOA; avulsion; fracture of navicular bone
2537	**2680**	**84.43**	**-1.31**	**13**	**-0.5**	**30**	**1**	33.25	38.25	3	158.60	fracture of costa
2538	**2705**		**-1.5**	**12**	**-0.88**	**8**	**1**	28.00	37.00	2	153.96	avulsion; vOA, fracture of phalanx distal I (big toe)
2539	**2706**		**-1.07**	**14**	**-0.4**	**5**	**1**	50.67	56.67	5	165.30	DISH; vOA; DDD; pOA
2540	**2701**				**-0.9**	**20**	**1**	34.00	40.00			hyperostosis frontalis interna (beginning)
2541A	**2707**		**-1**	**10**	**-1.06**	**32**	**1**	25.00	34.00	2	155.89	tuberculosis, fracture of clavicle and olecranon; abscess; spina bifida occulta S1; os lambdoideum; bladder stones
2542	**2708**		**-1.33**	**12**			**1**	51.33	57.33	5	166.60	osteoporosis; avulsion; Allen's fossa
2543	**2709**	**87.6**	**-1.32**	**19**	**-1.19**	**32**	**1**	28.00	33.00	3	157.40	osteoma; scoliosis; Allen's fossa; spina bifida occulta S1
2544	**2756**		**-1.36**	**14**	**-0.91**	**32**	**1**	48.67	54.67	5	164.10	parturition scar; sacrilization of L6; rachitis
2545	**2710**		**-0.45**	**11**			**1**	37.00	46.00	3	160.51	rachitis
2547	**2712**		**-1.58**	**19**	**-1.75**	**32**	**1**	28.00	33.00	3	158.37	fracture of femur; spondylolysis L5
2549	**2716**		**-1.3**	**10**	**-0.81**	**22**	**1**	48.00	54.00	4		lumbalization S1; hyperostosis frontalis interna
2550A	**2719**		**-1.6**	**10**	**-1.36**	**25**	**1**	35.00	55.00		166.22	Scheuermann's disease; scoliosis; pOA; abscess; avulsion; haematoma L5-S1
2550B			**-1.25**	**12**			**1**					
2550C			**-1.14**	**14**			**1**					parturition scar
2551	**2715**		**-1.07**	**15**	**-1.04**	**25**	**1**	48.67	54.67	5	159.44	DISH; Bell's palsy
2552	**2718**		**-1.8**	**10**			**1**	40.00	60.00		161.00	
2553	**2722**				**-0.61**	**23**	**1**	47.00	63.00			uncovertebral OA
2555	**2723**				**-1.18**	**11**	**1**	23.00	40.00			
2556A	**2727**		**-0.71**	**7**	**-0.79**	**24**	**1**	43.00	59.00		157.43	uncovertebral OA; DISH (beginning)
2556B					**-1.42**	**19**	**1**	30.00	60.00			hyperostosis frontalis interna
2557	**2724**				**-1**	**11**	**1**	40.00	80.00			
2558	**2726**						**1**	27.00	34.00	2		DISH; pOA; avulsion; scoliosis; osteoma os frontalis; metopic suture; fractures of radius, ulna and several distal phalanx I of one foot

Skeleton Nr.	Grave Nr.	Cranial Index	Pelvis (1)	Pelvis (2)	Cranium (1)	Cranium (2)	Sex (3)**	Age Min.(4)	Age Max. (5)	Interval (6)	Trotter (cm;'58,'70)	Main pathology (7)
2559	**2730**		**-0.78**	**9**			**1**	37.00	46.00	3	157.42	pOA
2560	**2731**		**-1**	**9**			**1**				157.68	
2561	**2735**		**-0.89**	**19**	**-1.61**	**31**	**1**	42.33	48.33	4	152.16	vOA; pOA; Paget's disease; avulsion; fracture of radius; spina bifida occulta; osteochondritis dissecans
2562	**2725**	**80.92**	**-1**	**9**	**-0.59**	**32**	**1**	46.00	52.00	4	164.47	DISH; Reiter's syndrome; pOA; osteoma; bladder stones; impression fracture of vertebras (Fig. 17)
2563	**2737**		**-1**	**4**	**-0.67**	**3**	**1**					
2564	**2750**		**-1**	**12**			**1**	40.00	70.00	4	157.79	foramen olecrani
2565	**2738**		**-1**	**6**	**-1.4**	**20**	**1**	34.00	40.00	3		vOA; metopic suture
2566	**2740**		**-1.5**	**6**	**-0.35**	**23**	**1**	30.00	60.00	3		foramen olecrani
2568	**2744**						**1**	15.00	18.00	1		
2569	**2743**		**-1.8**	**10**	**-1.39**	**23**	**1**	50.00	65.00	5	157.09	avulsion haematoma
2571A	**2746**		**-1**	**10**			**1**	40.00	70.00	4	164.82	DISH; vOA; pOA
2571B			**-0.5**	**6**	**-1.4**	**5**	**1**			2		pOA
2572	**2753**				**-2**	**3**	**1**	23.00	40.00	2		
2573	**2757**		**-1.67**	**12**			**1**	30.00	60.00	3	161.46	
2574	**2758**		**-1.64**	**14**	**-0.75**	**28**	**1**	52.00	61.00	5	159.12	pOA; vOA; foramen olecrani (left)
2575	**2759**		**-2**	**3**			**1**					
2577	**2765**	**82.2**	**-1.94**	**16**	**-1.97**	**32**	**1**	26.00	32.00	2	162.56	rachitis
2578	**2768**		**-0.83**	**12**			**1**	40.00	60.00	4	160.02	DISH (beginning)
2580	**2767**		**-1.6**	**5**	**-1**	**14**	**1**	23.00	40.00	2		fracture of clavicle
2582	**2770**				**-1**	**6**	**1**					
2584	**2771**		**-1**	**3**	**-1**	**16**	**1**	23.00	40.00	2		DDD
2585	**2803**				**-0.95**	**20**	**1**	40.00	80.00	4		
2587	**2805**				**-1**	**23**	**1**	23.00	40.00	2		DISH
2589	**2818**		**-1.33**	**12**	**-1.46**	**26**	**1**	34.00	40.00	3	167.23	fracture of clavicle; metopic suture; avulsion; Allen's facet; sinusitis
2590	**2808**		**-1.71**	**7**	**-1.23**	**13**	**1**	19.00	28.00	2		metopic suture; foramen olecrani

Skeleton Nr.	Grave Nr.	Cranial Index	Pelvis (1)	Pelvis (2)	Cranium (1)	Cranium (2)	Sex (3)**	Age Min.(4)	Age Max. (5)	Interval (6)	Trotter (cm;'58,'70)	Main pathology (7)
2591	**2809**	**82.51**	**-1.42**	**19**	**-1.2**	**25**	**1**	24.00	30.00	2	167.09	parturition scar; impression fracture of vertebras
2594	**2815**		**-0.81**	**16**	**-1.52**	**31**	**1**	21.00	23.00	2	161.52	foramen olecrani
2592	**2810**		**-1.55**	**11**	**-0.96**	**26**	**1**	34.75	39.75	3	153.62	DISH
2593	**2822**		**-0.95**	**19**	**-0.93**	**30**	**1**	40.33	46.33	4	162.00	DISH
2595	**2816**		**-1.5**	**10**	**-1.35**	**20**	**1**	55.00	61.00	5	155.40	DISH; avulsion; pOA;
9501	**2807**		**-1.42**	**12**	**-0.5**	**26**	**1**	33.00	39.00	3	158.60	vOA; pOA; Allen's fossa
9503	**2825**		**-1**	**10**	**-0.68**	**28**	**1**	52.00	61.00	5		
9505	**2813**		**-1.71**	**7**	**-2**	**12**	**1**	25.00	34.00	2		
9506	**2811**		**-1**	**3**	**-1.32**	**25**	**1**	40.00	80.00	4		pOA; metopic suture
9507	**2819**		**-0.79**	**14**	**-1.22**	**23**	**1**	22.00	23.00	2	156.94	distinct arachnoideal granulations; osteochondritus dissecans
9508	**2817**		**-1.57**	**14**	**-0.53**	**30**	**1**	53.33	59.33	5	161.17	pOA; spondylolysis; Allen's facet; haematoma
9509	**2821**		**-1.38**	**8**	**-0.88**	**25**	**1**	51.00	57.00	5	163.81	DISH; pOA; foramen olecrani; scoliosis
9510	**2886**	**81.23**	**-1.33**	**18**	**-1.53**	**32**	**1**	31.33	37.33	3	156.61	avulsion
9511	**2887**	**81.32**	**-1**	**8**	**-0.64**	**25**	**1**	43.33	49.33	4		
2501	**2629**		**0.31**	**18**	**0.5**	**27**	**2**	45.25	50.52	4	160.28	DISH; Reiter's syndrome; foramen olecranon; rachitis
2507	**2640**		**0.56**	**16**	**1.45**	**29**	**2**	26.75	31.75	2	167.39	DISH; pOA
2510	**2611**		**0.25**	**8**	**0.8**	**15**	**2**	62.00	71.00	6	158.30	pOA; DDD; fracture of ulna; osteoporosis; metastases; osteoma
2513	**2645**		**1.16**	**19**	**1.38**	**32**	**2**	39.50	44.00	4	172.47	Allen's fossa; metopic suture; fracture of frontal bone; foramen olecrani; extra facets on mandible (Fig. 19); costo-clavicular facet (Fig. 20)
2523Ch	**2670**		**1**	**10**	**0.6**	**20**	**2**	37.33	43.33	4	162.93	DISH; DDD; pOA; fracture of 2 ribs; periostitis mandibulae; abscess
2527	**2652**				**1.9**	**21**	**2**	30.00	60.00			
2588	**2806**				**0.86**	**22**	**2**	34.00	40.00	3		hyperostosis frontalis interna
9502	**2812**	**84.57**	**2.27**	**11**	**0.8**	**25**	**2**	36.00	42.00	3	175.74	Allen's fossa; osteochondritus dissecans; osteoma
9504	**2814**	**84.83**	**0.95**	**19**	**1**	**25**	**2**	42.75	48.75	4	163.52	avulsion; extra teeth
2500	**2622**						**3**	18.00	25.00	1		
2505	**2636**						**3**	7.00	11.00	0		
2509A	**2641**						**3**	18.00	20.00	1		

