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## ABSTRACT

Looting is a destructive force at archaeological sites and sites of cultural heritage around the world. Looting is affected by **culture practices, religious beliefs and practices, political climate, and economic stability**. With the prevalence of looting both in antiquity and modernity it has become increasingly important to understand the effects of looting on archaeological and skeletal collections from recent fieldwork as well as museum storage. This research investigates quantitative bioarchaeological methods that can be utilized to understand taphonomic processes and reconstruct mortuary practices. Based on qualitative (in situ and laboratory conditions) and quantitative (fragmentation size and weight) observations, there are statistically significant differences between skeletal remains from looted and unlooted contexts, but not within each context.

## BACKGROUND

- Traditional mortuary analysis relies on grave goods and other funerary items that accompany the body

- Looting activity is rarely evaluated in a systematic or rigorous way in mortuary studies

- Bioarchaeological studies of taphonomy as a means of understanding human activity are rare

## RESEARCH QUESTIONS

- Can looting be detected in a systematic and quantifiable manner through the analysis of human skeletal remains?

- Is there a significant difference between preservation of anatomical regions within a given context?

- Is there a significant difference between preservation of anatomical regions between looted and undisturbed contexts?

## INVENTORY, FRAGMENTATION & ZONATION

Categories for Understanding Fragmentation, Presence, and Absence		
Category	Quantitative	Qualitative
<b>Absent</b>	Less than 25% of anatomical region/bone present in the laboratory	Anatomical region/bone appeared absent from the archaeological matrix
<b>Crushed</b>	Greater than 25% of anatomical region/bone present in the laboratory	Anatomical region/bone appears present but crushed in the archaeological matrix
<b>Disarticulated</b>	Greater than 25% of anatomical region/bone present in the laboratory	Anatomical region/bone was not recovered in situ during excavations
<b>Fragmentary</b>	25-50% of anatomical region/bone present in the laboratory	Anatomical region/bone is present but destroyed post-mortem but prior to excavation
<b>Present</b>	Greater than 50% of an anatomical region/bone present in the laboratory	Anatomical region/bone appears present in the archaeological matrix
<b>No Data</b>	Based on individual's age estimation (<2 lunar years) elements were not expected to be present and/or ossified and therefore not considered for analysis in the above categories	

