

Analysis and Quantification of Commingled Human Skeletal Remains in Syracuse University's Historic Medical Teaching Collection Using the CoRA Ecosystem

By Madeline Kelly



Outline

Background

Project Goals

Methods and the Commingled Remains Analytics (CoRA) ecosystem

Results

Future Directions and additional applications of CoRA

Conclusion

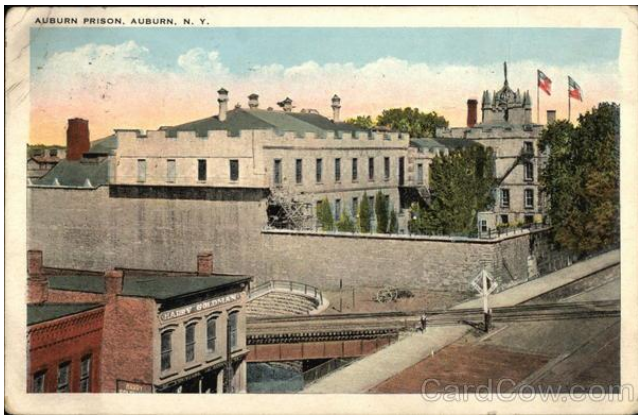
A historical illustration depicting a plague scene inside a church. In the foreground, a group of people in period clothing are gathered around a body lying in an open wooden coffin. Some are looking on with concern, while others appear to be tending to the body. In the background, a large, ornate skeleton is mounted on the wall, holding a cross. The church interior features Gothic architecture with pointed arches and stone carvings. The overall tone is somber and macabre.

Background

Anatomical Era

- Beginning in the late 18th and early 19th century¹
- Textbooks/ lectures → Dissections and anatomical demonstrations^{1,2}
- Increase in the need for human cadavers^{1,2}
- Disproportionately affected immigrant groups, minorities, and the poor¹





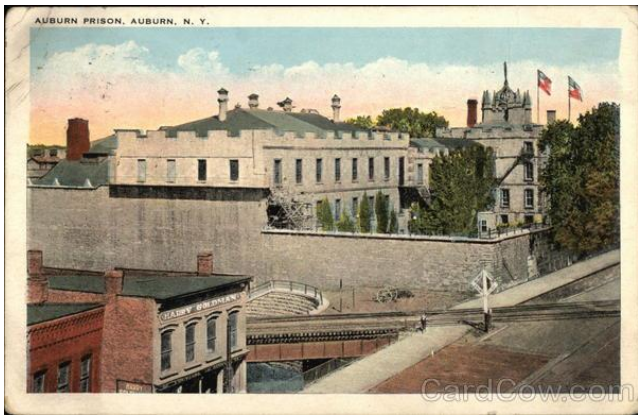
Prisons



“Body-snatching”



Unclaimed Persons



Prisons



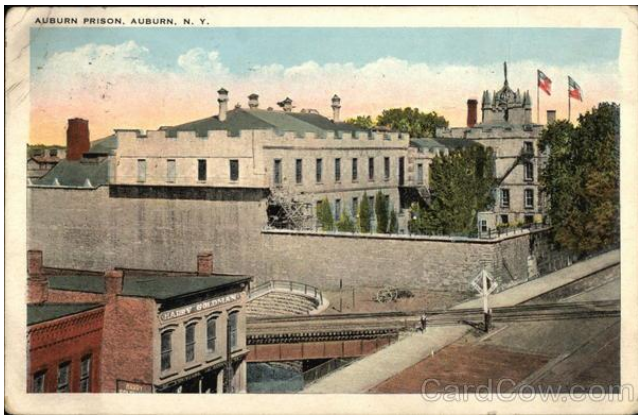
“Body-snatching”



Unclaimed Persons



Dissections/ Anatomical
Demonstrations



Prisons



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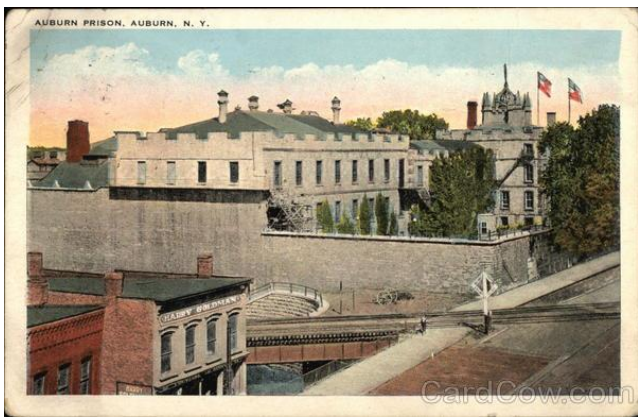
Dissections/ Anatomical
Demonstrations



Osteological Collections



Disposal



Prisons



“Body-snatching”



Unclaimed Persons

Directly to cleaning/processing



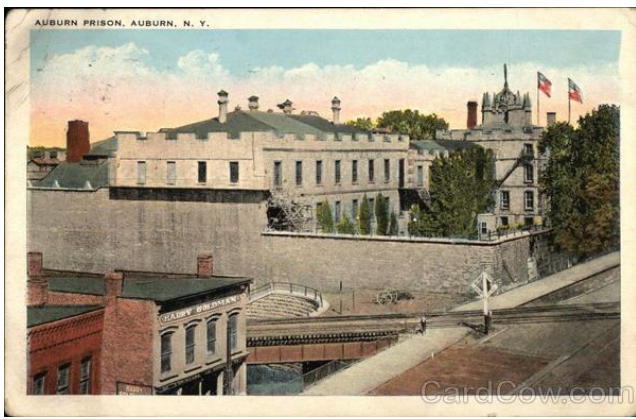
Dissections/ Anatomical Demonstrations



Osteological Collections



Disposal



Prisons



“Body-snatching”



Unclaimed Persons

Directly to cleaning/processing



Dissections/ Anatomical
Demonstrations



Osteological Collections



Disposal



Osteological Collections

Syracuse University's Medical Teaching Collection - History



What we know

- > Previous and subsequent schools associated with Syracuse University
- > Anatomy courses and dissection opportunities
- > Archival material – exhumation, cadaver trade, Auburn prison



What we don't know

- > Age of the collection/ length of accumulation
- > Method of procurement
- > Fate of the Gevena College Anatomical Museum

Syracuse University's Medical Teaching Collection - Contents



What we know

- > Mainly adult human skeletal remains with some sub-adult specimens
- > Mostly commingled and sorted by element and side



What we don't know

- > Number of individuals
- > Information associated with biological profiles (age, sex, ancestry, stature)
- > Age of remains/ where they were obtained from
- > Trauma, pathology, taphonomy, anomalies, etc?

Project goals


Is there evidence to support the theory that these remains were part of a medical/ anatomical teaching collection?



How many individuals are present in this collection?



Can CoRA be used as a valuable database and data analysis tool for documenting and analyzing anatomical and medical teaching collections of skeletal remains?



Materials and Methods

What is CoRA?

Commingled Remains Analytics (CoRA) – web application, database, and Application Programming Interface³

Created by **Dr. Sachin Pawaskar**, University of Nebraska Omaha

Developed specifically for inventorying and analyzing assemblages of **commingled human remains**³



UNIVERSITÀ
DEGLI STUDI
DI MILANO

Why CoRA?



Why CoRA?



Why CoRA?



We need standardization, organization, and cooperation!

Why CoRA?

Old Methods

ID Number 1	ID Number 2	New ID	Element	Side
AC-06-127	HB3		Fem	L
HB2005		AC-06-40	Femur	Left
0-AC-06-128	HB11	Fem01	femur	lft

New Methods

<input type="checkbox"/>	Key	Bone	Side	External ID
<input type="checkbox"/>	SUTC:::132	Femur	Right	AP-2000-1-84
<input type="checkbox"/>	SUTC:::143	Femur	Right	AP2000-1-379
<input type="checkbox"/>	SUTC:::126	Femur	Right	AP2000-1-54

Why CoRA?