Skeleton Nr.	Grave Nr.	Cranial Index	Pelvis (1)	Pelvis (2)	Cranium (1)	Cranium (2)	Sex (3)**	Age Min.(4)	Age Max. (5)	Interval (6)	Trotter (cm;'58,'70)	Main pathology (7)
2525	**2786**						**3**	8.50	9.00	0		
2541B							**3**	9.00	11.00	0		
2548	**2713**						**3**					
2554	**2720**						**3**					
2567	**2748**						**3**	15.00	18.00	1		
2570	**2749**						**3**	40.00	60.00	4		
2571C							**3**					
2576	**2760**						**3**	48.00	56.00	4	155.68	
2579A	**2763**						**3**	19.00	24.00	1		
2579B							**3**				163.91	periostitis; eburnation of patella
2581	**2761**						**3**					
2583	**2777**						**3**	40.00	60.00	4	162.16	
2586	**2804**						**3**					
2596	**2778**						**3**					pOA; rachitis
2597	**2779**						**3**				164.80	exosteosis distal end fibula (Fig. 21)
2598	**2840**						**3**					
2599	**2823**						**3**				159.68	
9500	**2841**						**3**					

1: degree of sexualization
2: weight of sex indicators
3: 1 = female, 2 = male, 3 = unknown
4: minimum age (years)
5: maximum age (years)
6: e.g. 5 = 50-59 years
7: DDD = degenerative disc disease
vOA = vertebral osteoarthritis
pOA = peripheral osteoarthritis
OA = osteoarthritis
DISH = diffuse idiopathic skeletal hyperostosis

Table 4. MAIN DEMOGRAPHIC DATA (1296-1535 AD)

	(varia)	s.d.	N inspected
Number of individually distinct skeletons			120
Horizontal cranial index (10♀ / 2♂)	82.4	4.3	34
Percentage of adult males	7.5%		9
Percentage of adult females	75.0%		90
Adults of unknown sex	17.5%		12
Percentage of individuals under 20 years	5.8%		7
Percentage of individuals over 20 years	92.5%		111
Individuals of unknown age	1.7%		2
Mean age of death of population over 20 years	43.2	11.5	89
Idem, for males (years)	43.1	10.5	9
Idem for females (years)	43.0	11.7	79
Stature of males (Trotter & Gleser, 1958) (cm)	165.2	5.7	9
Stature of females (Trotter & Gleser, 1958) (cm)	159.9	4.6	54

s.d. = standard deviation
N = number of individuals inspected

Table 5. TOTAL COUNT OF TEETH FROM ADULTS

	Mean per individual	s.d.	N of teeth	%	N of individuals inspected
N erupted	31.37	1.35	2384	NA	76
N retarded	0.39	1.19	30	NA	76
N supernumery	0.04	0.26	3	NA	76
AM loss	3.38	4.14	257	15.5	76
PM loss	6.74	7.56	512	36.6	76
N insp.	18.42	10.41	1400	NA	76
N caries	1.91	2.05	145	10.4	76
N abscess	0.58	1.13	44	3.1	76
N fistulas	0.29	0.73	22	1.6	76

s.d. = standard deviation
N = number
NA = not applicable

Table 6. DENTAL STATUS IN PERCENTAGES

	N inspected	%
Ante mortem loss	76	15.5
Post mortem loss	76	36.6
Caries frequency	76	10.4
Abscess frequency	76	3.1
DM (F) Index	76	22.6

DM(F) = decayed, missing, (filled)
N = number of individuals

Table 7. MAIN PATHOLOGICAL CHANGES IN BONES

Pathology		N affected	N inspected	%
MECHANICAL TRAUMAS				
Healed fractures (spines excluded)		16	120	13.3
Individuals with multiple fractures (spines excluded)		4	120	3.3
Skull wounds		1	87	1.1
Pubic parturition scars		3	87	3.4
INFECTIONS				
Tuberculosis, spinal*		2	75	2.7
DEFICIENCY DISEASES				
Rickets, tibias:				
	Adults	6	99	6.1
	Non-adults	0	7	0.0
Osteoporosis		2	120	1.7
TUMOURS				
Osteoma,				
	Cranium	2	87	2.3
	Tibia	2	162	1.2
	Fibula	1	156	0.6
Osteochrondroma		2	120	1.7
Metastases, Cranium		2	87	2.3
Metastases, Tibia		1	162	0.6

N = number of individuals
NA = not applicable
* = spines with most vertebras present

Table 8. MAIN PATHOLOGICAL CHANGES IN JOINTS
(120 individually distinct, but incomplete, skeletons)

Pathology	N indiv. affected	N bones inspected	%	N indiv. inspected	%
ARTHROPATHIES					
Degenerative disc disease (DDD)	18	NA	NA	80	22.5
Vertebral osteoarthritis (vOA)	15	NA	NA	80	18.8
Peripheral osteoarthritis (pOA) hip	9	141	6.4	78	11.5
Peripheral osteoarthritis (pOA) knee	6	131	4.6	73	8.2
Peripheral osteoarthritis (pOA) thumbs	1	81	1.2	52	1.9
Peripheral osteoarthritis (pOA) temporo-mandibular.	1	NA	NA	79	1.3
Peripheral osteoarthritis (pOA) acromio-clavicular	12	136	8.8	79	15.2
Peripheral osteoarthritis (pOA) costo-clavicular	2	143	1.4	80	2.5
Peripheral osteoarthritis (pOA) sterno-clavicular	2	NA	NA	39	5.1
Scheuermann's disease	1	NA	NA	80	1.3
Osteochondritis dissecans	3	NA			
SERONEGATIVE ARTHOPATHIES					
Reiter's syndrome	2	NA	NA	80	2.5

N indiv. = number of individuals
NA = not applicable

Table 9. MISCELLANEOUS PATHOLOGICAL CHANGES
(120 distinct, but incomplete, skeletons)

Pathology	N affected	N inspected	%
DISH*	21	75	28.0
Paget's disease	2	87	2.3
Hyperostosis frontalis interna	4	87	4.6
Allen's fossa	8	90	8.9
Poirier's facet	1	90	1.1
Bladder stones	3	NA	
Costo-claviculair articulation	1	NA	
Facial nerve paralysis	1	87	1.1
Extra facet mandible	1	79	1.3

N= number of individuals
NA = not applicable
* = spines with most vertebras present

Table 10. FREQUENCY OF ANOMALIES IN ADULTS (120 distinct, but incomplete, skeletons)

Pathology	N affected	N inspected	%
Sutura Metopica	8	87	9.2
Foramen olecrani	10	85	11.8
Sternal foramen	1	39	2.6
Spina bifida occulta :	4	66	6.1
Lumbar	1	65	1.5
Sacral	3	66	4.5
Os lambdoideum	1	87	1.1
Os epipterium	2	87	2.3
Scoliosis eci*	2	75	2.7
Sacralisation L5	2	66	3.0
Lumbalisation S1	1	65	1.5

* = spines with most vertebras present

Table 11. FREQUENCY OF HEALED FRACTURES IN ADULTS
(120 distinct, but incomplete, skeletons)

