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Arthritis in a Palaeopopulation

by

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ABSTRACT

While the cause of osteoarthritis is unknown, it is associated with age, stress, and trauma. The study of its expression in a palaeopopulation can yield information on stress and joint trauma particular to that population's lifestyle.

In order to accomplish this type of study, the severity and incidence of arthritis in each joint surface must be examined. To facilitate discussions of severity, I have developed a five-stage scale to define the degree of arthritic degeneration. Joint surfaces from the Gray Site are examined, by sex, for incidence and severity of arthritis. These data can then be compared with other sites to delineate variations in arthritic expression and thus, possibly, variations in joint stress.

The relationship between dental infections and arthritis (especially vertebral) has long been hypothesized. Analysis of the Gray Site skeletons supported this positive relationship. Other than association of both diseases with age, no cause for this was found.

Arthritis in the Gray Site was attributed to osteoarthritis and ankylosing spondylitis. No evidence of rheumatoid arthritis was present, supporting the theory of a recent origin for the disease. Generally, females were affected more frequently than males, particularly in the fingers and spinal column. The foot and ankle showed an

unexpectedly high incidence. Comparison with the Fairty Site confirmed the unusual incidence of foot and ankle changes and emphasized the low frequencies of changes in the temporomandibular, shoulder, hip, and knee joints. The vertebrae showed strikingly different patterns of degeneration.

The lack of information on the effects of various stresses on joint degeneration is a factor limiting this type of research. Inferences can be made about possible causes for discrepancies in incidences of osteoarthritis; nevertheless, these will remain speculative until studies on stress influences become available, and until more sites are examined in such a manner as to allow interpopulation comparisons.

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CHAPTER I

INTRODUCTION

The Population

The Gray Site material was excavated during the field seasons of 1969-1973 by various crews from the University of Saskatchewan, Saskatoon. The site (near Swift Current, Saskatchewan) yielded 305 identified skeletons (So and Wade 1975:2). The cultural affiliation of the site is believed to be Oxbow (Millar et al. 1972:13-21; Millar 1973:3). There have been six radiocarbon dates from samples of bone from the burials (Millar 1973:13):

Burial Unit	Sample Number	Date (B.P.)
23	S619	4955 ± 165
42	S646	3755 ± 100
46	S647	5100 ± 390
59	S693	3550 ± 295
30	S706	3485 ± 195
65	S707	3750 ± 180

Millar (Ibid.:3) notes that the two wide-spread sets of dates constitute a significant problem in analysis of the site, although both series appear to be associated with the Oxbow point type. So and Wade (1975:2-3) feel that when one considers the standard error units, occupation of the site may not be as discontinuous as it seems. The dates, whether they indicate a single occupation or a sequence of occupations, do not, at present, outline areas of divisions within the material. Therefore, the skeletal collection was analysed as a single group.

The choice of this population for the present study

was based on the fair state of preservation of the skeletal remains, the size of the group (305 identified individuals), and its uniqueness in North American prehistory, in the context of both size and antiquity. The burials are in single and multiple units, with both primary and secondary interments. As well as providing joint surfaces, some studies on complete individuals were permitted. The collection allowed a study of frequencies in all joints (although some samples of joint surfaces were extremely small, for example, 7 female pubes) and yet, was a convenient size to demonstrate the feasibility of such a complete analysis of osteoarthritis in a population. The availability of results from concurrent demographic and dental studies was also helpful.

The Study of Osteoarthritis

The study of osteoarthritis in skeletal material poses many difficulties. Literature related to the disease is generally soft tissue oriented. Other than Bourke's (1967) review of the disease, one must turn to medical sources, which concentrate on soft tissue symptoms and drug and surgical therapy, rather than bone changes and their significance. Thus, the first problem is to examine medical references in order to glean a description of the disease, its etiology, manifestation in bone, and the sequence of osteological changes.

To properly assess the degree of joint involvement it is necessary to develop a guideline for severity of the

disease. Although these categories are arbitrary, they serve the purpose of differentiating between marginal joint involvement and total joint destruction by qualitative, well-defined stages. In order to promote continuity in the literature, these stages were adapted from Chapman (1968:7-8) and Rogers (1966:174-175).

0 - Joint within the normal range of variation for the population.

I - Erosion and pitting, or eburnation of joint surfaces; slight sharpening or lipping at the joint margins (splaying).

II - Irregularity of joint margins; marked erosion or eburnation; more pronounced lipping (curvature) and osteophyte formation.

III - Extensive lipping and osteophyte formation (recurvature); erosion of the cortex; and subchondral cyst formation.

IV - Initiation of joint destruction, bridging, and beginning of bony ankylosis; increased osteophyte and spur formation.

V - Complete joint destruction, subluxation, and/or complete ankylosis.

The Gray Site material was examined by joint surface and graded for severity of involvement. The presence of multiple burials created a large number of indeterminate materials for which sex and age could not accurately be assigned. This material was included in the analysis of

overall percentages of involvement to create a more accurate picture of the population. Individuals under 12 years of age were not included in the analysis due to the general lack of epiphyses and poor preservation of these remains. The examination of these individuals revealed no signs of osteoarthritis.

Comparing this population to others in North America is difficult since descriptive analyses of osteoarthritis are lacking. Mentions of the disease in anthropological literature tend to be brief statements of a single percentage of involvement for all joints in the whole population. Such statements are meaningless since each joint has different patterns of involvement and different patterns of severity of involvement. Only Anderson (1963) gives a description of arthritic changes by joint surface percentages. This dearth of comparative data makes statements on stress patterns between populations of dubious value.

Dental data on the Gray Site population were used in the examination of the association between dental abcesses and arthritis (Knutson, 1975:pers. comm.). The analysis is patterned after Inglemark, Møller-Christensen, and Brinch (1959). Statistical tests are made in an effort to establish the presence of statistical correlations between the diseases. Finally, the data from the Gray Site are compared to similar studies on other materials.

The lack of suitable comparative material precludes definitive statements on the use of osteoarthritis as an

indicator of stress differences between populations. The need for more detailed studies of the disease in various skeletal groups is paramount in assessing interpopulational stress patterns. Since osteoarthritis is a 'wear and tear' phenomenon, its utility in distinguishing joint use patterns as well as age changes cannot be underestimated.

CHAPTER II

OSTEOARTHRITIS

Definition

Osteoarthritis, also termed arthrosis, osteoarthrosis, arthritis deformans, degenerative arthritis, and post-traumatic arthritis, is the most common type of arthritic disease. It is a non-inflammatory disorder of diarthrodial joints with synovial capsules, characterized by cartilage degeneration and abrasion, bony eburnation, and the formation of new bone, especially bony spurs (osteophytes) at joint margins. The main difference between osteoarthritis and rheumatic diseases is that the former is non-inflammatory (although it may be accompanied by inflammatory synovitis) and the latter is very much so.

Etiology

The etiological basis for osteoarthritis is poorly understood. It appears to be a mixture of genetic and traumatic factors. Two types of osteoarthritis are differentiated: primary osteoarthritis, which arises from no particular predisposing articular etiology, and secondary osteoarthritis, which arises as a result of joint trauma. The causes of each will be examined separately.

Primary Osteoarthritis: It is generally well known that the prevalence of osteoarthritis increases with age. However, since aging cartilage is different from osteoarthritic cartilage, it is presumed that factors other

than senescence alone are involved (Boyle and Buchanan 1971). The nature of these factors is unknown. There are definite sex influences in mice. These are not demonstrated in humans however and, with the exception of Heberden's nodes, both sexes are approximately equally affected (Ibid.). Endocrine factors, well documented in mice, do not appear associated in humans. While some authors (e.g., Stecher 1955) suggest an increase in the degenerative process with menopause, there is actually little evidence for this in humans (Sokoloff 1966; Boyle and Buchanan 1971). Although acromegaly gives rise to a form of arthritis, this is not true osteoarthritis (Boyle and Buchanan 1971; Jessop 1970). Diabetes Mellitus plays a role in the susceptibility of cartilage to degenerative changes and thus to the development of osteoarthritis. This is, however, a predisposing factor-- not a cause. The relationship of obesity to osteoarthritis is unclear, being partially mechanical. There is also a non-mechanical factor increasing prevalence of sterno-clavicular involvement in both sexes, and Heberden's nodes in obese men.

Genetic factors in the development of osteoarthritis are complex and not well understood. Stecher (1955) postulates the transmission of Heberden's nodes by a single autosomal gene, dominant in females and recessive in males. Most authors (e.g., Boyle and Buchanan 1971) now tend to favour a complex polygenic tendency toward development of osteoarthritis. It must be borne in mind, also,

that familial aggregations of diseases may also be due to common familial environmental circumstances. Unknown mechanisms of genetic abnormalities of cartilage and joint development may also be predisposing factors (Boyle and Buchanan 1971).

Climate does not cause osteoarthritis. Rather, certain types of climate, especially dampness, tend to aggravate its symptoms. The only metabolic cause for osteoarthritis is Kashin-Beck disease (Boyle and Buchanan 1971; Jessop 1970).

Secondary Osteoarthritis: This is due to trauma, which may be of a stressful nature-- excessive joint use, obesity, or injury-- or it may be the result of an inherited abnormality-- dysplasia, pelvic tilt deformity, Marfan's Syndrome, or chondro-osteodystrophy. Osteoarthritis commonly occurs following dislocations, fractures (especially malaligned ones), or slipped epiphyses. It is also associated with postural abnormalities such as knock-knees or bow-legs, and disorders such as recurrent luxations of the patella and shoulder caused by laxness of ligaments (Sokoloff 1966). Osteoarthritis is a normal sequela to rheumatic diseases (Boyle and Buchanan 1971; Murray 1965; Jessop 1970) which makes the two impossible to distinguish in advanced cases in skeletal material.

Thus, with two exceptions (i.e., Kashin-Beck disease and Heberden's nodes), the cause of osteoarthritis is very unclear. Murray (1971) states that most hip osteoarthritis

is caused by trauma; be it as slight as a shallow acetabulum or pelvic tilt abnormality that can only be discovered with thorough radiographic study. This probably applies to most joints, although it has not been as well documented.

Pathology

The first changes in osteoarthritis appear in the joint cartilage. Although it is not completely understood, there is a generally agreed upon sequence of cartilage degeneration.

As stated above, normal aging cartilage is different from osteoarthritic cartilage. The former is characterized by water loss with retention of the normal concentration of chondroitin sulphate, the latter is notable for a decrease in chondroitin sulphate concentration and chain length, and an increased water content (Boyle and Buchanan 1971:17-18). The initial stage in the degenerative process is focal chondromucoid swelling of the matrix associated with proliferation of the chondrocytes adjacent to the swollen areas and a decrease within them (Boyle and Buchanan 1971:8; Sokoloff 1966:849; 1969:7-8). This is followed by a loss of metachromasia (presumed to be a decrease in chondroitin sulphate) with depolymerization of chondromucoprotein and a decrease in chain length of the chondroitin sulphate (Ibid.). The next stage is a proliferation of chondrocytes around minute fissures in the articular surface. This appears to be an abortive attempt at healing, or a reaction to the proximity of the synovial fluid (Sokoloff 1966:849-

850; 1969:9). Then follows fibrillation of the cartilage and a decrease in the number of chondrocytes (Ibid.). The surface of the cartilage tends to flake and develop fissures. The flaked-off cartilage cells are phagocytosed by the synovial fluid, sometimes causing synovitis (Jessop 1970:207). These changes lead to cartilage degeneration and exposure of the bone surface.

Bony Changes and Joint Remodelling: The bony changes associated with osteoarthritis are better documented. With the erosion of the articular cartilage the bone surface, exposed to joint wear, becomes hardened and sclerosed. The surface becomes worn smooth and polished, a process termed eburnation (Sokoloff 1966:852; Boyle and Buchanan 1971:20). Osteophytes (bony proliferations) appear at a number of characteristic places. They may protrude into the joint space, appear laterally at the joint surface where the joint capsule meets the periosteum, or develop within ligamentous attachments (Boyle and Buchanan 1971:21; Sokoloff 1966:851). The contour of the joint surface changes through erosion and proliferation of tissue (Sokoloff 1966:854; 1969:10). The remodelling of the joint surfaces can mechanically impede joint function or destroy the joint entirely.

Capsule and Synovial Changes: Capsular thickening and venous abnormalities are frequent findings in osteoarthritis of the hip (Boyle and Buchanan 1971:22). Synovitis can appear as a foreign body reaction, mimicing rheumatoid

arthritis. Increases in the volume and composition of the synovial fluid are also noted (Ibid.).

Heberden's Nodes: This is a well-known characteristic of primary generalized osteoarthritis. Heberden's nodes appear on the distal interphalangeal joints and have been associated with genetic, endocrine, and traumatic origins (Boyle and Buchanan 1971:32; Sokoloff 1966:857; 1969:16). These osteophytes resemble those of osteoarthritis in the later stages. However, some arise through cartilage hypertrophy rather than degeneration (Ibid.). Heberden's nodes are primarily found in tendon insertions and the periosteum (Ibid.). They are composed of bone and cartilage causing a difference between radiological and clinical size (Boyle and Buchanan 1971:32-33).

Subchondral Cyst Formation: These cysts remain pathologically uncertain. Landells (1953:649) described them as resulting from defects in the watertight layer between the joint space and the cancellous bone. Cyst formation was ascribed to intrusion of pressurized synovial fluid and destruction of trabeculae. Rhaney and Lamb (1955: 674) attributed the cysts to traumatic bone necrosis due to bone shock in the absence of articular cartilage. Jacobs (1963:134) pointed out that occasionally cysts are noted before other symptoms, and hence formed an entity; a precursor, rather than a sequela, to osteoarthritis. Ondrouch (1963) described the cysts and their formation in detail. The cysts, beneath the surface bone lamellae,

are spherical or pear-shaped with a communicating passage to the joint surface. The walls are formed of cancellous bone trabeculae reinforced with newly formed bone. He speculates their cause is due to the uneveness of the articular surface (an effect produced by arthritic remodelling), causing overloading in certain areas. The bone is destroyed in these force areas and compensation is attempted by new bone formation around the edges. The difference between osteoarthritic cysts and cysts formed in gout or hemophilic arthropathy is that the latter also intrude into the degenerative marrow space (Sokoloff 1966:854). The cysts occur mainly in the femur head.

The Vertebral Column: Generally there are two types of spinal degenerative diseases distinguished. Osteoarthritis proper is usually considered as only in the apophyseal joints. Degenerative disk disease is termed spondylosis, osteophytosis, or spondylarthrosis. Since the degenerative processes are indistinguishable, both will be considered here.

Apophyseal osteoarthritis consists of cartilage degeneration and synovial joint changes characteristic of diarthrodial joint arthritis. Its pattern of incidence and distribution is the same as spondylosis.

Pallis et al (1954) consider spondylosis separate from osteoarthritis. However, its presence may cause osteoarthritis, characterized by posterior osteophytes. It may also be considered as a specialized type of arthritis.

Spondylosis is manifested initially by degeneration of the nucleus pulposis and the hyaline plates attaching it to the vertebral bodies (Sokoloff 1966:856). This cartilage degeneration is indistinguishable from that in articular cartilage (Ibid.). Eburnation of the subchondral bony plate also occurs (Ibid.). Marginal osteophytes occur and cyst-like Schmorl's nodes may appear.

Nathan (1962:264) puts forth the theory that osteophytes develop as a defense mechanism in response to pressure. The osteophytic bone is stronger, more compact, bone. They develop in areas of maximum curvature (C5, T8, and L3-4) and are more frequent anteriorly on the thoracic vertebrae and posteriorly on the cervical vertebrae (Nathan 1962:258). Osteophytes may give rise to bony bridges between closely approximated proliferations (Sokoloff 1966: 856).

Bick (1956:1255) describes an osteophytosis which he does not consider osteoarthritic. These occur in the longitudinal vertebral ligaments, or at their insertions. There are no other vertebral structural changes. The osteophytes are small, rounded or triangular, and smooth-surfaced ossicles (Bick 1956:1256).

Schmorl's nodes give rise to cyst-like formations in the vertebral bodies. They are caused by displacement of the nucleus pulposis into the vertebral body (Sokoloff 1966: 856). They are usually covered by a bone shell and contain more cartilage than the above mentioned subchondral cysts

(Sokoloff 1966:856).

