Dry bone and virtual modality interchangeability for the estimation of sex on the human pelvis

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Introduction:
Visual-tactile *vs* visual-only sensation
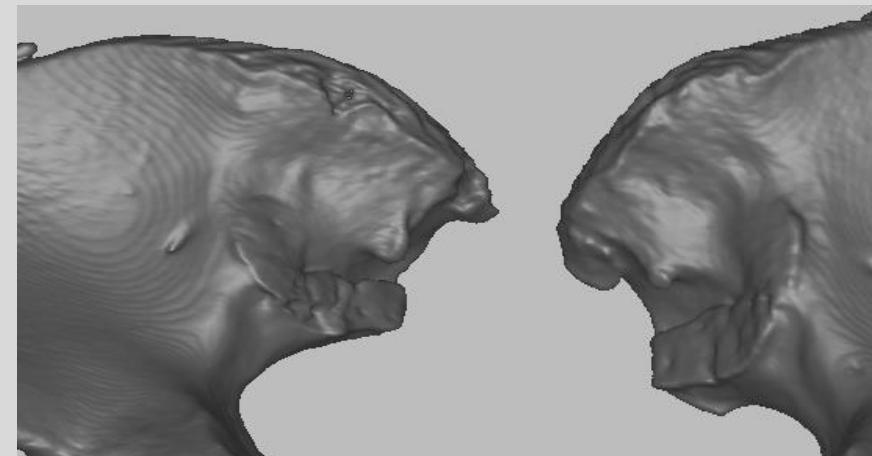
Source: Zweisimmen individual 69, photo: S. Braun

Introduction:
Virtual osteological collections

- The New Mexico Decedent Image Database (NMDID, 1972) Albuquerque (Edgar & Berry, 2019)

- Subadult Virtual Anthropology Database (SVAD, 2015) Reno (Stull & Corron, 2022)

- Bakeng se Afrika (BsA, 2019) Pretoria (L'Abbé et al., 2021)

Introduction: Interchangeability studies

- Research on virtual modalities without direct comparison with dry bones
  (Decker, Davy-Jow, Ford, & Hilbelink, 2011; Dereli et al., 2018; Grabherr et al., 2009; Ramsthaler, Kettner, Gehl, & Verhoff, 2010; Fahrni et al., 2017)

- Research on modality comparison with small sample sizes (Abegg et al., 2021; Chapman et al., 2014; Corron, Marchal, Condemi, Chaumoître, & Adalian, 2016; Colman et al., 2019)

- Research on interchangeability with narrow anatomical focus (Braun, Ridel, L'Abbé, Theye, & Oettlé, 2022)

# Rationale and research question

Summarizing rationale:

- Despite increased use of virtual modalities, no comprehensive study on interchangeability of analogous and virtual pelves

Aim:

- Consistency of methods and traits on dry bone, CT and 3D surface scans

# Materials: 200 archaeological pelves from sites in Switzerland
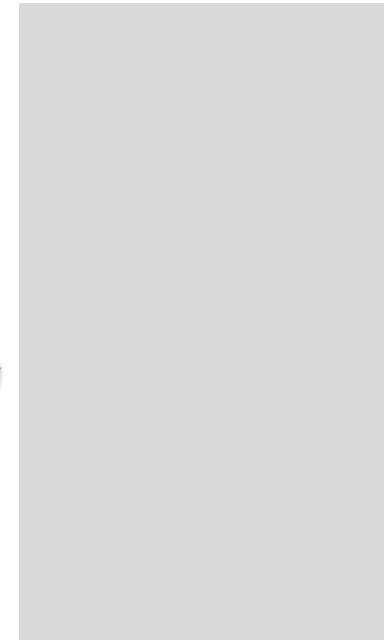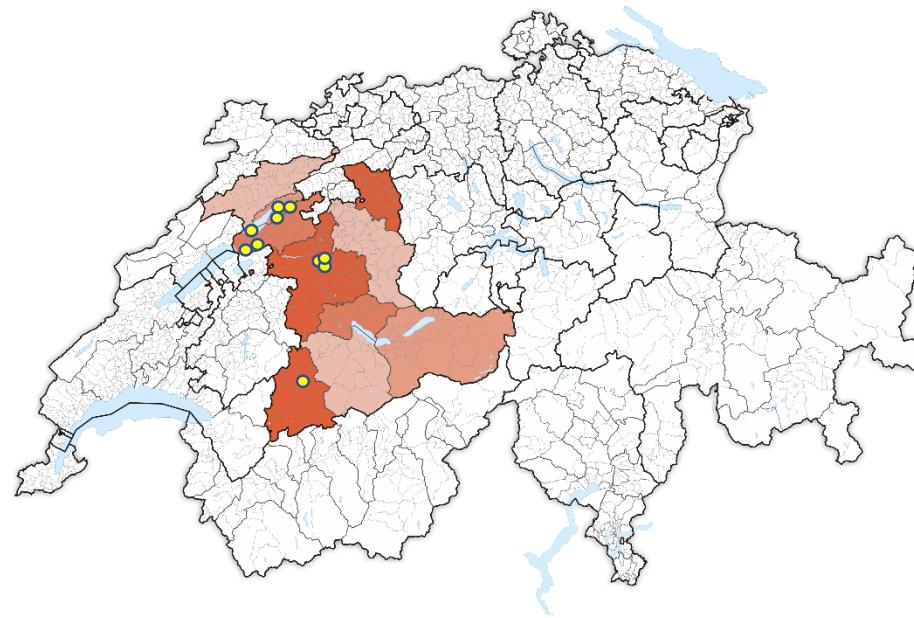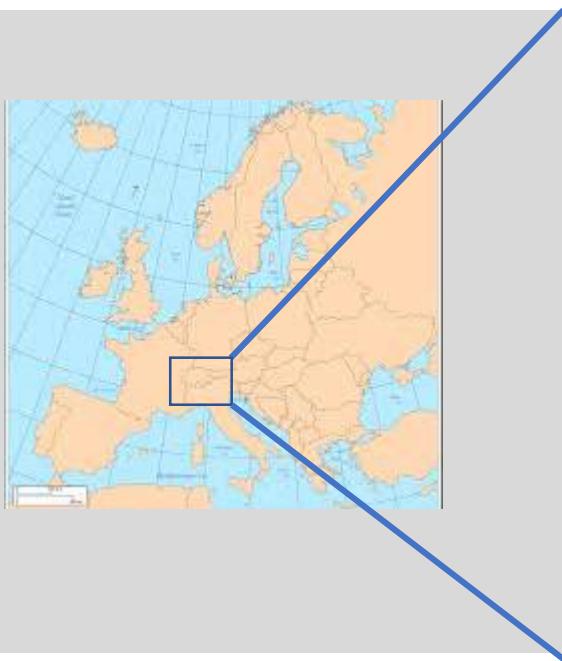
Materials: Dry bone (gold standard) / CT (n=200); 3D surface scans (n=39)


Dry bone (**B**), CT (**C**)

Artec 3D surface scans (**A**)