Fractured bone	N affected	N insp	%
Frontal bone	1	87	1.1
Vertebra, Avulsions*	14	75	18.7
Impression fracture vertebra*	2	75	2.7
Spondylolysis*	2	75	2.7
Ribs	3	NA	
Clavicle	4	80	5.0
Acromion	1	NA	
Radius	2	84	2.4
Ulna	2	85	2.4
Olecranon	1	NA	
Phalanx and naviculair	3	NA	
Femur	2	90	2.2
Fibula	1	85	1.2

N= Number of individuals
NA= not applicable
* = spines with most vertebras present

Table 12. AVERAGE AGE AND LENGTH OF DUTCH FEMALES BETWEEN 1265- 1652 AD

Cemetery	Period AD	Age at death (years)	N	T&G (cm)	s.d. (cm)	N	Author
Delft 1	1265-1433	47	52	164	7.8	14	Onisto et al., 1998
Dordrecht	1275-1572	43	107	161	6.1	80	Maat et al., 1998
Delft 2	1433-1652	49	49	162	7.1	20	Onisto et al., 1998
Gorinchem	1455-1572	51	9	161	.	11	Maat and Mastwijk, 2000
Breda	1296-1535	43	78	160	4.6	50	this study

s.d. = standard deviation
N = number of individuals
T&G = Trotter & Gleser, 1958

Table 13. PERCENTAGE OF POSTMORTEM TOOTH LOSS IN SEVERAL POPULATIONS BETWEEN 1070- 1858 AD

Cemetery	Period AD	% PM Loss	Author
Dordrecht	1275-1572	37.0	Maat et al., 1998
Delft (1 and 2)	1265-1652	5.5	Onisto et al., 1998
Maastricht	1070-1521	19.7	Janssen and Maat, 1999
's Hertogenbosch	1830-1858	18.6	Maat et al., 2002
Breda	1296-1535	36.6	this study

Table 14. CARIES RELATED CHANGES IN THE NETHERLANDS

Cemetery	Period AD	AM loss (%)	Caries frequency	DM(F) index	Author
Valkenburg	50-225	3.6	6.5	.	Lonnée and Maat, 1998
Maastricht	1070-1521	11.0	17.0	31.0	Janssen and Maat, 1999
Delft 1	1265-1433	16.2	7.6	22.5	Onisto et al., 1998
Dordrecht	1275-1572	12.0	12.0	26.0	Maat et al., 1998
Delft 2	1433-1652	19.1	12.3	30.1	Maat and Mastwijk, 2000
Spitsbergen	1642-1800	6.8	13.4	19.3	Maat, 1987
Alkmaar	1725-1828	.	12.2	.	Beatsen, 2001
's- Hertogenbosch	1830-1858	16.5	20.7	36.2	Maat et al., 2002
Breda	1296-1535	15.5	10.4	22.6	this study

Table 15. PERCENTAGE OF RICKETS IN DUTCH POPULATIONS BETWEEN 1265- 1828 AD

Cemetery	Period AD	% of Rickets	Author
Dordrecht	1275-1572	4	Maat et al., 1998
Delft (1 and 2)	1265-1652	2	Onisto et al., 1998
Leiden	17-18th century	1-1.5	Maat et al., 1984
Breda	17th century -1824	33	Maat and Mastwijk, 2000
Zwolle	1725-1828	5	Aten, 1992
Breda	1296-1535	6	this study

Table 16. PERCENTAGE OF DDD COMPARED TO OTHER POPULATIONS BETWEEN 1265- 1828 AD

Cemetery	Period AD	% of DDD/VO	Author
Den Bosch	1830-1858	59	Maat et al., 2002
Dordrecht	1275-1572	64	Maat et al., 1998
Delft 1	1265-1433	38	Onisto et al., 1998
Delft 2	1433-1652	44	Onisto et al., 1998
Gorinchem	1455-1572	57	Maat and Mastwijk, 2000
Breda	17th century-1824	40	Maat and Mastwijk , 2000
Alkmaar	1725-1828	62	Baetsen, 2001
Breda	1296-1535	28	this study

Table 17. PERCENTAGE OF VOA COMPARED TO OTHER POPULATIONS BETWEEN 1265- 1828 AD

Cemetery	Period AD	% of vOA	Author
Den Bosch	1830-1858	36	Maat et al., 2002
Dordrecht	1275-1572	28	Maat et al., 1998
Delft 1	1265-1433	16	Onisto et al., 1998
Delft 2	1433-1652	15	Onisto et al., 1998
Breda	1296-1535	23	this study

Table 18. PERCENTAGE OF DISH COMPARED TO OTHER POPULATIONS BETWEEN 1265- 1828 AD

Cemetery	Period (AD)	% of DISH	Author
Den Bosch	1830-1858	11	Maat et al., 2002
Dordrecht	1275-1572	19	Maat et al., 1998
Delft 1	1265-1433	8	Onisto et al., 1998
Delft 2	1433-1652	20	Onisto et al., 1998
Gorinchem	1455-1572	42	Maat and Mastwijk, 2000
Breda	17th C- 1824	20	Maat and Mastwijk, 2000
Breda	1296-1535	28	this study

LEGENDS

Figures addressed in the text:

Fig. 1: Map of Breda showing the location of the excavation in Park Valkenberg (arrow).

Fig. 2: Map showing the position of the graves.

Fig. 3: Overall age at death distribution in 10-year intervals. N= 86.

Fig. 4: Healed fractures of the elbow joint of a 27-34 year old female (2558).

Fig. 5: Mechanical trauma (impression fracture) (arrow 1) and an osteoma on the frontal bone (arrow 2) of a 40-44 year old male (2513).

Fig. 6: Parturition scars on the pubic bone of a 49-55 year old female (2544, arrow).

Fig. 7: Periostitis on the mandible of a 38-44 year old male (2523, arrow).

Fig. 8: Osteochondroma on a tibia of a 36-42 year old individual of unknown sex (9502, arrow).

Fig. 9: Metastasis in the skull of a 63-68 year old female (2517, arrow), exterior view.

Fig. 10: Reiter's disease. Bilateral bone changes on the sacro-iliitic surface of the same female (2562, arrows).

Fig. 11: Reiter's disease. Arthrotic changes of the hip joint of a 46-52 year old female (2562, arrows).

Fig. 12: Diffuse Idiopathic Skeletal Hyperostosis (DISH). Ossification (ankylosis) of the anterior longitudinal ligament of a 51-66 year old female (2504).

Fig. 13: Unilaterial disposition of tartar on the dentition of a 49-55 year old female (2551). The individual did not use the left side of her mouth that resulted in the development of tartar.

Fig. 14: Bladder stones of a 46-52 year old female (2562).

Figures addressed in Table 3:

Fig. 15: Arthrosis of the hip joint caused by infection or trauma in a 51-66 year old female (2504).

Fig. 16: Mechanical trauma of the acromion of a 38-44 year old female (2506).

Fig. 17: Impression fracture of the vertebra Th6 of a 46-52 year old female (2562, arrow).

Fig. 18: An avulsion haematoma between L4 and L5 in a 50-65 year old female (2569).

Fig. 19: Osteophyte at right temporo-mandibular joint (pOA) (arrow 1) and two extra facets on the mandible of a 40-44 year old male (2513, arrows 2 and 3).

Fig. 20: Extra costo-clavicular joint facet of a 40-44 year old male (2513, arrow).

Fig. 21: Exosteosis on the distal end of the fibula of an individual of unknown age and sex (adult) (2597, arrow).

