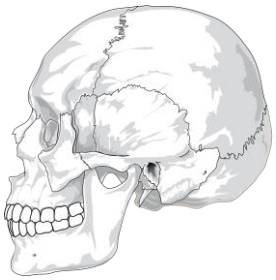


The Science: Postmortem skeletal analyses

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

Department of PATHOLOGY
University of Cape Town

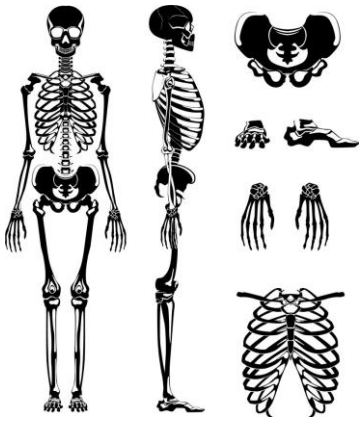
Division of Forensic Medicine & Toxicology

The science behind postmortem skeletal analyses.

Human bones are useful in medicolegal investigations as they contain individualizing features that can help with identification. When human skeletal remains are discovered; estimations of sex, ancestry, age and stature are essential in constructing a reliable demographic profile of the deceased. In addition to this, analyses of bone biomechanics can be useful in analyzing trauma, the order of impacts to a bone or minimum number of blows. Bones also provide information changes to the body since death that can be useful in estimating postmortem interval.

What is forensic anthropology?

- The application of osteology and skeletal biology
- Burnt, decomposed, mummified or skeletonised remains.
- Main focus: Identification of unknown individuals.
- May require maceration.



Post mortem analyses of skeletonised or decomposed remains falls within the realm of forensic anthropology. What is forensic anthropology? It is the application of osteology and skeletal biology to burnt, decomposed, mummified or skeletonised remains. The main focus is usually identification of unknown individuals. Forensic anthropologists may also facilitate in cases where the is soft tissue present, in these cases, the tissue is freed from the bone through the process of examination so the bone can be examined. FA can be performed by Forensic pathologists, medical examiners and trained forensic anthropologists.

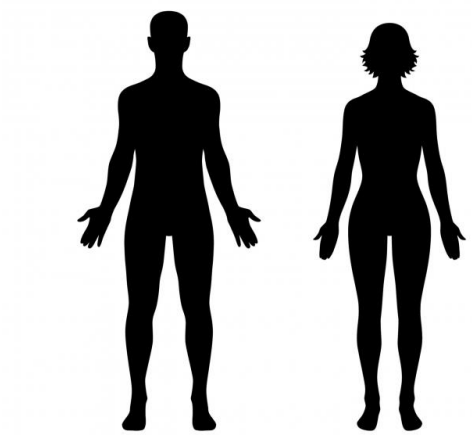
Bones as evidence

- Biological profile:
  - Sex estimation (Not gender)
  - Age estimation
  - Stature
  - Osteobiography/ individualsising features
- Trauma and pathology
- Taphonomy

A forensic anthropologist can read the evidence in a skeleton like you read a book. The techniques they use to answer questions in criminal cases can be applied to skeletons of any age, modern or ancient. The shape of pelvic bones provides the best evidence for the sex of the person. The stages of growth and development in bones and teeth provide information about whether the remains represent a child or adult. Abnormal changes in the shape, size and density of bones can indicate disease or trauma. Bones marked by perimortem injuries, such as unhealed fractures, bullet holes, or cuts, can reveal cause of death. The trained anthropologist is also able to identify skeletal clues of ancestry. Even certain activities, diet, and ways of life are reflected in bones and teeth. They are also able to determine the minimum number of individuals based on which bones are present.

