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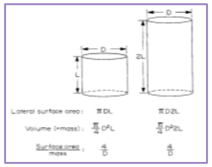
SEX, CLIMATE, AND SKELETONS:

Variation of Sexual Dimorphism Due to Climatic Stress

INTRODUCTION

Sexual dimorphism is well documented in the human skeleton and results from *ultimate* (reproduction, ancestral pressures, climate) and *proximate* (nutrition, genetics, environment) causes (5). There are broad **ecogeographic trends** in human skeletal morphology, described by the cylindrical model (11). Changes in climate result in changes in breadth for heat retention or release.

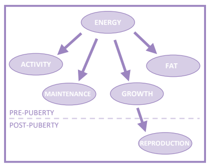


Ruff 1994

Life history, or an individual's climatic, nutritional, or health history, have an effect on skeletal morphology. Therefore, these factors could also have an effect on sexual dimorphism of the skeleton in general. Such processes are described by **allocation theory**, which is based in thermodynamics (4).

Research regarding climate's effect on sexual dimorphism has been inconclusive, but some have shown that current standard sexing procedures may be insufficient. For example, populations of similar ancestry but differing climatic and geographic influences differ significantly, resulting in accuracies as low as 31% (9).

My research aims to quantify the effects of climate on human skeletal sexual dimorphism.

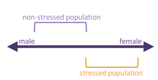


Adapted from Hill and Hurtado 1996

HYPOTHESES

1. NULL HYPOTHESIS
Different climates produce no variation and no shift. Populations of differing climatic stress will demonstrate the same degree of sexual dimorphism despite the outside pressures.

2. POPULATON SHIFT HYPOTHESIS
Differing climate produces no variation but does produce population shift towards a more extreme build. No net difference between the sexes occurs.



3. SEXUAL DIMORPHISM VARIATION HYPOTHESIS
Populations in higher climatic stress have a lesser degree of sexual dimorphism due to excessive energy allocation to maintenance and activity.

SKELETAL SAMPLES

TERRY BLACK (3, 8)
- Environmentally stable population
- 99 individuals (50 female, 49 male)
- 1898-1967; St. Louis, Missouri
- Believed to be of African ancestry
- Mean temperature: 13.4°C (56.2°F)

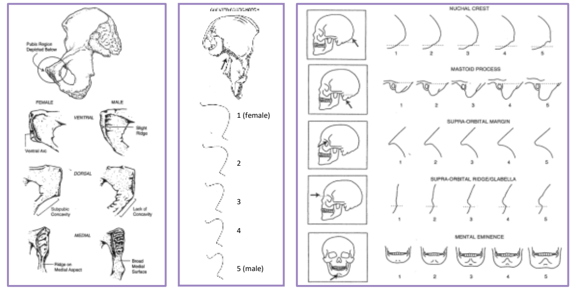
NATIVE ALASKANS (7, 14)
- Environmentally stressed population
- 104 individuals (50 females, 104 males)
- 1600-1800; coastal Alaska
- Archaeological sample
- Mean temperature: -1.17°C (29.9°F)

SAMPLE DIVISIONS

POOLED POPULATIONS
all Native Alaskans,
all Terry Black,
all males,
or all females

SUBSAMPLES
Native Alaskan males (NAM),
Native Alaskan females (NAF),
Terry Black males (TBM),
or Terry Black females (TBF)

SEXING PROCEDURES



Adapted from Buikstra and Ubelaker 1994

STATISTICAL PROCEDURES

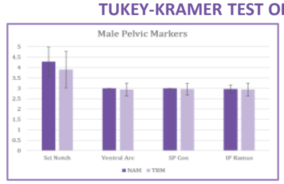
TUKEY-KRAMER METHOD (11)
Testing pooled populations and subsamples against each other, respectively.

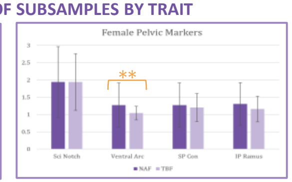
GREENE'S T-TEST (2)
Tests the dimorphism for each population. Shows any differences in the range of skeletal characteristics.

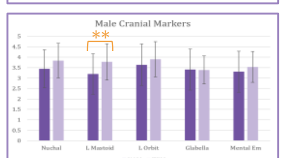
RESULTS

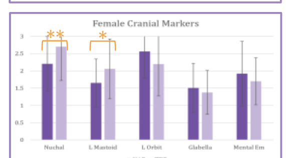
** statistically significant differences: $p \leq 0.05$
* interesting differences (non-significant): $p \leq 0.15$

TUKEY-KRAMER TEST OF SUBSAMPLES BY TRAIT

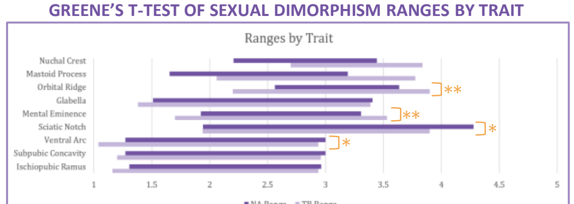








GREENE'S T-TEST OF SEXUAL DIMORPHISM RANGES BY TRAIT



DISCUSSION

1. **NULL HYPOTHESIS Disproven** due to statistically significant results in both the Tukey-Kramer and Greene tests.
2. **POPULATON SHIFT HYPOTHESIS** Tukey-Kramer showed significance for the nuchal crest and mastoid process, suggesting that environmental stress shifts a population towards a **hyperfemale build.** Greene's test confirms that the range did not change.
3. **SEXUAL DIMORPHISM VARIATION HYPOTHESIS** Greene's test showed significant changes in orbital ridge and mental eminence ranges shows that environmentally stressed populations have **less sexual dimorphism.**

OTHER FINDINGS

The ventral arc showed a significant shift towards a **hypermale build**, which contrasts with previous research (12) and non-significant but interesting **reduction in sexual dimorphism**, which concurs with life history theory (4). Non-significant trends include a shift towards the female build in male crania and a slight shift towards the male build in male pelves due to environmental stress, which also defies life history theory.

POTENTIAL CONFOUNDING FACTORS

- **CONTEMPORARY/ARCHAEOLOGICAL SAMPLES** The Native Alaskan remains could have been assessed incorrectly due to taphonomy. The ventral arc has been shown to be difficult to assess in archaeological remains (7).
- **OCCUPATIONAL/NUTRITIONAL DIFFERENCES** According to life history theory, these two factors could have a confounding influence on the samples, such as the slight shift to male build in male pelves (4).
- **ANCESTRAL DIFFERENCES** Sexual dimorphism has been shown to shift significantly between populations of differing ancestry (13).
- **THE OSTEOLOGICAL PARADOX** Archaeological samples are undocumented individuals, and as such we will never know their life history for certain (16).

CONCLUSIONS

Environmental stress does effect sexual dimorphism, but in a very complex way. For certain traits, a population will either shift towards a hyperfemale build or reduce their sexual dimorphism, as allocation theory would suggest. More research taking potential confounding factors into account is necessary to further explore this complex relationship.

FUTURE DIRECTIONS

Much research has shown that environmental stress can have an effect on sexual dimorphism (6, 9, 10, 13). Furthermore, this research shows that the relationship between the two are very complex and riddled with confounding factors. Further research using two samples taking into account the potential confounding variables would produce a more accurate representation for climate's effect (if any) on sexual expression and dimorphism.

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