Old Methods

ID Number 1	ID Number 2	New ID	Element	Side
AC-06-127	HB3		Fem	L
HB2005		AC-06-40	Femur	Left
0-AC-06-128	HB11	Fem01	femur	lft



External ID	Accession Numl	Provenance
HBV5	SUTC	
HBV12	SUTC	
HBV40	SUTC	
HBV41	SUTC	
HBV13	SUTC	
HBV10	SUTC	
HBV42	SUTC	
HBV28	SUTC	
HBV31	SUTC	
A70.62	SUTC	
AC-06-239	SUTC	
HBV3	SUTC	



New Methods

<input type="checkbox"/>	Key	Bone	Side	External ID
<input type="checkbox"/>	SUTC::132	Femur	Right	AP-2000-1-84
<input type="checkbox"/>	SUTC::143	Femur	Right	AP2000-1-379
<input type="checkbox"/>	SUTC::126	Femur	Right	AP2000-1-54

Key	Bone	Side	External ID	Bone Group	Individual Number	DNA Sample Number	Mito Sequence Number	Associations	Methods	Pathology	Measured	Complete	Isotope Sampled	Action
<input type="checkbox"/>	SUTC::1624	Tooth 9	Middle	AC-06-103	Mastlery dentition	AC-06-103			OP 0A 0R 0M	0A 0S 0An	OP 0T 0A			
<input type="checkbox"/>	SUTC::1623	Tooth 8	Middle	AC-06-103	Mastlery dentition	AC-06-103			OP 0A 0R 0M	0A 0S 0An	OP 0T 0A			
<input type="checkbox"/>	SUTC::1622	Tooth 7	Middle	AC-06-103	Mastlery dentition	AC-06-103			OP 0A 0R 0M	0A 0S 0An	OP 0T 0A			
<input type="checkbox"/>	SUTC::1621	Tooth 5	Middle	AC-06-103	Mastlery dentition	AC-06-103			OP 0A 0R 0M	0A 0S 0An	OP 0T 0A			
<input type="checkbox"/>	SUTC::1620	Tooth 4	Middle	AC-06-103	Mastlery dentition	AC-06-103			OP 0A 0R 0M	0A 0S 0An	OP 0T 0A			
<input type="checkbox"/>	SUTC::1619	Mastlery	Left	AC-06-103	Mastlery dentition	AC-06-103			OP 10A 0R 0M	0A 0S 0An	OP 0T 0A			
<input type="checkbox"/>	SUTC::1626	Tooth 11	Middle	AC-06-103	Mastlery dentition	AC-06-103			OP 0A 0R 0M	0A 0S 0An	OP 0T 0A			
<input type="checkbox"/>	SUTC::1632	Cranium	Middle	AC-06-103	Mastlery dentition	AC-06-103			OP 10A 0R 0M	0A 0S 0An	OP 0T 0A			

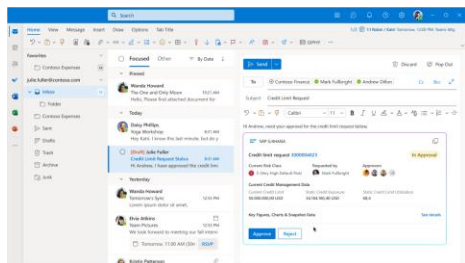
Why CoRA?

Old Methods

ID Number 1	ID Number 2	New ID	Element	Side
AC-06-127	HB3		Fem	L
HB2005		AC-06-40	Femur	Left
0-AC-06-128	HB11	Fem01	femur	lft



The screenshot shows the Microsoft Excel interface with the 'Formulas' tab selected on the ribbon. The 'Paste' dropdown menu is open, showing options like 'Paste', 'Copy', 'Formulas', and 'Font'. The worksheet displays a table with columns A, B, C, and D. Row 1 contains the header 'External ID' in column B and 'Accession Numl - Provenance' in column C. Rows 2 through 10 contain data for various HBV strains, including HBVc10, HBVc41, HBVc13, HBVc10, HBVc42, HBVc28, HBVc31, A70.62, and AC-06-239. The 'Formulas' tab is active, and the 'Paste' dropdown menu is open, showing options like 'Paste', 'Copy', 'Formulas', and 'Font'.



New Methods

<input type="checkbox"/>	Key	Bone	Side	External ID
<input type="checkbox"/>	SUTC::132	Femur	Right	AP-2000-1-84
<input type="checkbox"/>	SUTC::143	Femur	Right	AP2000-1-379
<input type="checkbox"/>	SUTC::126	Femur	Right	AP2000-1-54

CORA

Medical Teaching Collect...

Accession

SJTC

Home / Search

Specimen Search

Specimen search by Accession Number: SJTC

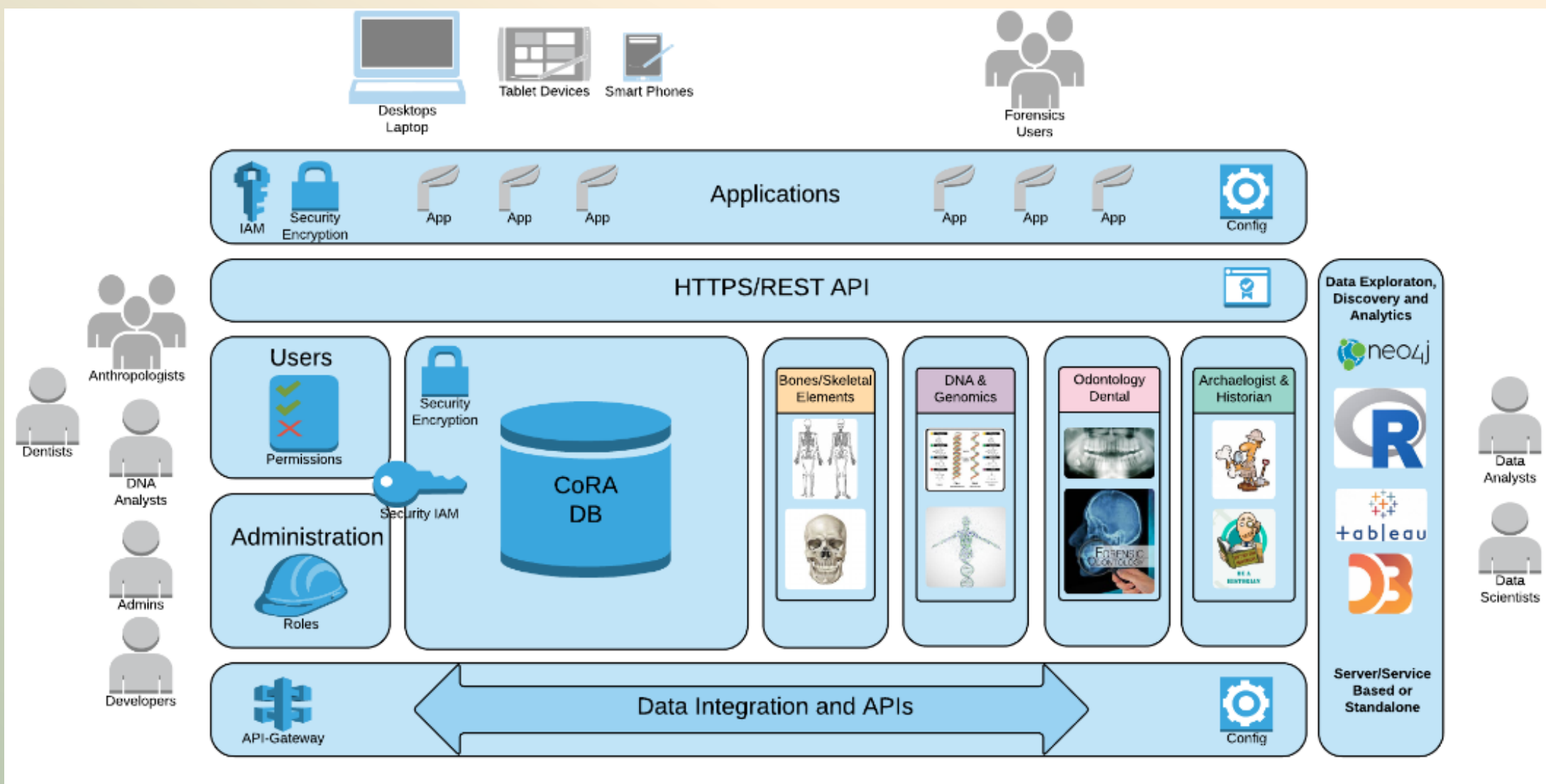
EXCEL

PDF

COLUMN VISIBILITY

<input type="checkbox"/>	Key	Bone	Side	External ID	Bone Group	Individual Number	DNA Sample Number	Mito Sequence Number	Associations	Methods	Pathology	Measured	Complete	Isohope Sampled	Action
<input type="checkbox"/>	SJTC%1624	Tooth 9	Middle	AC-96-103	Mastoidary dentition	AC-96-103			OP-DA OK DM	Olig DS Olen	SP OT DA				edit
<input type="checkbox"/>	SJTC%1623	Tooth 8	Middle	AC-96-103	Mastoidary dentition	AC-96-103			OP-DA OK DM	Olig DS Olen	SP OT DA				edit
<input type="checkbox"/>	SJTC%1622	Tooth 7	Middle	AC-96-103	Mastoidary dentition	AC-96-103			OP-DA OK DM	Olig DS Olen	SP OT DA				edit
<input type="checkbox"/>	SJTC%1621	Tooth 5	Middle	AC-96-103	Mastoidary dentition	AC-96-103			OP-DA OK DM	Olig DS Olen	SP OT DA				edit
<input type="checkbox"/>	SJTC%1620	Tooth 4	Middle	AC-96-103	Mastoidary dentition	AC-96-103			OP-DA OK DM	Olig DS Olen	SP OT DA				edit
<input type="checkbox"/>	SJTC%1630	Mandib	Left	AC-96-103	Mastoidary dentition	AC-96-103			OP-TGA OK DM	Olig DS Olen	SP OT DA		<input checked="" type="checkbox"/>		edit
<input type="checkbox"/>	SJTC%1626	Tooth 11	Middle	AC-96-103	Mastoidary dentition	AC-96-103			OP-DA OK DM	Olig DS Olen	SP OT DA				edit
<input type="checkbox"/>	SJTC%1632	Cranium	Middle	AC-96-103	Mastoidary dentition	AC-96-103			OP-TGA OK DM	Olig DS Olen	SP OT DA	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		edit