Fig. 1

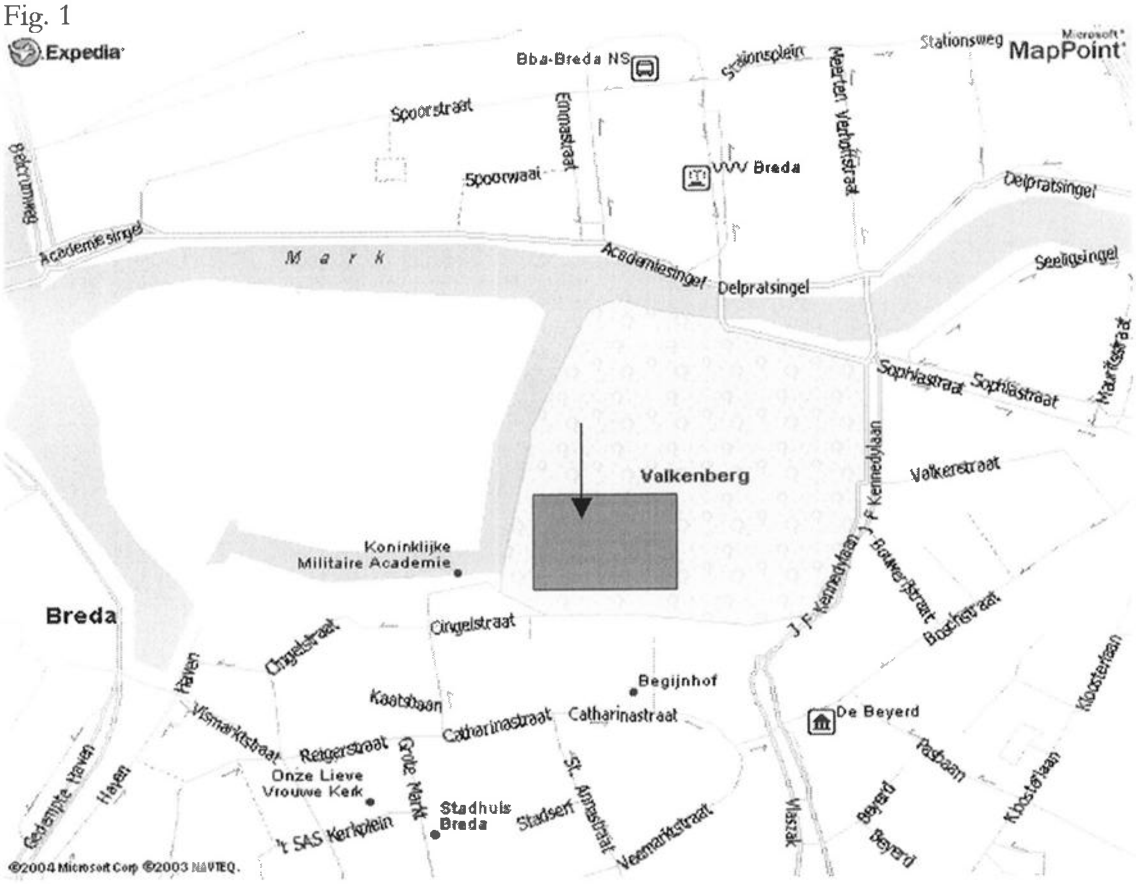
Expedia
MapPoint
Bba-Breda NS
Stationsplein
Stationsweg
Spoorstraat
Spoorwaai
Emmastraat
Meerten Verhoffstraat
Breda
Delpratsingel
Academiesingel
Mark
Seeligsingel
Sophiastraat
Mauritsstraat
Valkenberg
Valkenstraat
J F Kennedylaan
Koninklijke Militaire Academie
Breda
Cingelstraat
Boschstraat
Haven
Kaatsbaan
Begijnhof
Catharinastraat
De Beyerd
Vismarktstraat
Reigerstraat
Grote Markt
St. Annastraat
Onze Lieve Vrouwe Kerk
Stadhuis Breda
Stadserf
Veemarktstraat
Vlaszak
Beyerd
Pasbaan
Kloosterlaan
Gedempte Haven
't SAS Kerkplein
©2004 Microsoft Corp ©2003 NAVTEQ.

Fig. 2

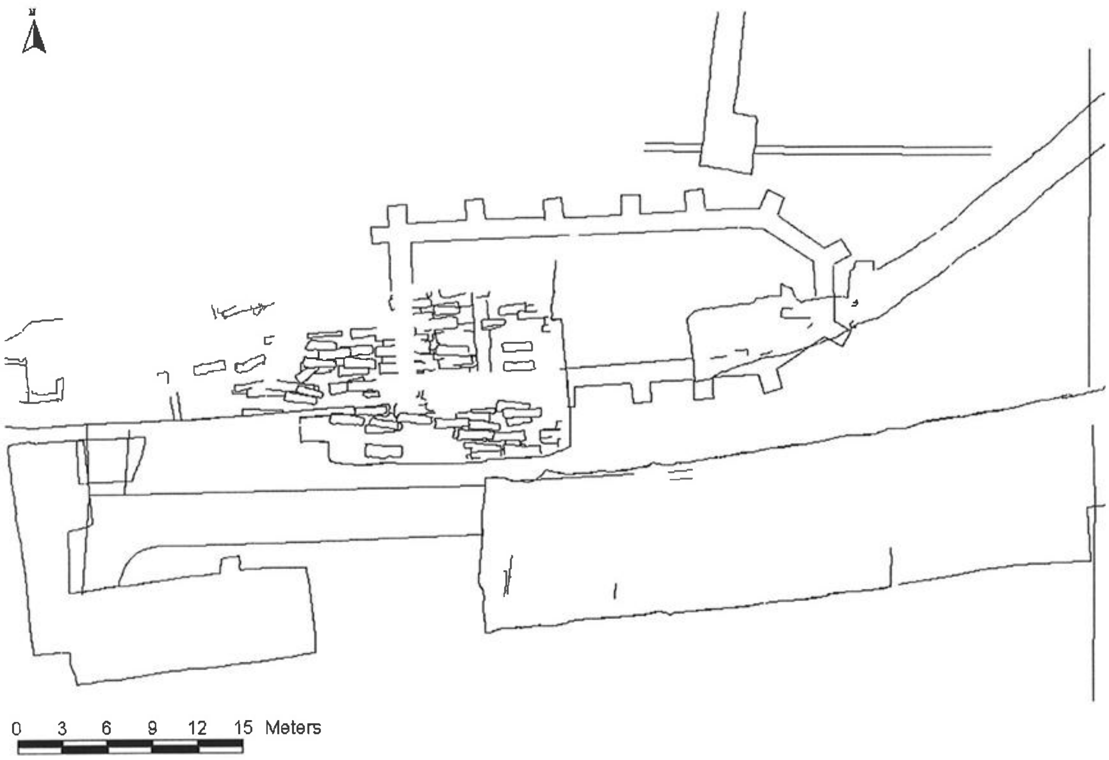
N
0 3 6 9 12 15 Meters

Fig. 3

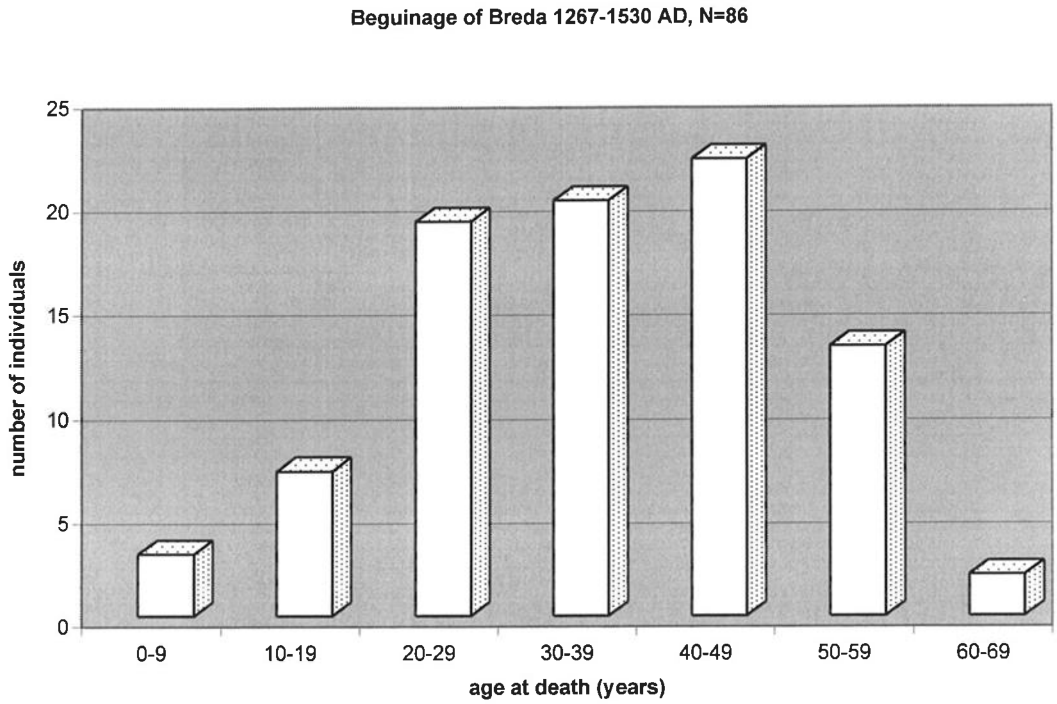
Beguinage of Breda 1267-1530 AD, N=86
number of individuals
25
20
15
10
5
0
0-9
10-19
20-29
30-39
40-49
50-59
60-69
age at death (years)

