

**ANT 230
ANTHROPOMETRICS
Spring 2009**

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OFFICE HOURS: MWF 7:00-8:00, 9:00-10:00, TTH 9:30-12:00 and by appointment

DESCRIPTION

This is a course in the use of statistics in anthropology. Univariate and bivariate descriptive and inferential statistics will be used to explore variation in the human form and behavior. Strengths and weaknesses of statistical approaches in anthropology will be discussed.

TEXT: Caldwell, Sally 2007 Statistics Unplugged. 2nd edition. Thomson/Wadsworth Publishing. Belmont CA. ISBN 0-495-09077-8.

REQUIREMENTS

- 20% EXERCISES: Assignments of exercises from the text and handouts. Exercises are to be prepared for class presentation.
- 60% EXAMS: Three multiple choice exams covering key concepts.
- 10% FINAL: A comprehensive final requiring that you reflect on the semesters work and critically exam the use of statistics in anthropology.
- 10% ATTENDANCE: Attendance will be taken randomly. Percent attendance will be based on the total number of attendance checks.
- PARTICIPATION: Participation is expected. Thoughtful participation can raise your grade.

A = 100-90 %,: B = 89-80: C = 79-70: D = 69-60: F = <59

Note:

Students with disabilities who believe they may need accommodations in this class are encouraged to contact the Disability Support Services (970-351-2289) as soon as possible to better ensure that such accommodations are implemented in a timely fashion.

TOPICAL OUTLINE

WEEK 1 Statistics, Theory & Measurement in Anthropology

STUDY: Introduction, Ch 1.

Why Measure?
Sources of Variation in Anthropometric Variables
Levels of Measurement
Samples, Populations, Statistics and the Goals of Research
Description and Inference

WEEK 2 Describing Data

STUDY: Ch 2

Central Tendency: The Mean, Median, and Mode
Dispersion: The Range, Deviations, Variance, and Standard Deviation

WEEK 3 Picturing Data

STUDY: Chs 3 and 4

Frequency Distributions Graphing Techniques
Tables and Graphs
Standardizing Data
The Normal Curve
Using the Normal Curve to Make Probability Statements

EXAM #1

WEEK 4 Inference

Random Sampling
The Normal Distribution
Interpreting Standard Scores

WEEK 5 Analysis of Variance

ANOVA and the experimental method
Partitioning Variance: The search for causation
Single Factor ANOVA

WEEK 6 Correlation

Relations between random variables
Two Space
Covariation
Pearson's r

WEEK 7 Regression and Prediction

Linear Regression
Explained and Unexplained Variation
Correlation and Causation

EXAM #2

WEEK 8 What are the Chances? --Probability

Randomness
Formal Properties of Probability
Probability and the Normal Curve

WEEK 9 Making the Leap for Samples to Populations: Inference

Sampling Distributions

Statistical Significance

Hypothesis Testing

Types of Error in Hypothesis Testing

WEEKS 10-11 Inferences about Population Means

The Sampling Distribution of the Mean

Point Estimation

t-tests

Confidence Intervals

Tests of Significance for Pearson's r

STUDY CHAPTER 14

WEEK 12 Chi-Square Analysis

EXAM #3

WEEKS 13- 15

Review

FINAL

WEEKS 10-15 PRACTICUM IN APPLIED ANTHROPOMETRY

This section of the course is a "practicum" in the analysis of anthropometric data. This time will be devoted to working numerous examples of statistical data analyses addressing issues interesting to physical anthropologists. The examples will primarily focus on the topics of human variation, evolution, and adaptation. Students will be responsible for presenting results of worked exercises in class and for providing a workbook of completed exercises for evaluation. The workbook should have the following format.

Title Page

Table of Contents

Exercises demonstrating knowledge of

- a) research design
- b) hypothesis testing
- c) distributions, tables & graphs
- d) statistical summaries & tests
- e) interpretation of results
- f) the interests of physical anthropologists

Index of Variables

Index of Variable Types

Index of Statistical Concepts

Index of Topics

Glossary

References

Websites

EXERCISES

1. *Locate a more recent (within the last five years) tabulation of infant mortality rates for those under one year of age for the countries listed in exercise 3.4.*

Perform the operations described in exercise 3.4 on these data.

Select five other exercises. Be prepared to present a solution to each of these problems in class.

or

Locate another data set that may be used to illustrate the concepts discussed in Chapter 3. Look for either data to be arranged in tables and/or graphs or informative tables and graphs themselves that do their job of conveying information particularly well.