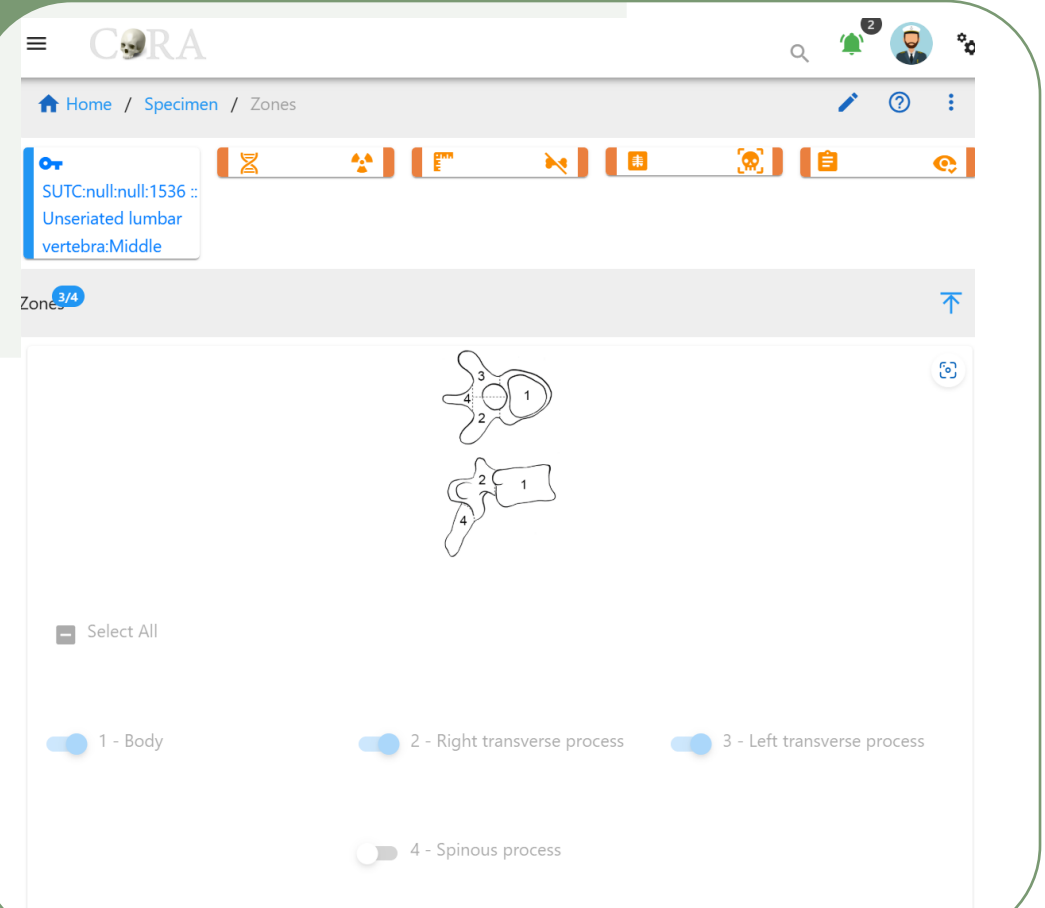


Methods

1. Basic Inventory

<input type="checkbox"/>	Key	Accession Number	Bone	Side	External ID	Bone Group	Individual Number
<input type="checkbox"/>	SUTC:::727	SUTC	Ulna	Left	AP2000-1-411		
<input type="checkbox"/>	SUTC:::114	SUTC	Femur	Left	AP-2000-1-68		
<input type="checkbox"/>	SUTC:::728	SUTC	Ulna	Left	AP2000-1-416		
<input type="checkbox"/>	SUTC:::115	SUTC	Femur	Left	AP-2000-1-69		
<input type="checkbox"/>	SUTC:::729	SUTC	Ulna	Left	AP2000-1-429		
<input type="checkbox"/>	SUTC:::1254	SUTC	Cranium	Middle	AC-06-104		
<input type="checkbox"/>	SUTC:::1081	SUTC	Rib 11	Left	HBR145		
<input type="checkbox"/>	SUTC:::1082	SUTC	Rib 11	Left	HBR161		
<input type="checkbox"/>	SUTC:::1083	SUTC	Rib 11	Left	HBR205		
<input type="checkbox"/>	SUTC:::1084	SUTC	Rib 2	Left	HBR3		

2. Completeness



Methods

3. Measurements



SUTC:null:null:70
:: Clavicle:Left

Measurements 9/9

Assigned Instruments: 0

You can assign instruments for this user/specimen

Cla_01 Maximum Length 138	Cla_02 Maximum Diameter of the Clavicle 16	Cla_03 Minimum Diameter of the Clavicle 10
Cla_04 Sagittal (Anterior-Posterior) Diameter 16	Cla_05 Vertical (Superior-Inferior) Diameter 10	Cla_06 Maximum Width at the Distal End 30
Cla_07 Breadth at the Inflexion Point at th 17	Cla_08 Maximum thickness at the Inflexio 13	Cla_09 Maximum Anterior-Posterior Width 26

4. Taphonomy

CORA

Home / Specimen / Taphonomy

SUTC:null:null:1756
:: Tibia:Right

Taphonomies 8

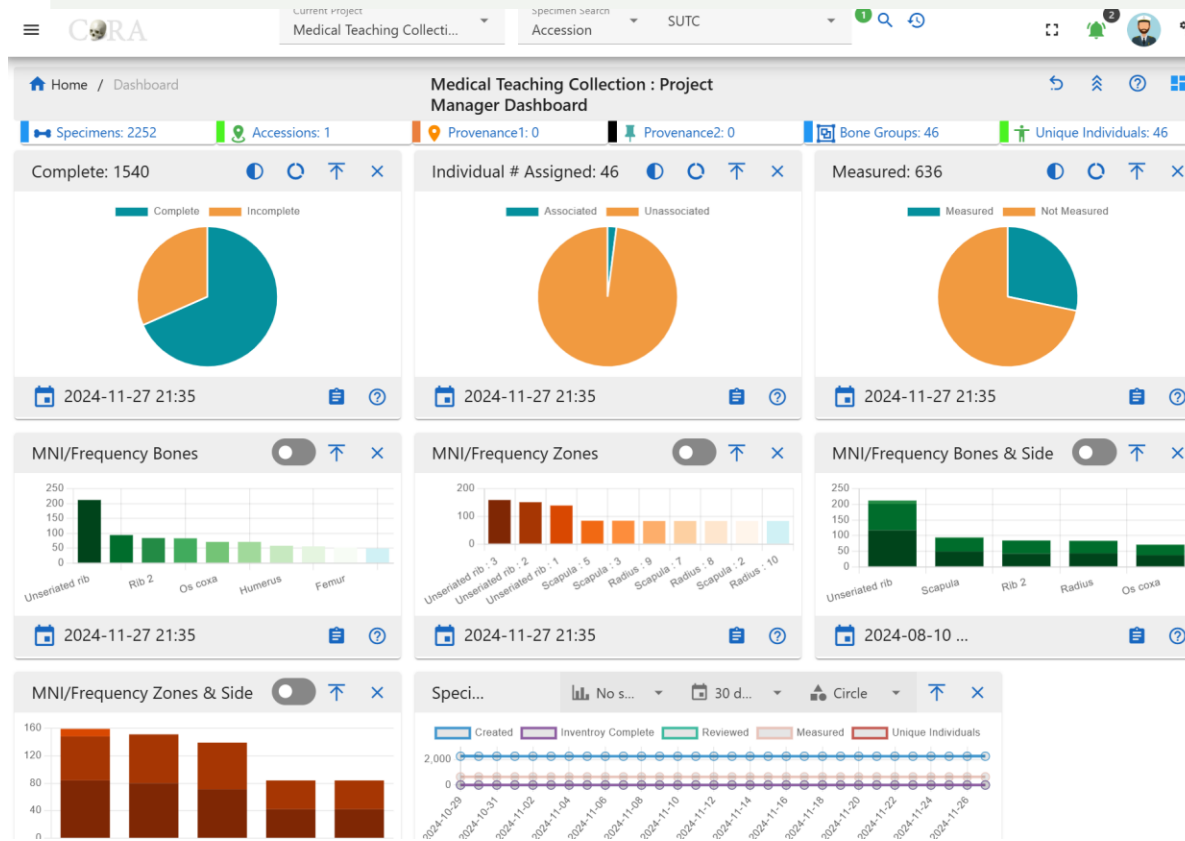
Taphonomies

- Adherent Materials-Soil
- Human Modification-Cut Marks
- Human Modification-Drill Hole
- Staining-Brown
- General Color-Yellow to Tan
- Physical-Scratches/Abrasions
- Human Modification-Hardware Attached
- Staining-Grey/Silver