Fig. 4

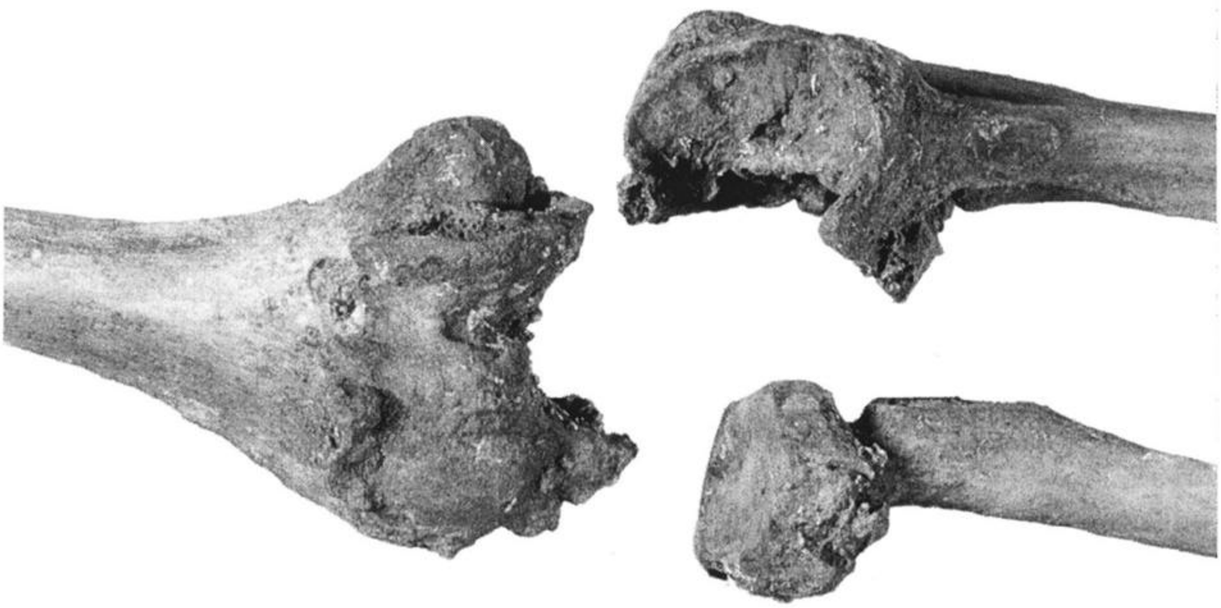

Fig. 5

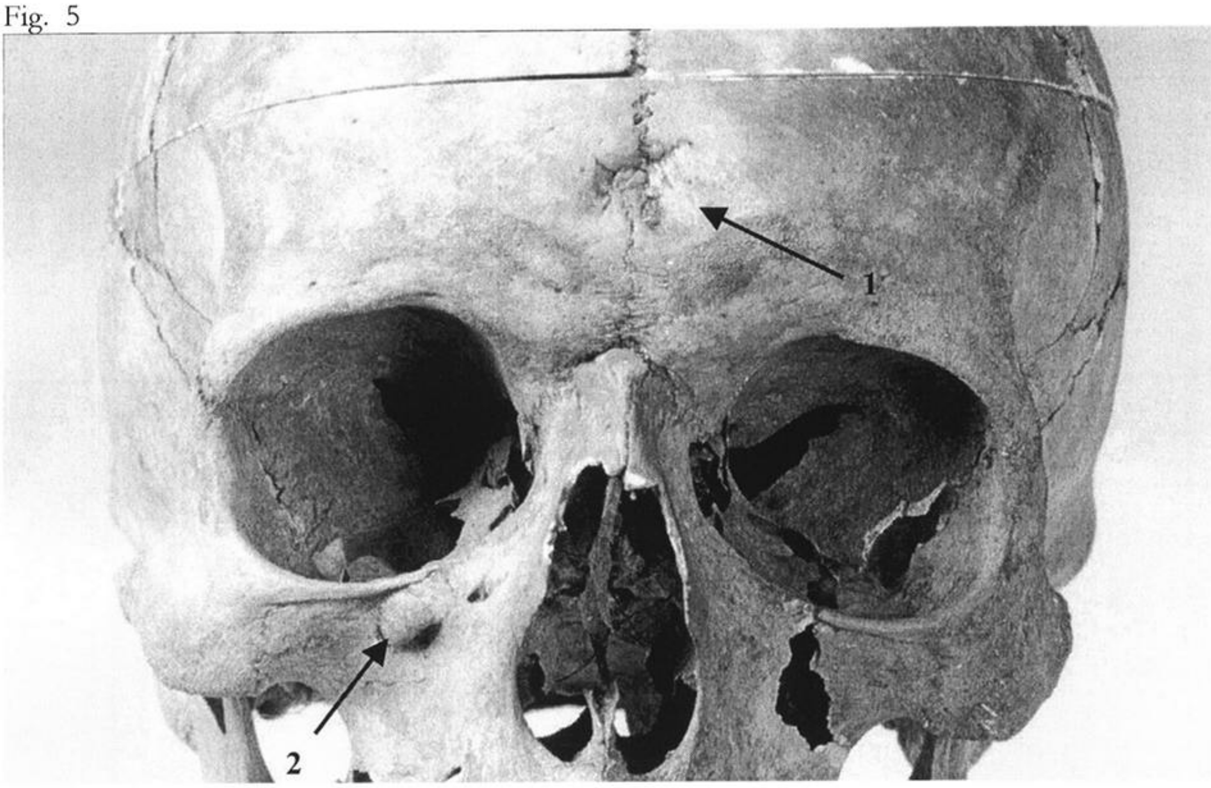

Fig 6

Fig. 7

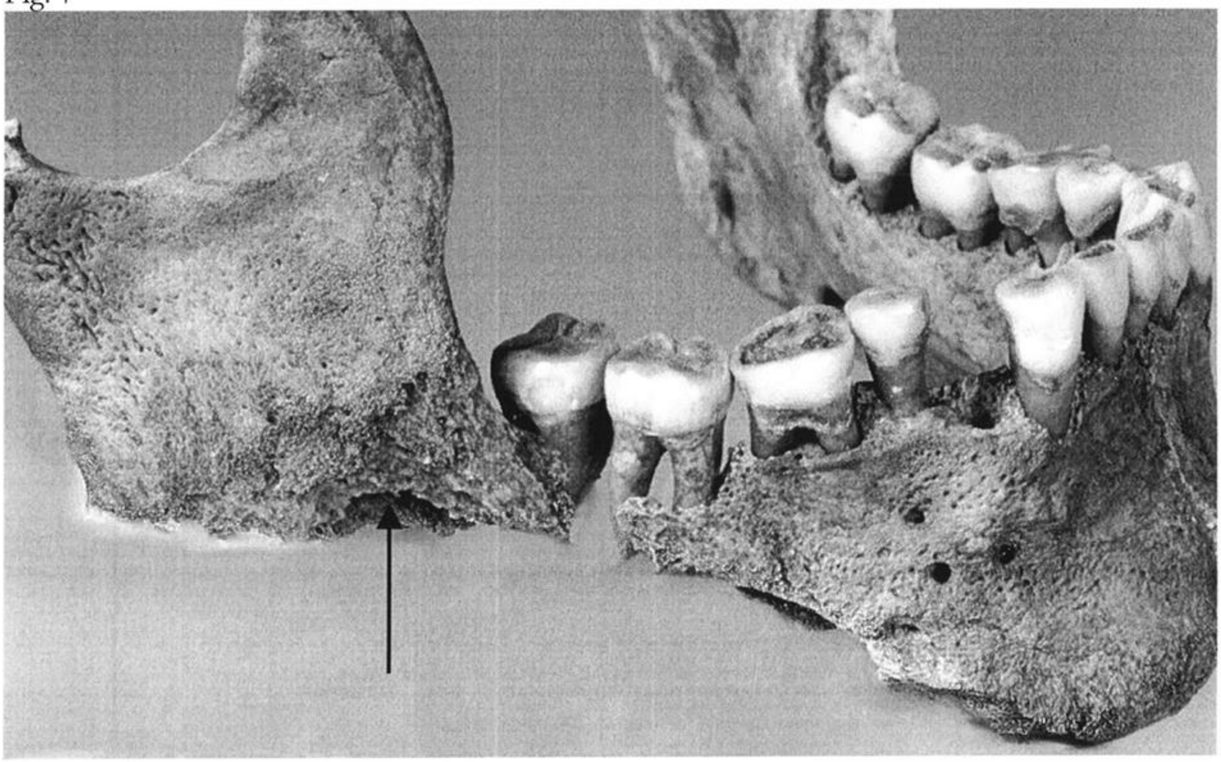

Fig. 8