Joint Analysis

Osteoarthritis is a disease of middle and older age (onset age of 45 years plus) except in a few cases of trauma or specific disease. In modern industrialized populations it has the same relative frequency in males and females, although females are more often affected in hands, knees, and cervical spine; and males in hips and lower back.

The radiological findings in osteoarthritis are fairly distinctive. The characteristic signs are as follows:

1. Narrowing of the joint space.
2. Sharpened articular margins.
3. Marginal osteophyte formation and lipping.
4. Damaged, thickened, eburnated subchondral bone.
5. Subchondral sclerosis (new bone laid down in subchondral adjacent ends causes radio-opaqueness).
6. Bone cyst formation.
7. Deformity-- collapse of subchondral bone and cysts, subluxation, gross bony overgrowth, and presence of loose osteophytes.

Primary generalized osteoarthritis is characterized by Heberden's nodes as well as other joint involvement. It is most common in middle-aged women (Kellgren and Moore 1952:187). Kellgren (1954:63) claims there is a 10:1 sex ratio, female to male. The joint involvement in order of frequency is: hand and foot, lumbar spine, knees, hip and

elbow, and acromio-clavicular (Ibid.).

Temporomandibular: Blackwood (1963:320) claims that osteoarthritis is the most common disease in the mandibular joint. It is radiologically identified by glenoid eburnation. It is found in about 25% of older persons in post-mortem examination (Schwartz 1960).

Sternoclavicular Joint: Silberberg et al. (1959:861) noted that osteoarthritis appeared in the third decade, increased in frequency to 80 years, then sharply declined in frequency after 90 years. They also noted a higher frequency in males than females, and a higher frequency in Negroes than Whites.

Elbow Joint: Uncommon, except following trauma, osteoarthritis is usually characterized first by floating bodies in the joint (Boyle and Buchanan 1971:30; Jessop 1970:212).

Wrist: Although osteoarthritis very rarely occurs in this joint, it may follow an ununited fracture, or rheumatoid arthritis (Jessop 1970:212).

Hands: Osteoarthritis may occur in the carpo-meta-carpo-phalangeal joints. Swezey et al. (1969:410) describes "radial, hook-like osteophytes" which appear in those joints. Arthritis in the interphalangeal joints is usually accompanied by Heberden's nodes on the distal joint and its proximal counterpart, Bouchard's nodes. Radiological studies show bone end enlargements, a distorted joint space, and an irregular joint surface (Abrams 1966:875). In a

sample of 172 cases of osteoarthritis (132 female and 40 males) of the first metacarpal, Ylzarbe (1966) noted the following: average age of onset was 53.5 years; the ratio of occurrence left to right was 4:3 with 23 cases of bilateral osteoarthritis; and the primary cause was trauma, due to functional stress (e.g., scrubbing and wringing out clothes).

Costovertebral Joints: Usually osteoarthritis is seen in the first, eleventh, and twelfth joints, whose articulation with the vertebrae are different (Boyle and Buchanan 1971:36). In these joints the intervertebral disk plays no part, and hence, the joint would be more vulnerable to the mechanical irritation of constant rib motion (Nathan et al. 1964:235). Nathan et al. (Ibid.) also noted a regular frequency distribution curve from T2 to T10, which paralleled rib length and breadth of thorax. T6 to T8 have the longest ribs, and hence, more extensive motion. They observed a higher frequency of osteoarthritis in the inferior hemifacet of the vertebrae (upper hemifacet of the costovertebral joint) due to the obliqueness of the rib (medial and upward to the vertebral bodies) transferring forces preferentially to the upper facet. The observations were made on 346 Negro and White skeletons from the Todd collection (48% of which were affected), and 100 random roentgenograms of thoracic spines, of which 17 were affected (Nathan et al. 1964:229-230). Occurrence begins with the third decade (Boyle and Buchanan 1971:36).

Vertebral Column: Nathan (1962:257), in studying 346 skeletons from the Todd collection and 54 cadavers, noted the first appearance of osteophytes by the age of twenty. He claimed that by the forties there was a 100% occurrence of one or another type.

1. Cervical spine: apophyseal joint-- usually appears in middle-aged women as part of primary generalized osteoarthritis (Jessop 1970:215).
   intervertebral joints-- common in C5 - C7, a common cause of spinal root depression (Jessop 1970:215-216).
2. Thoracic spine: least common site of the three, may also cause nerve root depression (Jessop 1970:217; Abrams 1966:880-881).
3. Lumbar spine: common in persons (usually male) doing heavy physical labour (Abrams 1966: 881). Degenerative joint disease usually includes both joints with marginal lipping and joint space narrowing (Abrams 1966:881; Jessop 1970:221).

Hip Joint: Commonly called coxarthrosis, this is one of the more frequent sites of osteoarthritis. It may be part of primary generalized osteoarthritis, but more often arises due to trauma. It is frequently bilateral, and radiological findings correlate fairly well with symptoms. Lloyd-Roberts (1955:17-19) gives a resume of radiological findings:

cysts - occur with advanced degeneration
- indicate painful arthritis

bony ridges on the femoral neck - indicate new formation of bone on the under surface of the femoral neck
- occurs in advanced disease
- indicates presence of capsular fibrosis and adhesions
- present in more than half of advanced cases resulting in a slight increase in disability

osteophytes - conspicuous
- core of cancellous bone continuous with parent bone.

Knee: The most common site of osteoarthritis, symptoms usually begin at 40 or 50 years (Abrams 1966:876-877). Early onset is the result of injury or infection (Ibid.). Radiological findings indicating loss of joint space, osteophytes, sclerosis, and cysts are common (Boyle and Buchanan 1971:48).

Foot: Osteoarthritis rarely occurs in the ankle, except following repeated or severe trauma, as in football players (Boyle and Buchanan 1971:53). The first metatarso-phalangeal joint is commonly affected in primary generalized osteoarthritis (Jessop 1970:213). It is more common in men and is often bilateral (Boyle and Buchanan 1971:53). Mid-tarsal joint osteoarthritis is frequent, but asymptomatic. It often occurs as a result of calcaneous or talus fractures (Boyle and Buchanan 1971:54).

Summary

Osteoarthritis is a disease affecting mainly older persons, 45 years of age and over. There are two types distinguished, a localized, trauma induced, secondary

arthritis, and a generalized type caused by genetic, endocrine, and scenescent factors. It is a wear and tear degeneration in joints, usually reflecting abnormal stress (especially in secondary osteoarthritis).

In the bone, it is characterized by hardening and sclerosis, eburnation, sharpening of articular margins and intra-articular structures, osteophytes, marginal lipping, and subchondral cysts. Advanced cases show joint remodelling, luxations, and ankylosis.

The disease is of a crippling nature, reducing joint mobility and functional capabilities. It is also noted for severe, immobilizing pain. These factors must be kept in mind when examining a palaeopopulation where such reduction of functional capability would be of paramount importance.

CHAPTER III

OTHER FORMS OF ARTHRITIS

Ankylosing Spondylitis

Definition: Ankylosing spondylitis, also termed Marie-Strümpell disease, spondylitis ankylopoietica, and rheumatoid spondylitis, is an inflammatory disorder of the spine and costo-vertebral joints. The disease is characterized by synovitis, erosion of bone, remodelling of joint margins, and bony ankylosis. In the final stages there is total spinal fusion with calcification of the vertebral ligaments giving rise to the 'bamboo' appearance.

Etiology: Although there is no definite etiology for ankylosing spondylitis, a genetic predisposition is suspected. Boland (1966:636) suggests a single autosomal factor with 70% penetrance in males and 10% penetrance in females. Boyle and Buchanan (1971:300) are more conservative pointing out evidence for familial aggregation; they hypothesize a more complex genetic component with the additional influence of environmental factors. Other theories of etiology, such as metabolic, allergic, endocrine, and genito-urinary infections, have not been substantiated (Boyle and Buchanan 1971:300; Boland 1966:637).

Pathology: Ankylosing spondylitis affects mainly the sacroiliac joints and apophyseal joints. The costo-vertebral joints and other cartilagenous joints (manubrio-sternal, costosternal, symphysis pubis, and intervertebral

disks) are also common sites of affliction. Less frequently there is peripheral joint involvement of the shoulders, hips and knees (Boyle and Buchanan 1971:285). Hands and feet are rarely involved (Ibid.).

The initial changes in ankylosing spondylitis occur in the synovial capsule. First there is an inflammatory infiltration of lymphocytes, plasma cells, and macrophages around the small subsynovial blood vessels (Boyle and Buchanan 1971:285; Boland 1966:637). This is followed by villous synovitis (proliferation of the synovial membrane) and invasion of the joint cartilage and bone (Ibid.). This invasion of hyperplastic synovial tissue into the joint causes erosion and destruction of articular cartilage (Boland 1966:637). Finally, there is filling of the joint space with granulation tissue and fibrous adhesion of the joint (Ibid.).

Articular bone takes on an eroded, roughened, "moth-eaten" appearance (Boland 1966:637). Adjacent bone is sclerosed and characterized by patchy osteitis (Boland 1966: 637; Boyle and Buchanan 1971:285). The joint space and margins become irregular, and finally, ankylosis occurs with ossification of the granulation tissue within the joint (Ibid.). In the final stages of the disease, there is ossification of the vertebral ligaments and anterior annulus fibroses, forming syndesmophytes between the vertebrae (Ibid.). This leads to the rib cage and vertebral column becoming a fixed block, flexed so that in some cases

the head cannot be raised and it is impossible to see forward.

Ankylosing spondylitis is generally considered a disease of young males, although this appears to be a selection bias and there is no clinical evidence for this (Boyle and Buchanan 1971:282-283). It affects specifically the sacroiliac, apophyseal, and costovertebral joints, with lesser involvement of cartilagenous joints and more infrequently peripheral joints.

The characteristic radiological findings in ankylosing spondylitis are as follows (Boyle and Buchanan 1971:290-296):

Sacroiliac:

1. Generalized osteoporosis and sclerosis in bone adjacent to joint margins and widening of joint space.
2. Erosion of joint margins.
3. Ankylosis of the joint with disappearance of the margins.

Spinal changes:

1. Narrowing of intervertebral disk space especially in lumbar regions.
2. Ossification of annulus fibrosis; appearance of syndesmophytes.
3. Osteoporosis.
4. Irregularity of joint margins, loss of joint space, and ankylosis of apophyseal joints.
5. Squaring of the vertebral bodies.
6. Bony ankylosis with appearance of 'bamboo' spine.

Other changes:

1. Blurring of joint margins and ankylosis of symphysis pubis, costovertebral joints, sternoclavicular, and costosternal joints.
2. Periostitis and sclerosis in the region of the ischial tuberosities, ischiopubic rami, iliac crests, and trochanters.

Sacroiliac Joints: The first joints affected by ankylosing spondylitis are the sacroiliac joints. Involvement of this joint is bilateral and may be the only sign of the disease.

Vertebral Involvement: The vertebral spine is affected inferiorly to superiorly. Changes are generally in the apophyseal joints. In severe cases, there may be ossification of the annulus fibrosis causing bridging of vertebral bodies. Total fusion causes flexion deformity and inability to rotate the thorax or head.

Costovertebral Joints: This is a common site of involvement. Impairment of chest expansion is considered an early and useful diagnostic criterion (Boyle and Buchanan 1971:283). In severe cases, it is characterized by total fusion of the rib cage to the vertebrae.

Peripheral Involvement: As already mentioned, ankylosing spondylitis has an affinity for cartilagenous joints. Ankylosis is seen in the sternal joints and symphysis pubis. Next in frequency are the large joints, shoulder, knee, and hip. Small joints of the hands and

feet are rarely involved (Boyle and Buchanan 1971:285). Huskisson and Hart (1973:7) note the following frequencies: shoulders and hips (40%), knees (15%), ankles (10%), feet (5%), wrists (5%), and hands rarely.

Palaeopathological Implications: Ankylosing spondylitis is a disease of early adulthood, the mean onset age being 15 - 30 years. Although generally believed to affect males almost exclusively (rates of male to female involvement generally about 8 or 9 to 1), this varies with population, and indeed this belief may be unfounded (Boyle and Buchanan 1971:282-283).

The disease is generally characterized by bilateral sacroiliitis and costovertebral involvement. The bone is eroded and roughened. Sclerosis and osteitis appear adjacent to the joint. Synosteosis occurs as ossification of the fibrous adhesions of the joints progress.

As in osteoarthritis, the severely debilitating nature of this disease must be considered. The crippling nature of a totally fused spinal column and rib cage is obvious. In a hunting population such as the Gray Site people, the inability to raise the head and look forward or the inability to expand the chest in breathing would be a severe disadvantage. Keeping this in mind, it is interesting to note the lack of very severe involvement in this population.

Rheumatoid Arthritis

The pathological history of rheumatoid arthritis poses an enigma. Unlike osteoarthritis there is no

evidence for rheumatoid arthritis in non-human animals (Pearson 1966:119). Indeed, the palaeopathological evidence for the disease is sketchy. Bourke (1967:357) blames archaeologists for not carefully preserving and examining the bones of hands and feet, though such an explanation is of dubious value. He presents one possible seventeenth century example of the disease, in contrast to three or more pages of examples and plates of ankylosing spondylitis and osteoarthritis (Ibid.). Rheumatoid arthritis is not mentioned in Wells' review of palaeopathology (Wells 1964).

Boyle and Buchanan (1971) present some interesting thoughts on the antiquity of rheumatoid arthritis. They bring up the following points concerning its history:

1. The disease is not clearly described before the mid 1800's.
2. The term 'rheumatoid arthritis' was first used in 1858.
3. There are no certain palaeopathological examples of the disease.
4. Competent, astute observers described most aspects of osteoarthritis before 1850 and there is no description of the changes of rheumatoid arthritis.
5. There is no reference to the debilitating characteristics of rheumatoid arthritis in early literary works or paintings, although many other chronic diseases including osteoarthritis are well

represented (Boyle and Buchanan 1971:74-75).

An examination of the prevalence of arthritic diseases is significant. Osteoarthritis occurs extensively in man and animals. Boyle and Buchanan (1971:1) review some examples of the disease which includes expression in fossil man, aquatic and terrestrial animals, and dinosaurs and birds. Ankylosing spondylitis, although not present in animals, has a long history in humans. Bourke (1967:357-360) cites examples from ancient Egypt. Rheumatoid arthritis has no well documented history, no incidence in non-human animals, and although presently widespread, at least one known population, the Tristan da Cunha islanders, is totally free of rheumatoid arthritis (Black et al. 1963).

The etiology of rheumatoid arthritis is unknown. However, theories of etiology are not incongruent with the hypothesis of a recent introduction of the disease. It is generally accepted that a combination of predisposing factors is responsible. Usually discussed are auto-immunity, genetic predisposition, and infection by way of a slow virus (Boyle and Buchanan 1971:75-85). Cobb (1971) cautiously enlarges a theory originally presented by Solomon and Moos (1964). Cobb (1971:61-62) sees the etiology of rheumatoid arthritis in three ways-- a possibly inherited susceptibility to collagen diseases, infection or trauma, and social stress or strain. Some combination of these factors would precipitate the clinical expression (Ibid.). He presents modest epidemiological

evidence for social stress and personality conflict, in conjunction with infection or trauma, being precursors of clinical expression (Ibid.). Short et al. (1957) observe that "the most common combination was strain of long duration before an onset immediately preceded by an infection, operation, or injury". These theories of causation by social stress and conflict would be in keeping with recent increases in the prevalence of rheumatoid arthritis.

Since there are no examples in the Gray Site population that resemble rheumatoid arthritis and in view of the questionable history of the disease, there will be no further discussion of it in reference to the material under study.

CHAPTER IV

POPULATION STUDIES OF OSTEOARTHRITIS AND ANKYLOSING SPONDYLITIS

Relevant Studies of Osteoarthritis

In a study of osteoarthritis in the general United States population, Gordon (1966:391) found evidence of the disease in 37.4% of persons aged 18-79 years. The prevalence varied from 4% in ages 18-24 years to 85% in persons aged 75-79 years (Ibid.). The disease was mostly of a mild degree with only 8.2% of all adults with moderate to severe osteoarthritis (Ibid.). Although males and females were equally affected, the prevalence was higher in males below 45 years, equal at 45-54 years, and higher in females over 54 years (Ibid.). The diagnoses were based on X-rays of the hands and feet.