You can apply multiple taphonomies to this specimen

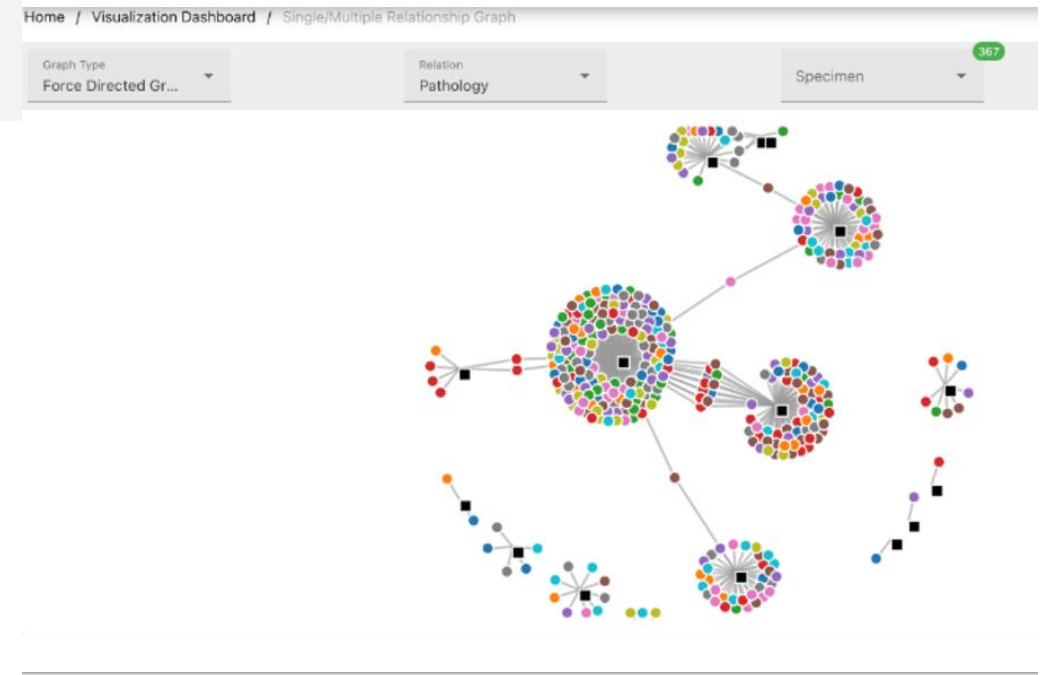
Methods

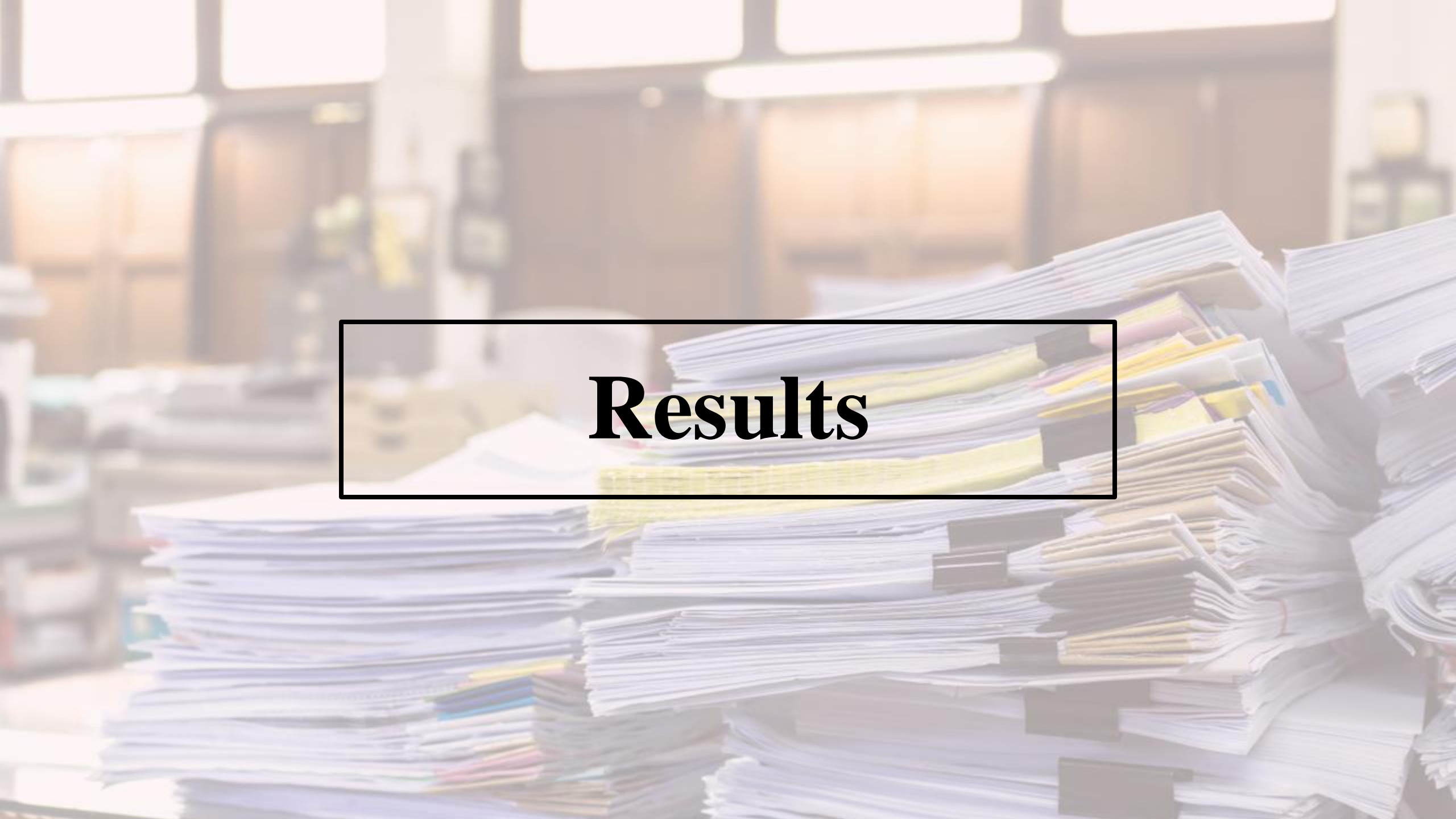
5. Data Visualization



Single/Multiple Relationships Graph

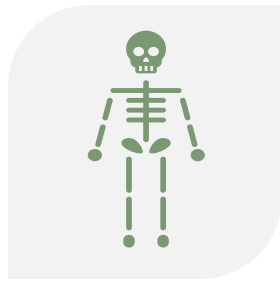
This will allow you to visualize relationships as a single-layered/multiple-layered graph.



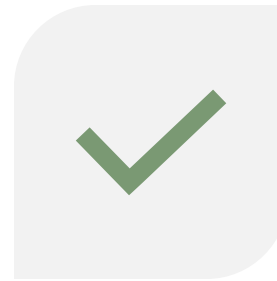
The background of the image shows a cluttered office desk with a massive, disorganized pile of papers, folders, and documents. Some papers have yellow sticky notes attached to them. In the background, there are blurred office shelves and windows, suggesting a busy, unorganized workspace. Overlaid on this scene is a black rectangular box containing the word "Results" in a bold, black, serif font.