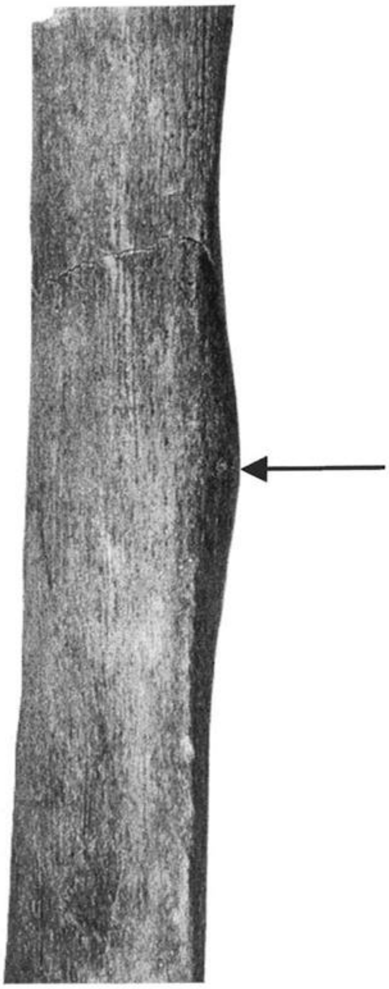

Fig. 9

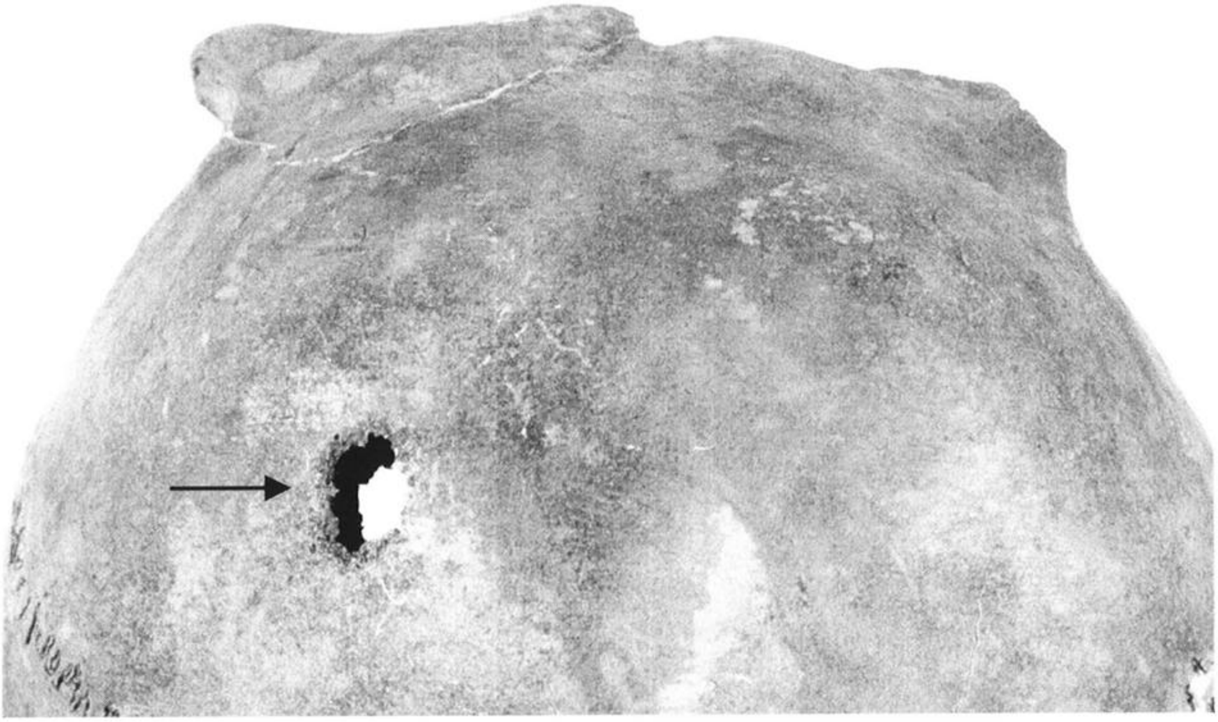

Fig. 10

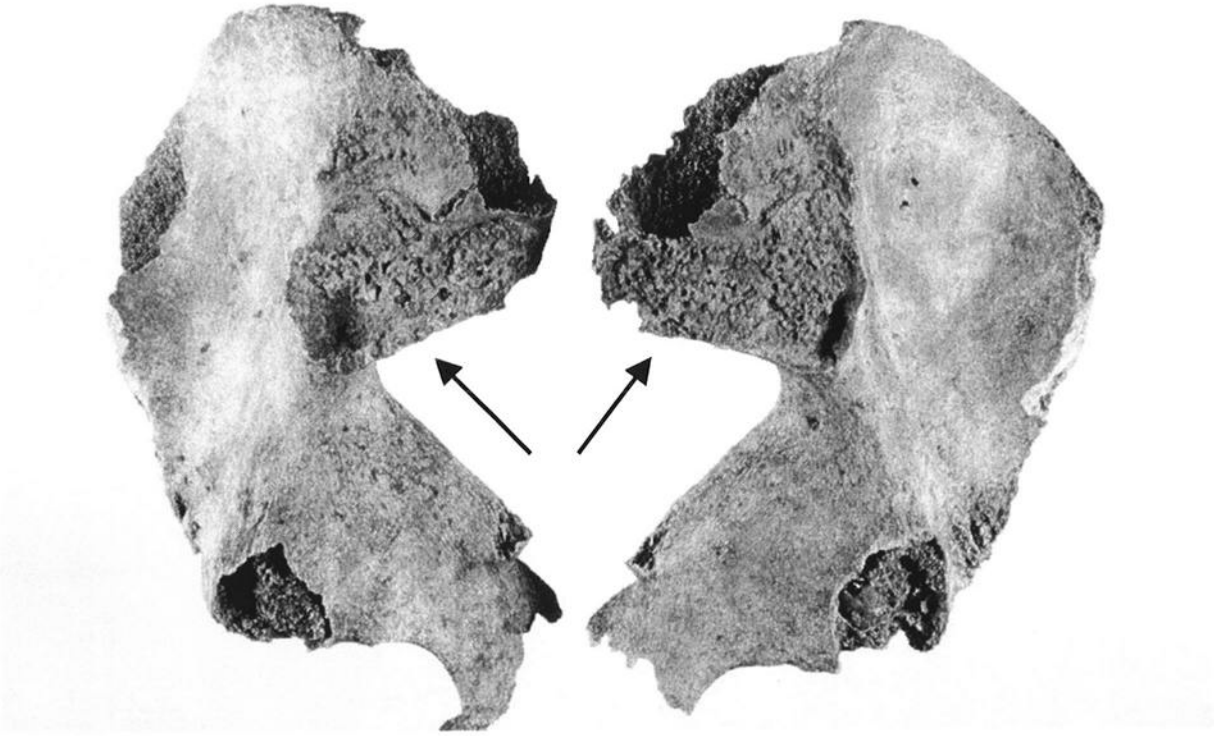

Fig. 11

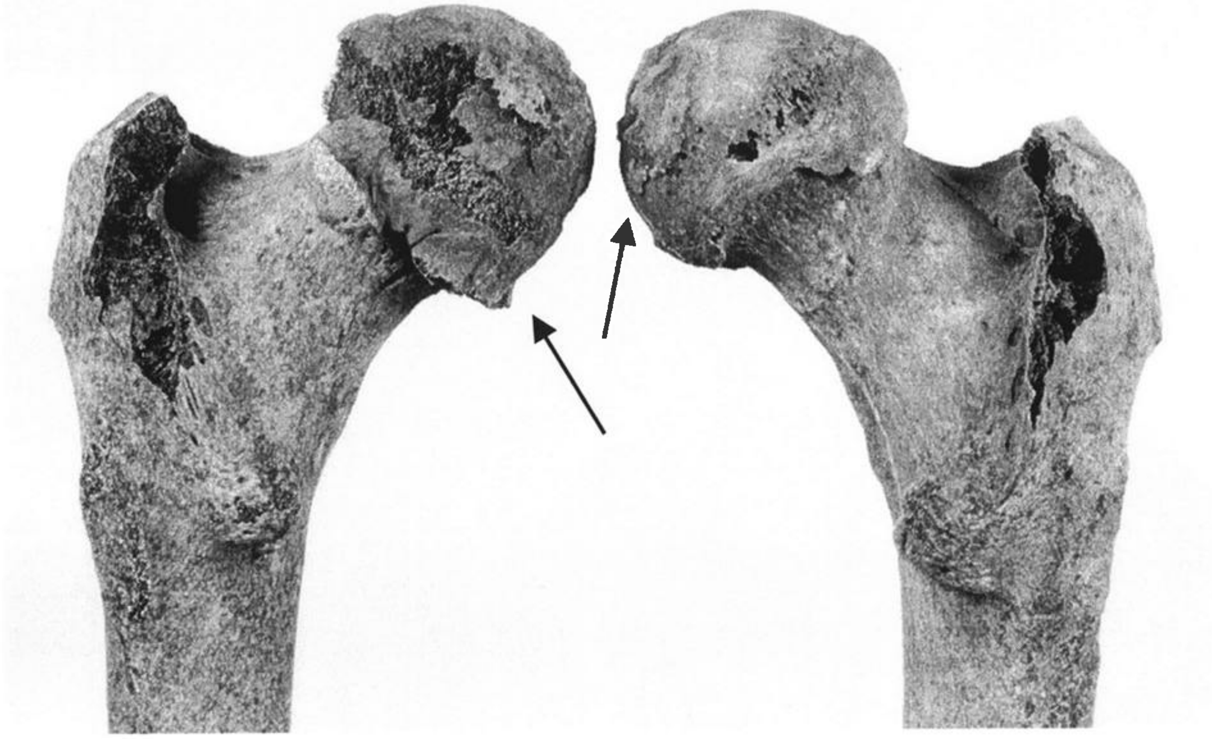

Fig. 12