Osteoarthritis was found more frequently in the hands than feet, males and females affected equally in the hands, and males affected less in the feet than females (Gordon 1966:391). The only significant variable affecting prevalence of osteoarthritis was occupation (Ibid.:392). There was no significant differences between White and Negro, region, urban and rural, or population size (Ibid.).

Bennett and Burch (1966a) reported a study of osteoarthritis from hand and foot X-rays of Blackfeet and Pima Indians from Montana and Arizona respectively. In the Blackfeet, the incidence of Heberden's nodes rose from less

than 3% at age 30 years to 22% of males and 51% of females at age 55-64 years, and to 56% of males and 63% of females aged 75 years and over (Ibid.:407). In the Pima, the males display a higher incidence at all ages with a prevalence of 50% of males and 36% of females aged 75 years and over (Ibid.). In general, the Blackfeet showed a higher incidence than the Pima (Ibid.:408).

Osteoarthritis showed a rapid increase in incidence to age 55 years, after which there was almost total involvement (Bennett and Burch 1966a:408-9). Males are affected more frequently at younger ages in both groups (Ibid.). In the Blackfeet, there is no constant sex difference, while the Pima males show a higher frequency at all ages (Ibid.).

It was found that Heberden's nodes were associated with moderate to severe osteoarthritis. 95% with nodes had moderate to severe osteoarthritis, while 50% of those with nodes had severe osteoarthritis compared with 13% without (Bennett and Burch 1966a:409). There was no evidence that osteoarthritis is related to climatic factors (Ibid.:412).

Relevant Studies of Ankylosing Spondylitis

Bennett and Burch (1966b) in a study of the Blackfeet and Pima assessed the value of the diagnostic criteria for ankylosing spondylitis. They found that although bilateral sacroiliitis was a fairly specific and early indicator of the disease, it was not a complete indicator and its

absence did not exclude the disease (Ibid.:307-8). However, when bilateral sacroiliitis or radiological spondylitic changes in the cervical spine were considered it gave radiological criteria to 70% of clinical ankylosing spondylitis (Ibid.:311). Limitation of chest expansion and lumbar movement were also valuable criteria (Ibid.). Pain and iritis seemed of no value in accurate diagnosis.

The study revealed no significant differences in the prevalence of sacroiliitis between the Blackfeet and Pima Indians (Bennett and Burch 1966b:305). Ankylosing spondylitis was found more frequently in males of both tribes (the sex difference in Blackfeet was not significant) and more frequently among the Pima than Blackfeet (Ibid.).

Gofton, Robinson, and Trueman (1966) studied the prevalence of ankylosing spondylitis in the Haida Indians of the Queen Charlotte Islands. After finding an unusually high prevalence of the disease in a 1962 study, another more complete survey was conducted in 1964 with the same results. A point prevalence of definite disease of 6.2% was found (Ibid.:527). Previous estimates had not exceded 1%. The study was confined to males although one female is known to have active ankylosing spondylitis (Ibid.).

The unusually high incidence of ankylosing spondylitis in the Haida was confirmed by Gofton et al. (1966a; 1966b) in their study of sacroiliitis. They found the Haida prevalence of sacroiliitis to be as follows: over 15 years - 7.6%, over 35 years - 11.3%, and over 55 years - 12.0%

(Gofton et al. 1966a:530). The only group with a rate of incidence comparable to the Haida was a familial study of ankylosing spondylitis in England (Ibid.). The incidence among the Haida is not believed to be due to genetic isolation (Ibid.:531). The comparable age-standardized rates are:

Grades 2-4 sacroiliitis	Pima	3.85%
	Blackfeet	2.67%
	Haida	9.86%
Grades 3-4 sacroiliitis	Pima	0.79%
	Blackfeet	1.23%
	Haida	6.70%

(Gofton et al. 1966a:531). There was no evidence of sacroiliitis among a Jamaican sample indicating the disease is probably rare (Ibid.:530). The overall frequencies indicate the possibility of geographical (possibly climatic, especially humidity) differences in the prevalence of ankylosing spondylitis (Ibid.:532).

CHAPTER V

ARTHRITIS IN THE GRAY SITE POPULATION

The discussion of arthritis in the joints of the Gray Site population includes only individuals 13 years of age and older. Although there are no signs of arthritis in individuals 12 years or younger, there is a lack of joint surfaces due to poor preservation and a general absence of epiphyses. The joint surfaces are discussed individually in order to completely define the pattern of the diseases manifested.

Temporomandibular

TABLE 1. Temporomandibular Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Temporomandibular Fossa									
L.	33	30	3	0	1	0	0.00	3.33	0.00
R.	32	30	3	0	2	0	0.00	6.67	0.00
Mandibular Condyle									
L.	23	14	3	0	0	0	0.00	0.00	0.00
R.	21	12	2	0	1	0	0.00	8.33	0.00

In the temporomandibular joints two females showed arthritic changes. One showed stage I changes in both temporomandibular fossae. The other had stage I changes in the right temporomandibular fossa and stage II on the right mandibular condyle. Both were in the developmental age 36-55 years and of the five-year age groups 50-54 years

and 45-49 years respectively. Both individuals showed general arthritic changes in most joints. The latter also had evidence of four abcesses.

Sternoclavicular

TABLE 2. Sternoclavicular Involvement

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Manubrium									
	3	0	3	0	0	1	0.00	0.00	33.33
Clavicle									
L.	3	2	3	0	0	1	0.00	0.00	33.33
R.	4	3	0	0	0	0	0.00	0.00	0.00

One manubrium and clavicle demonstrated stage I arthritic changes. The individual is indeterminate, however all individuals in this burial exhibit some abcessing.

Acromial

TABLE 3. Acromial Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Scapula Acromion									
L.	8	1	4	0	1	1	0.00	100.00	25.00
R.	7	0	1	0	0	0	0.00	0.00	0.00
Clavicle Acromial									
L.	5	2	3	0	0	0	0.00	0.00	0.00
R.	8	4	2	1	2	1	12.50	50.00	50.00

The percentages in this group show skewing due to small sample size. Of the two scapulae involved, one is of

indeterminate association and the other is an old female (50-54 years) who exhibits stage II lipping. The male clavicle is that of an older male (45-49 years). The individual has multiple shoulder and cervical involvement, bursitis in the right shoulder, and six abcesses with pulp necrosis and one without. The female clavicles were both from older persons (40-44 years and 45-49 years). The latter exhibited stage III changes accompanied by moderately severe general body involvement and abcessing. The former (stage IV involvement) also demonstrated moderate to severe total body degeneration. The indeterminate stage I may be associated with the sternoclavicular stage I mentioned above.

Shoulder

TABLE 4. Shoulder Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Glenoid Fossa									
L.	18	15	17	2	5	2	11.11	33.33	11.76
R.	18	13	11	3	5	4	16.67	38.48	36.36
Humerus (Proximal)									
L.	19	10	2	0	3	0	0.00	30.00	0.00
R.	19	14	2	1	2	0	5.26	14.29	0.00

The incidence of arthritis in the shoulder is more frequent in females than males. One male evidenced stage II lipping in both glenoids and stage I on the right humerus. This male (aged 45-49 years) has bursitis in the right

shoulder, abcesses, and general cervical and shoulder arthritis. Another male (50-54 years) shows bilateral stage I involvement with associated general arthritis (severe cervical) and nine abcesses, one with pulp necrosis. The male who shows only right involvement is 20-24 years, and has only this isolated sign of joint margin sharpening.

One female (50-54 years) suffered stage IV destruction in both humeri and glenoids. The joints demonstrate gross remodelling. This is accompanied by stage IV changes in other joints in association with four abcesses. A female (45-49 years) shows bilateral stage I changes in the humeri as well as moderate to severe total body involvement. Yet another female (50-54 years) has a stage I left humerus and stage II right and left glenoid fossae. She too, exhibits total body involvement and abcesses. Two other females show bilateral glenoid changes. One (45-49 years) has stage I left and stage II right, the other (50-54 years) has both stage I. Both demonstrate total body involvement; the former had abcessing. The last two females show unilateral stage I lipping. One (50-54 years) on the right, and one (40-44 years) on the left. Both have abcesses and general joint changes.

Of the indeterminate material affected, only one pair (stage II left and stage I right) can be shown associated with abcesses.

Elbow

The involvement of the elbow in more frequent in

females than males. Two males are involved. One shows stage I in the right humerus (bursitis proximally) and stage I in the left ulna, stage II in the right. The other has stage I bilaterally on the ulnae. They are 45-49 years and 50-54 years respectively, and both exhibit involvement of most joints with moderate to severe lipping.

TABLE 5. Elbow Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Humerus (Distal)									
L.	19	16	4	0	2	0	0.00	12.50	0.00
R.	20	17	3	1	4	0	5.00	23.53	0.00
Ulna (Proximal)									
L.	17	17	7	2	3	3	11.76	17.65	42.86
R.	20	16	6	2	2	3	10.00	12.50	50.00
Radius (Proximal)									
L.	19	15	3	0	2	0	0.00	13.33	0.00
R.	18	18	0	0	4	0	0.00	22.22	0.00

The females all demonstrate the same type of recurring involvement. All are in the 45-54 year age bracket. Table 6 shows joints affected by individual. All five show bilateral involvement except the third where there is no material from the left arm.

One individual of indeterminate sex (45-49 years) shows stage I in the right radius. Other than five abcesses and three cases of pulp necrosis the fragments of this individual appear normal. One stage I left ulna comes

from an indeterminate group of bones comprised of the skeletons of the third female above and a 20-24 year old male, indicating probable association with the female-- since she already has shown elbow involvement.

TABLE 6. Female Elbow Involvement By Age.

Age (Years)	Humerus	Radius	Ulna
50-54	Stage I right		Stage I right
			Stage I left
50-54	Stage I right	Stage I right	
	Stage I left	Stage I left	
50-54	Stage III right	Stage III right	
50-54		Stage I right	
			Stage I left
45-49	Stage I right	Stage I right	Stage I right
	Stage I left	Stage I left	Stage I left

Thus, all (excluding indeterminate material) cases of arthritis in the elbow are associated with individuals of at least 45 years of age with a sex ratio of 2.5:1 favouring females. All individuals affected have arthritis in several joints, except one indeterminate example.

Wrist

The wrist was typified by no obvious male-female discrepancies in involvement. Two males were affected. They both have elbow and shoulder arthritis as well as general joint deterioration. The elder (50-54 years) has a stage II right radius and a stage III right ulna, both

lunates at stage II, and stage I in one scaphoid. The other (45-49 years) shows stage I in the right and left radii, right ulna, and lunate.

TABLE 7. Wrist Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Radius (Distal)									
L.	15	14	1	1	1	0	6.67	7.14	0.00
R.	15	15	3	2	2	1	13.33	13.33	13.33
Ulna (Distal)									
L.	13	8	2	0	2	0	0.00	25.00	0.00
R.	12	10	1	2	1	1	16.67	10.00	100.00
Scaphoid									
	11	12	14	1	0	0	9.09	0.00	0.00
Lunate									
	18	11	11	3	0	0	16.67	0.00	0.00

The two females involved also have elbow and shoulder changes and moderate to severe total joint degeneration. One (45-49 years) demonstrates stage I in both radii and ulnae, and the other (50-54 years) has stage I in the right radius and left ulna. Both cases are bilateral.

The difficulty of sorting hand and foot bones is evident in the large numbers of indeterminate carpals. The two groups of indeterminate materials showing wrist involvement here also previously exhibited arthritis of the shoulder and elbow.

<u>The Hand</u>

The hand will be discussed in four steps: carpometacarpal joints, metacarpophalangeal joints, proximal interphalangeal joints, and terminal interphalangeal joints.

TABLE 8. Carpometacarpal Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Capitate	17	15	14	0	0	0	0.00	0.00	0.00
Hamate	11	13	14	0	2	0	0.00	15.38	0.00
Trapezoid	10	12	12	1	1	0	10.00	8.33	0.00
Trapezium	8	8	8	1	1	0	12.50	12.50	0.00
Triquetrum	8	7	10	3	2	0	37.50	28.57	0.00
Pisiform	4	4	7	0	0	1	0.00	0.00	14.29
Proximal Metacarpals									
1	18	15	12	2	1	0	11.11	8.33	0.00
2	20	22	19	0	3	0	0.00	13.64	0.00
3	17	21	16	2	2	0	11.76	9.52	0.00
4	19	19	17	2	0	0	10.53	0.00	0.00
5	19	18	20	1	2	0	5.26	11.11	0.00

As expected, the ratio of female to male involvement is 2:1. The same two males are affected with low grade to moderate lipping. Both have several joints affected.

Three of the four females involved show changes in the other arm joints above. Two have multiple involvement and one has a single fifth metacarpal affected. The fourth shows vertebral, lower limb, and foot involvement as well as stage II changes in all terminal interphalangeal joints, indicating a generalized osteoarthritic syndrome.

TABLE 9. Metacarpophalangeal Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Distal Metacarpal									
1	18	14	9	2	5	0	11.11	35.71	0.00
2	18	17	14	0	3	0	0.00	17.65	0.00
3	14	17	11	0	2	0	0.00	11.76	0.00
4	15	16	10	0	1	0	0.00	6.25	0.00
5	17	15	14	0	1	0	0.00	6.66	0.00
Proximal First Phalangeal									
1	16	10	10	4	6	0	25.00	60.00	0.00
2	16	7	15	1	3	0	6.25	42.86	0.00
3	21	15	8	0	3	0	0.00	20.00	0.00
4	19	10	10	4	2	0	21.05	20.00	0.00
5	12	8	7	3	1	0	25.00	12.50	0.00

Females again have a higher rate of incidence and the ratio of females to males is 2:1. As expected, the two males consistently afflicted with joint deterioration displayed symptoms of metacarpophalangeal arthritis. The third (25-29 years) shows changes in both great toes, four proximal interphalangeal joints, a single proximal first

row phalanx, and five rib tubercles.

The four females with carpometacarpal arthritis show multiple metacarpophalangeal involvement. One other female (50-54 years) is marked by severe shoulder arthritis. The sixth female (45-49 years) has vertebral and rib changes and some terminal interphalangeal involvement.

TABLE 10. Proximal Interphalangeal Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Distal First Phalangeal									
1	16	12	10	4	5	1	25.00	41.67	10.00
2	20	12	16	1	5	1	5.00	41.67	6.25
3	22	15	10	4	6	1	18.18	40.00	10.00
4	20	13	12	4	2	2	20.00	15.38	16.67
5	15	8	7	3	1	0	20.00	12.50	0.00
Proximal Second Phalangeal									
1	11	7	6	1	2	1	9.09	28.57	16.67
2	15	5	7	1	2	0	7.14	40.00	0.00
3	17	14	11	4	5	0	23.53	35.71	0.00
4	10	8	11	4	2	0	40.00	25.00	0.00
5	9	6	6	2	2	0	22.22	33.33	0.00

Again, the incidence of expression is higher in females. The sex ratio of individuals is 2:1, females to males affected.

The three males demonstrating metacarpophalangeal arthritis also show proximal interphalangeal changes. Five of the females had metacarpophalangeal involvement. One

female (35-39 years) has a single proximal joint involved and severe osteophytosis in the terminal joint. She also has moderate to severe lipping in the vertebrae and ribs. This is possibly a case of Heberden's nodes.

The indeterminate remains are unsorted materials.

TABLE 11. Terminal Interphalangeal Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Distal Second Phalangeal									
1	4	2	0	0	2	0	0.00	100.00	0.00
2	15	7	6	1	3	0	6.67	42.86	0.00
3	17	15	10	2	5	0	11.76	33.33	0.00
4	10	9	11	2	2	0	20.00	22.22	0.00
5	8	6	6	2	2	0	25.00	33.33	0.00
Third Phalangeal									
Total	31	23	18	7	13	2	22.58	56.52	11.11

The sex ratio in this category is 4:1 favouring females to males. The two males included show complete joint involvement in the arm and hand with several joints affected. They are in the age range of 45-54 years and show generalized degenerative osteoarthritis.

