A RAPID METHOD FOR RECORDING HUMAN SKELETAL DATA

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The Osteological Database

The osteological database has been designed to make the recording of whole human skeletons into the database as quickly and accurately as possible, and to ensure that data are held within a simple data structure. The techniques used to ensure integrity and speed of data entry are to enforce validation rules wherever they are applied and by only prompting for data that are appropriate to record, including block group inserts. One of the features of the database is that data are policed at the entry level. Certain fields will only accept values from a pre-defined range of values or from a list of values (LOV).

The value of a simple data structure is to ensure that the structure remains comprehensible to the target users of the system, and the way they are likely to interact with the data.

General Information

Site Code

This is the unique identifying code given to all Museum of London Archaeology Service (MoLAS) sites, and all site codes are entered in a list of values on the database. For example, Spitalfields Market the site code is SRP98.

Context

This is the unique identifying number given to each skeleton and is the unique identifying number for each individual in that sample.

X-radiography and photography

This is recorded if an x-ray or photograph has been taken of any elements of the skeleton with links to the images.

Bone preservation

The general state of preservation of the bones in the skeleton is visually assessed using a three point grading system (good, moderate and poor). In cases where the degree of preservation is variable, the most predominant grade should be assigned. The categories are as follows:

1 = Bone surface is in good condition with no erosion, fine surface detail such as coarse woven bone deposition would be clearly visible (if present) to the naked eye
2 = Bone surface is in moderate condition with some post-mortem erosion on long bone shafts but the margins of articular surfaces are eroded and some prominences are eroded
3 = Bone surface is in poor condition with extensive post-mortem erosion resulting in pitted and eroded cortical surfaces and long bones with articular surfaces missing or severely eroded

Features

Features refers' to a series of general characteristics recorded about each skeleton regarding its overall state and integrity. They consist of a series of tick boxes.

Intrusive human or animal bone

This is to enable you to indicate when there are human or non-human intrusive remains included with the skeleton. Do not give any further details in the comments box. The only exception to this would be in cases where it is considered that the additional remains have funerary significance.

Stained

This is to record whether the skeleton has any unusual staining, e.g. a green stain from a copper alloy object. If present, the tick box is marked and then details on size, location and colour are recorded in the comments field.

Truncation

This is to indicate that the skeleton has been truncated. Care is taken in distinguishing between truncation and poor preservation/recovery, e.g. a pair of missing feet. Details are not given in the comments field.

Sub-sampled

This is to indicate that the skeleton has had a bone or tooth sample removed from it. This could be for any analytical purpose but would generally include sampling for C14, aDNA or isotopic work. Further details are given in the comments field, e.g. contact details, reference numbers and the purpose of sampling.

Elements artificially deleted (EAD)

When skeletons come from an area of a cemetery where there is a high burial density it is not unusual to find intrusive human bones from other individuals. However, in some cases it can be difficult to distinguish between intrusive and non-intrusive bones', this is particularly true of hands and feet. In these instances the entire element or zone should not be counted, e.g. do not record the hands as present. This will enable any analysis of skeletal recovery to be conducted using non-EAD skeletons only. If it is suspected that there is more than one individual present and confidently separating the two is not possible, the EAD tick box is marked. Details are not given in the comments field.

Cartilage

Certain cartilaginous structures within the body can occasionally ossify. There are a series of tick boxes to indicate whether thyroid, cricoid or costal cartilages have been recovered. The 'other' tick box should be used for soft tissue calcifications or unidentified calcifications, further details are given in the comments field.

Ear Ossicles

The presence of ear ossicles is simply noted by being marked in a tick box. The particular ear ossicle or side is not recorded unless pathologically altered.

Comments field

This consists of an area of free text in capitals only. The comments field is intended for further details relating to the general characteristics of the skeleton as described above, or any other relevant data. Avoid recording non-essential information.

Inventory - Recording the bones present (LEVEL 1)

The osteologist records the bones present in a particular skeleton. During data entry all bones that could be recorded for any given skeleton are shown and the osteologist indicates which bones, or components of bones are actually present.

At least 50% of a bone or bone component must be present before it can be counted Each anatomical element or component is recorded using binary arrays on a presence/absence basis where

1 = Present
0 /null = Absent

Skull

The skull group deals with the cranium, mandible and hyoid bones and single digit entries.

The Sphenoid needs to be entered with two digits for the Greater wing and Lesser wing e.g. 10, 01, 11

Axial (sternum, ribs and vertebrae)

Sternum

The sternum is recorded in three sections. The body of the sternum is recorded as a four digit binary array with each digit corresponding to the four sternebrae (e.g. a complete body would be 1111)

- The manubrium
- The body
- Xyphoid Process

Ribs

Only the head of ribs are counted for left, right and those not possible to side. The rib head constitutes the portion of the ribs with the costo-vertebral and costo-transverse articular facets. A total count is entered for the left and right and, if necessary, those not sided. The total should not be more than 24.

Vertebrae

The Vertebral Column is recorded so that the structure of each individual vertebra may be recorded.