Sex estimation

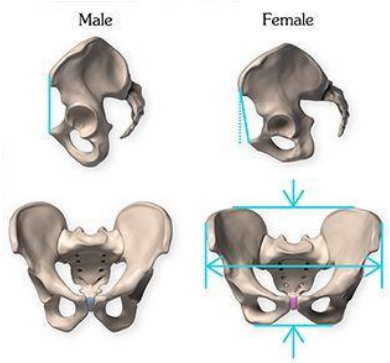
- Body size
- Muscularity
- Adaptation for childbirth



Skeletal remains can be used to provide critical information about an individuals identify. Sex is important in identifying an individual from missing persons reports. Sex estimation is predicated on differences between men and women in body size, muscularity and pelvic shape due to adaptation for childbirth. Men are 10-15% larger on average due to increased testosterone levels. As a result, men are generally larger and muscle markings are bigger. This is seen in the long bones in the arms and legs but also the skull. There are several anatomical differences that exist between men and women.

Sex estimation

- Pelvic shape and size differences

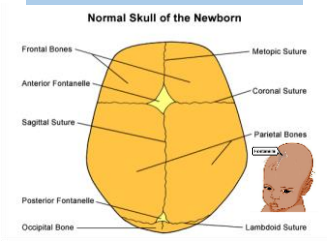


- Skull shape and size differences in the skull

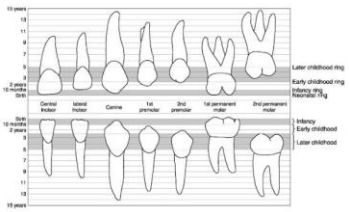
The greatest differences between men and women occurs in the pelvic shape and size, but also the skull shape and size. The pelvis has a (98%) sex estimation accuracy. This is because the female has shape suited for childbirth. As a result the female pelvic is broader and wider and the male is smaller with a smaller pelvic outlet and inlet. If you look at the skulls, you can see that the male skull is larger, broader while the female skull on the right is more gracile and slender.

Age estimation: Juveniles

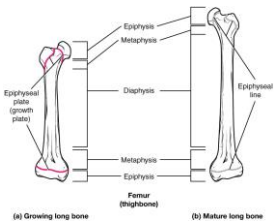
Soft spot fusion



Tooth eruption



Bone growth

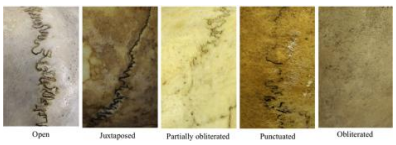


Age estimation is possible because our bodies grow and changes occur as we age. If you look at the 1st image, the skull of a newborn looks very different from the age of an adult. By looking at the soft spot of a baby, you are able to determine age. This is because these fuse within the first 2 years of life. Tooth eruption or the appearance of different teeth can also be used to estimation and in juveniles. Bone growth can also be used to assess age in juveniles, but once growth ceases, this may become difficult.

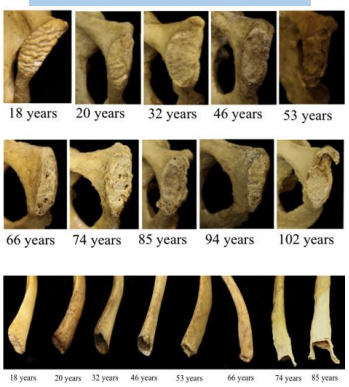
Age estimation: Adults

Tooth eruption

Bone growth



Bone degeneration



In adults we look for signs of tooth eruption. As most of our teeth are erupted by the age of 16 years old, the only tooth that can be used in adults is the presence of wisdom teeth. Signs of bone degeneration and cessation of bone growth are also useful in estimating age. We can see in the image on the right that there are significant changes that happen in articular surfaces, where two bones are separated by a piece of cartilage. As an individual ages, bones begin to degenerate and change in shape and morphology. Using population-specific standards, we are able to estimate age from various different bones like the ribs, skulls and pelvis.

Ancestry estimation

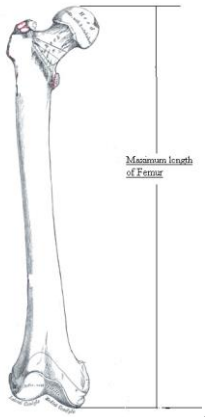
- Very broad geographic ancestry groups.
- Shape and size of structures in the cranial region.