Six females (40-54 years) show the same type of generalized degenerative osteoarthritis. A female (45-49 years) has stage I lipping in this joint associated with cervical arthritis and abcesses. The other, aged 35-39 years, is a possible case of Heberden's nodes. Out of three distal phalanges, one has stage I lipping and two

have stage IV osteophyte formation. The only other involvement here is in the vertebrae and ribs.

Pubic Symphysis

TABLE 12. Pubic Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Pubic Symphysis									
L.	10	7	1	0	4	0	0.00	57.14	0.00
R.	9	7	0	0	4	0	0.00	57.14	0.00

Pubic changes are visible in four old females (40-54 years) all of whom show moderate to severe general arthritis. The relatively high incidence in old females may possibly be due to childbirth trauma.

Hip

TABLE 13. Hip Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Acetabulum									
L.	21	13	5	0	4	0	0.00	30.76	0.00
R.	21	17	2	0	3	0	0.00	17.65	0.00
Femur (Proximal)									
L.	20	16	1	0	1	0	0.00	6.25	0.00
R.	21	15	0	0	1	0	0.00	6.67	0.00

Again, changes are present only in old females (40-54 years). Three have bilateral stage I involvement and one has stage II changes in the left acetabulum. In addition, one (40-44 years) shows stage I changes in the femoral head.

The hip was not characterized by severe or debilitating arthritis.

Knee

TABLE 14. Knee Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Femur (Distal)									
L.	19	16	1	0	3	0	0.00	18.75	0.00
R.	22	17	0	0	4	0	0.00	23.53	0.00
Fibula (Proximal)									
L.	10	5	0	1	1	0	10.00	20.00	0.00
R.	10	8	0	0	2	0	0.00	25.00	0.00
Tibia (Proximal)									
L.	18	13	0	0	1	0	0.00	7.69	0.00
R.	19	15	1	0	1	0	0.00	6.67	0.00
Patella									
L.	9	12	5	1	1	0	11.11	8.33	0.00
R.	9	11	4	1	1	0	11.11	9.09	0.00

Two males show arthritic changes. One (50-54 years) exhibits stage II lipping in both patellae, associated with generally degenerative joints. The other (45-49 years) has slight (stage I) changes in the left fibula. He too displays general joint degeneration.

Five older females (40-54 years) who demonstrated degenerative disease in the upper limbs, also show (as would be expected) moderately severe changes in the knee, with multiple bone involvement. A younger female, aged

35-39 years, has low grade sharpening and lipping along the margins of the right femur. An old female (50-54 years) has sharpening and lipping on both femoral heads. The only other arthritis present in this person is stage IV destruction of the superior body of the sacrum.

The knee involvement fits well into the degenerative profiles of the two males and five of the females.

Ankle

TABLE 15. Ankle Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Fibula (Distal)									
L.	12	10	0	0	0	0	0.00	0.00	0.00
R.	9	10	0	0	1	0	0.00	10.00	0.00
Tibia (Distal)									
L.	19	14	0	0	0	0	0.00	0.00	0.00
R.	19	16	1	0	0	0	0.00	0.00	0.00
Talus	21	28	22	4	8	4	19.05	28.57	18.18
Calcaneous	21	31	18	3	7	6	14.29	22.58	33.33

Only one right distal fibula shows stage II changes. It is from an old female of 50-54 years, with general degenerative disease, including stage I changes in a calcaneous and talus. The other female involvement is that of four old females (40-54 years) with multiple joint arthritis.

One old male (45-49 years) shows stage I changes in the calcaneous and talus. This is predictable considering the arthritic changes in all of his other joints. A second male of 20-24 years has a very slight but unmistakable sharpening and low-grade lipping on all the tarsals. Although the changes are slight they are considered outside the range of normal variation for the group. Potter (1972:1429) mentions in passing, that flat feet can cause the "development of bony ridges and deformities in the intertarsal and metatarsophalangeal joints". However, I have been unable to further substantiate this, and for the purposes of this paper, will consider the lipping of degenerative origin.

The incidence of arthritic changes in the calcaneous and talus are higher than expected. In modern populations, osteoarthritis rarely occurs in the ankle, except in cases of severe and repeated trauma, such as that in soccer players. The high incidence in the Gray Site people could possibly be attributed to a more rugged lifestyle, having required pedestrian transport.

The Foot

The foot will be considered in three parts: tarsometatarsal joints, metatarsophalangeal joints, and interphalangeal joints.

As expected, there is a low incidence of arthritis in the tarsals. One male, aged 20-24 years, has bilateral sharpening and low-grade lipping in all the tarsals and first metatarsal. As stated above, it is low-grade, but

outside the normal range of variation in the population. The female tarsals affected belong to two old (45-54 years) females with general moderate to severe joint involvement. Another male, aged 15-19 years, shows isolated lipping on a navicular.

TABLE 16. Tarsometatarsal Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Navicular									
	21	18	15	3	0	3	14.29	0.00	20.00
Cuboid									
	17	20	13	2	2	0	11.76	10.00	0.00
Medial Cuniform									
	17	14	17	2	1	1	11.76	7.14	5.88
Intermediate Cuniform									
	17	17	18	2	1	4	11.76	5.88	22.22
Lateral Cuniform									
	17	11	10	2	1	2	11.76	9.09	20.00
Metatarsals (Proximal)									
1	19	18	13	3	1	5	15.79	5.56	38.46
2	23	18	13	1	5	2	4.38	27.77	15.38
3	20	18	16	1	2	1	5.00	11.11	6.25
4	18	18	16	1	1	5	11.11	11.11	31.25
5	17	16	18	1	2	2	5.88	12.50	11.11

Metatarsal involvement is more limited. One male (45-49 years) has stage I changes in each of four metatarsals. He has shown arthritis in all joints discussed thus far,

and has osteoarthritic changes in vertebrae and ribs, also. Three old females who have had consistent joint degeneration also display metatarsal lipping. A young female (35-39 years), a possible case of Heberden's nodes, has slight lipping on both second metatarsals.

TABLE 17. Metatarsophalangeal Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Metatarsals (Distal)									
1	18	17	15	2	3	2	11.11	17.65	13.33
2	18	15	11	0	1	2	0.00	6.67	18.18
3	16	13	12	0	1	0	0.00	7.49	0.00
4	15	12	11	0	0	2	0.00	0.00	18.18
5	15	8	15	0	0	0	0.00	0.00	0.00
Proximal Phalanges									
1	17	13	9	2	1	3	11.76	7.69	33.33
2	20	13	8	0	0	0	0.00	0.00	0.00
3	13	11	13	0	0	0	0.00	0.00	0.00
4	14	9	16	0	0	0	0.00	0.00	0.00
5	8	7	7	0	0	2	0.00	0.00	28.57

Metatarsophalangeal arthritis is most common in the first joint. The female expression is part of a more generalized degenerative syndrome in two older females (40-54 years). The two males involved are much younger (20-29 years). One shows low-grade lipping, stage I, in all the tarsals as well as the two first metatarsals. The second displays stage I changes in the first row, proximal phalanges

of the foot, the distal hand phalanges, and the rib facets. Generally, however, the incidence of involvement of these joints is low and well within expectations.

TABLE 18. Interphalangeal Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Distal First Phalanges									
1	17	15	9	1	1	2	5.88	6.67	22.22
2	19	13	7	2	0	0	10.53	0.00	0.00
3	15	12	13	1	0	0	6.67	0.00	0.00
4	15	12	16	3	2	0	20.00	16.67	0.00
5	9	7	7	0	0	2	0.00	0.00	28.57
Second Phalanges									
1	12	8	10	0	0	2	0.00	0.00	20.00
Other	26	23	17	2	2	0	7.69	8.70	0.00
Third Phalanges (Total)									
	15	11	12	2	0	1	13.33	0.00	8.33
Fifth Phalanx (Fused 2 & 3)									
	3	4	3	0	0	0	0.00	0.00	0.00

All lipping in the phalanges was of stage I. The two females exhibiting phalangeal arthritis are old (45-54 years) victims of generalized degenerative processes. The males include two older (45-54 years) individuals with osteo-arthritic involvement of most joints. Two younger males, aged 20-29 years, show isolated lipping on the phalanges of the foot. Generally, the incidence of arthritic manifestation in the foot is low, and does not require special

explanation or comment.

Ribs

TABLE 19. Rib Involvement.

		Joints Present			Joints Affected			% Involvement		
		Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
(Note: T indicates tubercle; H indicates head)										
1	T	15	12	15	1	1	0	6.67	8.33	0.00
	H	11	9	5	0	4	0	0.00	44.44	0.00
2	T	15	11	12	3	4	6	20.00	36.37	50.00
	H	11	11	9	0	3	3	0.00	27.28	33.33
3	T	9	8	4	0	1	2	0.00	12.50	50.00
	H	6	4	0	3	0	0	50.00	0.00	0.00
4	T	11	3	2	5	0	0	45.45	0.00	0.00
	H	8	2	1	3	0	0	37.50	0.00	0.00
5	T	8	4	2	4	1	1	50.00	25.00	50.00
	H	4	4	2	0	0	0	0.00	0.00	0.00
6	T	11	5	4	1	2	0	9.09	40.00	0.00
	H	6	4	4	0	1	0	0.00	25.00	0.00
7	T	10	4	4	3	2	2	30.00	50.00	50.00
	H	6	2	4	1	0	0	16.67	0.00	0.00
8	T	10	5	4	1	3	1	10.00	60.00	25.00
	H	8	4	2	1	0	0	12.50	0.00	0.00
9	T	7	4	3	0	2	0	0.00	50.00	0.00
	H	7	3	3	0	0	0	0.00	0.00	0.00
10	T	7	5	3	1	1	0	14.29	20.00	0.00
	H	7	3	3	0	0	0	0.00	0.00	0.00
11	H	8	5	4	1	2	0	12.50	40.00	0.00

TABLE 19. Continued.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
11 or 12									
H	4	11	3	1	4	0	25.00	36.37	0.00
12 H	8	5	4	6	2	0	75.00	40.00	0.00
13 H	2	0	0	0	0	0	0.00	0.00	0.00
Misc.									
T	33	61	93	11	18	31	33.33	29.51	33.33
H	13	44	26	0	8	5	0.00	18.18	19.23

Total tubercles present	404
Total tubercles affected	108
% tubercle involvement	26.73
Total heads present	235
Total heads affected	49
% head involvement	20.85

TABLE 20. Severity of Rib Involvement.

	Total	Stage I		Stage II		Stage III		Stage IV		Stage V	
	%	#	%	#	%	#	%	#	%	#	%
	Tubercles										
M	27.78	22	20.37	3	2.78	4	3.70	1	0.93	0	0.00
F	32.41	17	15.74	16	14.81	1	0.93	1	0.93	0	0.00
I	39.82	33	30.56	9	8.33	1	0.93	0	0.00	0	0.00
	Heads										
M	34.69	14	28.57	3	6.12	0	0.00	0	0.00	0	0.00
F	48.98	9	18.37	9	18.37	4	8.16	2	4.08	0	0.00
I	16.32	4	8.16	4	8.16	0	0.00	0	0.00	0	0.00

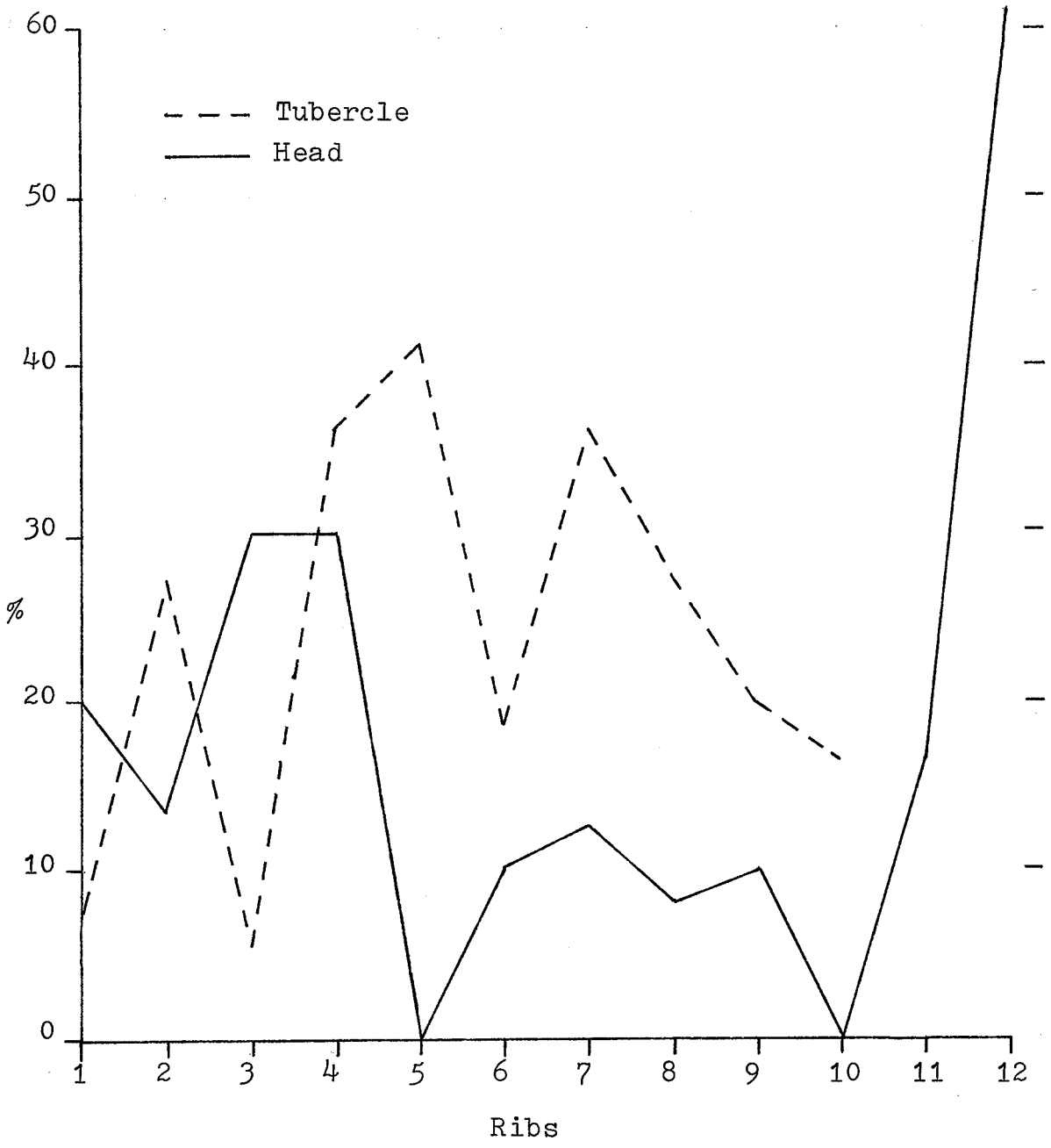


Figure I. Involvement of Ribs

The ribs show a high percentage of arthritic changes in both the tubercle and head. Females have a slightly higher incidence of involvement with a much higher percentage in stage II than males. The arthritis seems to be of a less severe nature with approximately 90% of the changes in stages I and II. All males exhibiting stage III and IV changes also had evidence of fractured ribs implying possible secondary osteoarthritis. There were no ribs fused to vertebrae (stage V).

Figure I shows the percentage of joint involvement by rib. The sample is very small, hence the results can only be taken as an indication of population tendencies in rib involvement. Tubercles show a higher incidence of arthritis increasing from superior to inferior to about the fifth or sixth rib, then decreasing. Head involvement tends to be higher in the superior area, decreasing to the twelfth rib which shows a very high incidence. The pair of thirteenth ribs showed no arthritis.