1. complete vertebra with both the centrum and neural arch
2. vertebra consisting of the centrum only
3. neural arch only

Upper Limbs

Most of the upper limb is recorded as binary arrays. Each of these are scored as present (1) or absent (0).This means a complete bone would be recorded as 111 or other derivatives for example 100, 110, 010 etc

The Scapula is recorded as a four digit array as follows:

- Glenoid fossa
- Coracoid process
- Acromion
- Infraspinous portion of the blade

Clavicle is recorded

- Sternal third
- Middle third
- Acromial third

Long bones (Humerus, Radius and Ulna)

- Proximal third
- Middle third (shaft)
- Distal third

Carpal bones make up an eight digit binary sequence (e.g. 11111101)

- Scaphoid,
- Lunate,
- Triquetral
- Pisiform
- Trapezium
- Trapezoid
- Capitate
- Hamate

Metacarpals are recorded as a five digit array from MC1 to MC5 (e.g. 11111) with each digit corresponding to each metacarpal

Hand phalanges (manual) are divided into proximal, intermediate and distal phalanges. If possible they are assigned to the left and right side but where this is not possible they may be recorded as unsided but for proximal should not add up to more than 10, the intermediate more than 8 and the distal more than 10.

Lower Limbs

The lower limbs are recorded in a very similar way to the upper limbs in binary arrays or single digits.

The pelvic girdle is divided into each of its component elements with each pelvic element must be counted separately.

- Ilium
- Ischium
- pubis

Long bones (Femur, Tibia and Fibula) are recorded as a three digit binary array, each digit corresponding to the following, scored as present (1) or absent (0)

- Proximal third
- Middle third (shaft)
- Distal third

The Patellae are recorded as a single digit.

Tarsals

The Calcaneum and Talus are recorded separately from the rest of the tarsal bones as a single digit in their respective cells. The remaining tarsal bones are recorded as a five digit binary array corresponding to the following sequence:

- Navicular
- Cuboid
- Medial cuneiform
- Intermediate cuneiform
- Lateral cuneiform

Metatarsals are recorded as a five digit array (e.g. 11111) from MT1 to MT5

Foot phalanges (pedal) are recorded in the same way as the hand phalanges and are divided into proximal, intermediate and distal phalanges. If possible they are assigned to the left and right side but where this is not possible they may be recorded as unsided but for proximal should not add up to more than 10, the intermediate more than 8 and the distal more than 10.

Tooth Codes

The aim of the dental inventory is simply to count all of the individual teeth and tooth positions available for examination. This initial quantification allows assessment of how complete the dentition is, and in turn permits the calculation of the prevalence of dental pathology (see Connell 2003). There are two tooth groups, a deciduous group and a permanent group. Both sets are available and also enabled is the recording of transitional dentitions. Both tooth groups have a common set of dentition codes to enable the osteologist to quickly record the presence or absence of individual teeth within the dentition. These codes are as follows:

Null (Blank) = Area Missing

1. Tooth Present
2. Post-Mortem Loss
3. Ante-Mortem Loss
4. Congenital Absence
5. Present (No Socket/Socket Damaged)
6. Tooth Erupting (Always use this in relation to recording the presence of teeth in very young juveniles, for the inventory & being aware they are present)
7. Deciduous Retention

Cribra Orbitalia

This must be recorded and is recorded as 0, 9 or 1 to 5 following the guidelines of P. Macadam 1989. It is listed under the pathology codes for Blood Disorders, where the Left Orbit is 1001 and the Right Orbit is 1002.

0	Normal bone surface
1	Capillary like impressions on the bone
2	Scattered fine foramina
3	Large and small isolated foramina
4	Foramina have linked into a trabecular structure
5	Outgrowth in trabecular form from the outer table surface
9	Not present/unobservable

LEVEL 2

Determination of age at death

This section deals with determining the age at death of the individual and it is designed to cover all age ranges from a foetal skeleton to a fully mature adult. As many age indicators as possible should be considered to arrive at the best age estimate for any given skeleton.

Subadult age determination

Subadult age at death is based on a series of age indicator data derived from changes in the developing skeleton and dentition. The skeletally based indicators include the diaphyseal lengths of the major limb bones (see measurements). For perinatal individuals the linear regression equations should be used following Scheuer et al (1980). This will accept figures 10-50 weeks. Estimates of age derived from epiphyseal fusion are based on data given in Scheuer and Black (2000). A single entry should be made for epiphyseal fusion and an age in whole years entered into this field (e.g. 14 years or 10 years). For dental eruption the scheme developed by Gustafson and Koch (1974) is used, and record the nearest estimate in years. A more precise estimation, the developmental stage of individual teeth are also recorded following Moorrees et al (1969a, 1969b) with the Smith (1991) recalibration.

MFH tooth codes

This section enables the Moorrees, Fanning and Hunt (1963a; 1963b) dental stages to be recorded for up to three teeth. Please select the canine and then the two most recently developed molar teeth. There are two cells, the left hand cell is for the tooth itself (in FDI code) and the right hand cell will accept codes 1-14 corresponding to Fig 23 in Buikstra and Ubelaker (1994). The raw data are entered here, but the final age determination should be based on Smith (1991) and entered into the dental development cell.

Adult age determination

A total of four methods are applied to each adult individual. The first method is tooth wear following Brothwell (1981). Tooth wear, although affected by factors such as diet and oral pathology, is included here as a broad indicator of age group and this should only be applied to reasonably complete sets of molars and should not be used for an isolated tooth. The tooth wear codes 1-4 representing the four age groups given by Brothwell (1=17-25 years, 2=25-35 years, 3=35-45 years and 4=45+ years). The second method is the pubic symphysis following Brooks and Suchey (1990) and the codes 1-6 correspond to the six pubic phases. The third method is the auricular surface following Lovejoy et al (1985) and Buckberry and Chamberlain (2002) and the codes 1-8 correspond to the eight auricular surface phases. The fourth method is the costo-chondral method following Iscan et al (1984; 1985) and the codes 0-8 correspond to the eight phases. All of the adult age methods will also accept a 9 to indicate that the technique was not applied. The Overall Age Estimate is for the overall age in years, this need not be completed if the individual is an adult because the raw data and age code are supplied.