Results

Overall Inventory



2252 individual
specimens recorded
(excluding hands/feet)



Over **two-thirds** of the
specimens were
complete



Most common
elements: Ribs 3-10 >
Scapula > Rib 2

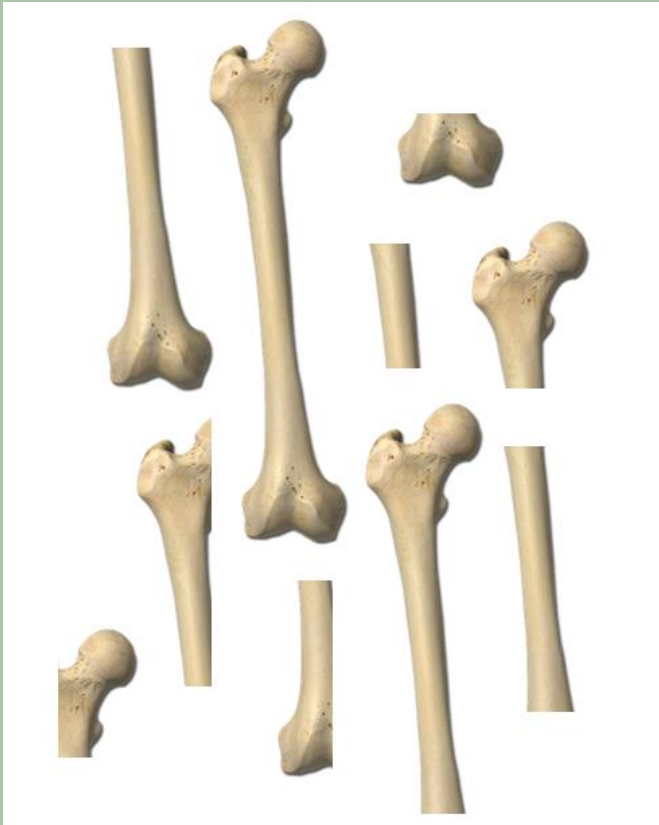
Minimum Number of Individuals – Traditional vs. Zonation MNI

Traditional MNI =



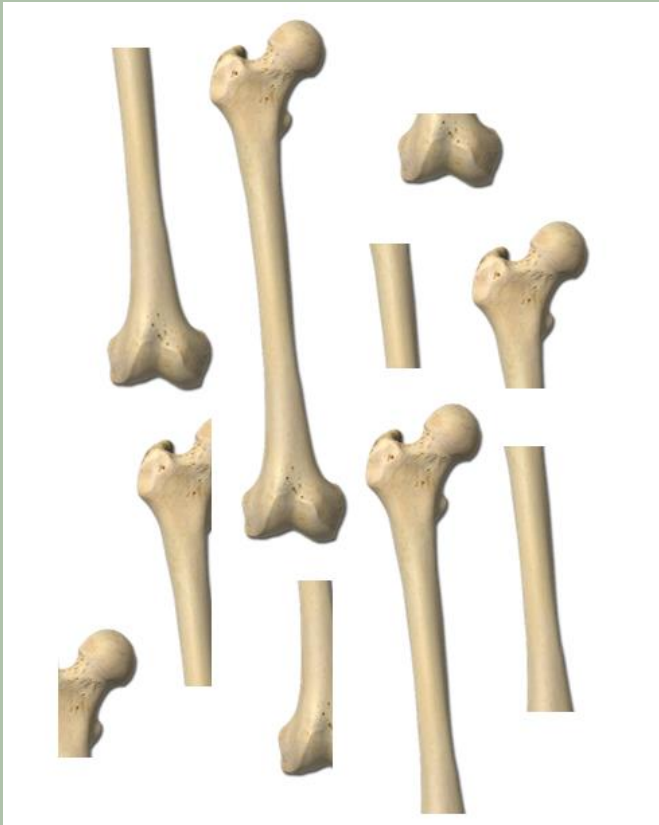
Minimum Number of Individuals – Traditional vs. Zonation MNI

Traditional MNI = 10



Minimum Number of Individuals – Traditional vs. Zonation MNI

Traditional MNI = 10



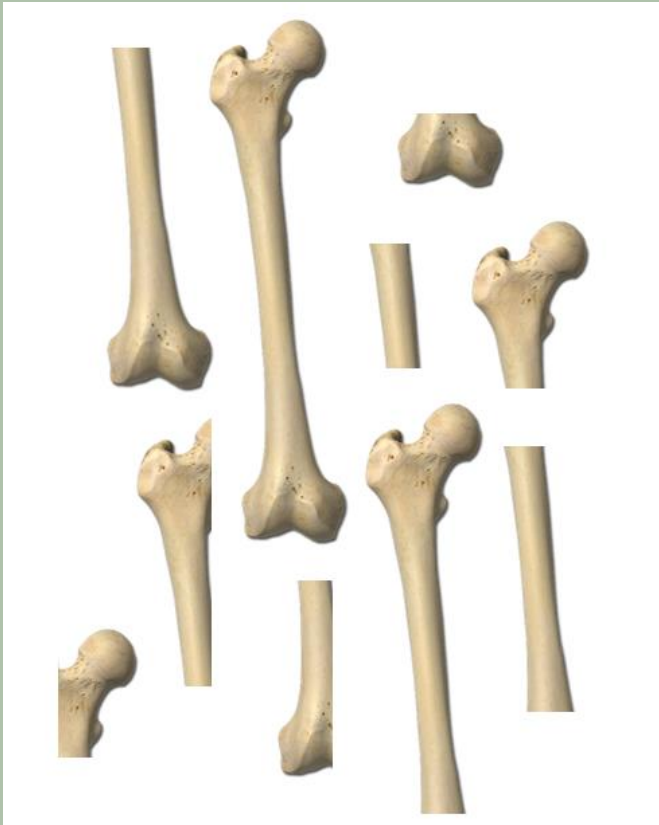
VS.

Zonation MNI =



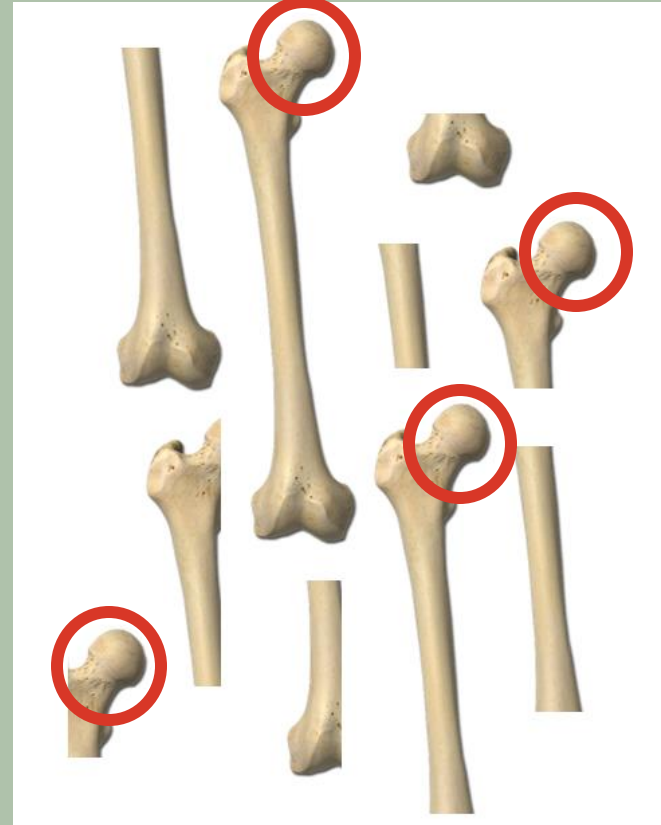
Minimum Number of Individuals – Traditional vs. Zonation MNI

Traditional MNI = 10



VS.

Zonation MNI = 4



Traditional vs. Zonation MNI

Element (left)	Traditional MNI	Zonation MNI
Scapula	43	42
Radius	43	43
Os Coxa	33	27
Humerus	24	24
Clavicle	29	29
Femur	24	24
Tibia	23	23
Ulna	26	25
Fibula	17	16
Patella	12	12

Element (right)	Traditional MNI	Zonation MNI
Scapula	49	43
Radius	40	40
Os Coxa	37	25
Humerus	34	33
Clavicle	27	26
Femur	28	27
Tibia	26	26
Ulna	22	22
Fibula	22	21
Patella	18	18

Traditional vs. Zonation MNI

Element (left)	Traditional MNI	Zonation MNI
Scapula	43	42
Radius	43	43
Os Coxa	33	27
Humerus	24	24
Clavicle	29	29
Femur	24	24
Tibia	23	23
Ulna	26	25
Fibula	17	16
Patella	12	12