Write an exercise along the lines of those in Chapter 3 based on the information you have located.

WEEK 3 Measures of Central Tendency and Variation

*Mean, Median and Mode
Variance and Standard Deviation*

EXERCISES

1. *Collect some data on average family size desired by a sample of college women in the 19-24 years of age. Compare the mean and standard deviation of these data with these measures for a similar sample of men.*
2. *Read and summarize "Homogeneity of Personality Characteristics: A Comparison Between Old Order Amish and Non-Amish". On reserve.*

PRACTICAL EXAM #1 Height, Weight, Ponderal Index, Age & Sex: Describing Central Tendency and Variability

THEORY EXAM #1

WEEK 4 Introduction to Probability

*Rules for Expressing Probabilities
Probability as Relative Frequency
Randomness and Random Sampling
Problems in Sampling*

EXERCISES

1. *Another sampling experiment.*

WEEK 5 Probability Distributions

Discrete Variables: The Binomial Distribution

Continuous Variables: The Normal Distribution

EXERCISES

1. *Probability Models in Population Genetics:
Heritability and Selection*

Coefficients of Inbreeding

WEEK 6 Point and Interval Estimation of Means and Variances

Sampling Distribution of the Mean

Central Limit Theorem

Sampling Distribution of Differences Between Sample Means

EXERCISES

- 1. Smoking and Birthweight*

WEEK 7 Hypothesis Testing

Philosophy of Hypothesis Testing

Procedures

Statistical Significance

WEEKS 8 & 9 Student's t-distribution and t-tests

EXERCISES

- 1. Craniometry TBA*

PRACTICAL EXAM #2 Hypothesis testing using craniometric data
THEORY EXAM #2

WEEKS 10 & 11 Linear Regression

Linear Models

The Principal of Least Squares

Model I and Model II Regression

EXERCISES

- 1. Estimating Stature from Long Bone Measurements.*

WEEKS 12 & 13 Measures of Covariation: Correlation

The Concept of Correlation

Pearson's r

Spearman's r

EXERCISES

1. *Predicting Stride Length for Australopithecus*

WEEK 14 Nonparametric Test: Chi-square tests

*Nonparametric Statistics
Chi-square Tests*

EXERCISES

1. *Sampling Experiment Part II: Goodness of Fit Tests*

PRACTICAL EXAM #3 TBA

THEORY EXAM #3.

FINAL

EXERCISES

WEEK 13 Nonparametric Test: Chi-square tests

Nonparametric Statistics

Chi-square Tests

EXERCISES

PRACTICAL EXAM #3 TBA

THEORY EXAM #3.

FINAL

EQUATIONS

$$\sum_j \sum_i (X_{ij} - \bar{X})^2 =$$

$$\sum_j \sum_i (X_{ij} - \bar{X})^2 = \sum_j n_j (X_j - \bar{X})^2 = n_j \sum_j (X_j - \bar{X})^2$$

$$\sum_j \sum_i (X_{ij} - \bar{X}_j)^2 =$$

$$\sigma^2 = \sum_i (X_i - \mu)^2 / N$$

$$\sigma = \sqrt{\sigma^2}$$

$$S^2 = \frac{\sum_i (X_i - \bar{X})^2}{n}$$

$$s^2 = \frac{\sum_i (X_i - \bar{X})^2}{n-1}$$

$$\sigma_{\bar{X}}^2 = \frac{\sigma^2}{n}$$

$$\sigma_{\bar{X}} = \frac{\sigma}{\sqrt{n}}$$

$$N\sigma_{\bar{X}}^2 = \sigma^2$$

$$\sqrt{N}\sigma_{\bar{X}} = \sigma$$

$$MS_w = \frac{\sum_j \sum_i (X_{ij} - \bar{X}_j)^2}{n-j}$$

$$MS_b = \frac{n_j (X_j - \bar{X})^2}{j-1}$$

$$F = \frac{MS_b}{MS_w}$$

$$z = \frac{(X_i - \bar{X})}{s}$$

$$r = \frac{\sum z_x z_y}{N}$$

$$r = \frac{\sum z_x z_y}{N-1}$$

$$z_{y'} = r z_x$$

$$r^2 = \frac{\sum (z_{y'} - \bar{z}_{y'})^2}{\sum (z_y - \bar{z}_y)^2} = \frac{\sum z_{y'}^2}{N}$$