Age Codes

A series of codes have been devised to allow subdivision of a skeletal population by broad age groups. Each individual skeleton will have its own age determination and the codes merely allow groups of skeletons to be counted in broad age bands or retrieved from the database in smaller samples. For subadults there are six age codes, the first three age codes (AC1-3) are for perinatal and infant skeletons. Age code 1 (AC1) is a category that is for perinatal skeletons covering pre-term (≤ 36 weeks) following the definition in Scheuer and Black (2000) up to and including 4 weeks post-partum (neonatal). The post-neonatal infant age group is divided into two groups, AC2 for 1 month to 6 months (early post-neonatal infant) and AC3 for later post-neonatal infant (7-11 months). For demographic purposes all three categories can be pooled as 'infant' (AC1-3). The age codes 4-6 are designated for older children. If for a subadult no ageing criteria is present AC12 (<18) is used for the overall age code.

The current level of accuracy associated with adult age estimation techniques would suggest that further divisions other than the four groups shown (AC7-10) would be unwise. If no ageing criteria is present for an adult AC11 (>18) is used for overall age code. If no ageing criteria is present for a subadult, AC12 is used for the overall age code, it is important that the age caterogy cells are left blank and the 9 is NOT entered in to the cells.

Category	Code	Age group	Description
Sub – Adult	1	Perinatal	IU - Neonate
	2	1 – 6 Months	Early Post Neonatal Infant
	3	7 – 11 Months	Later Post Neonatal Infant
	4	1 – 5 Years	Early Childhood
	5	6 – 11 Years	Later Childhood
	6	12 – 17 Years	Adolescence
Adult	7	18 – 25 Years	Young Adult
	8	26 – 35 Years	Middle Adult A

	9	36 – 45 Years	Middle Adult B
	10	>46 Years	Mature Adult
Unclassified	11	Adult	>18 Years
	12	Sub - Adult	< 18 Years

Sex determination codes

The methods employed here are based on the visual assessment of a predetermined set of skeletal features. The most reliable parts of the human skeleton for the determination of biological sex are the pelvis and the skull. A total of fourteen sexually dimorphic characters are visually assessed using seven pelvic, and seven skull characters. The set of assessed features are listed:

Sex Determination	
Pelvic	Skull
Greater sciatic notch	Supraorbital ridges
Preauricular sulcus	Mastoid process
Ventral arc	Inion protuberance
Medial portion of pubis	Nuchal crest
Subpubic angle	Forehead
Subpubic concavity	Zygoma root
Median ischiopubic ridge	Gonions

For the pelvis, the pubic characters described by Phenice (1969) should be followed; the other characters follow the definitions given in Brothwell (1981), Ferembach et al (1980) or Bass (1995). Each character should be graded as follows:

Male	?Male	Intermediate	?Female	Female
1	2	3	4	5

If the area of bone showing the sex character is missing postmortem record this as 9 (indeterminate). However, if the sex character shows an ambiguous morphology record this as 3 (intermediate), NOT 9. When each character has been considered separately for the pelvis and skull, make a final decision about each of these elements in Overall Pelvic Sex and Overall Skull Sex using the same codes as above. A final sex determination is given in Overall Sex, again using the same codes. As secondary sex characters are not manifest until puberty, sex codes should not be given to children in Age Code 1 – 6, here a 0 (zero) should be entered to indicate a non-sexed subadult. For subadults do not need to enter 9 into the other fields for sex estimation, simply put a 0 (zero) in the last field.

Measurements

Measurements of the bones follow the definitions of Buikstra and Ubelaker (1994), Brothwell (1981) and Bass (1995). All measurements are recorded in millimetres. The Level 2 table for metric data has data validation ranges derived from the

Spitalfields Market pilot study (Connell 2002) and have been calculated from a pooled sex mean value ±3 unit's standard deviation.

Skull measurements

A total of 37 measurements are made on each cranium (31 single and six paired left and right). A full list of each individual measurement is given below. A further twelve measurements are taken on the mandible see below. Skulls that are deformed post-mortem are not measured, or the skulls of juvenile individuals where the speno-occipital synchondroses have not fused.

Measurement	Abbreviation	Measurement	Abbreviation
maximum length	L	total facial height	TFH
maximum breadth	B	upper facial height	G'H
basi-bregmatic height	H'	bizygomatic breadth	J
basi-nasal length	LB	bimaxillary breadth	GB
basi-alveolar length	GL	nasal height	NH'
transverse biporial arc	BQ'	nasal breadth	NB
frontal arc	S1	simotic chord	SC
parietal arc	S2	bi-dacryonic chord	DC
occipital arc	S3	bi-dacryonic arc	DA
frontal chord	S1'	palatal length internal (st-o)	G'1
parietal chord	S2'	palatal breadth internal (end-end) - if maxillary torus is present do not measure	G'2
occipital chord	S3'	palatal external length	ext-L
maxm. circumference	U	palatal external breadth (ecm-ecm)	ext-B
biasterionic breadth	Biast B		
foraminal length	FL	orbital breadth L/R	O'1
foraminal breadth	FB	orbital length L/R	O'2
bi-orbital breadth	ec-ec	porion-bregma height L/R	PBH
upper facial breadth	fmt-fmt		