African Asian European

Ancestry estimations are possible due to the systematic variation between individuals based on their geographic ancestry. Currently in forensic anthropology, there is a move away from estimating ancestry as these may not be helpful or accurate. This is because the standards only provide very broad estimates based on three ancestral groups. These three main groups are African, Asian and European. Depending on an individuals country, like in the South African context these terms may not be particularly helpful, these results may be confusing as genetic admixture in an individuals family tree may complicate ancestral estimation. As a result ancestry estimations are rarely used by forensic anthropologists in certain laboratories.

Stature

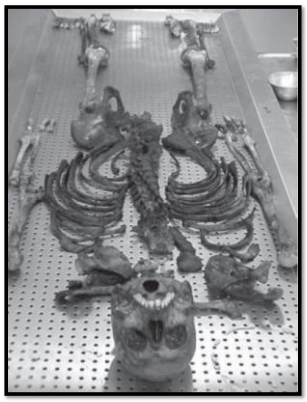
- Measurement of long bones.
- Population specific equations to estimate living stature.



Stature estimation is possible through measurement of long bones . As you can see here, the femur is the most commonly used bone in estimating stature. Population specific equations to estimate living stature. Stature, sex, age and ancestry are all part of the demographic profile that can be generated from skeletal remains.

What can we learn from skeletal remains?

1. Pathology
2. Behaviours
   - Occupation/habitual markers
   - Cultural/medical intervention
3. Diet and health status
   - Bone and tooth decay
   - Stress and growth disruptions
4. Violence and trauma
5. Taphonomy



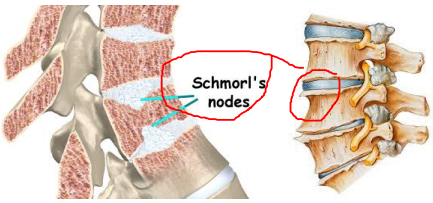
A lot can be learnt from skeletal remains. Evidence of pathology, various behaviours linked to occupation/habitual markers or cultural/medical intervention can be identified on the bones. Diet and health status can be assessed through bone and tooth decay, stress and growth disruptions. Evidence of violence and trauma and taphonomic changes can also be left as evidence on the bone.

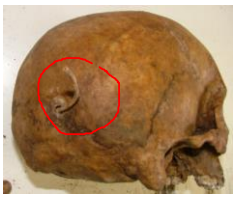
1. Pathology

There are various different conditions that can be shown on bone. The first image, indicated low grade systemic infection that was present in an individual at or around the time of death. The pin prick like structures in the orbital region and top of the skull, are indicative of anaemia. The top image shows venereal syphilis on the bone, and the bottom picture shows evidence of osteoarthritis changes in the knee region.

2. Behavioural

- Occupation/habitual markers: Osteoarthritis, joint degeneration, overuse markers.
- Cultural/medical intervention: Stents, joint replacements, 'Cape flats smile'.



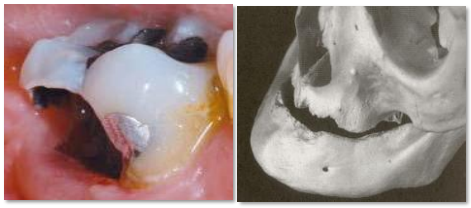


Bone retains evidence of occupation/habitual markers. Examples are shown here. Generally osteoarthritis in the spine in younger individuals suggest labour intensive activities or work. Other cultural/medical interventions that have been identified include stents or joint replacements. The 'Cape flats smile', is a unique South African socio-cultural dental modification practice that can also be useful in identification.

3. Diet and health status

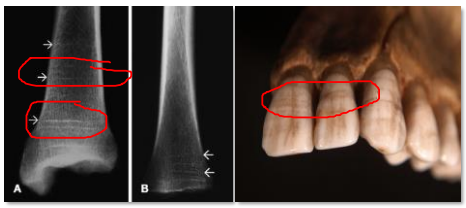
Dental health

- Carries/ cavities, Abscess formation, antemortem toothloss.