Cervical Vertebrae

TABLE 21. Cervical Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
1									
Dens	12	17	13	5	11	2	41.67	64.71	15.38
Apophyses									
L.	12	16	14	1	6	1	8.33	37.50	7.14
R.	12	16	14	1	6	1	8.33	37.50	7.14

TABLE 21. Continued.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
2									
Dens	14	17	9	2	9	2	14.29	52.94	22.22
Apophyses									
L.	13	16	10	2	8	0	15.39	50.00	0.00
R.	13	14	10	1	7	0	7.69	50.00	0.00
Body	12	10	9	0	4	1	0.00	40.00	11.11
3									
Body	8	10	2	2	5	0	25.00	50.00	0.00
Apophyses									
L.	7	10	3	3	5	0	42.86	50.00	0.00
R.	8	10	3	2	3	0	25.00	30.00	0.00
4									
Body	8	11	0	2	6	0	25.00	54.55	0.00
Apophyses									
L.	9	10	0	2	2	0	22.22	20.00	0.00
R.	8	11	0	3	2	0	37.50	18.18	0.00
5									
Body	10	10	1	2	6	1	20.00	60.00	100.00
Apophyses									
L.	11	10	1	2	2	0	18.18	20.00	0.00
R.	11	11	1	2	3	0	18.18	27.27	0.00
6									
Body	10	12	0	2	5	0	20.00	41.67	0.00
Apophyses									
L.	8	13	0	0	0	0	0.00	0.00	0.00
R.	9	11	0	1	0	0	11.11	0.00	0.00
7									
Body	5	11	2	2	5	1	40.00	45.45	50.00
Apophyses									
L.	4	11	2	2	1	0	50.00	9.09	0.00

TABLE 21. Continued.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
7 Apophyses									
R.	6	10	2	2	1	0	33.33	10.00	0.00
Misc.									
Body	5	4	33	1	1	10	20.00	25.00	30.03
Apophyses									
L.	5	5	31	0	1	0	0.00	20.00	0.00
R.	5	5	32	0	1	0	0.00	20.00	0.00

The dens shows a high rate of involvement. In the atlas, sharpening of the dens facet was noted in 55% of the population present. The females demonstrated this twice as frequently as males. The dens itself was marked by osteophytic growth in 35% of the axis vertebrae present. The growth occurred generally on the cranial end.

The apophyses in the cervical region were marked by severe involvement.

TABLE 22. Severity of Cervical Involvement.

			Total		Stage I		Stage II		Stage III		Stage IV		Stage V	
			%	#	%	#	%	#	%	#	%	#	%	
Apophyses	Left	M	31.57	3	7.89	1	2.63	3	7.89	5	13.16	0	0.00	
		F	65.79	15	39.47	3	7.89	3	7.89	2	5.26	2	5.26	
		I	2.63	1	2.63	0	0.00	0	0.00	0	0.00	0	0.00	
	Right	M	33.33	2	5.56	1	2.78	4	11.11	5	13.89	0	0.00	
		F	63.89	9	25.00	5	13.89	2	5.56	5	13.89	2	5.56	
		I	2.78	1	2.78	0	0.00	0	0.00	0	0.00	0	0.00	

TABLE 22. Continued.

		Total	Stage I		Stage II		Stage III		Stage IV		Stage V	
		%	#	%	#	%	#	%	#	%	#	%
Bodies	M	23.91	5	10.87	2	4.35	1	2.17	3	6.52	0	0.00
	F	69.57	8	17.39	10	21.74	9	19.57	3	6.52	2	4.35
	I	6.52	3	6.52	0	0.00	0	0.00	0	0.00	0	0.00

Females show cervical arthritis approximately twice as often as males. There are two pair of fused vertebrae--both female. One occurs as a congenital synostosis in the 4th and 5th cervical vertebrae of a 10-14 year old. The other is noted as stage V above. It appears to be caused by osteophytic bridging.

The bodies show lipping and osteophyte formation in 34% of the cervical vertebrae. Females were affected approximately three times as often as males. The bodies show a high frequency of stages I-III as shown in Table 22. Again, the stage V refers to the fused vertebrae mentioned above.

TABLE 23. Ages of Cervical Involvement.

Age Group	Male	Female
10 - 14		1
15 - 19	2	1
20 - 24	2	2
25 - 29	1	1
35 - 39		2
40 - 44		1
45 - 49	1	3
50 - 54	2	4

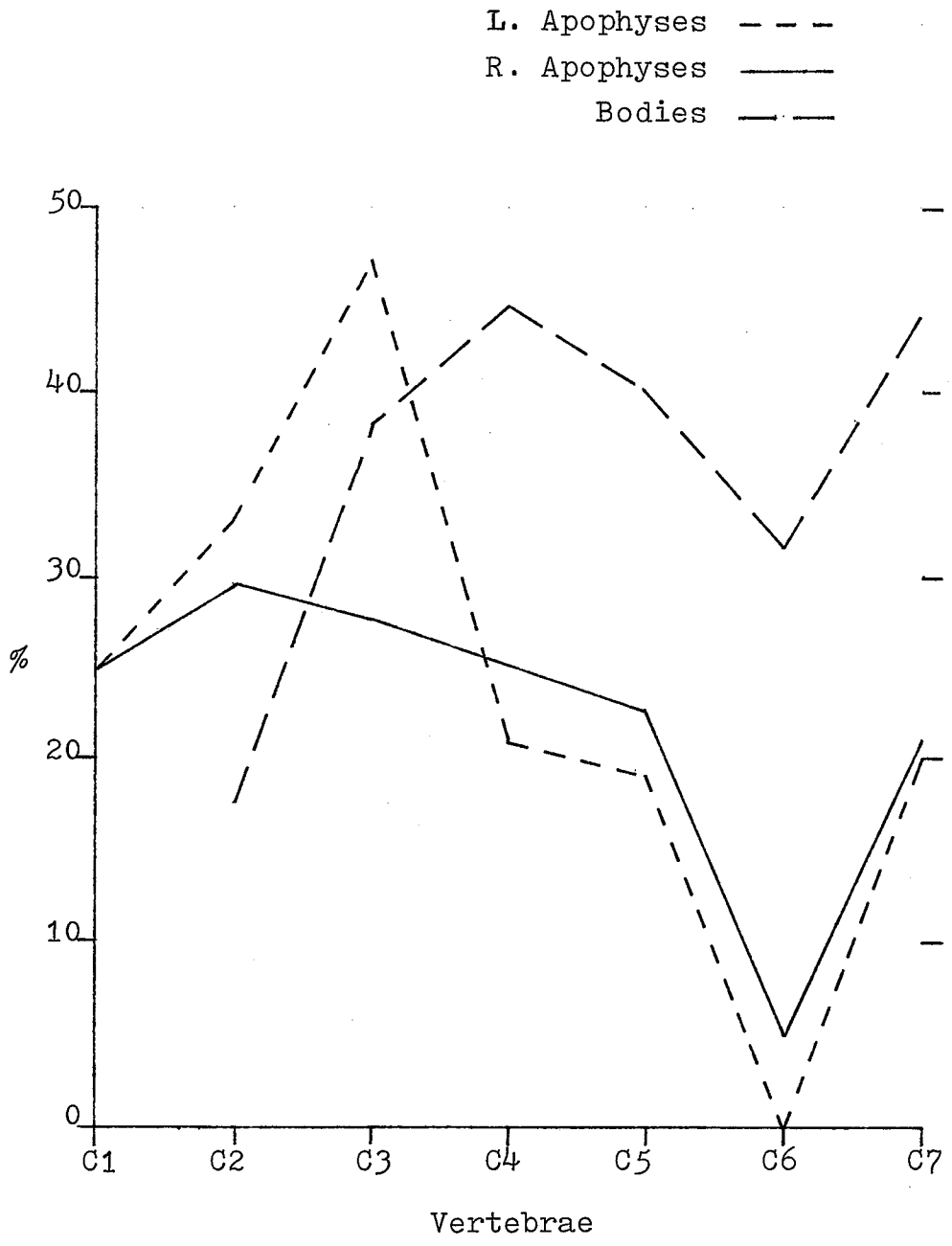


Figure II. Involvement of the Cervical Vertebrae

The ages of involvement show arthritic changes in all groups studied, with no patterns detected. Noteworthy is the very young age of onset.

Figure II shows a decrease in apophyseal involvement from C2 to C6 and a rise at C7. The bodies show a general increase from superior to inferior.

Thoracic Vertebrae

TABLE 24. Thoracic Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
1									
Body	9	8	2	1	2	1	11.11	25.00	50.00
Apophyses									
L.	10	10	2	2	1	1	20.00	10.00	50.00
R.	10	10	2	2	1	1	20.00	10.00	50.00
Rib									
L.	9	7	2	3	2	1	33.33	28.57	50.00
R.	9	6	2	4	1	1	44.44	16.67	50.00
Transverse									
L.	7	3	2	1	0	0	14.29	0.00	0.00
R.	7	3	2	0	0	0	0.00	0.00	0.00
2									
Body	8	6	2	0	1	1	0.00	16.67	50.00
Apophyses									
L.	8	7	2	1	1	0	12.50	14.29	0.00
R.	8	7	2	1	1	0	12.50	14.29	0.00
Rib									
L.	8	7	2	1	2	1	12.50	28.57	50.00
R.	8	6	2	1	1	1	12.50	16.67	50.00
Transverse									
L.	8	5	2	2	0	0	25.00	0.00	0.00
R.	8	3	1	2	0	0	25.00	0.00	0.00

TABLE 24. Continued.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
3									
Body	7	6	1	0	1	0	0.00	16.67	0.00
Apophyses									
L.	8	7	2	0	2	0	0.00	28.57	0.00
R.	8	7	2	0	2	0	0.00	28.57	0.00
Rib									
L.	6	5	1	0	1	0	0.00	20.00	0.00
R.	8	6	1	0	1	0	0.00	16.67	0.00
Transverse									
L.	7	2	1	0	0	0	0.00	0.00	0.00
R.	5	2	1	0	0	0	0.00	0.00	0.00
4									
Body	9	4	2	0	2	1	0.00	50.00	50.00
Apophyses									
L.	9	7	2	0	1	0	0.00	14.29	0.00
R.	9	6	2	1	1	0	11.11	16.67	0.00
Rib									
L.	9	5	2	0	1	1	0.00	20.00	50.00
R.	8	5	2	0	1	1	0.00	20.00	50.00
Transverse									
L.	8	3	1	0	1	0	0.00	33.33	0.00
R.	5	3	1	0	1	0	0.00	33.33	0.00
5									
Body	9	5	3	0	2	1	0.00	40.00	33.33
Apophyses									
L.	8	6	3	1	3	0	12.50	50.00	0.00
R.	9	8	3	1	3	0	11.11	37.50	0.00
Rib									
L.	8	4	2	0	1	0	0.00	25.00	0.00
R.	9	4	3	0	1	1	0.00	25.00	33.33
Transverse									
L.	8	3	2	0	1	0	0.00	33.33	0.00
R.	5	3	3	0	1	0	0.00	33.33	0.00

TABLE 24. Continued.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
6									
Body	9	5	3	0	2	1	0.00	40.00	33.33
Apophyses									
L.	9	8	3	1	3	0	11.11	37.50	0.00
R.	9	7	3	1	3	0	11.11	42.86	0.00
Rib									
L.	9	5	3	0	1	0	0.00	20.00	0.00
R.	9	5	3	0	1	0	0.00	20.00	0.00
Transverse									
L.	7	1	3	0	0	0	0.00	0.00	0.00
R.	6	2	1	0	0	0	0.00	0.00	0.00
7									
Body	9	4	1	1	2	0	11.11	50.00	0.00
Apophyses									
L.	9	8	2	1	2	0	11.11	25.00	0.00
R.	9	8	2	1	2	0	11.11	25.00	0.00
Rib									
L.	9	4	1	1	1	0	11.11	25.00	0.00
R.	9	4	1	1	1	0	11.11	25.00	0.00
Transverse									
L.	7	4	1	0	0	0	0.00	0.00	0.00
R.	7	1	1	0	0	0	0.00	0.00	0.00
8									
Body	9	6	2	1	2	1	11.11	33.33	50.00
Apophyses									
L.	9	7	2	1	1	0	11.11	14.29	0.00
R.	9	7	2	1	1	0	11.11	14.29	0.00
Rib									
L.	9	6	2	1	1	0	11.11	16.67	0.00
R.	9	6	2	1	2	0	11.11	33.33	0.00
Transverse									
L.	8	3	0	1	0	0	12.50	0.00	0.00
R.	7	4	0	0	2	0	0.00	50.00	0.00

TABLE 24. Continued.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
9									
Body	8	8	1	1	4	0	12.50	50.00	0.00
Apophyses									
L.	8	9	2	1	3	0	12.50	33.33	0.00
R.	8	9	2	1	3	0	12.50	33.33	0.00
Rib									
L.	7	7	1	1	1	0	14.29	14.29	0.00
R.	8	7	1	1	1	0	12.50	14.29	0.00
Transverse									
L.	6	3	0	0	0	0	0.00	0.00	0.00
R.	7	4	0	2	0	0	28.57	0.00	0.00
10									
Body	8	6	2	1	1	0	12.50	16.67	0.00
Apophyses									
L.	8	10	2	1	2	0	12.50	20.00	0.00
R.	8	10	3	1	2	0	12.50	20.00	0.00
Rib									
L.	8	8	2	1	0	0	12.50	0.00	0.00
R.	8	7	2	1	0	0	12.50	0.00	0.00
Transverse									
L.	8	3	1	0	0	0	0.00	0.00	0.00
R.	8	3	1	0	0	0	0.00	0.00	0.00
11									
Body	8	4	2	1	2	0	12.50	50.00	0.00
Apophyses									
L.	8	9	2	1	2	0	12.50	22.22	0.00
R.	8	9	2	1	2	0	12.50	22.22	0.00
Rib									
L.	7	7	2	1	1	0	14.29	14.29	0.00
R.	8	7	2	1	1	0	12.50	14.29	0.00
12									
Body	9	11	1	0	1	0	0.00	9.09	0.00

TABLE 24. Continued.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
12									
Apophyses									
L.	9	13	2	1	2	0	11.11	15.38	0.00
R.	9	14	2	1	2	0	11.11	14.29	0.00
Rib									
L.	9	11	2	2	1	1	22.22	9.09	50.00
R.	9	12	1	2	2	0	22.22	16.67	0.00
13									
Body	1	0	0	0	0	0	0.00	0.00	0.00
Apophyses									
L.	1	0	0	0	0	0	0.00	0.00	0.00
R.	1	0	0	0	0	0	0.00	0.00	0.00
Rib									
L.	1	0	0	0	0	0	0.00	0.00	0.00
R.	1	0	0	0	0	0	0.00	0.00	0.00
Misc.									
Body	10	30	64	1	3	7	10.00	10.00	10.94
Apophyses									
L.	17	53	82	0	3	1	0.00	5.66	1.22
R.	23	51	81	3	2	1	13.04	3.92	1.23
Rib									
L.	13	22	49	0	2	3	0.00	9.09	6.12
R.	11	22	53	0	0	2	0.00	0.00	3.77
Transverse									
L.	3	16	27	0	0	0	0.00	0.00	0.00
R.	2	12	30	0	1	1	0.00	8.33	3.33

Compared with the cervical vertebrae, the thoracic area shows a lower percentage of involvement. The apophyses and bodies show a rather confusing pattern of involvement (Figure III) but a general decrease is visable from T1 to T2, an increase from T3 to T4 or T5, and a decrease at T12.