Manbibular Measurements

Maximum Length	ML
Bicondylar Width	W1
Symphyseal Helight	H1
Bigonial Breadth	GoGo
Biforamen Breadth	ZZ
Mandibular Angle	M<
Minimum Ramus Breadth	RB' (left/right)

Coronoid Height	CrH (left/right)
Ramus Height	RH (left/right)

Dental measurements

Dental measurements are recorded on a limited number of individual teeth, these being the maxillary and mandibular canines and first molars (permanent and deciduous). In cases where calculus obscures the crown surface at measurement points the measurement should not be recorded, unless it is established as policy that this should be removed. Teeth showing enamel hypoplasia should also not be measured. On the canine teeth the mesiodistal and buccolingual crown diameters are recorded. These are defined as the maximum diameter of the crown relative to the tooth long axis, not the crown long axis (see Buikstra and Ubelaker 1994:Fig. 32). Preferably the individual tooth should be extracted to enable the mesiodistal measurement to be taken. In molar teeth the mesiodistal crown diameter is taken between interproximal contact points. The buccolingual diameter is taken perpendicular to the mesiodistal plane. Crown diameters should not be recorded in cases where the crown is severely worn down or with interproximal attrition at contact points obscuring the shape of the crown.

Maxillary	Buccolingual	Mesiodistal	Mandibular	Buccolingual	Mesiodistal
R canine	50	51	R canine	58	59
L canine	52	53	L canine	60	61
R M^1	54	55	R M_1	62	63
L M^1	56	57	L M_1	64	65

Postcranial Measurements

A total of 61 measurements are recorded on the postcranial skeleton. In the upper limbs, measurements are recorded on all of the long bones, including the scapula. For the clavicle, only measure for an adult when the sternal end is fused. Three measurements are also taken from the sacrum. Bones in the lower limb are measured (principally the femur and tibia), but maximum lengths are recorded on the fibula, calcaneum and talus. A full list of individual measurements is given below.

Bone	Dimension
clavicle	CLL1
scapula	GLL
	GLB
	HuL1
	HuHD
humerus	HuD1
	HuD2
	HuC
	HuE1
radius	RaL
	RaHD

ulna	ULL1
sacrum	SaL
	SaB
	BW
femur	FeL1
	FeL2
	FeHD
	FeD1
	FeD2
	FeD3
	FeD4
	FeC
	FeE
tibia	TiL1
	TiL2
	TiD1
	TiD2
	TiE
fibula	FiL1
calcaneum	CaL
talus *	TaL

* talus is measured perpendicularly across the superior (dorsum) surface from the groove for flexor hallucis longus to the mid point of the talus head.

Diaphyseal lengths

The diaphyseal lengths are recorded separately from metric data proper for subadult individuals. The maximum lengths of the long bone diaphyses are recorded and these include the humerus, radius, ulna, femur, tibia, fibula and clavicle. If there is partial fusion DO NOT measure length for any of the long bones. If there is any pathology take this into consideration when using as part of an age estimation. Widths are also recorded on the distal humerus and femur. For young children and adolescents all of these measurements can then be compared to the data compiled by Maresh (1970) – in Scheuer and Black (2000). In addition to the lengths of long bone diaphyses several other ancillary measurements are recorded. These include the width and height of the ilium and the width and depth of the greater sciatic notch, following Buikstra and Ubelaker (1994). The length and breadth of the basioccipital (Scheuer and Black (1996); Fazekas and Kosa 1978) is also recorded. The final age determination should be put in the diaphyseal age field.

Non-metric Traits

The following scores are applied for the recording of non-metric traits:
trait present =1, trait absent =0 and area missing/not observable/not countable =9
For wormian bones in the skull able to count the actual number seen, entering number in the cell it will accept a value between 2-8 to indicate the number present, if do enter 8 then 8 = the actual number of 8 or above for Wormian bones.

Cranial Sutural Variation
Metopism
Lambdoid bone
Inca bone
Bregmatic bone
Asterionic bone
Epiteric bone
Saggital wormians
Coronal wormians
Lambdoid wormians
Squamo-parietal wormians
Parietal notch bone
Torus auditivi
Torus maxillaries
Torus palatinus

Cranial foraminal variation
Supraorbital foramen
Supraorbital groove
Mastoid foramen
Foremen of Huschke
Parietal foramen
Accessory infraorbital foramen
Posterior condylar canal

Mandibular
Multiple mental foramen
Torus mandibularis
Mylohyoid bridge

Postcranial
Sternal foramen
Manubrio-corpal synostosis
Os acromiale
Acromial articular facet
Septal aperture
Supracondylar process
Atlas: posterior bridge
Atlas: lateral bridge

Atlas: transverse foramina bipartite
Atlas: double facet
Accessory sacral/iliac facets
Acetabular crease
Third trochanter
Allen’s fossa
Hypotrochanteric fossa
Patella – vastus notch
Patella – bipartite
Tibia – medial squatting facet
Tibia – lateral squatting facet
Calcaneal facet absent
Calcaneal facet double
Talus – os trigonum
Talus – talar facet double
Talus squatting facet

Vertebral Pathology

Facets

Pathological changes recorded in facet joints followed the guidelines of Sager (1969), with osteoarthritis recorded at the joint interface level in the zygoapophyseal joints.