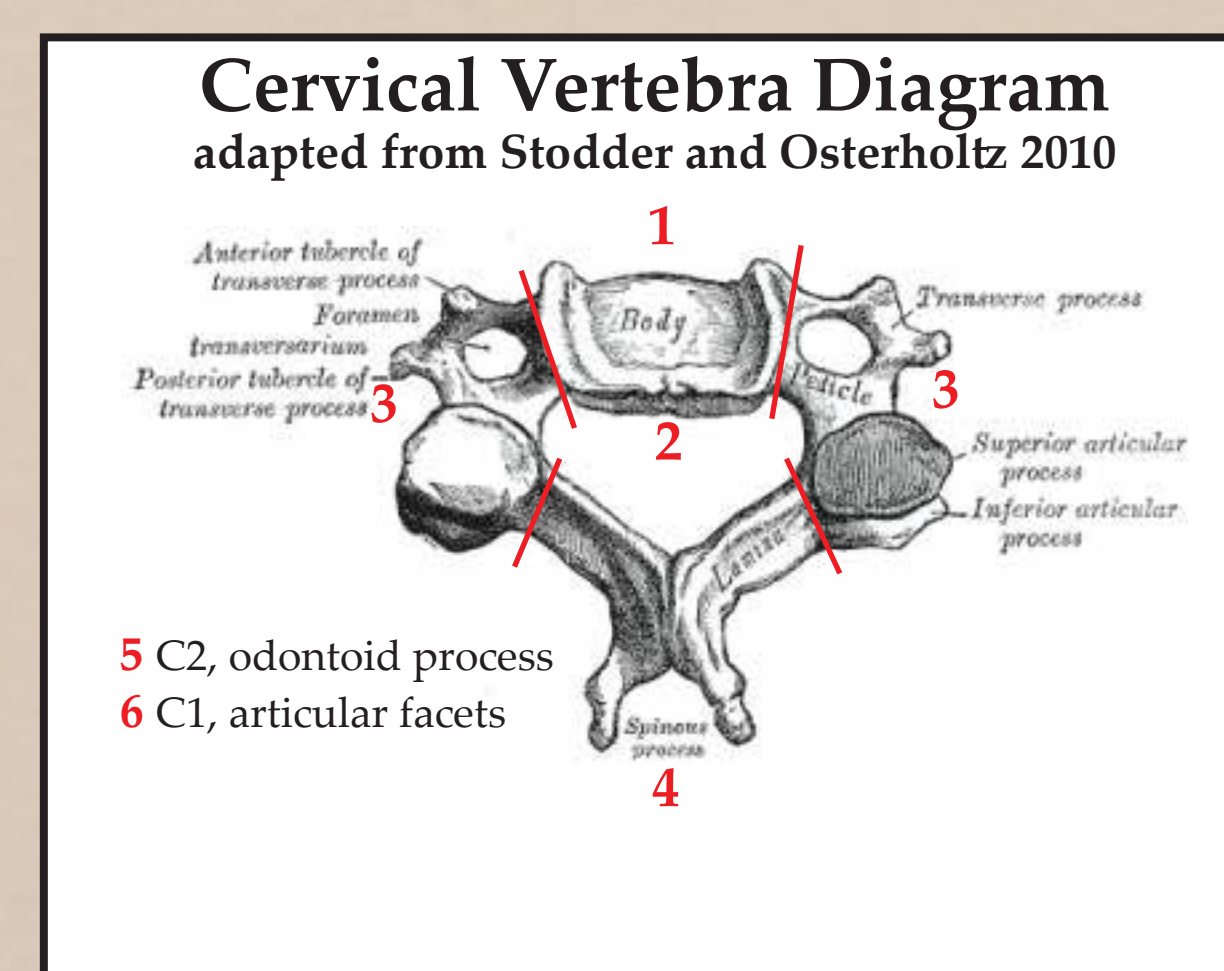
Identified Culturally Significant Anatomical Regions	
CSAR	Elements Included*
Head	Cranial bones, except facial bones (vomer, ethmoid, palatines, lacrimals) and auditory ossicles
Mandible	Mandible, without dentition
Neck	Atlas, Axis, and Cervical 3 – 6
Hands	Scaphoid, Lunate, Triquetrum, Pisiform, Trapezium, Trapezoid, Capitate, Hamate; Metacarpals 1 – 5; Proximal, Intermediate, and Distal Manual Phalanges
Feet	Calcaneus, Talus, Navicular, Cuboid, 1 <sup>st</sup> – 3 <sup>rd</sup> Cuneiform; Metatarsals 1 – 5; Proximal, Intermediate, and Distal Pedal Phalanges

\* Right and Left sides where applicable

- Inventories of each Culturally Significant Anatomical Region were taken using the Zonation method described in Stodder and Osterholtz 2010 and Knüsel and Outram 2004

- Quantitative Percentage Completeness was calculated based on Number of Zones Present, divided by Number of Zones Possible

- Qualitative Completeness was based off of photographs taken with the skeleton in situ during the excavation process



(vertebra image from Gray's Anatomy)