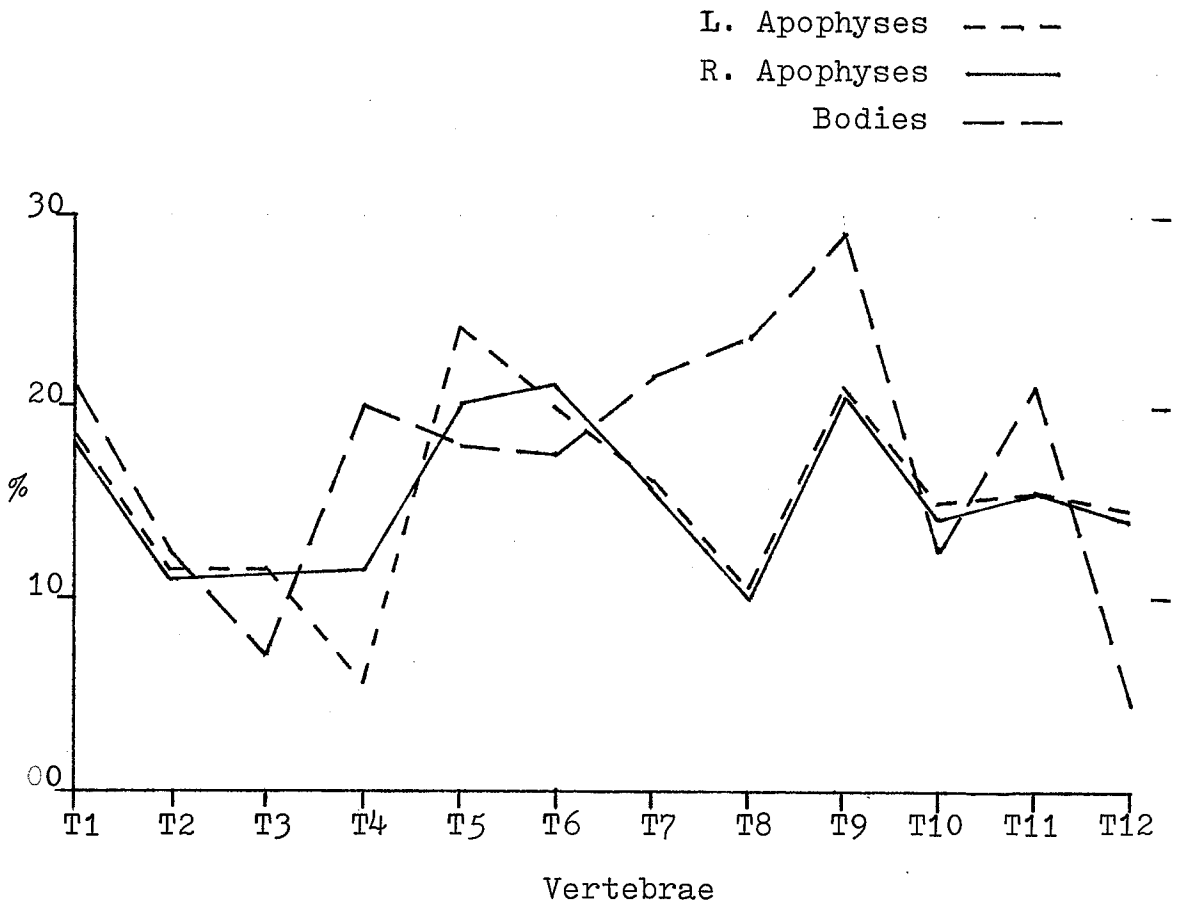


Figure III. Involvement of the Thoracic Vertebrae

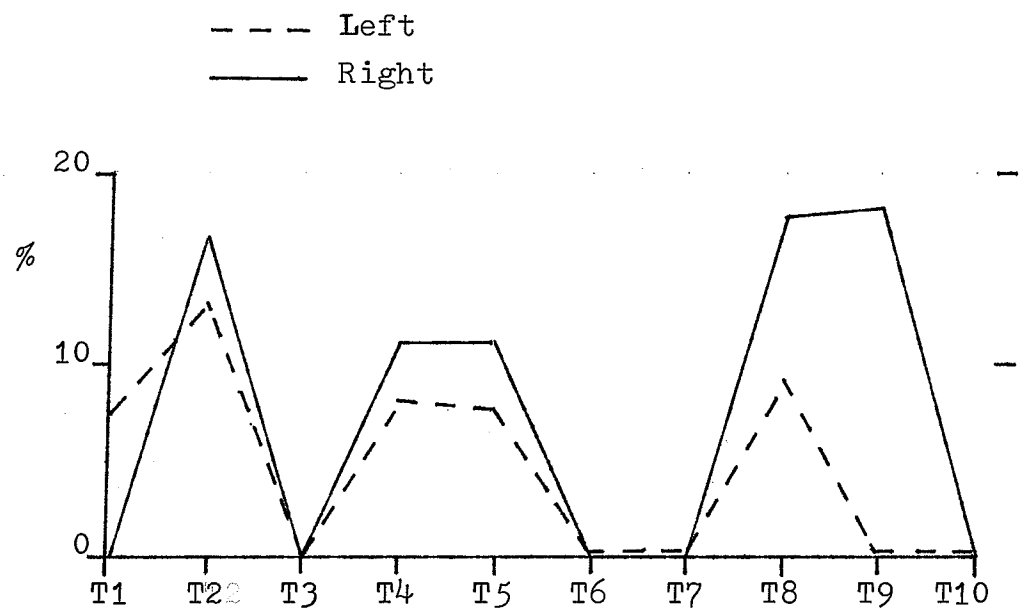
The rib and transverse facets show a more definite pattern; decreasing from T2 to T3, and increasing to a peak at T4 or T5, then decreasing at T6. T7 shows an increase to a final peak at T8 decreasing on the transverse to 0 at T10, and just dipping at T10 on the bodies to peak at T12 (Figure IV).

TABLE 25. Ages of Thoracic Involvement.

Age Group	Male	Female
10 - 14		1
15 - 19		1
20 - 24	2	1
25 - 29	1	
35 - 39		1
40 - 44		1
45 - 49	2	1
50 - 54	1	4

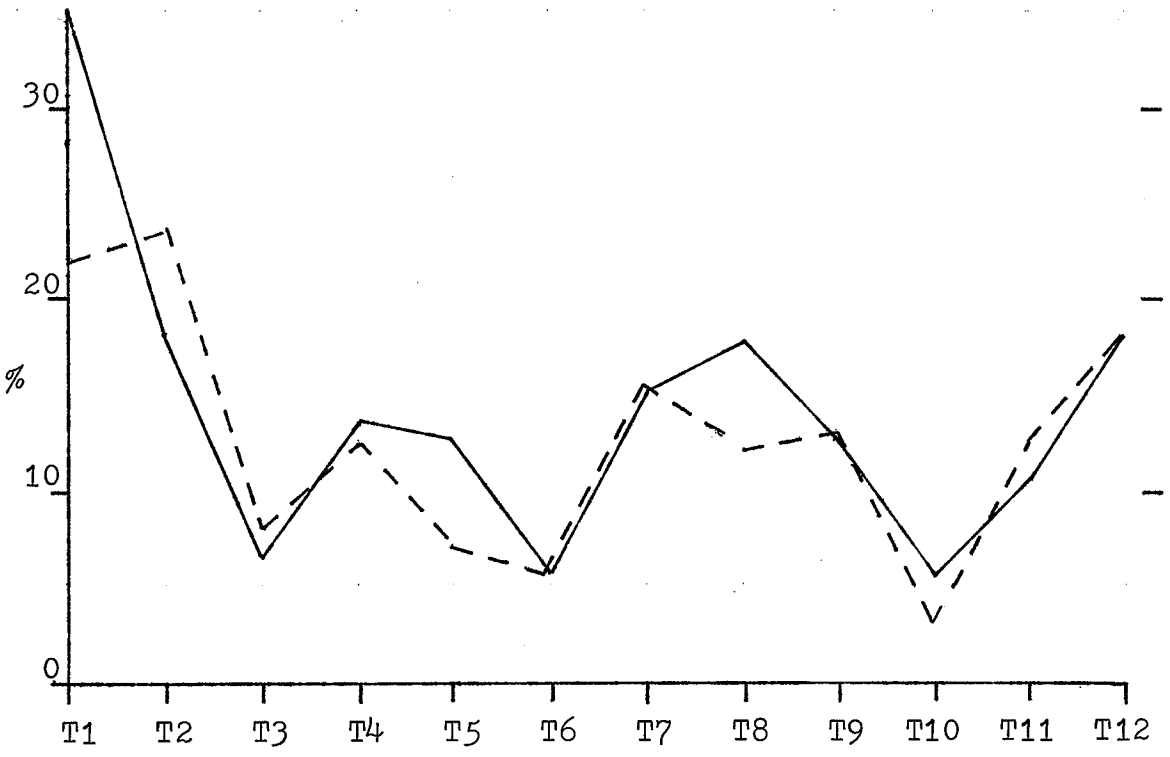
The age-sex table (Table 25) shows a low onset age for arthritic changes, lower in the females than males. The bodies and apophyseal joints show a high female incidence. The sex ratio in apophyseal joints is approximately 2:1, females to males. However, in the bodies, it is 12.50:1 in favour of the females. This is not expected and must be closely examined for population misrepresentation or, assured my sample is correct, some kind of stressful environmental explanation. The rib and transverse facets show no noteworthy sexual discrimination.

The rib and transverse facets show very low stage changes, indicating no severe disability. One exception is



Thoracic Vertebrae

Figure IV(a). Involvement of Thoracic Transverse Facets



Thoracic Vertebrae

Figure IV(b). Involvement of Thoracic Rib Facets

a stage V transverse process found in an old, generally arthritic male. The joint in this case was not fused, but demonstrated total facet destruction. Apophyseal joints show the same type of degenerative pattern as those in the cervical region. The bodies show low-grade lipping and osteophyte formation. There was no fusion in the thoracic region.

TABLE 26. Severity of Thoracic Involvement.

			Total		Stage I		Stage II		Stage III		Stage IV		Stage V	
			%	#	%	#	%	#	%	#	%	#	%
Apophyses	Left	M	28.95	0	0.00	3	7.89	3	7.89	5	13.16	0	0.00
		F	65.80	16	42.11	6	15.79	3	7.89	0	0.00	0	0.00
		I	5.26	1	2.63	1	2.63	0	0.00	0	0.00	0	0.00
	Right	M	34.88	4	9.30	4	9.30	3	6.98	4	9.30	0	0.00
		F	60.47	13	30.23	7	16.28	4	9.30	2	4.65	0	0.00
		I	4.65	1	2.32	1	2.32	0	0.00	0	0.00	0	0.00
Body		M	5.00	2	5.00	0	0.00	0	0.00	0	0.00	0	0.00
		F	62.50	3	7.50	13	32.50	9	22.50	0	0.00	0	0.00
		I	32.50	9	22.50	3	7.50	1	2.50	0	0.00	0	0.00
Rib	Left	M	21.86	7	21.86	0	0.00	0	0.00	0	0.00	0	0.00
		F	46.87	12	37.50	3	9.38	0	0.00	0	0.00	0	0.00
		I	31.25	6	18.75	2	6.25	2	6.25	0	0.00	0	0.00
	Right	M	38.71	10	32.26	2	6.45	0	0.00	0	0.00	0	0.00
		F	41.94	11	35.48	2	6.45	0	0.00	0	0.00	0	0.00
		I	19.35	5	16.13	1	3.23	0	0.00	0	0.00	0	0.00

TABLE 26. Continued.

			Total		Stage I		Stage II		Stage III		Stage IV		Stage V	
			%	#	%	#	%	#	%	#	%	#	%
Transverse	Left	M	50.00	2	25.00	0	0.00	1	12.50	0	0.00	0	0.00
		F	37.50	3	37.50	0	0.00	0	0.00	0	0.00	0	0.00
		I	12.50	1	12.50	0	0.00	0	0.00	0	0.00	0	0.00
	Right	M	44.44	3	33.33	1	11.11	0	0.00	0	0.00	0	0.00
		F	55.56	4	44.44	1	11.11	0	0.00	0	0.00	0	0.00
		I	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Lumbar and Sacral Vertebrae

TABLE 27. Lumbar and Sacral Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
1									
Body	10	10	3	0	3	0	0.00	30.00	0.00
Apophyses L.	10	13	3	2	5	0	20.00	38.46	0.00
R.	10	13	3	2	5	0	20.00	38.46	0.00
2									
Body	10	12	5	0	4	0	0.00	33.33	0.00
Apophyses L.	10	12	5	1	4	0	10.00	33.33	0.00
R.	10	14	5	1	5	0	10.00	35.71	0.00
3									
Body	10	10	8	1	4	1	10.00	40.00	12.50
Apophyses L.	10	13	8	2	5	1	20.00	38.46	12.50
R.	10	12	8	2	3	1	20.00	25.00	12.50
4									
Body	10	9	10	1	6	2	10.00	66.67	20.00

TABLE 27. Continued

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
4									
Apophyses									
L.	10	11	10	1	5	0	10.00	45.45	0.00
R.	10	10	10	1	4	1	10.00	40.00	10.00
5									
Body	10	9	9	2	5	2	20.00	55.56	22.22
Apophyses									
L.	10	9	9	1	5	1	10.00	55.56	11.11
R.	10	8	9	1	4	1	10.00	50.00	11.11
6									
Body	1	1	0	0	0	0	0.00	0.00	0.00
Apophyses									
L.	1	1	0	0	0	0	0.00	0.00	0.00
R.	1	1	0	0	0	0	0.00	0.00	0.00
Misc.									
Body	7	9	14	0	5	3	0.00	55.56	21.43
Apophyses									
L.	16	13	16	4	0	6	25.00	0.00	37.50
R.	25	10	17	5	0	7	20.00	0.00	41.18
Sacrum									
Body	13	11	1	1	4	1	7.69	36.36	100.00
Apophyses									
L.	14	11	1	1	5	0	7.14	45.45	0.00
R.	13	11	1	1	5	1	7.69	45.45	100.00
Coccyx									
	6	2	0	0	0	0	0.00	0.00	0.00

Arthritic development in the lumbar and sacral regions has a later onset age than in the thoracic and cervical vertebrae. The severity of the lumbar arthritis is much

greater than the other vertebrae. Females are more frequently affected than males, with, as in the thoracic, a great descrepancy in the bodies-- a ratio of 6:1. Almost half of the female lumbar bodies affected are stage IV with large osteophytic bridges between the vertebrae. No bodies demonstrate complete fusion although one shows a collapsed body with transverse facets on the vertebra and sacrum where they have come into articulation. Five apophyses show complete destruction with no recognizable signs of the original joint.

TABLE 28. Severity of Lumbar and Sacral Involvement.

			Total		Stage I		Stage II		Stage III		Stage IV		Stage V	
			%	#	%	#	%	#	%	#	%	#	%
Apophyses	Left	M	24.00	8	16.00	3	6.00	0	0.00	1	2.00	0	0.00
		F	58.00	9	18.00	8	16.00	4	8.00	5	10.00	3	6.00
		I	18.00	7	14.00	2	4.00	0	0.00	0	0.00	0	0.00
	Right	M	26.00	9	18.00	2	4.00	1	2.00	1	2.00	0	0.00
		F	54.00	8	16.00	13	26.00	0	0.00	5	10.00	1	2.00
		I	20.00	6	12.00	2	4.00	0	0.00	1	2.00	1	2.00
Body		M	11.36	3	6.82	1	2.27	1	2.27	0	0.00	0	0.00
		F	68.18	5	11.36	1	2.27	4	9.09	19	43.18	1	2.27
		I	20.45	0	0.00	3	6.82	2	4.54	4	9.09	0	0.00

The involvement of the bodies and apophyses vary greatly. The frequency of osteophytosis in the bodies increases from L1 to L4, where it peaks at L5 and decreases on the sacrum. The apophyses decrease in frequency of incidence from L1 to L2 with a general increase sacrally. Figure V shows these