1	**Grade 1**
2	Grade 2
3	Grade 3 (or eburnation on its own)

Osteophytes

The presence of osteophytes are recorded independently for the margin of the centrum. The severity of the osteophytes were based on the criteria of Sager (1969).

1	Intermittent
2	Continuous
3	Extensive Lipping

Intervertebral Disc Disease (IVD)

For intervertebral disc surfaces (centrum or body) the following definitions were applied and are recorded by intervertebral joint unit regardless of whether the changes occurred on the superior or inferior surface of the vertebrae. For further details see Rogers and Waldron, A Field Guide to Joint Disease in Archaeology.

1	Coarse pitting on centrum under the footprint of the annulus fibrosus (outer rim of the surface)
2	Coarse pitting on centrum on the central part of the articular surface
3	Coarse pitting on both of the above

Schmorl's nodes

The presence of Schmorls's nodes are recorded regardless of whether the lesion occurs on the superior or inferior surface of the vertebral body. A herniation of disc material (nucleus pulposus) can migrate in different directions and would result in counting the same disc twice. Schmorl's nodes are described by intervertebral joint unit and the severity of the lesions listed accordingly.

1	Small <15mm wide and/or in depth
2	Medium >15mm wide and/or in depth
3	Large >25mm wide and/or in depth

Fusion

Where two or more vertebrae are fused together the fusion point is recorded. It is vitally important that a distinction is made between pathological fusion (e.g. ankylosing spondylitis) and congenital fusion i.e. segmentation failure.

1	Fusion across centrum only: Right side

2	Fusion across centrum only: Left side
3	Fusion across centrum only: Median
4	Fusion across zygoapophyseal joints only
5	Fusion across centrum and zygoapophyseal joints
6	Fusion across centrum only: Median, right and left sides

Dental Pathology

Dental pathology covers five pathological changes (caries, calculus, hypoplasia, periodontitis and periapical lesions), dental anomalies are also considered. The basis for recording dental pathology is the tooth or tooth position, pathology such as caries, calculus and enamel hypoplasia are recorded at the level of the individual tooth, whereas periodontitis and periapical lesions are recorded at the tooth position, i.e. as it is bone tissue that displays the response rather than enamel or dentine. In order to identify individual teeth within the dentition the FDI system is used (Federation Dentaire Internationale 1971) for numeric coding of each tooth. The tooth sequence, i.e. the tooth arrangement in FDI code follows from right to left for both the maxilla and mandible, i.e. the quadrants are in the order 1, 2, 4 and 3 (not strictly in the FDI sequence).

Caries Codes

Carious lesions have two variables recorded, firstly the location on the tooth where the lesion has occurred and secondly the severity of the lesion. For this a two-digit combination code is used where the first digit denotes the position and the second the severity.

Code is 2 digits; location + severity

Position

1	Occlusal
2	Lingual
3	Buccal
4	Mesial
5	Distal
6	Gross (Site of origin cannot be identified)
7	Root Surface

Severity

1	Enamel Destruction Only
2	Destruction of Dentine; pulp chamber not exposed
3	Destruction of Dentine; pulp chamber exposed
4	Gross Destruction (Crown largely destroyed)

Calculus Codes

The amount of calculus deposit is recorded following Brothwell (1981). Calculus deposits are recorded by a two digit code. Grade the deposit based on the surface with the largest deposit. The first digit relates to whether the calculus is supra or sub-gingival:

Code is 2 digits; location + severity

Location

1	Enamel surface only
2	Root – if calculus touches the root at any point always code as 2 for location

Severity

1	Small (slight)
2	Medium
3	Large (heavy)

Enamel Hypoplasia

Grade 1 would not be felt clearly with a fingernail but would be clearly visible and caution must be exercised here not to count an enhanced perikymata. Grade 2 would be clearly felt using the fingernail test.

Code is 2 digits; location + severity (Score most serious defect if more than one present)

Location

1	Cusp/Crown
2	Middle Crown
3	Lower Crown

Severity

1	Linear Enamel Hypoplasia	Just Discernable
2	Linear Enamel Hypoplasia	Clear Groove on Teeth Surface
3	Linear Enamel Hypoplasia	Gross Defects (Ridges/Dentine Exposed)
4	Hypoplastic Pit	Circular defect on Crown

Periodontal Disease

The distance between the cemento enamel junction (CEJ) and the alveolar crest is considered to be 2mm in a healthy young adult. The severity of resorption of the alveolar margin and inflammatory changes in the alveolar bone itself are recorded as follows:

1	2-3mm
2	3-5mm
3	5mm + (majority of tooth root exposed)

Periapical Lesions (Abcesses)

The presence of a periapical lesion is recorded at the parent tooth position. A periapical lesion is coded according to the location of the drainage sinus (external, internal or maxillary sinus) and whether the abscess is derived from a carious lesion, from premature pulp cavity exposure due to heavy occlusal wear or where the tooth is missing post-mortem. The following codes are used:

10	External Drain Caries Related
20	Internal Drain Caries Related
30	Drain into Maxillary Sinus Caries Related
11	External Drain Pulp Cavity Exposure (Occlusal Wear)

21	Internal Drain Pulp Cavity Exposure (Occlusal Wear)
31	Drain into Maxillary Sinus Pulp Cavity Exposure (Occlusal Wear)
12	External Drain No Apparent Tooth Pathology or Lost Post-Mortem
22	Internal Drain No Apparent Tooth Pathology or Lost Post-Mortem
32	Drain into Maxillary Sinus No Apparent Tooth Pathology or Lost Post-Mortem

Vertebral Anomalies - Border shifts

The vertebral column is often the site of minor congenital anomalies. The tables are designed to allow the more commonly occurring defects to be recorded quickly and effectively. See Barnes (1994) for definitions of these defects. More complex defects such as hemimetameric hypoplasia/aplasia or asynchrony should be considered separately in the pathology comments field with a PBR if necessary.