## CASE STUDY: AL-WIDAY SUDAN

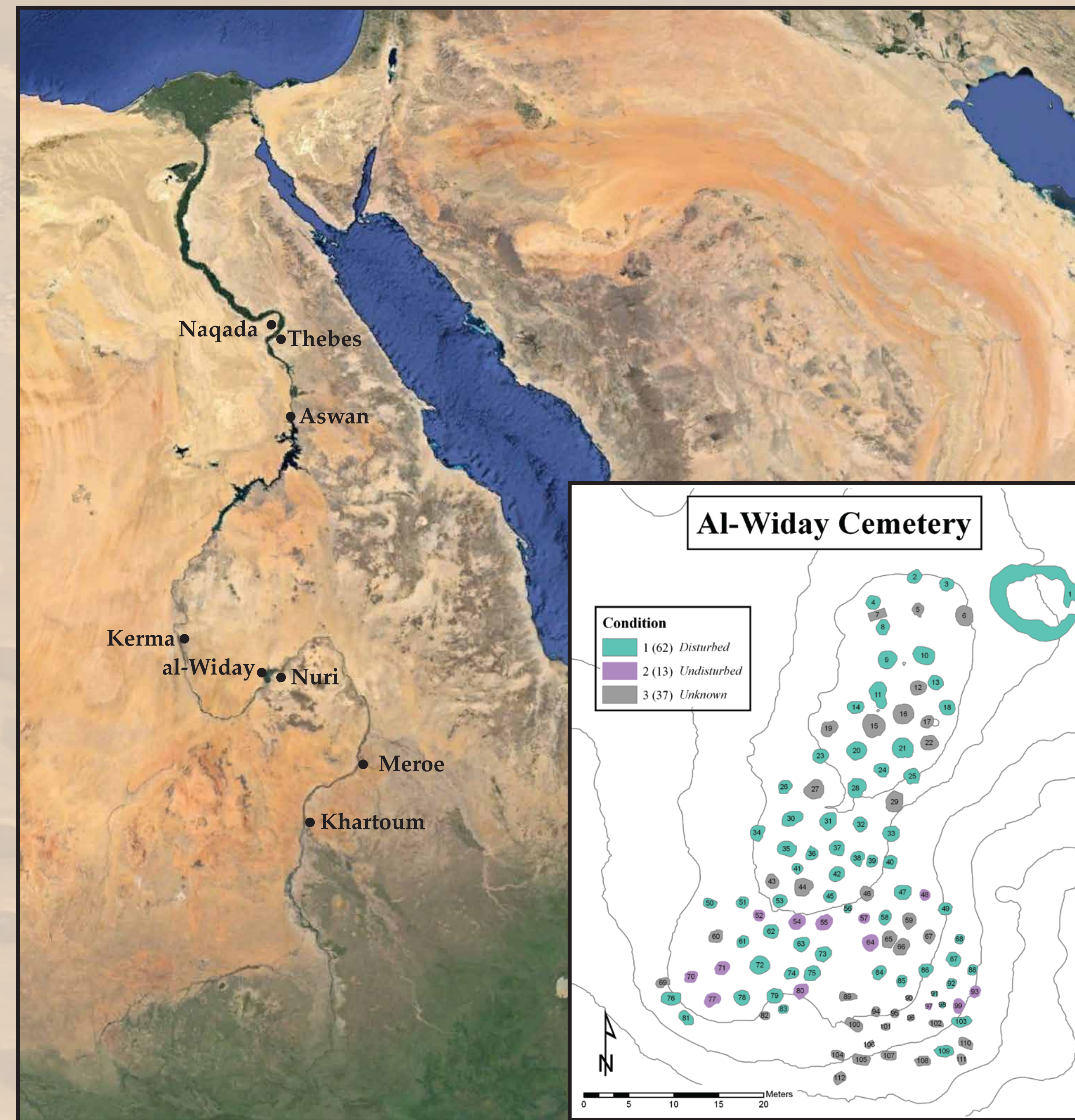
- Al-Widay has both **Kerma Moyen (2050–1750 BCE)** and **Kerma Classique (1750–1580 BCE)** tombs, which are round and rectangular respectively (see inset map, right).

- **105 burial pits with 114 individuals** recovered from the site during the Oriental Institute's 2007-2008 Salvage project.

- Al-Widay is now fully submerged under the Merowe Dam Reservoir.

- The undisturbed tombs are isolated to the southern-most part of the cemetery; this is potentially due to accumulation of sand and sediment in this area.

- Our goal is to use a Logistic Regression model to determine whether graves from unknown taphonomic contexts more closely match the disturbed and undisturbed signatures, unknown graves are shown in gray in the inset map.