Photos: S. Braun, J. Ryan

Methods: Sex estimation protocols *nonmetric*

Pspace

IT

PS

F = female
M = male

İşcan & Derrick 1984

8

Methods: Sex estimation protocols *nonmetric*
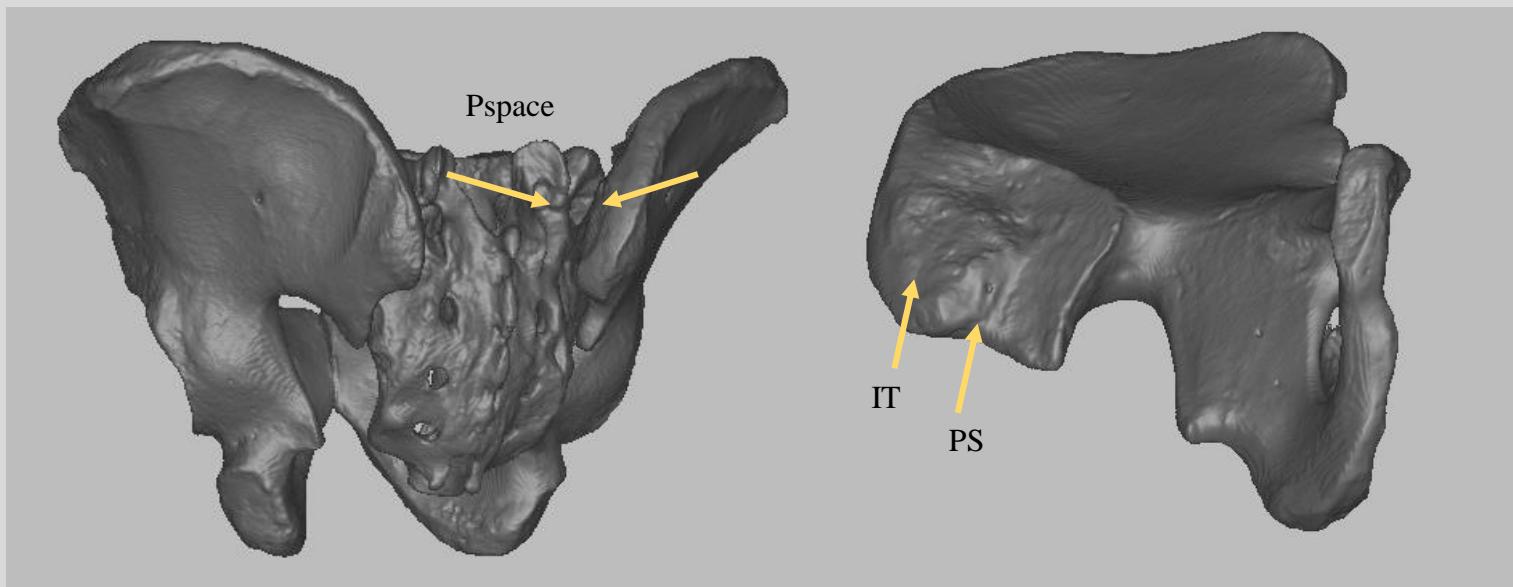
Bruzek 2002

F = female; M = male

Methods: Sex estimation protocols *nonmetric*

Scores 1-5

VA

SC

IR

Klales et al. 2012

Methods: Sex estimation protocols
## *metric*
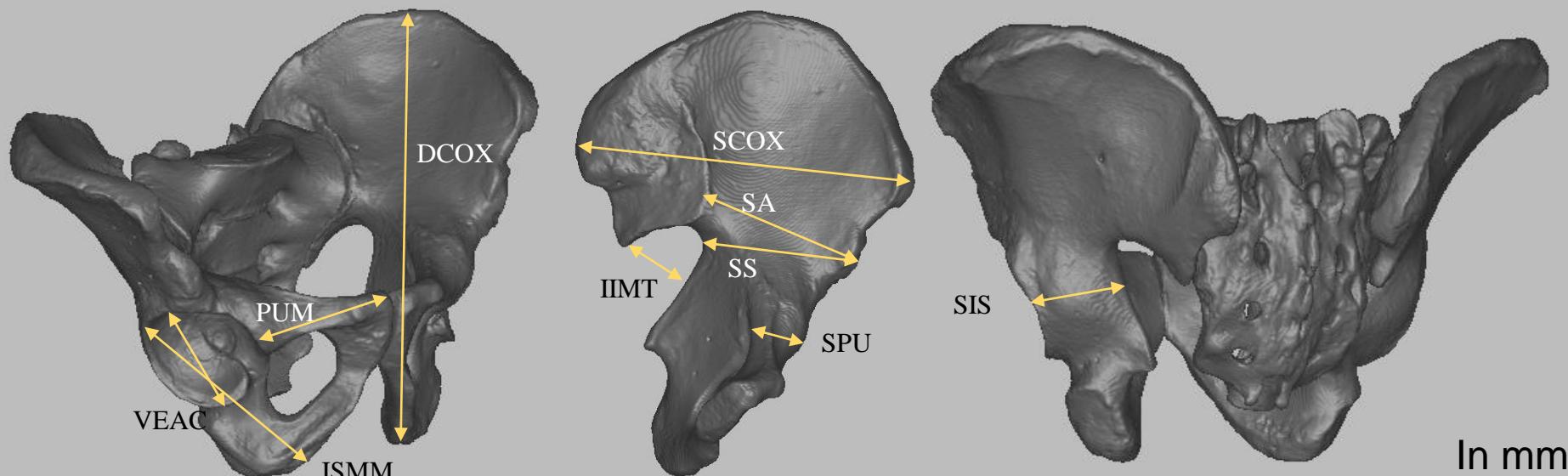
Bruzek et al. 2017

Methods: Statistical analyses

- Cohen's kappa (dichotomous) and
- Cohen's weighted kappa (ordinal) (Cohen, 1968)
  - κ -1 to 1 (Landis & Koch, 1977)
  - **κ > 0.6 acceptable agreement**