Border shifts are commonly seen in the axial skeleton and the following codes are composite codes. The codes should only be entered in the defect interface cell.
The first digit denotes the border

1. Occipitocervical,
2. Cervicothoracic,
3. Thoracolumbar,
4. Lumbosacral,
5. Sacrocaudal.

The second digit denotes direction of the shift

1. Cranial shift and
2. Caudal shift.

The third and /or fourth digits denote exact expression of any given border shift and coded as follows:

Occipitocervical border (1)

	111	Expression of occipital vertebra
	112	Precondylar process
	113	Bipartite occipital condyles
	114	Transverse basilar cleft
cranial	115	Odontoid process displacement
caudal	121	Atlas occipitalised
	1221	Paracondylar process R
	1222	Paracondylar process L
	1223	Paracondylar process Bilateral
	123	Hypoplasia of condylar facets
	124	Precondylar facets

Cervicothoracic border (2)

	2111	Expression of cervical rib: bony tubercle
	2112	Expression of cervical rib: blunt bony projection
	2113	Expression of cervical rib: rib extension without costal facet joint
cranial	2114	Cervical rib: complete with articular facets
caudal	221	Stunted transverse process
	222	Rudimentary first rib
	223	Second rib attaches to mesosternum only

Thoracolumbar (3)

	311	Hypoplastic rib 12
	312	Aplastic rib 12 (no rib facets on T12)
	313	Transitional facets on T11
cranial	314	T13 Present
caudal	321	Lumbar rib and facet on L1
	322	Small blunt rib on L1
	323	Transitional facets on L1

Lumbosacral border (4)

	4111	Ala-like transverse process L5 (non articulating) L
	4112	Ala-like transverse process L5 (non articulating) R
	4113	Ala-like transverse process L5 (non articulating) Bilateral
	4114	Ala-like transverse process L5: articulating L (partial sacralisation)
	4115	Ala-like transverse process L5: articulating R (partial sacralisation)
	412	Complete sacralisation of L5
	4121	Ala-like transverse process L6 (non articulating) L
	4122	Ala-like transverse process L6 (non articulating) R
	4123	Ala-like transverse process L6 (non articulating) Bilateral
	4124	Ala-like transverse process L6: articulating L (partial sacralisation)
	4125	Ala-like transverse process L6: articulating R (partial sacralisation)
	4126	Extra numerary lumbar vertebra (L6)
cranial	413	Complete sacralisation of L6
caudal	4211	Apophyseal joints between S1 and S2
	4212	Anterior cleft between S1 and S2
	4213	S1 and S2 Apophyseal joints and anterior cleft
	4221	Incomplete lumbarisation of S1 L
	4222	Incomplete lumbarisation of S1 R
	4223	Complete lumbarisation of S1 (bilateral)

Sacrocaudal (5)

	511	Incomplete separation of S5
cranial	512	Complete separation of S5
caudal	521	Incomplete sacralisation of first caudal vertebra
	522	Complete sacralisation of first caudal vertebra

Vertebral Anomalies - Segmentation failures

Congenitally fused vertebrae often occur, particularly in the cervical region. Fused vertebrae should be considered at each vertebral level. Non-union of the neural arch is also a commonly seen defect, particularly in the sacrum. To record block vertebrae apply a code for each vertebra. The following codes apply:

1	Fusion: Cranial segmentation failure	
2	Fusion: Caudal segmentation failure	
3	Fusion: Cranial and Caudal segmentation failure	
4	Cleft neural arch (spina bifida occulta)	Major defect
5	Bifurcate neural arch	Minor defect
6	Hypoplasia right transverse process	
7	Hypoplasia left transverse process	
8	Hypoplasia right centrum	
9	Hypoplasia left centrum	
10	Hyperplasia right transverse process	
11	Hyperplasia left transverse process	

12	Both transverse processes hyperplastic	

Dental Anomalies

A series of the commonly occurring dental anomalies are recorded and listed below. For definitions of dental anomalies refer to Hillson (1996).

Rotation

1	Single Tooth Rotated to mesial 45 degrees
2	Single Tooth Rotated to mesial 90 degrees
3	Single Tooth Rotated to distal 45 degrees
4	Single Tooth Rotated to distal 90 degrees
5	Bilateral winging to mesial 45 degrees (enter code for both teeth)
6	Bilateral winging to mesial 90 degrees (enter code for both teeth)
7	Bilateral winging to distal 45 degrees (enter code for both teeth)
8	Bilateral winging to distal 90 degrees (enter code for both teeth)

Crowding

For crowding enter 1 in the cells of the affected teeth to denote that the tooth mesial to the reference position is not in normal alignment. This is available for all permanent teeth.

Impaction
For impaction enter 1 in the cell of the impacted tooth. Never record details on position. This is available for all permanent teeth.

Transposition
For a transposed tooth enter the FDI code of the position that the tooth has moved to in the normal position, and the FDI code of the new position of the other tooth. This feature is available for all permanent teeth.

Enamel pearl
The presence of an enamel pearl should be scored as a 1 in the cell of the tooth. Never record details on size or location unless outside the range of normal variation. This feature is available for all permanent teeth.