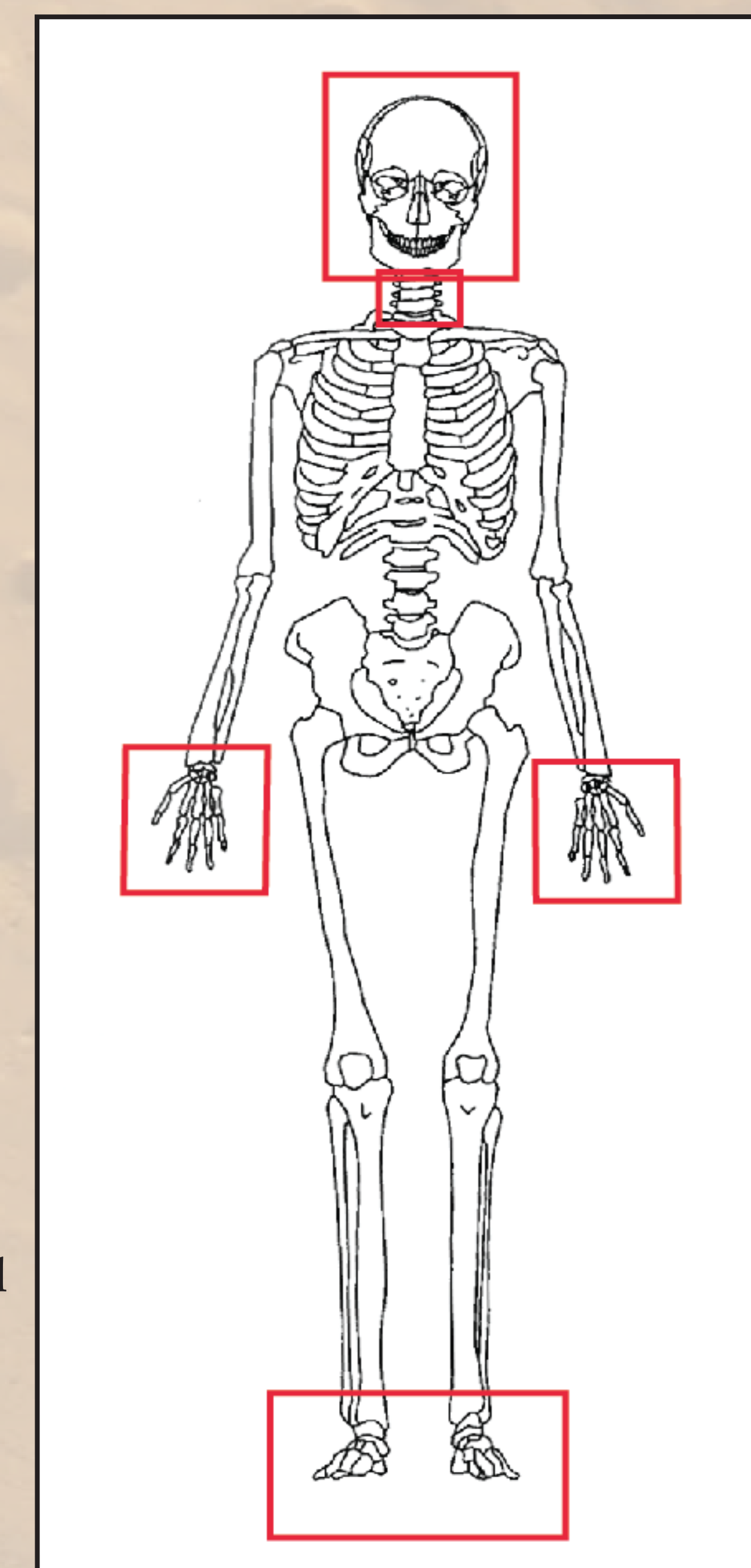


## CULTURALLY SIGNIFICANT ANATOMICAL REGIONS

Ethnographic and archaeological evidence for funerary practice in north-central Sudan was used to define **five Culturally Significant Anatomical Regions**:

- The **head and neck** region, which are usually adorned with beaded textiles, headdresses, necklaces, and other high-value pieces in both ancient and modern Nubian burial practice
- Stone and metal beads and other decorations were found near or around the **hands and feet** of individuals from undisturbed burials at Al-Widay

Anatomical regions were categorized as:  
**1. Present = Present, Crushed**  
**2. Disturbed = Fragmentary, Disarticulated**  
**3. Absent**  
 which are based on the degree of fragmentation and percentage completeness



Drawing adapted from Standards (1994)