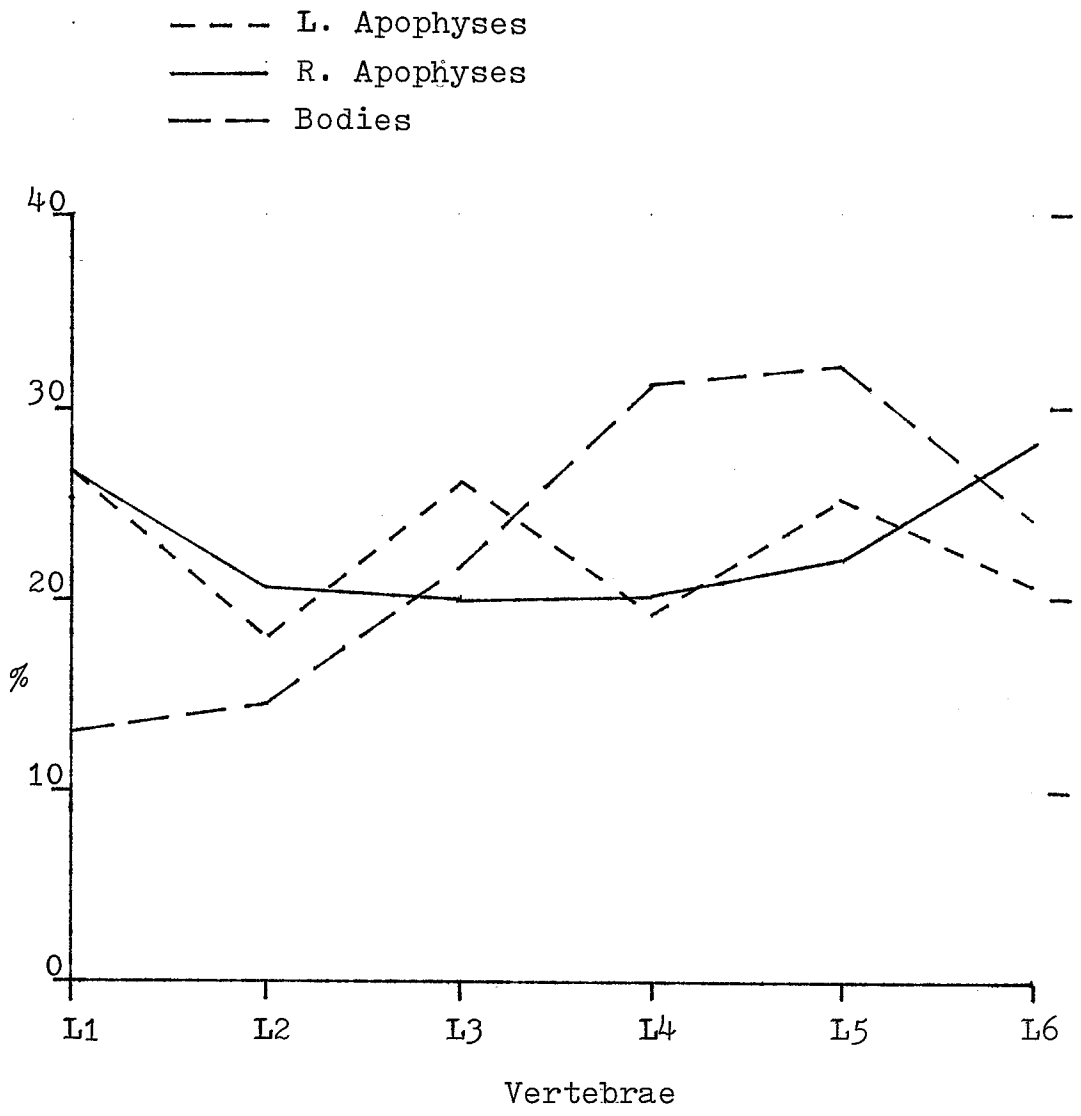


Figure V. Involvement of Lumbar and First Sacral Vertebrae

tendencies.

TABLE 29. Ages of Lumbar and Sacral Involvement.

Age Group	Male	Female
10 - 14		
15 - 19		
20 - 24	2	2
25 - 29		
35 - 39		1
40 - 44		1
45 - 49	1	2
50 - 54	1	5

Sacroiliac

TABLE 30. Sacroiliac Involvement.

	Joints Present			Joints Affected			% Involvement		
	Male	Female	Ind.	Male	Female	Ind.	Male	Female	Ind.
Ilium									
L.	19	10	4	1	5	1	5.26	50.00	25.00
R.	18	10	2	1	4	1	5.56	40.00	50.00
Sacrum									
L.	13	4	0	1	1	0	7.69	25.00	0.00
R.	12	5	0	1	2	0	8.33	40.00	0.00

As expected from sex ratios of involvement in the hip and lumbar region, females have a greater frequency of affliction in the sacroiliac articulation. One male (45-49 years) shows stage III changes in both ilia. He demonstrates a case of generalized osteoarthritis degeneration. Two of the females showed incipient fusion in the joint. One, aged

20-24 years, shows no arthritic changes anteriorly, however, small, circular facets appear posteriorly indicating joint space narrowing and beginnings of fusion. The other (50-54 years) demonstrates massive arthritic changes in the lower vertebral area with fusion of the sacroiliac, from posterior to anterior. These two are probably cases of sacroiliiitis, symptomatic of ankylosing spondylitis. Three other females exhibit lipping and osteophytosis of the sacra and ilia. Due to the fragility of the sacra, the sample is small.

CHAPTER VI

PATTERNS OF ARTHRITIS IN THE GRAY SITE POPULATION

Primary Generalized Arthritis

There are eight individuals 40 years of age and older with relatively complete skeletons. They all exhibit a type of primary generalized arthritis. This is characterized by a lack of Heberden's nodes, severe arthritic changes in the vertebral column, low-grade to severe changes in almost all of the joints present, and dental abcesses. This generalized degeneration has no apparent cause although it appears to be related to aging.

There are fourteen other relatively complete skeletons aged 10-39 years. Eight of these (15-24 years) showed no osteoarthritic changes. In five specimens (10-39 years) stage I and II changes were evident in the cervical vertebrae and costovertebral joints. One female (35-39 years) demonstrated stage III and IV changes in the cervical vertebrae, abcesses, and Heberden's nodes while the rest of her joints had low-grade or no changes present.

Cranial Arthritis

The occipital condyles were generally free of osteoarthritis. 89.7% showed no changes. 8.0% had stage I sharpening along the anterior margin of the condyle, and two individuals displayed stage IV degeneration unilaterally (2.3%). The two persons with stage IV changes were 36-55 years old and displayed the primary generalized arthritis

described above.

The temporomandibular joints were also essentially disease-free. Only two individuals displayed changes in the joint, one bilaterally in the fossae, and one unilaterally in the fossa and condyle. 5% is a lower frequency than expected. Schwartz (1960) reports a frequency of 25% in older persons at post-mortem. Snow (1948:506) describes a flattening and porosity in condyles and lipping in the fossae, but there is no mention of the frequency of occurrence. Nothing this severe was found at the Gray Site--only stage I changes in the fossae and stage II on the condyles.

Shoulder Girdle

Osteoarthritis in the shoulder itself was common and relatively severe. Female involvement was twice as frequent as male. Females demonstrated approximately 30% involvement. One female had stage IV destruction in both humeri and glenoids. The rest had stage I and II changes. Males had approximately 10% involvement in stages I and II.

Of the few acromial joints present, the females again had a higher, more severe incidence of arthritis. Three out of seven specimens demonstrate stage II-IV osteoarthritis. One male clavicle, out of eight, had stage I changes.

The samples of material in the shoulder are too small to allow conclusions. In the material present, it would appear that females are affected more frequently, and more severely than males. All persons showing shoulder changes

were 36-55 years of age.

Arms and Hands

Osteoarthritis in the elbow is characterized by low-grade changes. It occurs as part of a primary generalized osteoarthritic degeneration, in persons over 45 years. The sex ratio is 2.5:1 favouring females. This pattern appears to be quite different than Boyle and Buchanan's (1971:30) observation that elbow arthritis is rare except following trauma. Females had an average involvement of 17%.

Wrist involvement is also seen only as part of primary generalized arthritis. The changes are mild to moderate in severity, with no obvious sex difference. The minimum age of joint changes is 45 years.

Osteoarthritis in the hand is frequent, averaging about 10% in males and 25% in females. Frequency of joint changes increases from the wrist to fingertips. For example, in females, changes range from 9% in the carpometacarpal joints to 57% in the terminal interphalangeal joints. One male, aged 25-29 years, demonstrates arthritis in the hand; all other involvement is in the age group 36-55 years. The severity of changes ranges from stage I to stage IV. The high incidence in females is probably related to functional stress.

Thus, in summary, we can say that elbow and wrist arthritis occurs only as part of a more generalized osteo-arthritic syndrome. There are no occurrences that can be attributed to trauma. The hand has a high incidence of the

disease, females higher than males. This is probably due to functional stress, different because of some sexual division of labour.

Pelvic Girdle

Hip and pubic involvement is restricted to females. Four pubes out of seven show arthritic changes. All are older females (40-54 years). This is perhaps attributable to childbirth trauma.

Osteoarthritis in the hip is also restricted to older females (40-54 years). Changes are all stage I and II. Hip involvement is less common and less severe than one would expect, considering that now it is one of the commonest sites of osteoarthritis, frequently of a severe nature.

Leg and Foot Arthritis

Knee involvement is much higher in females than males. One male shows stage I changes on a fibula and one shows bilateral stage II changes in the patellae (out of samples of 10 and 9 respectively). Female involvement is about 14%. Five females of the seven with changes have primary generalized osteoarthritis. The other two show isolated changes, possibly resulting from trauma.

Osteoarthritis in the ankle is restricted (with the exception of one fibula) to the calcaneous and talus. These bones show frequencies of involvement of about 25% in females and 17% in males. Boyle and Buchanan (1971:53) state that arthritis in the ankle is rare except following

trauma. This would make the incidence in the Gray Site much higher than expected, and could be due to a more pedestrian lifestyle, with its increased ankle trauma.

The Ribs

The frequency of osteoarthritis in the ribs is high, 26.7% of tubercles and 20.8% of heads. Females have a slightly higher incidence and changes that are more severe. Male joint changes are predominantly stage I, while females demonstrate stage I and II equally. Approximately 90% of the total changes are stages I and II. All the arthritis of stage III and IV in males are associated with evidence of fractured ribs, implying traumatic origins. Rib osteoarthritis tends to decrease inferiorly to the twelfth rib which displays over 60% involvement.

Vertebral Involvement

Females experienced vertebral osteoarthritis about twice as often as males except in the lumbar bodies, where the sex ratio is 6:1 favouring females. In the cervical vertebrae, female frequency of joint changes is 66%, while that of males is 30%. The dens showed osteophytic growth 35% of the time, and the dens facet had sharpening and lipping in 55% of the population. Cervical involvement was marked by moderate to severe changes, including one fused pair. There was a peak in involvement at C3 or C4 and a decrease to C6, with a rise at C7.

The thoracic vertebrae show less of a sex discrepancy, with 53% involvement in females and 31% in males. In the

bodies, the sex ratio is 12.5:1 favouring females, an unexpected ratio. Generally thoracic changes were of a mild to moderate nature. The age of onset for thoracic involvement seems to be low since it appears in all age groups from 13-55 years.

Lumbar involvement has a high sex ratio-- 60% for females and 20% for males. The age of onset for this region is 20-24 years. The severity of changes is moderate to severe, with two-thirds of the affected female lumbar bodies being stage IV. One vertebra has a collapsed body and five apophyseal joints were destroyed beyond recognition. Incidence tended to increase from L1 to L5.

Sacroiliac involvement is more frequent in females than males. Five out of ten female ilia showed arthritic changes, two of which exhibited incipient fusion. Out of 18 male ilia, one demonstrated stage III changes. Changes were severe, but due to the small number of sacra present no conclusions can be made.

Generally, apophyseal arthritis has a much younger onset age than intervertebral changes. The former is present from 10-14 years and up while the latter appears to begin between 30 and 40 years. There is a higher frequency of incidence among females, and generally, they show more severe changes. Vertebral arthritis shows a direct correlation for frequency and severity with advancing age.

CHAPTER VII

ARTHRITIS AND DENTAL DISEASE

The association of dental abcesses and pulp necrosis with osteoarthritis has been hypothesized. Møller-Christensen and Brinch (1948:15) defined a disease, Morbus Aebelholt, as "pathologic alterations in the cervical part of the spinal column in combination with a dental focus". In 1959, a more complete study was published, defining the disease more fully (Inglemark, Møller-Christensen, and Brinch 1959). They view the positive relationship they find as causal; but, not one that proves dental infections are directly responsible for osteoarthritis (Ibid.:26). The choice of the term causal relationship is unfortunate; the use of positive relationship or positive correlation would have been better suited.

The dental focus referred to in the above definition is essentially a gangrenous pulp as exhibited in abcessing and/or pulp necrosis (Inglemark, Møller-Christensen, and Brinch 1959:10). They view the necrotic pulp as an "incubator" for bacteria and a focal point for the spread of infection (Ibid.). The individuals in the Gray Site study were defined as having dental disease with the presence of one or more abcesses, with or without defined pulp necrosis.

Osteoarthritis as related to dental disease is usually considered with regard to the apophyseal and intervertebral

joints. Snow (1948) examines the association between dental abcesses and lumbar arthritis while Inglemark, Møller-Christensen, and Brinch (1959) look at the association with the complete spinal column. I will examine the arthritic changes in the complete spinal column, to facilitate comparison with both studies. Since there were only fourteen complete columns, I used ten that were almost complete, having more than half of each type of vertebrae present, making a total sample of twenty-four.

TABLE 31. Abcesses and Arthritis in the Gray Site.

A. Spinal changes including Stages 1-V

		# with joint changes	
Skeletons with abcesses	12	9	75%
Skeletons without abcesses	12	3	25%
	24	12	

		# with abcesses	
Skeletons with joint changes	12	9	75%
Skeletons without joint changes	12	3	25%
	24	12	

B. Spinal changes including Stages II-V

		# with joint changes	
Skeletons with abcesses	12	9	75%
Skeletons without abcesses	12	0	
	24	9	

		# with abcesses	
Skeletons with joint changes	9	9	100%
Skeletons without joint changes	12	3	25%
	21	12	

Table 31 shows the occurrence of abcesses and arthritis in the population of 24 complete or nearly complete vertebrae. There is a noteworthy change when only spines with stage II-V changes are considered. The nine individuals with abcesses and stage II-V osteoarthritis are all 36-55 years of age. The three with abcesses and no joint changes are between 13 and 35 years. The three individuals with a few stage I changes and no abcesses are 13-55 years.

The high statistical correlation of abcessing and osteoarthritis in the spinal column can be demonstrated by the application of Fisher's Exact test. This test for statistical relationship was chosen over the traditional chi-square because it gives "exact, rather than approximate probabilities" and because it lessens the chance of type I errors (Blalock 1972:287,291). The chi-square test corrected for continuity tends to yield lower than exact probabilities, increasing the chance of rejecting the null hypothesis when it should be accepted (Ibid.). When the Fisher test was applied to the data in Table 31A (Stages I-V), a probability of 0.0196 was achieved. This indicates a definite statistical relationship. However, when a probability of 0.000168 was arrived at for the data in Table 31B (Stages II-V), there is no doubt that a positive correlation does exist between dental abcesses and arthritis. One must keep in mind that a positive correlation does not imply a causal relationship.

Since the cause of osteoarthritis is virtually unknown,

except for the wear and tear aspect, this relationship is difficult to explain. The fact that both abcesses and arthritis are features of aging would explain part of this association. Perhaps, that both are associated, to some degree, with infection might explain it. Yet, infectious flare-ups in osteoarthritis are only part of the syndrome, and the disease itself is non-infectious. The wear and tear phenomenon of arthritis would be accented by a more rugged lifestyle, as the lack of dental care and extreme wear would favour abcess and pulp gangrene development.

The series of 250 individuals studied by Inglemark, Møller-Christensen, and Brinch show a similar high correlation (Inglemark, Møller-Christensen and Brinch 1959). The material is from two Danish cemeteries from the period 1180 to 1561 (Ibid.). They found that 93% of the skeletons with "dental foci" exhibited spinal joint changes, while 17% of those without "dental foci" did, and that 94% of the skeletons with spinal joint changes had "dental foci" as compared to 18% without (Ibid.:7). After an examination of the known causes of arthritis, they concluded that it appears doubtful, but not impossible, that dental infections cause the arthritis present (Ibid.).

Snow, in his examination of the Indian Knoll skeletons, showed the relationship between abcesses and lumbar arthritis, which he considered "the usual locus of initial arthritis" (Snow 1948:502). He found that 44% of males and 31% of females displayed the association, 25% and 24% showed

abcesses and no arthritis, and 4.5% and 4.3% had arthritis and no abcesses (Ibid.). It is interesting to note that all the individuals with arthritis and no abcesses were aged 20-35 years, over which age they occur together.