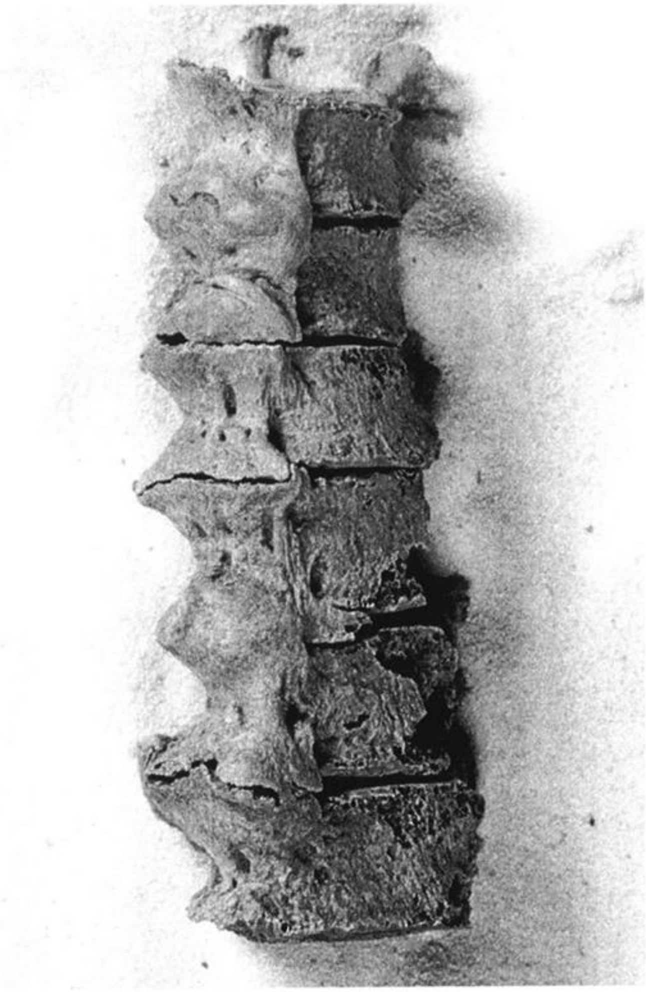

Fig. 13

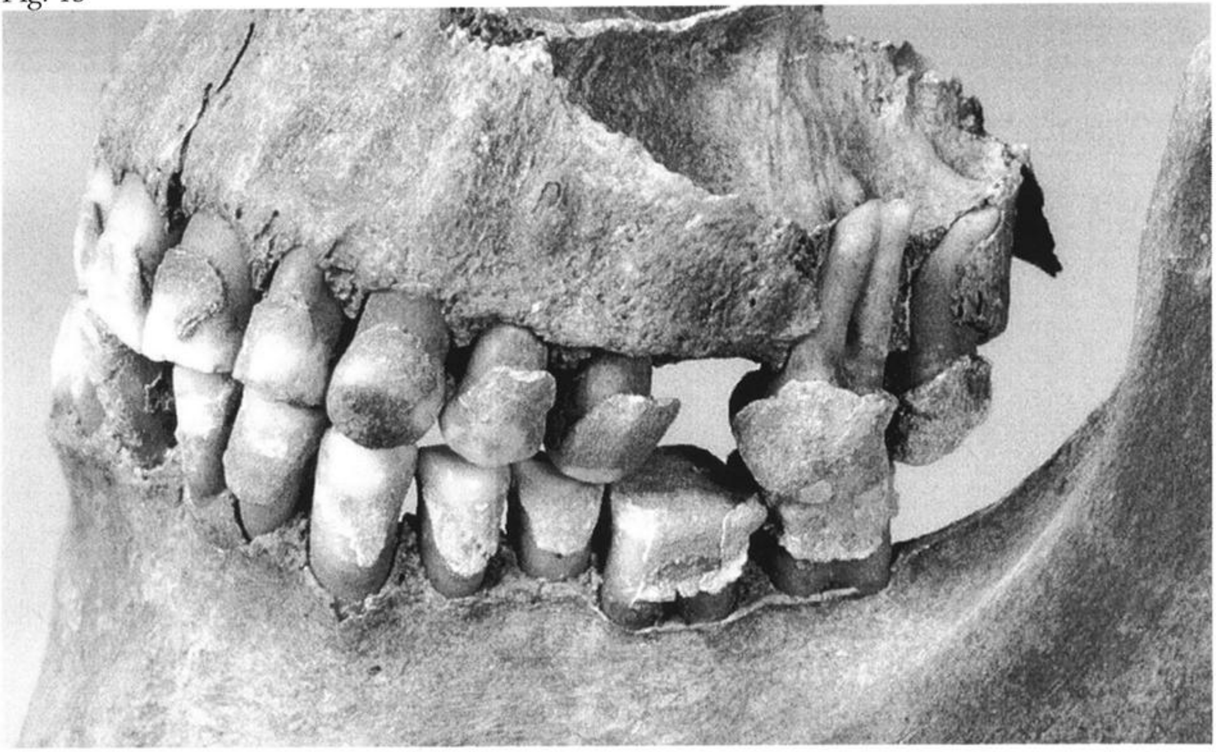

Fig. 14

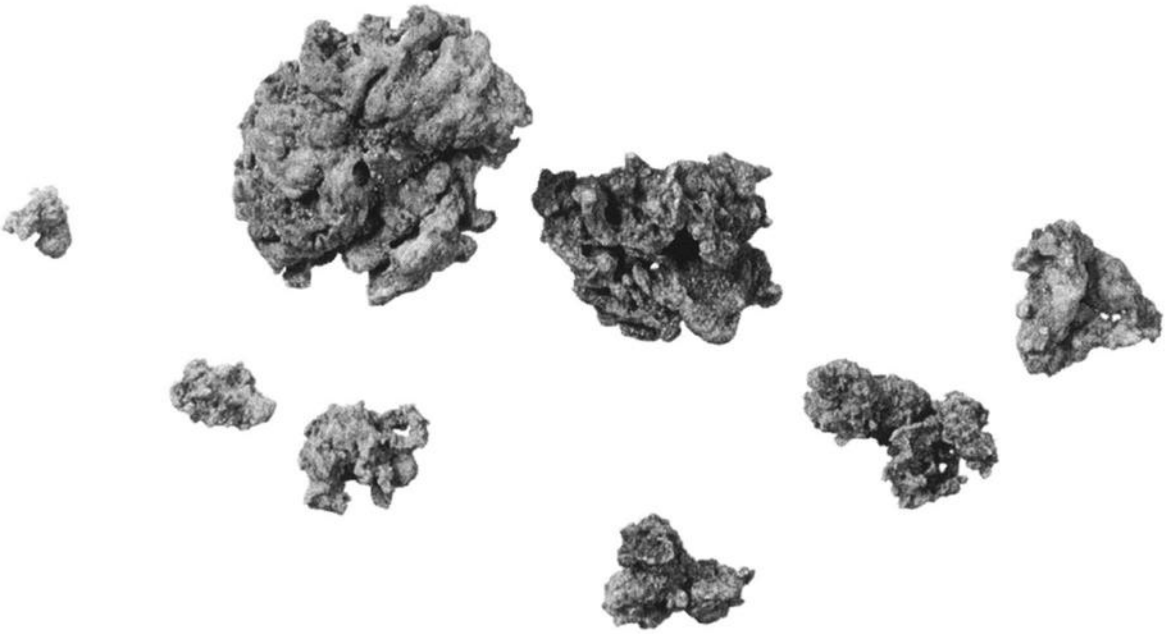

Fig. 15

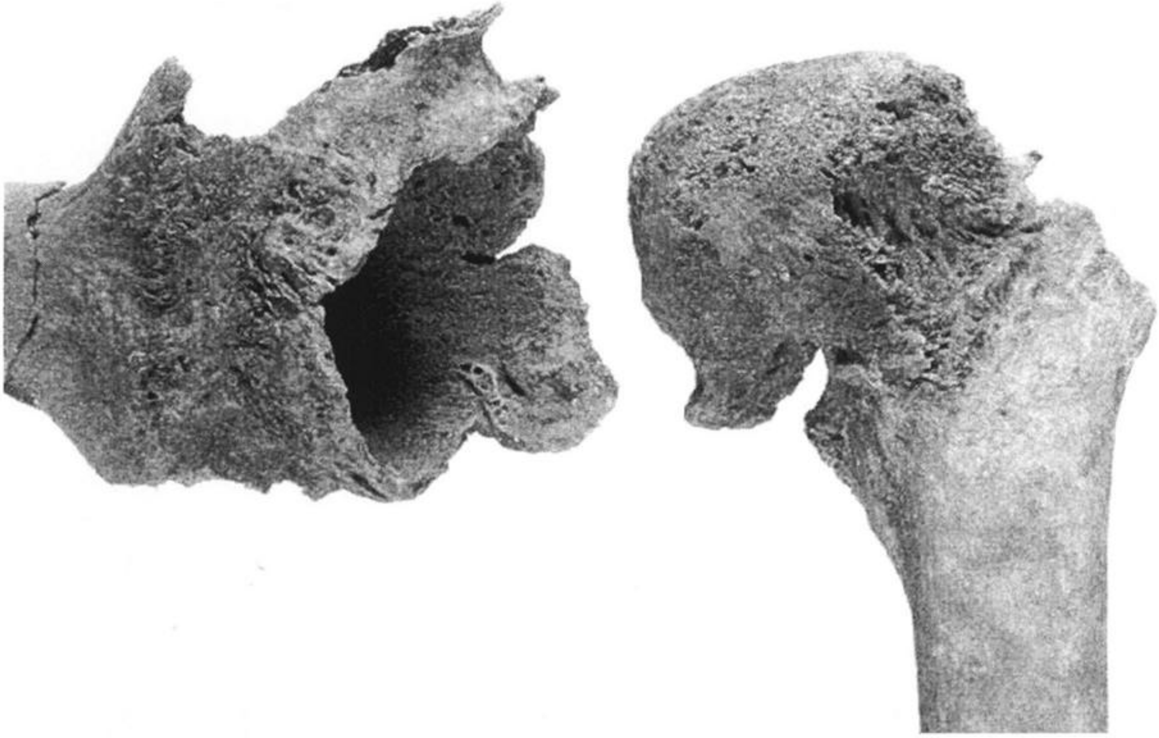