- Relative technical error of measurement (metric) (Bruzek et al., 2017)
  - **rTEM < 5% acceptable error**

- R version 4.1.4 in RStudio

Results: Nature of data
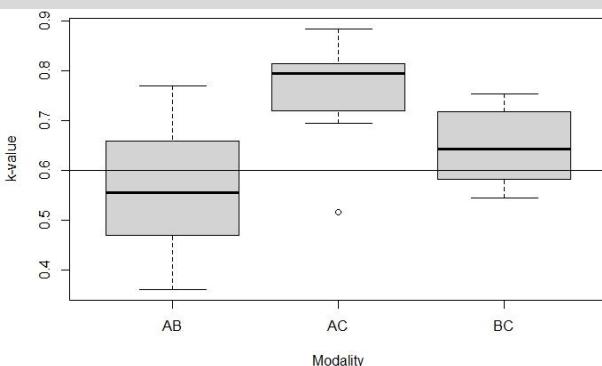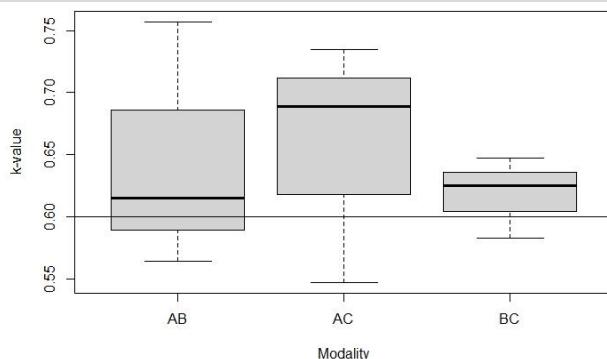
| Dichotomous	Ordinal	Metric
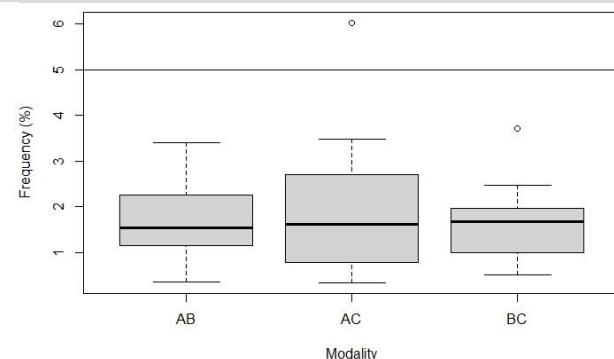
Metric data performed best, followed by ordinal and dichotomous data

Results: Trait analysis
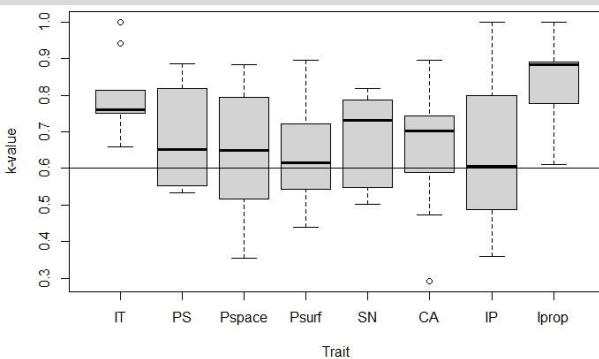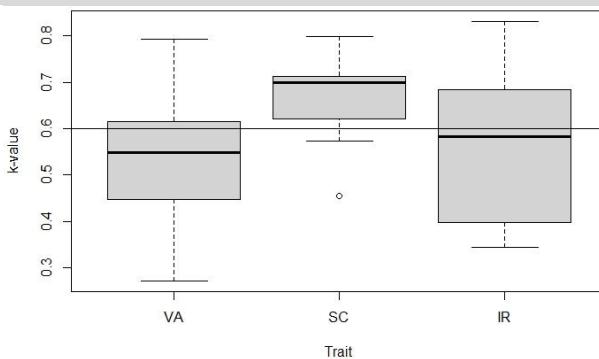
Dichotomous   Ordinal   Metric
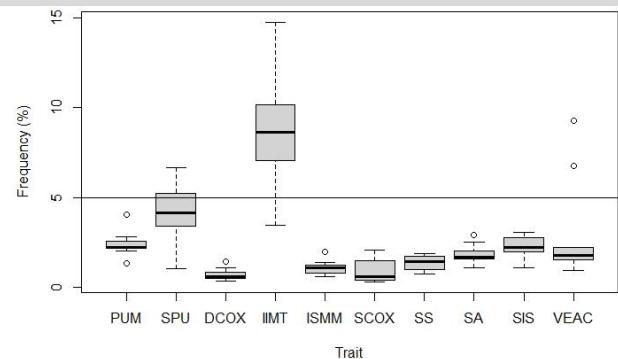
Dichotomous traits performed best, followed by metric and ordinal traits