$$\frac{(y_i' - \bar{Y})}{S_Y} = r_{xy} \frac{(x_i - \bar{X})}{S_X}$$

$$Y_i' = \bar{Y} + \frac{r_{xy} S_Y}{S_X} (x_i - \bar{X})$$

$$b_{Y \cdot X} = \frac{r_{xy} S_Y}{S_X}$$

$$b_{Y \cdot X} = \frac{r_{xy} S_X}{S_Y}$$

$$X_i' = \bar{X} + b_{X \cdot Y} (y_i - \bar{Y})$$

$$S_{Y \cdot X}^2 = S_Y^2 (1 - r_{xy}^2)$$

$$S_{Y \cdot X} = S_Y \sqrt{1 - r^2}$$

ANT 230 ANTHROPOMETRICS

Height, Weight, Age & Sex: Describing Central Tendency and Variability

Height and weight are the two most commonly taken anthropometric measures. Together these measures are important indicators of health status and are used routinely in studies of growth and in epidemiological research. Height and weight show both a hereditary component and an environmental component. (Hereditability)

Taken together, as a ratio, height and weight can provide a simple assessment of physique. Over the years several types of height/weight ratios have been used - H/W , $(H/W)^2$, $(H/W)^{.33}$. The ratio of height to the cube root of weight is called the Ponderal Index which has a long history of use as a measure of physique. The use of $W^{.33}$ requires some explanation. The cube root transformation of weight gives the denominator of the ratio the same "dimensionality" as the numerator. Height is a linear dimension having only one direction. Weight, on the other hand, is a volumetric measure and it increases as the cube of the linear dimension.

Description, in statistics, usually starts when a data set is organized into a frequency distribution and shown as a histogram or frequency polygon.

Physical anthropologists are interested in the interaction between biological and cultural variables. Among the innumerable possible "bio-cultural" interactions that suggest themselves is the practice of "assortative" mating.

Assortative mating refers to the phenomenon of individuals choosing mates who are either similar to or different from themselves. When individuals choose according to some dissimilarity the situation is called dissortative mating.

Here we'll conduct a preliminary study of assortative mating with regard to height and ponderal index. To do this we need to apply basic tools of statistics. We'll draw histograms of heights and ponderal indices for each sex separately, calculate the difference in height and ponderal index between the male and female spouses ($x(m)-x(f)=d$), and draw a third histogram of these differences.

PROCEDURES

From the data set provided in class, analyze the following characteristics of the sample for each sex: height, weight, the difference in height between married couples, ponderal index, and age.

1. Tabulate a frequency distribution and a relative frequency distribution for each variable.
2. Draw a histogram showing each distribution.
3. Calculate the mean, mode, and median for each variable.
4. Calculate ranges, standard deviations, and coefficients of variation for each distribution.
5. Title the tables and figures appropriately.
6. Write a summary of these results. Compare the female and male distributions by referencing the graphic displays and summary statistics. Does this analysis reveal any evidence for assortative mating with regard to height or ponderal index.

**EVALUATION FORM
EXERCISES #1**

1. TABULATIONS AND DISPLAYS

1.1 Clarity of Labels	1	2	3	4	5	
1.2 Descriptive Quality of Titles	1	2	3	4	5	
1.3 Appropriate Format		1	2	3	4	5

Total _____

2. DESCRIPTIVE STATISTICS

2.1 Accuracy of Means						1	2	3	4	5
2.2 Accuracy of Standard Deviations	1	2	3	4	5					
2.3 Accuracy of Coefficients of Var.	1	2	3	4	5					

Total _____

3. DESCRIPTIVE SUMMARY

3.1 Quality						1	2	3	4	5
3.2 Completeness						1	2	3	4	5
3.3 Accuracy						1	2	3	4	5

Total _____

Grand Total _____

EXERCISES #2: Going from the Known to the Unknown: Using Correlation and Regression to Solve Paleontological Problems.

INTRODUCTION

Among the numerous questions that the discovery of fossils raise, because of their fragmentary nature, is the question of size. The Primates began their evolution as small, squirrel sized, insectivores. Our Hominoid ancestors were smallish apes about the size of a gibbon. We have seen, in earlier exercises, that in a rich environment, like San Francisco, modern humans grow to a rather large size.

It is rare to find complete skeletons in the recovery of fossils, so paleontologists are often faced with the problem of trying to estimate the size of larger structures - arms, legs, stature - from fragmentary remains.

Problems of identifying fragmentary remains also occur in forensic work. In both areas, and in countless of areas of application, the statistical techniques of correlation and regression help shed light on questions of size and shape.

This exercise illustrates how, by studying relations between quantitative variables, in known populations, we can set the stage for predicting an unknown value from correlated measurements.