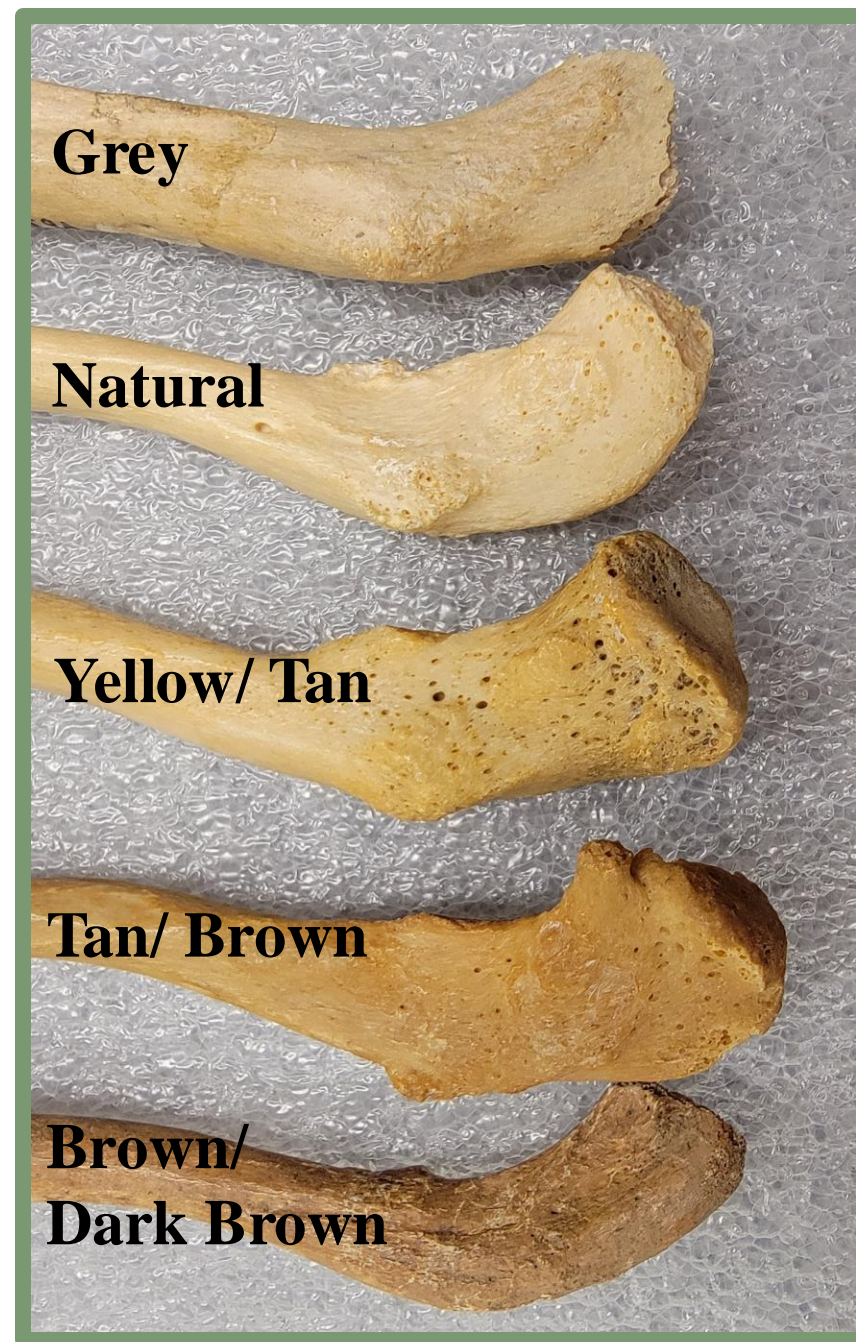
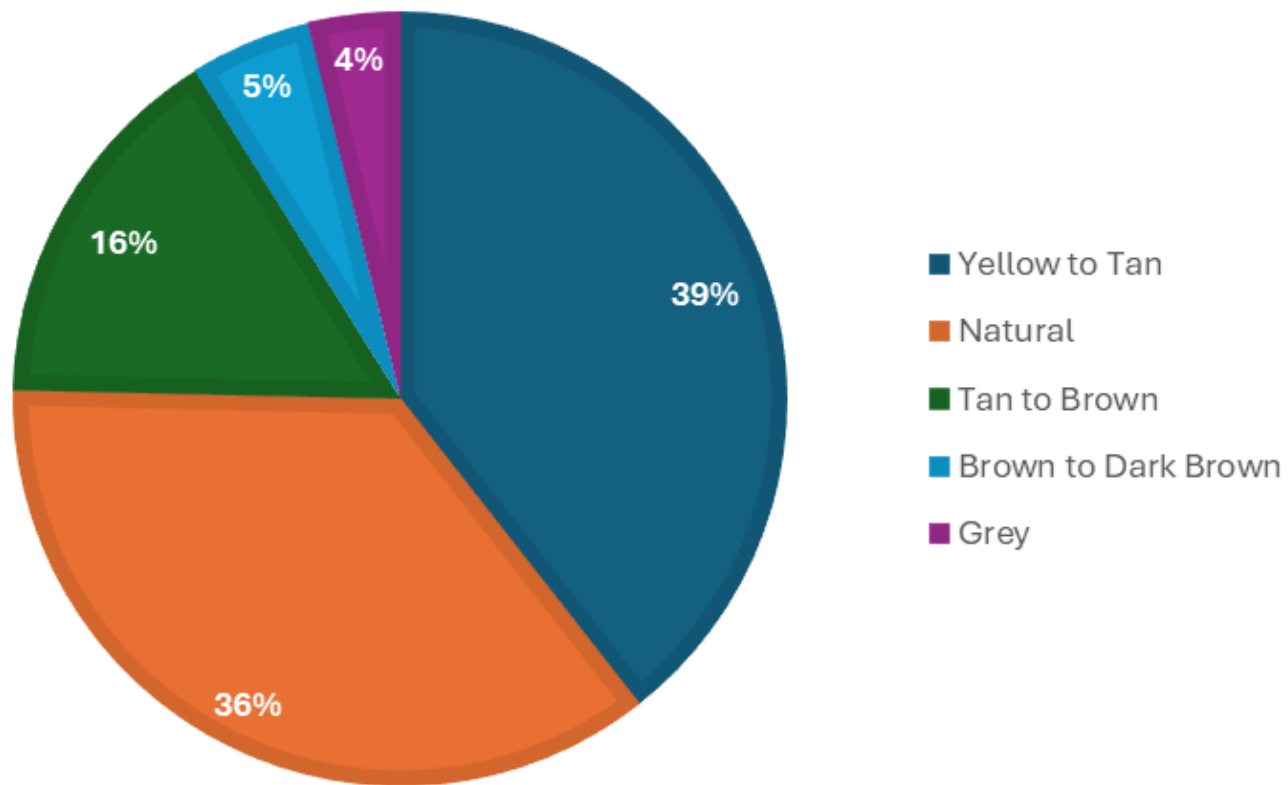
Element (right)	Traditional MNI	Zonation MNI
Scapula	49	43
Radius	40	40
Os Coxa	37	25
Humerus	34	33
Clavicle	27	26
Femur	28	27
Tibia	26	26
Ulna	22	22
Fibula	22	21
Patella	18	18

Traditional vs. Zonation MNI

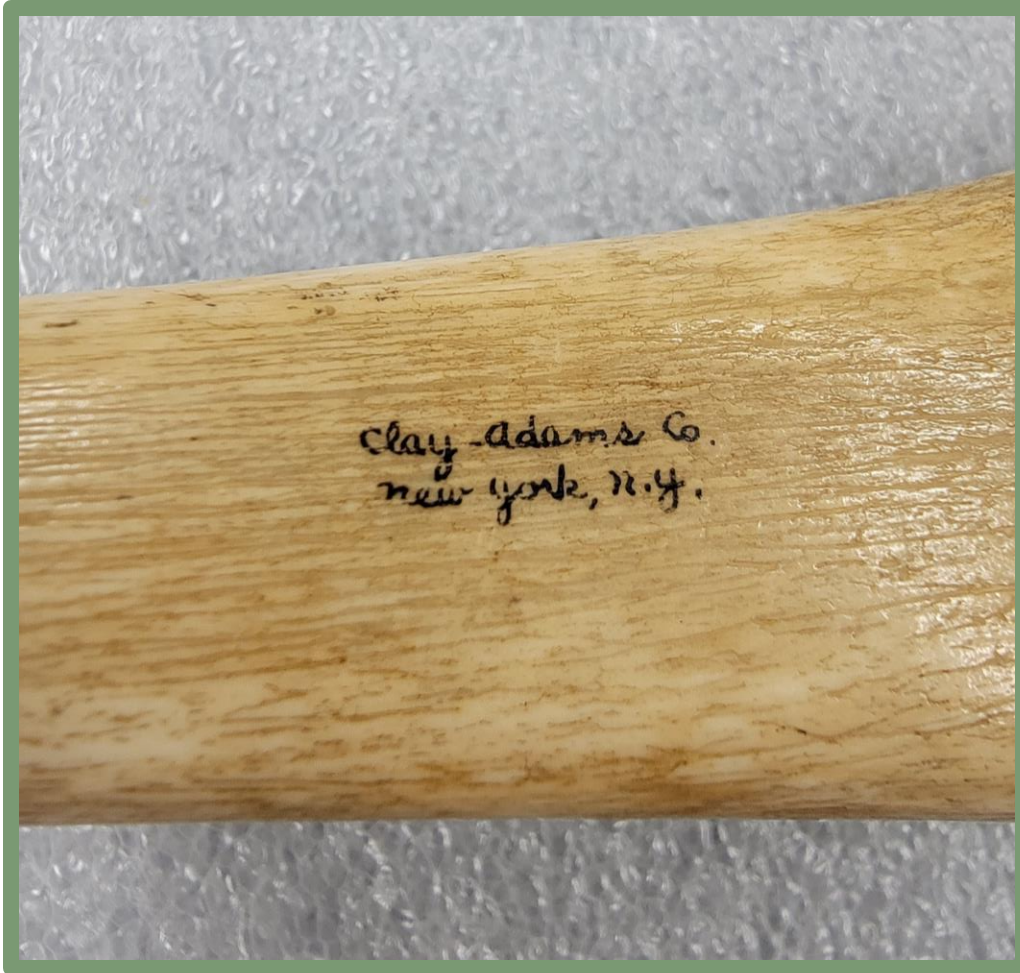
Element (left)	Traditional MNI	Zonation MNI
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Femur	24	24
Tibia	23	23
Ulna	26	25
Fibula	17	16
Patella	12	12