Peg Molar
The presence of a peg molar should be scored by entering a 1 in the position of the affected tooth. This is available for T18 and T28 only. Never record details of size unless outside range of normal variation.

Incisor shovelling
Although a classification system for incisor shovelling has been developed by Arizona State University (1991) clear definitions are difficult (Hillson 1996:86). Therefore to enable rapid scoring of presence /absence, shovelling is recorded when the marginal ridges are sufficiently prominent to give the lingual surface a distinct concave and shovelled appearance. These are available for T12, T11, T21 and T22 only.

Carabelli's cusp
The presence of a Carabelli's cusp should be scored as a 1 in the cell of the tooth; this is available for T16-18 and T26-28 only. Never record details on size.

Protostylid
The presence of a protostylid cusp should be scored as a 1 in the cell of the tooth; this is available for T36-38 and T46-48 only. Never record details on size.

Joints Inventory

The objective of recording an inventory of joints present is to quantify the number of joint surfaces available for examination. This in turn will permit the prevalence rates and distribution of various joint diseases to be calculated. A record of the specified joint surfaces is recorded as present =1 or absent = null. For some sites there is a four digit code for joints representing the joint being present, osteophytic lipping & the degree of severity 1-3, porosity & the degree of severity 1-3 and eburnation being present on <50% of the surface 1 or >50% of the surface 2. For example 1111 denotes the joint present and slight changes in lipping & porosity and eburnation >50%, 1322 denotes joint present, severe lipping, intermediate porotic changes and eburnation covering more >50% of the surface. Pathological joint changes should be described in the pathology comments section and the appropriate code entered from Joint disease codes.

For subadult individuals, the unfused epiphyses should also be counted. The units are to keep recording within manageable and sensible proportions. Recording this section in juveniles is also carried out because the presence of a joint surface implies presence of the epiphysis and this helps count towards the percentage completeness estimation and analysis of recovery levels.

Skeletal pathology

Pathology comments field

The osteological database allows for the systematic recording of commonly occurring skeletal pathology such as dental pathology and degenerative changes in the vertebral column. Provision has also been made for recording what could be described as non-systematic pathology, that is, the disease conditions not regularly encountered during routine analysis. Comments are recorded to enable key-word searches to be undertaken in this field.

The pathology recording procedures designed for this protocol formed the basis for the MoLAS contribution to the BABAO standards document (Brickley et al 2004). The guidelines for ALL pathology recording is based on Roberts and Connell (2003:40-48) and this should be consulted for further details.

Pathology codes

A series of codes have been developed to enable the numbers and types of different pathological conditions to be quantified and managed on a database. These codes are intended to represent a classification system that provides a working method of counting skeletons with differentially diagnosed skeletal pathology.

There are a total of nine fields for pathology codes in the catalogue block; these include congenital, infection, joint disease, trauma, neoplastic, metabolic, endocrine, circulatory and ‘other’ disease categories. Each type or class of pathology is given a prefix; for example, all infectious disease starts with a 2, all joint disease with a 3 and so on. A second digit is added (e.g. 21 or 22) to denote a particular type of disease process and a third digit may be added as a further sub-division for a more specific classification or diagnosis (e.g. 221 is tuberculosis). Codes for the main disease conditions readily identified in human skeletal remains are given in tables below.

In some cases the pathological changes in a skeleton may be extensive or present a challenge in terms of differential diagnosis. In such cases the alternative pathology code is also entered with DIFFERENTIAL DIAGNOSIS at the beginning of the explanation and description. In some instances if there is insufficient space and/or it

is necessary to include sketch plans of skeletal elements a paper based record (PBR) is created and the PBR tick box is marked to indicate that this has been done.

Pathology codes

Congenital abnormality codes

Disease	Prefix	Code	Pathology
other congenital		12	skull malformation
other congenital		13	spinal disorders
other congenital		14	limb abnormality
skull malformation	12	120	skull malformation (general)
		122	anencephaly
		123	microcephaly
		124	hydrocephalus
		125	bathrocephaly
		126	cleft palate
		127	craniofacial abnormality
		128	artificial cranial abnormality
spinal disorders	13	131	scoliosis
		132	kyphosis
		133	kyphoscoliosis
limb abnormality	14	141	achondroplasia
		143	suspected hip dysplasia if acetabulum missing
		1420	upper limb aplasia/hypoplasia/malformation
		1430	lower limb aplasia/hypoplasia/malformation
		1431	DDH
		1432	CDH
		1433	congenital talipes equinovarus

			(CTEV)
	15	1511	spondylolysis (bilateral)
		1512	spondylolysis (unilateral L)
		1513	spondylolysis (unilateral R)
		1521	spondylolithesis
	16	160	other (congenital)

Infectious disease codes

Disease	Prefix	Code	Pathology
other infectious		21	non-specific infection
other infectious		22	specific infection
other infectious		23	miscellaneous-other infections
non-specific infection	21	211	non-specific periostitis
		212	non-specific osteomyelitis
		213	sclerosing osteomyelitis (Garre)
		214	non-specific osteitis
specific infection	22	221	tuberculosis (*M.tuberculosis/bovis*)
		222	treponematosis (*Treponema sp*.)
		223	leprosy (*M. leprae*)
		224	brucellosis (*Brucella sp*.)
		225	tuberculosis/brucellosis
		2260	actinomycosis
		2261	typhoid fever
		2262	nocardiosis
		2263	smallpox
		227	rubella

other infection	23	230	mycotic infection (unclassified)
		231	poliomyelitis
		232	septic arthropathy (non-specific)
		233	parasitic infection (unclassified)