The positive correlation between dental abcesses and pulp necrosis, and osteoarthritis in the vertebral column has been reaffirmed in the Gray Site material. The correlation is much higher when only the more advanced stages (II-V) of arthritis are considered. Only individuals under 36 years display abcesses without arthritis, and only those with a few joints affected by stage I changes do not have abcesses. All individuals over 35 years that demonstrate abcesses have widespread, more severe vertebral degeneration and vice versa. Aging seems to play a definite role in this association, as also severity of the osteoarthritis does. In the Indian Knoll material, no individual over 35 years demonstrated arthritis without abcesses, and only 5 out of 116 individuals showed abcesses without arthritis in the 35-55 year group (Snow 1948:502). In the Gray Site, one person over 35 years shows stage I changes in two superior lumbar apophyses and four superior sides of lumbar bodies without having dental abcesses. A very mild case of arthritis indeed!

The relationship of both diseases with age seems to play a large part in their correlation. The non-infectious nature of osteoarthritis seems to preclude a direct causal relationship by infection, but, until the etiology of

arthritis is better understood this cannot be ruled out nor can a cause or complex of causes for both diseases be rejected.

CHAPTER VIII

POPULATION COMPARISONS

General Comparisons

Population comparisons of the incidence of osteoarthritis are difficult because, with two exceptions, Anderson (1963) and Chapman (1962, 1963, 1968, 1972), there are only general statements of incidence and trends, with no joint analyses documented. These statements are useless in drawing conclusions about interpopulational variation since the important differences will be noted between individual joints and the severity in these joints. The close association of arthritis and age makes the overall incidence in populations very similar-- one naturally expects increasing incidence with age and 100%, or close to 100% incidence in middle age and over. Thus, statements expressing this in a population are meaningless.

Hooton (1930:306) tells of an arthritic affliction known as "spondylitis deformans". It is unclear whether this refers to ankylosing spondylitis or osteoarthritis (osteophytosis) in the vertebral column. The incidences of 73% of males and 27% of females probably indicate the latter disease. He also describes "degenerative arthritis deformans" (appendicular arthritis) with an overall incidence of 65% in males and 55% in females. His samples appear to be small.

At Mesa Verde, Miles (1966:93) states that all individ-

uals over 35 years, except one, had significant degenerative arthritis, which was common to all ages. The frequency in order of joints was: spine, knee, shoulder, hip, temporo-mandibular, ankle, sub-calcaneous, and elbow. At Indian Knoll, 60% of the adult population had lumbar arthritis (Snow 1948:506). As mentioned before, Snow (Ibid.) found osteoarthritis in the temporomandibular joint expressed as a flattened or eroded and porous condyle and lipped and perforated fossae. Nothing like this was observed in the Gray Site.

Wade (1970:135) in his examination of the Houck material, found that osteophytes were not present in individuals below 21 years. More severe osteophytosis was present more frequently in males (Ibid.). Osteoarthritis was rare in phalanges, and there was no intervertebral ankylosis in this group (Ibid.). In the vertebral column, there was no notable sex discrepancy, except in extreme osteophytosis, where the sex ratio was 2:1 favouring males (Wade 1970:136). The overall incidence was 5% slight, 20% moderate, and 40% extreme, a total involvement of 65% (Ibid.). Young adults (21-35 years) showed 11.1% slight, 16.7% moderate, and 11.1% extreme (total sample 18); middle-aged (35-55 years) had 35.3% moderate and 47.1% extreme (total sample 17); and advanced (55+ years) showed 100% extreme osteophytosis (total sample 6) (Ibid.). In the appendicular skeleton, males were affected twice as frequently as females in moderate and severe cases (Ibid.). The overall incidence

here was 16.7% slight, 18.8% moderate, and 6.3% extreme, with the following age breakdown: young adults (21-35 years) showed 24% slight, 4% moderate; middle-aged (35-55 years) had 5.9% slight, 35.3% moderate, and 11.8% extreme; and advanced (55+ years) had 14.3% slight, 28.6% moderate, and 14.3% extreme (Wade 1970:136-137). The overall percent involvement of the appendicular skeleton was 41.7%-- a lower frequency than the vertebrae, and with much less severe involvement.

The Appendicular Skeleton

Only Anderson (1963) in his analysis of the Fairty ossuary gives a description of osteoarthritis by joint surface. Chapman's (1962, 1963, 1968, 1972) work involves description and population comparisons of osteophytosis in the vertebral column. Hence, it is with Anderson's Fairty population that the interpopulational comparisons will be made. The comparisons are displayed in Table 32.

The Gray Site data was manipulated to make total percentages to correspond to those of Anderson (1963:41-55). Total bone counts for joint surfaces were calculated by adding the results of left and right for males, females, and indeterminate material. The combined total had the advantage of making the statistical samples for the Gray Site material larger, and hence, the percentages are possibly more representative of the population than when broken down for sex and side.

TABLE 32. Comparison of Osteoarthritis in the Appendicular Skeletons of the Gray Site and Fairty Populations.

	Gray Site	Fairty
Occipital condyles	10.3%	16.0%
Temporomandibular fossae	2.3%	31.4%
Mandibular condyles	1.3%	7.9%
Sternoclavicular - sternum	16.7%	10.2%
- clavicle	6.7%	8.0%
Acromial - clavicle	16.7%	38.0%
- scapula	9.5%	25.0%
Glenoid fossae	22.8%	46.0%
Humerus - proximal	9.1%	10.0%
- distal	8.9%	5.0%
Ulna - proximal	18.1%	19.0%
- distal	13.0%	15.0%
Radius - proximal	8.2%	9.0%
- distal	11.1%	9.0%
Hamate	5.3%	5.8%
Capitate	0.0%	4.2%
Trapezoid	5.9%	12.2%
Trapezium	8.3%	12.7%
Scaphoid	2.7%	8.5%
Lunate	7.5%	14.5%
Triquetrum	25.0%	13.0%
Metacarpals - proximal	5.5%	2.0%
- distal	6.4%	5.0% (severe)
Acetabulum	8.9%	43.0%

TABLE 32. Continued.

	Gray Site		Fairty	
Femur - proximal	2.7%		less than 10.0%	
- distal	9.3%		21.0% (severe)	
Patellae	8.0%		15.0%	
	Right	Left	Right	Left
Tibia - proximal	2.9%	3.2%	20.1%	9.2%
- distal	0.0%	0.0%	5.9%	0.5%
Fibula - proximal	12.1%		0.0%	
- distal	2.4%		2.5%	
Calcaneous	22.9%		2.0%	
Cuboid	8.0%		3.6%	
Cuniforms	11.6%		3.5%	
Metatarsals - proximal	12.6%		1.0%	
- distal (first)	14.0%		11.4%	
(2-5)	1.9%		1.0% (severe)	
Proximal first phalanx	15.4%		7.5% (severe)	

The first noticeable discrepancy between the sites is in the temporomandibular joint. As mentioned before, in comparison to Schwartz's (1960) data on post-mortems of 25% temporomandibular involvement, the Gray Site yielded an extremely low incidence of osteoarthritis. Anderson's findings are more in keeping with this incidence.

The incidence of osteoarthritis in the acromial joints from the Gray Site is less than half that of the people of Fairty. The sample for this joint in the Gray Site is too small (22 clavicles and 24 acromions) to warrant any

reliance on these percentages. The glenoid fossa also shows the incidence of arthritis in the Gray Site as half that of Fairty, while the humoral heads show essentially the same incidence in both sites.

In the hand, the incidences are variable, but generally low for both groups. Anderson (1963:50) mentions severe involvement of the lunate-- this was not noted in the Gray Site.

There is a great discrepancy in osteoarthritis in the acetabula of the two sites. Again, involvement of this joint in the Gray Site is lower than expected. The knee also demonstrates a much lower incidence in the Gray Site, except for the proximal fibula. The left-right difference noticed by Anderson is also not apparent.

In the foot, the occurrence of osteoarthritis at the Gray Site is much higher than that of Fairty. This may be an indicator of different lifestyles, especially mobility.

With the exception of the foot, osteoarthritis in the appendicular skeleton was not as common in the Gray Site as in the Fairty group. The greatest differences were noted in the temporomandibular and large joints (shoulder, hip, and knee).

Sacroiliac Involvement

Anderson (1963:50) notes sacroiliac arthritis in 35% of the population. Wade (1970:136) reports the disease in 71% of the Houck group (75% females, 66.7% males). In the Gray Site, osteoarthritis was observed on 20.6% of ilia and

14.7% of sacra. Females were affected more frequently than males at both articulations: ilia-- 5.4% males, 45.0% females and sacra-- 8.0% males and 33.3% females. Due to the fragility of sacra, small sample skewing may be present here.

Vertebrae

TABLE 33. Comparison of Osteoarthritis in the Vertebrae of the Gray Site and Fairty Populations.

	Gray Site	Fairty
Atlas - dens facet	42.9%	38.7%
- apophyses	19.0%	superior 7.1%
		inferior 17.1%
Axis - dens	32.5%	32.0%
- apophyses	23.7%	superior 2.0%
		inferior 7.0%
C3 - C6 - apophyses	19.4%	superior 29.0%
		inferior 18.0%
- bodies	33.7%	80.0%
C7 - apophyses	17.1%	superior 3.0%
		inferior 32.0%
- bodies	44.4%	37.0%
T1 - apophyses	18.2%	4.0%
- bodies	21.0%	4.0%
T2 - apophyses	11.8%	12.0%
- bodies	12.5%	10.0%
T3 - T11 - apophyses	15.5%	13.0%
- bodies	19.1%	34.0%

TABLE 33. Continued.

	Gray Site	Fairty
T12 - apophyses	12.2%	6.0%
- bodies	4.8%	22.0%
Lumbar - apophyses	22.5%	7.0%
- bodies	23.0%	48.0%
Sacrum - body	24.0%	22.7%

There is a great discrepancy in the patterning of vertebral osteoarthritis between the Gray Site and Fairty populations. Anderson (1963:44-46) noted a difference in frequency of involvement between superior and inferior apophyseal facets. This difference was not observed in the Gray Site. Involvement of the dens and dens facet were essentially the same for both groups. The percentages for the dens include degeneration of the dens articulation and ossification of the apical ligament. The apophyses of the atlas and axis in the Gray Site were afflicted more frequently than those of Fairty. The bodies of C3-C6 show the greatest discrepancy; osteophytosis occurred more than twice as often in the Fairty group than the Gray Site. The apophyses of C3 to C6 also display osteoarthritis less frequently in the Gray Site than among the Fairty group. The bodies of C7 show a low level of involvement in the Fairty group. The discrepancy between superior and inferior apophyseal involvement is most pronounced at this level in the Fairty population. The degeneration at the Gray Site is the average of the combined superior and inferior

apophyseal rates of the Fairty Site.

The thoracic vertebrae also show variance in the frequency of osteoarthritic degeneration. T1 shows the greatest discrepancy-- the Gray Site having approximately five times greater involvement than that of Fairty. T2 shows about the same rate of degeneration in both sites. The apophyses of T3-T11 also show similar involvement, while the bodies show a higher rate at the Fairty Site. T12 has opposite frequencies-- with osteoarthritis in the apophyseal joints higher in the Gray Site, and osteophytosis in the bodies higher in the Fairty Site.

Lumbar frequencies show the same patterns as T12; apophyseal involvement is higher in the Gray Site and involvement of the bodies higher in the Fairty Site. Sacral bodies show approximately the same rate of degeneration.

Generally, the vertebral bodies at the Fairty Site show osteophytosis more frequently than the Gray Site. The greatest differences are at C3-C6, T12, and in the lumbar vertebrae. Thoracic and lumbar apophyses show higher rates of involvement in the Gray Site. These discrepancies in patterns indicate possible stress differences between the populations, with greater stress on apophyseal joints in the Gray Site and the above mentioned bodies in the Fairty Site.

Chapman (1962, 1963, 1968, 1972) did work on osteophytosis in complete vertebral columns. She assigned a single stage to the complete column, then compared these results from several North American sites. The Gray Site

material was not compared to this data for two reasons. First, the nature of the Gray Site burials is essentially secondary; therefore, there are very few complete vertebral columns. Secondly, Chapman does not explain her classification of the vertebral columns by stages. It is crucial information, whether she took the single most severe stage present, or the most common stage present, or had some other criteria for staging the columns. These two reasons preclude meaningful comparisons.

CHAPTER IX

CONCLUSIONS

Deriving an adequate background for the disease in question constitutes the greatest problem in a palaeopathological study. This problem, when dealing with osteoarthritis, is compounded by a maze of confusing terminology and the lack of a concise description of osteological changes, their consequences, and their etiology. The background study included here (extracted from rheumatology texts and medical journals) provides a description of the disease as well as information enabling one to discern its manifestation in osteological samples. That information, coupled with a survey of studies of the disease among living Indian groups, yields the basic knowledge necessary to conduct such a study in a palaeopopulation.

Osteoarthritis is a disease of unknown causes. Stress and physical abuse of a joint are known to precipitate the disease, as does direct joint trauma. Osteoarthritic analysis must be conducted by examination of each joint and joint surface since stress and trauma would vary considerably between joints. The Gray Site demonstrated these inter-joint variations as did the Fairty Site (Anderson 1963). This variation gives a basis to the study of stress factors in different populations and to their comparison between populations to obtain data on inherent differences in cultural patterns. A prerequisite for this type of compari-

son is research into how specific stresses affect joints and the development of osteoarthritis within them (of special interest would be the study of load stressing, for example, carrying heavy loads, pedestrian transport, and carrying children, as well as functional stresses as in dressing hides or using agricultural tools). It also requires a more comprehensive list of sites for which complete joint analyses have been done.

In conducting the analysis of the Gray Site population, I adopted a five-stage scale to assess severity of joint involvement. The use of such a scale is arbitrary, however, specific definition of terms in assessing severity is essential. The use of terms such as slight or severe without careful definition is of no value in interpopulation comparison. It is also recommended that complete joint analyses be done on more skeletal collections. Comparison of the Gray Site data with that of Fairty provided a number of similarities and differences in the patterns of osteoarthritic affliction in the two groups. More comparisons of this type are required to understand the relationship of these patterns to specific cultural characteristics and stress patterns.

Arthritic changes in the Gray Site were attributed to osteoarthritis and ankylosing spondylitis. There was no evidence of rheumatoid arthritis in the material, and keeping in mind that the disease is probably of a recent origin, its absence is not surprising. The correlation of

arthritis with age is well displayed in the Gray Site. In the relatively complete skeletons, all individuals over forty (total of 8) exhibited a generalized osteoarthritic degeneration. In general, incidence frequencies in the Gray Site are low to expected values. Especially low occurrences were noted in the temporomandibular fossae and large joints-- shoulder, hip, and knee. The foot and ankle provide an exception having a higher rate of incidence than expected in comparison with both modern data and the Fairty group. It is not unreasonable to speculate that this may result from pedestrian transport and from carrying stress in a Plains environment demanding a high degree of mobility. If this is so, one would anticipate a change in the incidence of osteoarthritis in the foot and ankle with the advent of an equestrian lifestyle.

Another area where stress factors may be dominant is in the fingers where females have a higher incidence than males. Vertebral bodies are also affected more frequently in women as seen in the following female:male ratios: cervical 3:1, thoracic 12.5:1, and lumbar 6:1. Apophyses and sacroiliac joints also showed higher incidences in women. Stress factors, especially from transporting heavy loads, may contribute to this.

The comparison of the Gray Site and Fairty populations emphasized the very low incidence of arthritic changes in the temporomandibular, shoulder, hip, and knee joints in the Gray Site, as well as the high incidence of foot

changes. The patterning of vertebral arthritis in the two sites is almost opposite. The Fairty people show a high degree of degeneration in the bodies, especially C3-C6, T12, and the lumbar, while the Gray Site people had a higher incidence of arthritic changes in the thoracic and lumbar apophyses. Information on the reaction of these joints to various stresses may help to clarify this discrepancy.

The association of dental abcesses and osteoarthritis, especially in the vertebrae, has long been hypothesized. Data from the Gray Site statistically confirmed this correlation. Other than the fact that the frequency of both diseases increases with age, and that much of the high correlation was noted in older individuals, no cause for this association is clear.

Finally, it is recommended that the disease, osteoarthritis, be studied in greater detail, from the osteological standpoint as well as its etiology, and that comprehensive use be made of medical and radiological knowledge to advance our understanding of its effects on bone. It is also recommended that more studies of this nature be conducted to enhance the potential use of osteoarthritis in predicting patterns of physiological stress and comparing these stress patterns between osteological populations.

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