Element (right)	Traditional MNI	Zonation MNI
Scapula	49	43
Radius	40	40
Os Coxa	37	25
Humerus	34	33
Clavicle	27	26
Femur	28	27
Tibia	26	26
Ulna	22	22
Fibula	22	21
Patella	18	18

Taphonomy – General Color



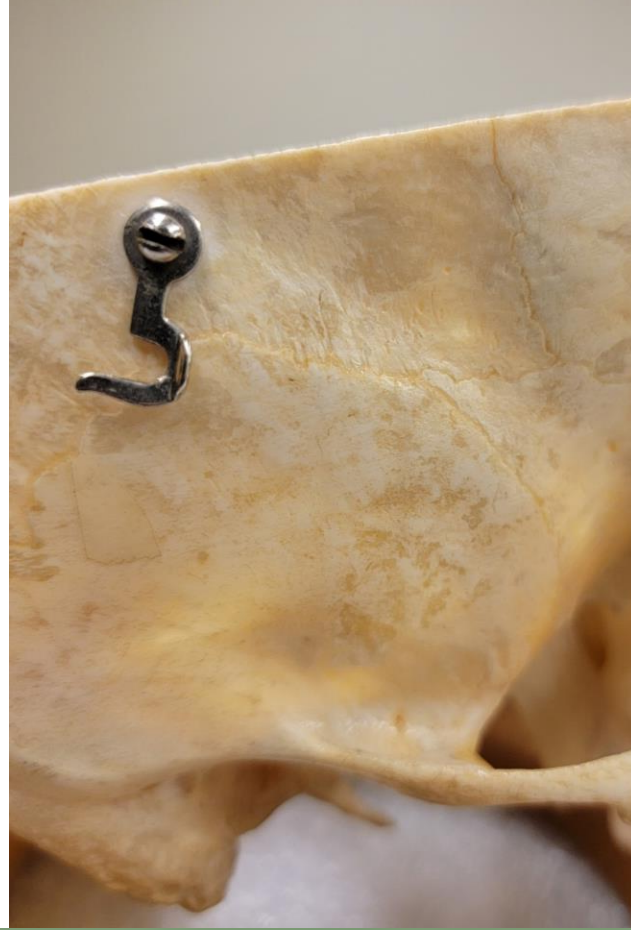
Taphonomy – Human Modification



Writing



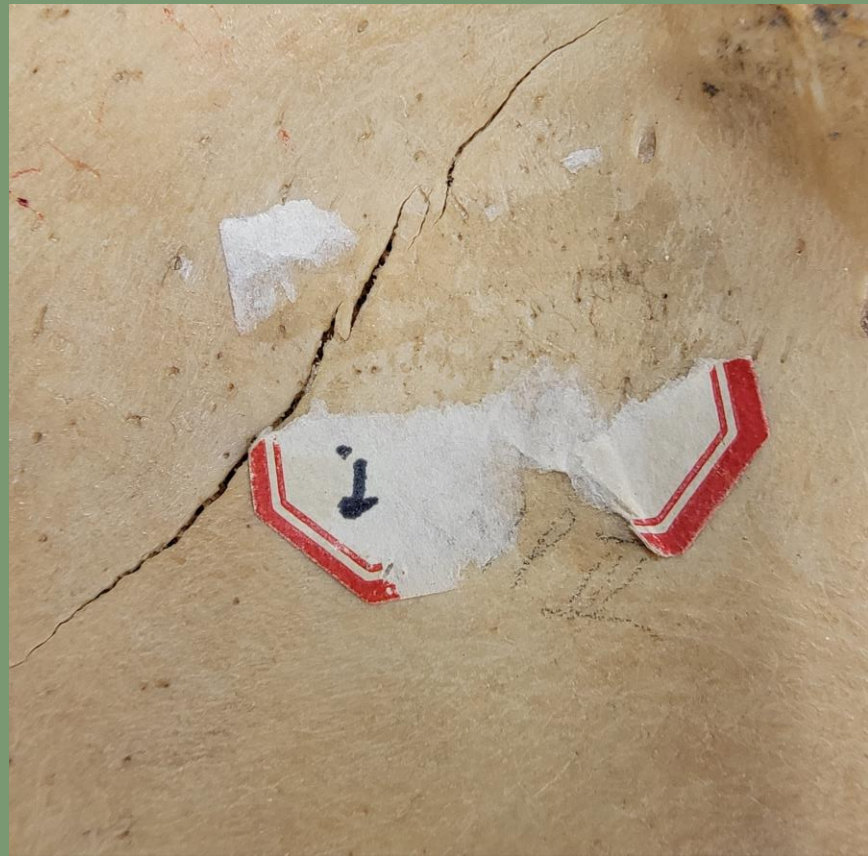
Drill Hole



Hardware Attached

Taphonomy – Human Modification

Taphonomy – Human Modification

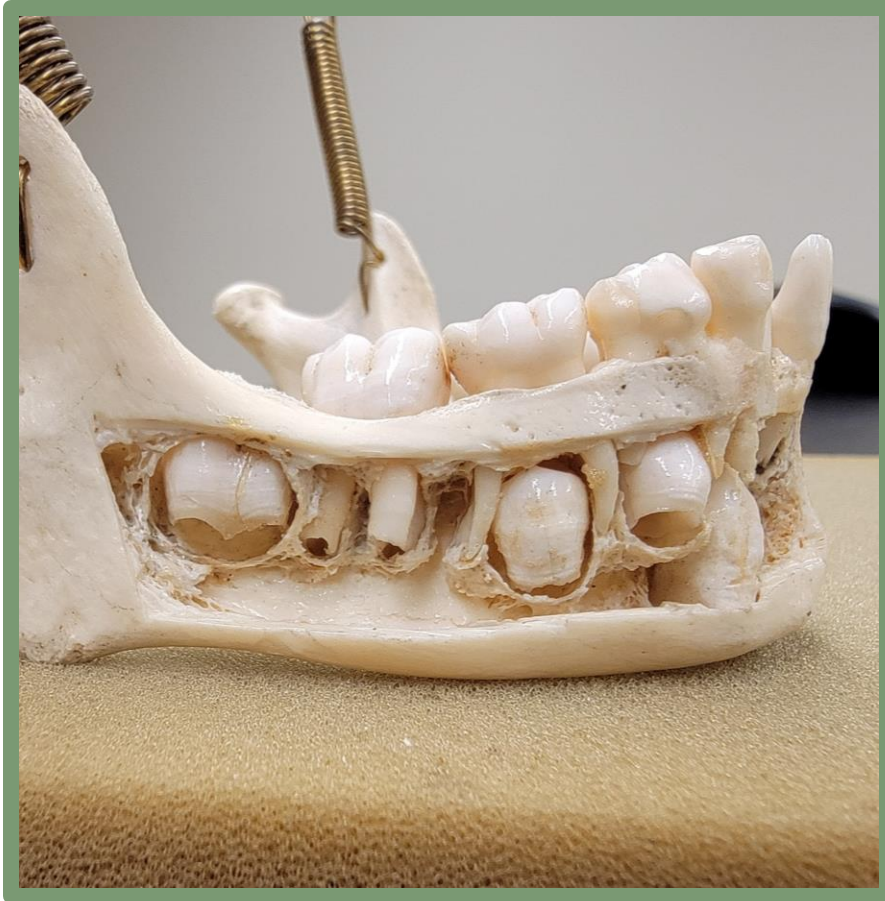


Adherent Material

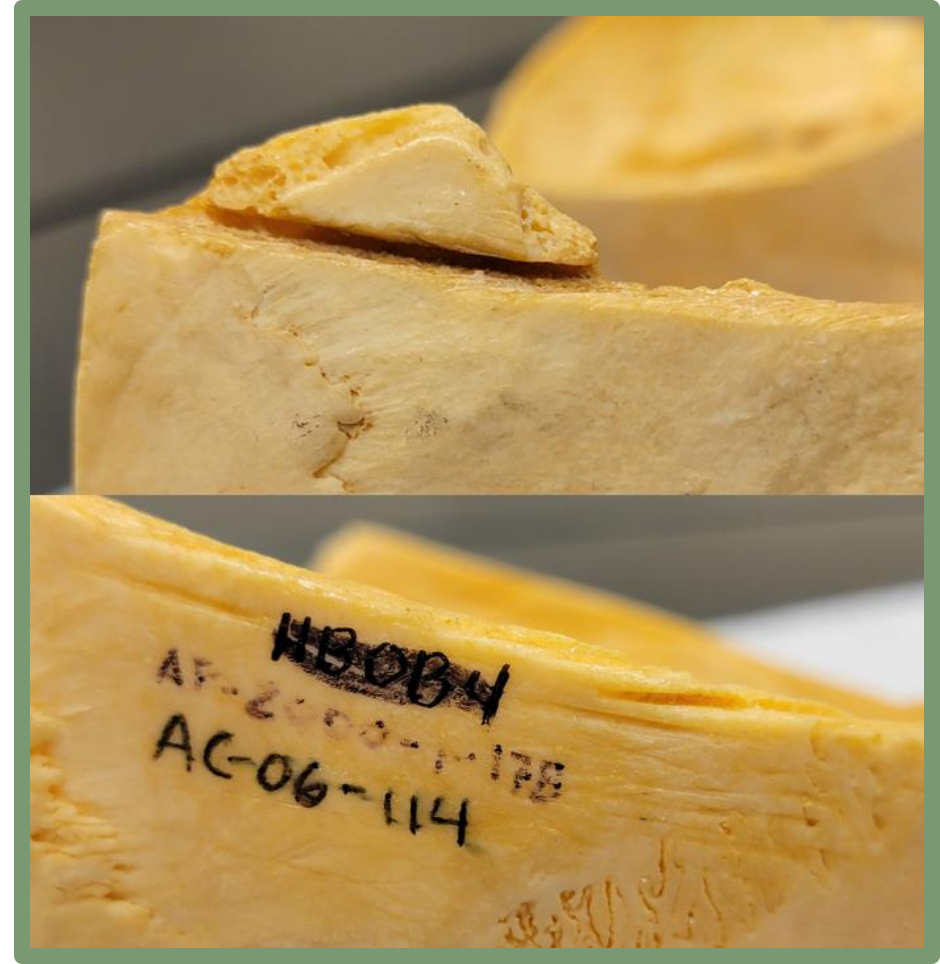


Reconstructive Material

Taphonomy – Human Modification



Bone Section Removed



Cut Marks

Project Goals... Met!

1. Evidence for medical/ anatomical teaching collection?

- **Taphonomic traits** consistent with other known skeletal teaching collections (i.e., sectioning of the skull, attached hardware, etc.)
- **Archival Records** of dissection/ anatomy courses at SU

2. Minimum number of individuals?

- Traditional MNI = **49** (right scapula)
- Zonation MNI = **43** (right scapula/ left radius)

3. CoRA as a valuable tool for documenting/ analyzing this collection?

- Increased **organization** and ease of **inventorying/ documentation** of specimens
- **Data Analysis** and **visualization** features (i.e., project dashboard, MNI charts, single/multiple relationships graphs)

Future Directions



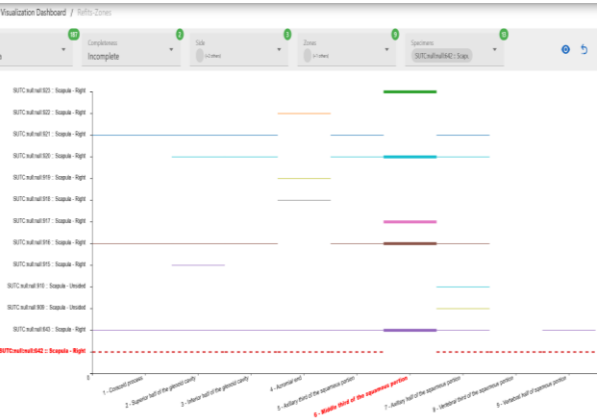
Inventory remaining specimens



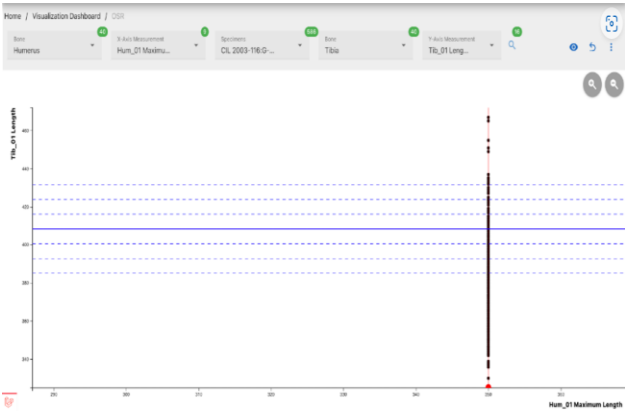
Resolution of commingled remains/ identification of individuals using CoRA



Alternative quantification methods



Refits

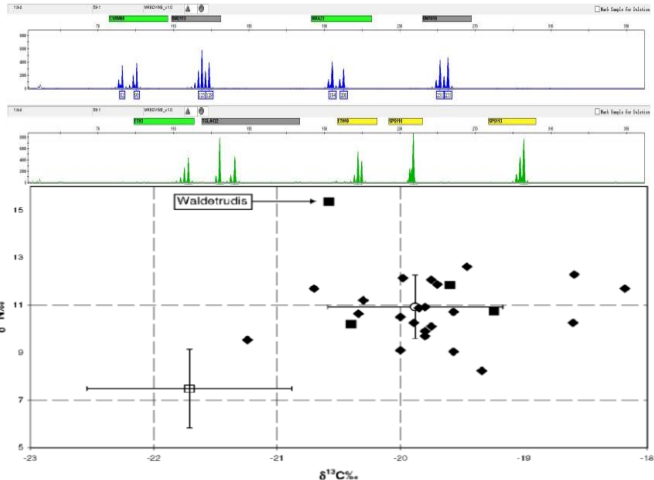


Osteometric Sorting Regression

Biological Profile

- # Age
- Sex
- Ancestry
- Stature

Biological Profile



DNA/ Stable Isotope Analysis



Questions?

References

1. Sappol M. A Traffic Of Dead Bodies: Anatomy and Embodied Social Identity in Nineteenth-Century America. 2002.
2. Wright KW. Foundations Well and Truly Laid: A History Leading to the Formation of the State University of New York Health Center at Syracuse. Alumni Association of the SUNY Health Center at Syracuse; 1994.