Results: Trait revision
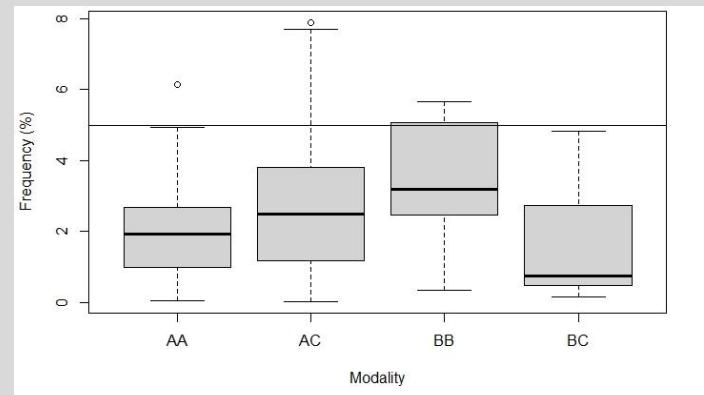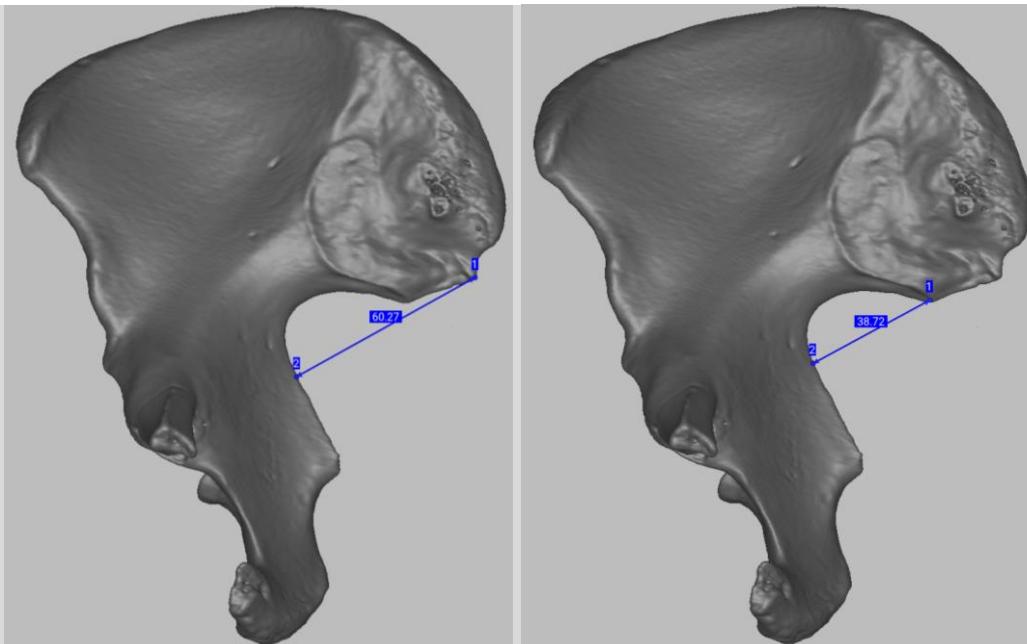
rTEM below 5% with revised trait

Discussion & Conclusion

- Modalities (**A**, **B**, **C**) are interchangeable for most of the analyzed sex estimation traits

- CT (**C**) and surface scans (**A**) yield even better results, both non-tactile

- Metric method (DSP2) best, dichotomous trait data intermediate, ordinal data poorest

- Trait definition more important than modality

Limitations

- Other virtual modalities and devices (MicroScribe digitizer, micro-XCT, etc.)

- Other skeletal regions should be included, results based on pelvis only

- Observers without previous virtual modality experience

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Thank you for your attention!

Any questions?