Growth disruption

- Bones and teeth.



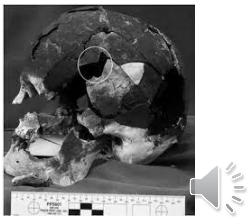
Bones and teeth can also contain information about an individuals diet and health status. Dental health or the absence of dental health due to carries/ cavities can indicate an individual of poor health. This can tell us about an individuals lifestyle, and possible care or treatment they pursued and pain experienced around the time of death. Antemortem toothloss can also be useful in identification of unknown individuals. Growth disruptions can be retained by bones and teeth. In these images period of growth disruptions appear as lines on bones.

4. Violence and trauma

- Bones provide information about type of weapon, directionality, speed of an impact.

Blunt force trauma- slow (km/h	Sharp force - slow (km/h)	Ballistic bone trauma- rapid (m/sec)	Burned bone- heat fractures



Evidence of violence and trauma can be retained on bones. This provides information on type of weapon, directionality, speed of an impact. Evidence on bone can outlast trauma on soft tissue. But trauma on soft tissue may not necessarily reflect on the bone, this doesn't mean that there was no trauma but rather that if there was trauma it did not impact the underlying bone. Blunt force trauma refers to trauma at a slow speed and causes several radiating fractures from the site of impact. The evidence of sharp force trauma includes cuts or and depressions of similar shape and size to the object used to make the incision. Ballistic bone trauma may sometimes have exit and entrance wounds visible. Understanding the location and trajectory of these wounds can be helpful in how the gunshot wound was experienced. How far the person who fired the gun was, and what angle fired the gun at. Trauma on burnt bone occurs in the way of heat fractures

5. Taphonomy

Processes that happen from death to discovery and post-discovery of an organism.

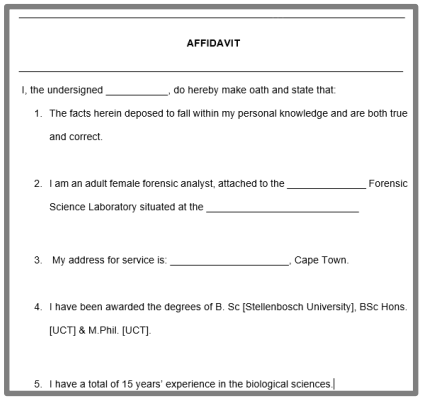
Scavenger activity

Discolouring due to sunlight, water or soil

Bones can also contain information about taphonomy. Processes that happen from death to discovery and post discovers of an organism. The most common ones indicated here are evidence of scavenger activity and discolouring due to sun, water or soil. Scavenger activity may not mean the role of the scavenger in the death, but rather that a scavenger has access to the body after death. Discolouring due to environmental exposures may provide information about the position of the body at death. And what surfaces of the body were exposed to the elements. This is helpful when assessing evidence of concealment.

The postmortem report

- In affidavit form.
- Author of report.
- Details of examination.
- Demographic profile (age, sex and stature).
- Pathology, trauma and taphonomy



AFFIDAVIT

I, the undersigned _____, do hereby make oath and state that:

1. The facts herein deposed to fall within my personal knowledge and are both true and correct.

2. I am an adult female forensic analyst, attached to the _____ Forensic Science Laboratory situated at the _____

3. My address for service is: _____, Cape Town.

4. I have been awarded the degrees of B. Sc [Stellenbosch University], BSc Hons. [UCT] & M.Phil. [UCT].

5. I have a total of 15 years' experience in the biological sciences.

The outcome of the skeletal analysis is a postmortem report in the form of an affidavit. This includes the author of report, details of examination, demographic profile (age, sex and stature), pathology, trauma and taphonomy

Voice over: Elizabeth Dinkele
Slide design: Elizabeth Dinkel

Slides provided by the Division of Forensic Medicine and Toxicology,
Faculty of Health Sciences, University of Cape Town
Contact person: Dr Laura Heathfield
Laura.Heathfield@uct.ac.za