Human paleontologists have been excited over the discovery, in 1978, of a trail of fossil footprints of three early hominids walking across a stretch of soft volcanic ash. The "Laetoli" footprints, as they're called, take their name from the 3.8 million year old deposits in Tanzania called the Laetoli beds.

The footprints not only give us a glimpse at the size and shape of the foot but are also a frozen moment in time - the passing of three individuals. The footprints are a record not only of anatomy but of behavior - people walking together.

Leakey et al have estimated the height of the Laetoli hominids from the size of the footprints. Assuming that foot length is 15% of height, Leaky estimates the Height of the smaller individual as 1.2 m (3'10") and the next larger individual as 1.4 m (4'7"). Tuttle arrives at similar estimates based on a regression analysis of foot length and stature among Machiguenga Indians ($r^2 = .786$).

How well can we estimate stature from stride length and foot length? Tuttle reports a stride length of .829 m for hominid G1 and .876 m for hominid G3. How can we use this information to predict the stature of hominids that tracked across the lava at Laetoli?

PROCEDURES

1. Read the following articles:

Richard L. Hay and Mary D. Leakey The Fossil Footprints of Laetoli

R. Tuttle, D. Webb, E. Weidl and M. Baksh 1990. Further Progress on the Laetoli Trails. Journal of Archaeological Science **17**,347-362.

2. Write a brief critique of each.

3. Design a form to record the data.

3. Gather data on the following variables for a sample of 10 females and 10 males: Age, Height, Leg Length, Foot Length, Stride Length, Relative Leg Length. Use the protocols provided or invent usable substitutes.

4. Complete Form S1 titled "Statistical Summary of Height, Leg Length, Stride Length & Relative Leg Length for 10 Women (Girls) and 10 Men (Boys).

5. Complete Form S2 titled "Correlation and Regression Summary of Gait Study.

6. Write a summary report to accompany forms S1 and S2. Include an introduction, methods, results, and conclusions sections.

Form S1: Statistical Summary of Age, Height, Leg length, Stride Length, & Relative Leg Length for 10 Males and 10 Females

Distributions	Females	Males	Combined	Frequency
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AGE (cm)

X	_____	_____	_____		
s	_____	_____	_____		
C.V.	_____	_____	_____		
Range	_____ - _____	_____ - _____	_____ - _____		_____

HEIGHT (cm)

X	_____	_____	_____		
s	_____	_____	_____		
C.V.	_____	_____	_____		
Range	_____ - _____	_____ - _____	_____ - _____		_____

LEG LENGTH (cm)

X	_____	_____	_____		
s	_____	_____	_____		
C.V.	_____	_____	_____		
Range	_____ - _____	_____ - _____	_____ - _____		_____

FOOT LENGTH (cm)

X	_____	_____	_____		
s	_____	_____	_____		
C.V.	_____	_____	_____		
Range	_____ - _____	_____ - _____	_____ - _____		_____

STRIDE LENGTH (cm)

X	_____	_____	_____		
s	_____	_____	_____		
C.V.	_____	_____	_____		
Range	_____ - _____	_____ - _____	_____ - _____		_____

RELATIVE LEG LENGTH (%)

X	_____	_____	_____		
s	_____	_____	_____		
C.V.	_____	_____	_____		
Range	_____ - _____	_____ - _____	_____ - _____		_____

MEASUREMENT PROTOCOLS FOR GAIT STUDY

SEX Recorded as a 1 for females and 0 for males.

AGE Recorded in years from birth.

HEIGHT Measured with an anthropometer or suitable substitute to nearest .5 cm. Subject stands without shoes, in erect stance with heels together. Subject is encouraged to lengthen their bodies while being mildly 'stretched' by the investigator at the mastoids.

LEG LENGTH Measured with an anthropometer or suitable substitute to nearest .5 cm. Subject located the top of the greater trochanter by palpation and indicates the most superior point to the observer who measures to that point from the floor.

RELATIVE LEG LENGTH Calculated $(\text{Leg Length} \times 100) / \text{Height}$.
Rounded to the nearest 1/10th %.

FOOT LENGTH Maximum Length of the foot from heel to end of longest toe. Recorded to nearest .5 cm.

STRIDE LENGTH Stride length was measured as the average of five strides (ten steps). A strip of newsprint was taped to the floor covering the distance between six and ten meters from the starting line.