Fig. 16

Fig. 17

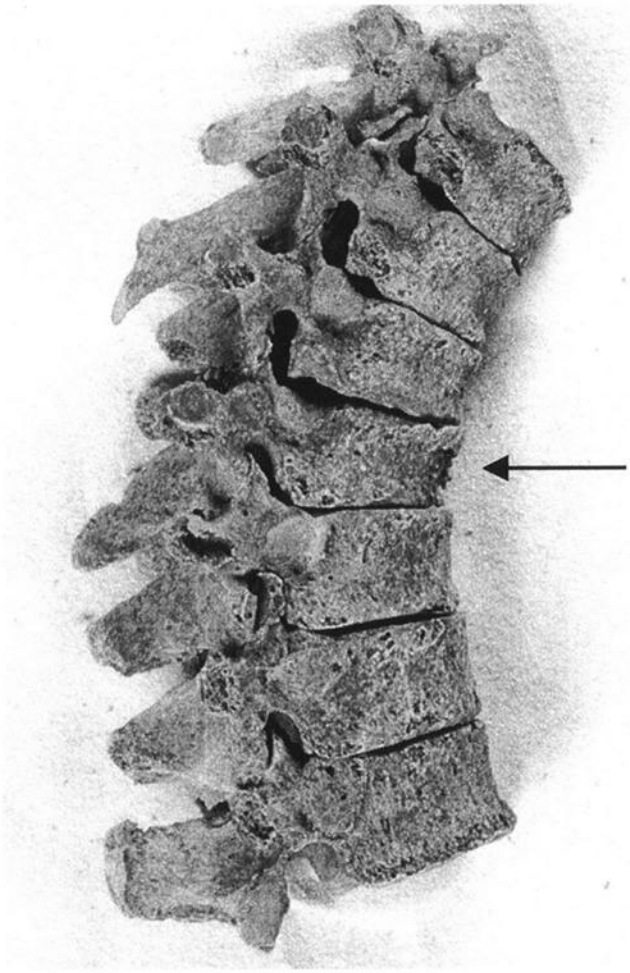

Fig. 18

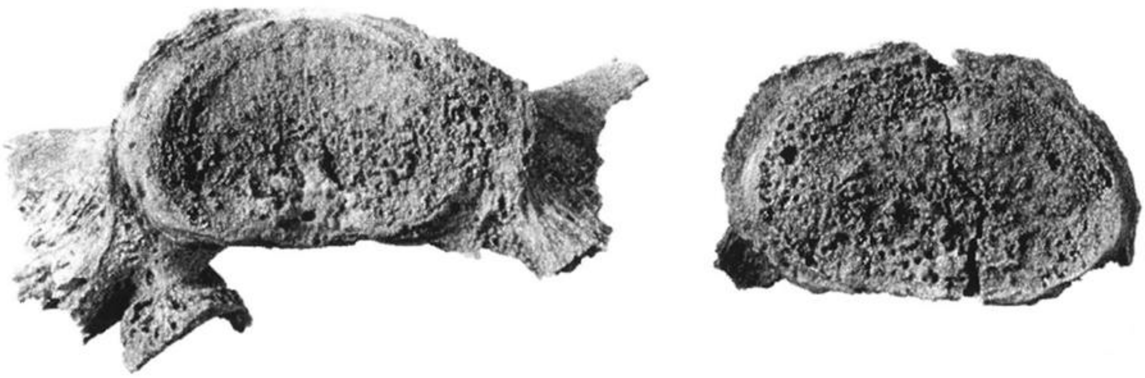

Fig. 19

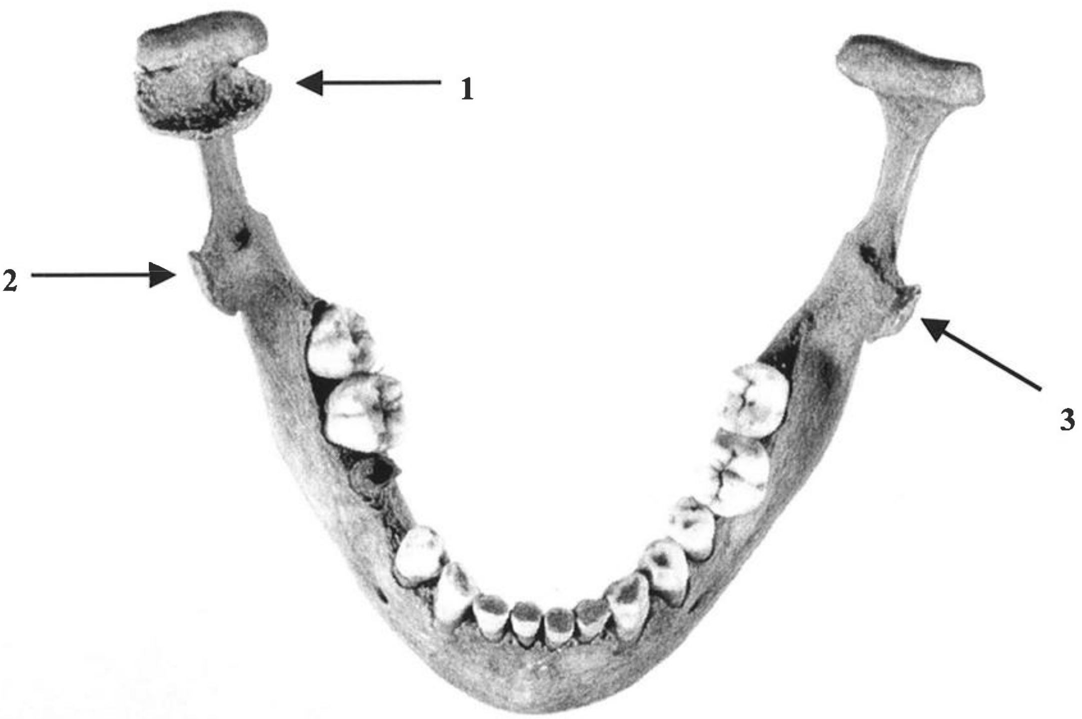

Fig. 20

Fig. 21