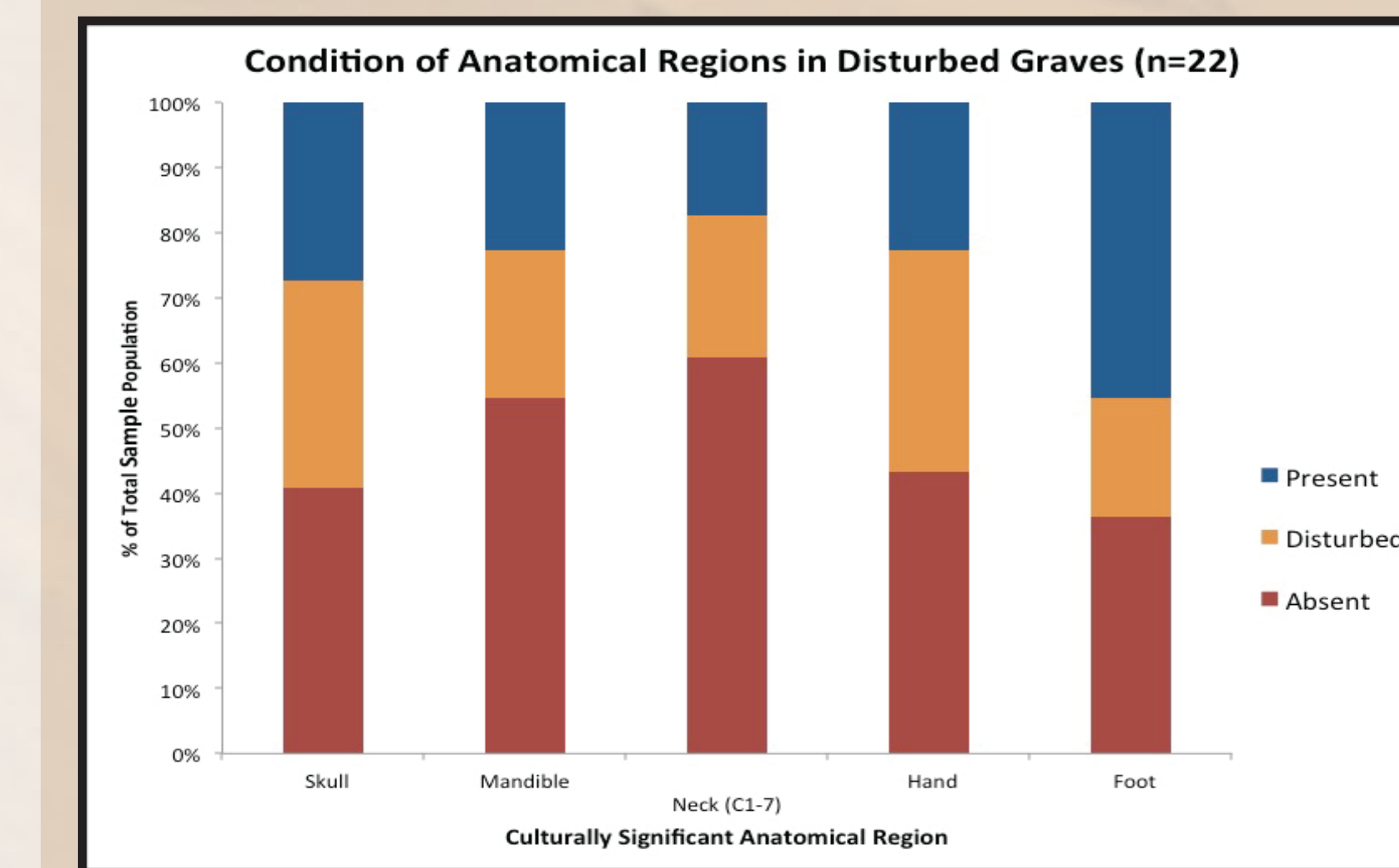


Photograph courtesy of Geoff Emberling

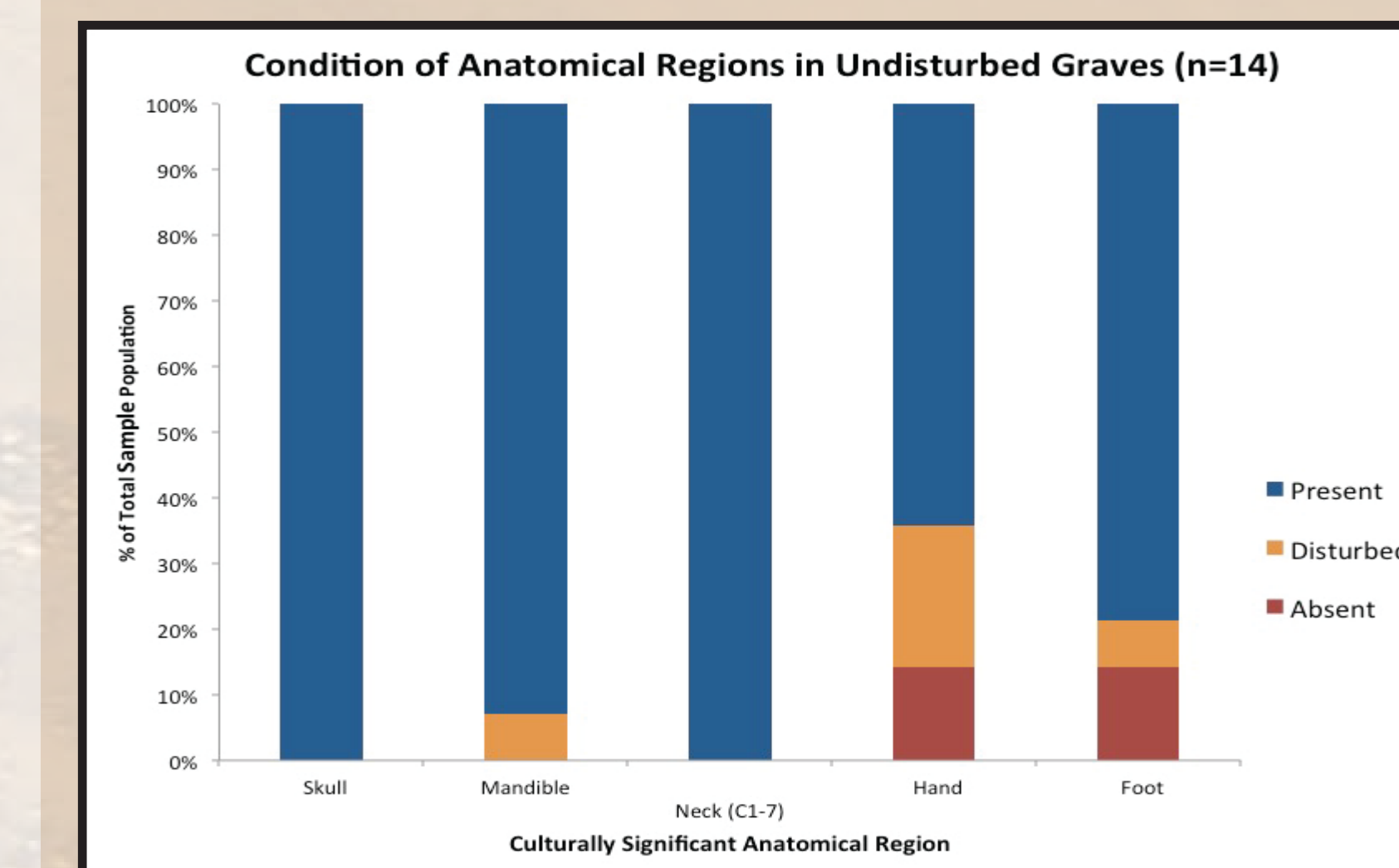
The photograph (above) shows an individual that has absent and fragmentary culturally significant anatomical regions.

The figure (left) highlights the anatomical regions identified for this analysis.

## STATISTICAL ANALYSIS



The results of exploratory data analysis (above and below) visually demonstrate differences in the preservation conditions of the five anatomical regions analyzed.



### Fisher's Exact Test Significance from al-Widay I

	Skull	Mandible	Neck	Hands	Feet
<b>Present vs. Disarticulated</b>	S		S	S	
<b>Present vs. Absent</b>	S	S	S	S	S

S= Significant

\* Disarticulated vs. Absent sample size was too small to calculate significance

• In the disturbed context, the neck has a higher proportion of absent bones than the other CSAR regions. This may be related to the distinctive articulation of the cervical vertebrae.

• No other anatomical region shows a significant difference from the overall pattern of variation within a given taphonomic context.

• For disturbed contexts, this pattern is relatively evenly divided between present, disturbed and absent bones, while in undisturbed contexts, present bones predominate.

• There are statistically significant differences between the undisturbed sample and the disturbed sample.

• Using Fisher's Exact Test, 2x2 comparisons of each anatomical region were made for each pair of taphonomic conditions (e.g. Present vs. Disturbed, Disturbed vs. Absent). Results suggest that there are significant differences in the preservational patterns of CSAR regions between Disturbed and Undisturbed contexts, particularly regarding the proportion of bones that are present relative to the proportion of bones that are absent.

## FUTURE RESEARCH

- Logistic Regression Analysis will be used to predict "looted" or "unlooted" status based on fragmentation data collected for each burial (Beck).

- Histological data collected from the Al-Widay collection will be investigated to see what types of histological preservation patterns are evident at the microscopic level, and to evaluate what effect porosity has on disturbed remains (Kinkopf).

## SELECTED REFERENCES

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