Joint disease codes

Disease	Prefix	Code	Pathology
other joints		31	osteoarthritis
other joints		32	seronegative spondylarthropathy
other joints		33	erosive arthropathy
other joints		34	joints miscellaneous
osteoarthritis	31	311	osteoarthritis
		312	inflammatory osteoarthritis
seronegative spondylarthropathy	32	321	ankylosing spondylitis
		322	Reiter's disease
		323	psoriatic arthropathy
erosive arthropathy	33	331	rheumatoid arthritis (including juvenile forms)
		332	gout
		333	enteropathic arthropathy

other	34	341	diffuse idiopathic skeletal hyperostosis (DISH)
		342	rotator cuff disease
		343	ankylosis
		344	neurotrophic arthropathy (Charcot joint)
		345	ochronotic arthropathy
		346	heamochromatosis
		347	CPPD
		348	sarcoidosis
		349	amyloidosis
	35	350	other

Trauma codes

Disease	Prefix	Code	Pathology
other trauma		41	surgical intervention
other trauma		42	accidental
other trauma		43	interpersonal violence
surgical intervention	41	411	trepanation
		412	amputation
accidental	42	4210	healed fracture
		4211	unhealed fracture (atrophic non-union)
		4212	unhealed fracture (hypertrophic non-union)
		422	fracture separation of epiphysis
		423	subluxation (full or partial)

		424	avulsion injury
		425	compression fracture (vertebrae)
		426	soft tissue trauma (ossified haematoma/myostitis ossificans)
		427	fracture with secondary infection
		428	pathological fracture
interpersonal violence	43	431	sharp force trauma (edged implement) healed
		432	sharp force trauma (edged implement) unhealed
		433	blunt force trauma (incl depressed cranial fracture) healed
		434	blunt force trauma (incl depressed cranial fracture) unhealed
		435	projectile injury
		436	other

Metabolic disease codes

Disease	Prefix	Code	Pathology
other metabolic		51	Vitamin D deficiency
other metabolic		52	Vitamin C deficiency
other metabolic		53	general
vitamin D deficiency	51	511	rickets
		512	osteomalacia
vitamin C deficiency	52	521	scurvy
	53	531	osteoporosis

Endocrine disease codes

Disease	Prefix	Code	Pathology
other endocrine		61	pituitary
other endocrine		62	parathyroid
other endocrine		63	thyroid
pituitary	61	611	hyperpituitarism (acromegaly)
		612	hyperpituitarism (gigantism)
		613	hypopituitarism
parathyroid	62	621	hyperparathyroidism
		622	hypoparathyroidism
thyroid	63	631	hyperthyroidism
		632	hypothyroidism

Neoplastic disease codes

Disease	Prefix	Code	Pathology
Other neoplastic		71	bone tissue
Other neoplastic		72	cartilage tissue
Other neoplastic		73	general
bone tissue	71	711	osteoma (including button osteoma)
		712	osteoid osteoma
		713	osteoblastoma
		714	osteosarcoma
cartilage tissue	72	721	chondroma
		722	chondroblastoma
		723	osteochondroma
		724	chondrosarcoma
fibrous connective tissue	73	731	FCD (fibrous cortical defect)
		732	other fibrous tissue (unclassified)
neoplastic general	74	741	giant cell reparative granuloma
		742	meningioma
		743	osteoclastoma
		744	Ewing’s sarcoma
		745	bone cysts
		746	other (unclassified)

Circulatory disease code

Disease	Prefix	Code	Pathology
other circulatory		91	other
other circulatory		92	osteochondroses
other circulatory		93	osteoarthropathy
	91	910	aneurysm
		911	osteochondritis dissecans
osteochondroses	92	921	Perthes disease
		922	Osgood-Shlatter's disease
		923	Sinding-Larsen's disease
		924	Blount's disease
		925	Sever's disease
		926	Kohler's disease
		927	Freiberg's disease
		929	Scheuermann's disease
		9210	Calves disease
		9211	Keinbock's disease
		9212	Preiser's disease
osteonecroses	93	931	femoral head necrosis
		932	femoral condyle necrosis
		933	slipped femoral epiphysis
		934	idiopathic osteonecrosis
osteoarthropathy	94	941	hypertrophic osteoarthropathy

Miscellaneous pathology codes

Disease	Prefix	Code	Pathology
General pathology comments	0	0	Any general comments that do not fit in any specific pathology codes
other blood disorders		10	blood disorders
blood disorders	10	1001	cribra orbitalia left orbit
		1002	cribra orbitalia right orbit
		1010	porotic hyperostosis
		1020	multiple myeloma
		1030	histiocytosis-X
other dysplasias		104	dysplasia
dysplasias	104	1040	spondyloepiphyseal dysplasia
		1041	diaphyseal aclasis
		1042	dyschondropasia
		1043	osteopetrosis
		1044	infantile cortical hyperostosis
		1045	diaphyseal dysplasia
		1046	osteogenesis imperfecta
		1047	chromosomal dysplasia
		1048	dysplasia (unclassified)
miscellaneous	105	1050	Paget's disease
		1051	Leontiasis ossea
		1052	hyperostosis frontalis interna
		1053	neuromechanical

			condition
		1054	Endocranial lesions
		1055	Dental