3. Pawaskar S, Streetman E, C. LeGarde, Jensen N, Stuti Raut, Damann F, et al. spawaskar-cora/cora-docs: v2.1.0 Open Community Release [Internet]. Zenodo; 2021 [cited 2024 Oct 29]. Available from: <https://zenodo.org/record/5694496>

Photos

1. My photo
2. <https://www.laphamsquarterly.org/roundtable/body-snatchers-old-new-york>
3. <https://www.villagepreservation.org/2018/05/17/elizabeth-blackwells-nyc-the-historic-sites-where-americas-first-female-doctor-made-her-mark/>
4. <https://www.cardcow.com/461826/birds-eye-view-auburn-prison-new-york/>
5. <https://www.civilwarmed.org/bodysnatching/>
6. <https://www.buzzfeednews.com/article/gabrielsanchez/pictures-history-of-new-york-city-hospitals-coronavirus>
7. <https://www.sciencephoto.com/media/150111/view/american-university-of-beirut>
8. <https://commonwealthtimes.org/2022/01/28/researchers-at-mcv-to-conduct-dna-analysis-on-19th-human-remains-found-on-campus/>
9. <https://www.shorpy.com/node/644>
10. <https://www.nationalww2museum.org/war/topics/defense-pow-mia-accounting-agency>
11. <https://universitypositions.eu/universities/europe/university-of-milan?>
12. Dr. Sachin Pawaskar
13. Dr. Sachin Pawaskar
14. My Photo
15. <https://cora-analytics.coracore.org/>
16. <https://i.pinimg.com/736x/3e/68/f7/3e68f786fe175b1f77b2abe34c6ba667--in-the-classroom-paper-industry.jpg>
17. My Photo
18. <https://www.dreamstime.com/royalty-free-stock-images-scribble-napkin-table-pen-image5310409>
19. <https://cora-analytics.coracore.org/>
20. https://techcommunity.microsoft.com/blog/microsoft_365blog/adaptive-card-based-loop-components-collaborate-on-live-content-in-teams-and-out/3644272

Photos

21. <https://www.sherpany.com/de/ressourcen/vorstandssitzungen/team-meeting-leitfaden/>

22. <https://www.dreamstime.com/users-interconnected-d-icon-white-background-simple-element-illustration-business-analytics-concept-sign-symbol-design-image141333244>

23. <https://docs.coracore.org/en/latest/>

24. <https://cora-analytics.coracore.org/>

25. <https://cora-analytics.coracore.org/>

26. <https://cora-analytics.coracore.org/>

27. <https://cora-analytics.coracore.org/>

28. <https://cora-analytics.coracore.org/>

29. <https://cora-analytics.coracore.org/>

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