The subject places a heel on the starting line and the of their foot behind, ready for the swing phase of the first step. The subject then takes ten steps and freezes in the stance phase of the tenth step. The observer marks the most posterior point on the heel and measures the location of the mark with a meter stick measuring the fractional distance from pre-marked 6,7,8, and 9 meter marks.

Stride length is taken as the total distance traveled in ten steps divided by 5 and is recorded to the nearest cm.

Form S2 Correlation and Regression Summary for Gait Study

1. Draw four scatterplots plotting Height vs Leg Length, Height vs Stride Length, Leg Length vs Stride Length, Foot Length vs Stride Length. Distinguish the sexes in your scatterplots.
2. Calculate correlations between the variables in each scatterplot. Calculate male and female correlations separately.
3. Calculate the regression statistics for the same set of variable pairs.
4. Describe the measurement protocols for obtaining the data.
5. Discuss possible sources of measurement error.
6. Calculate an estimated height from the stride length estimations for the Laetoli hominids.
7. Calculate a 95% confidence interval for your estimate.
8. Compose an introduction and conclusion for this study.

**ANT 230
ANTHROPOMETRICS**

**EVALUATION FORM
EXERCISES #2**

1. TABULATIONS AND DISPLAYS

1.1 Clarity of Labels	1	2	3	4	5	
1.2 Descriptive Quality of Titles	1	2	3	4	5	
1.3 Appropriate Format		1	2	3	4	5

Total _____

2. DESCRIPTIVE STATISTICS

2.1 Accuracy of Means				1	2	3	4	5
2.2 Accuracy of Standard Deviations	1	2	3	4	5			
2.3 Accuracy of Coefficients of Var.	1	2	3	4	5			

Total _____

3. DESCRIPTION OF MEASUREMENT PROTOCOLS

3.1 Quality	1	2	3	4	5
3.2 Completeness	1	2	3	4	5
3.3 Accuracy	1	2	3	4	5

Total _____

4. DESCRIPTIVE SUMMARY

4.1 Quality	1	2	3	4	5
4.2 Completeness	1	2	3	4	5
4.3 Accuracy	1	2	3	4	5

Total _____

Grand Total _____

COMMENTS:

COMMENTS:

CRANIOMETRY

DESCRIPTION OF CRANIAL MEASUREMENTS

CRANIUM

Alveolor Length, External: the distance along the midplane from prosthion to alveolon. Alveolon is defined as the intersection of the midplane and a line connecting the posterior alveolar borders. Taken with the skull base up and a small stick resting behind the 3rd molars to define alveolon (Key, 1983).

Basion-bregma height: distance from bregma to basion.

Basion-prosthion length: the facial length from prosthion to basion.

Basion-nasion length: direct length between nasion and basion.

Biauricular breadth: the least exterior breadth across the roots of the zygomatic processes, wherever found.

Bimaxillary breadth: the breadth across the maxillae, from one zygomaxillare anterior to the other.

Biorbital breadth: breadth across the orbits from ectoconchion to ectoconchion.

Bizygomatic breadth: the maximum breadth across the zygomatic arches, wherever found, perpendicular to the median plane.

Cranial breadth, maximum: the maximum cranial breadth perpendicular to the median sagittal plane (above the supramastoid crests).

Glabella-occipital length: greatest length, from the glabellar region, in the median sagittal plane.

Interorbital breadth: the breadth across the nasal space from dacryon to dacryon.

Nasal breadth: the distance between the anterior edges of the nasal aperture at its widest extent.

Nasal height: the average height from nasion to the lowest point on the border of the nasal aperture on either side.

Nasion-prosthion height: upper facial height from nasion to prosthion.

Orbital breadth, left: breadth from ectoconchion to dacryon, as defined, approximating the longitudinal axis which bisects the orbit into equal upper and lower parts.

Orbital height, left: the height between the upper and lower borders of the left orbit, perpendicular to the long axis of the orbit and bisecting it.

Palate breadth, external: the greatest breadth across the alveolar borders, wherever found, perpendicular to the median plane.

Height of the Mandibular Body: (Martin 1956, Oliver 1969) from the alveolar process to and perpendicular to the inferior mandibular border at the level of the mental foramen.

Minimum Ramus Breadth: (Martin 1956, Montagu 1960, Olivier 1969) least breadth of mandibular ramus perpendicular to the height of the ramus.

Maximum Ramus Height: (Martin 1956) distance from highest point on mandibular condyle to gonion.

Breadth of the Mandibular Body: (Martin 1956, Olivier 1969) maximum breadth perpendicular to the long axis of the mandibular body at the level of the mental foramen.

Bigonial Width: (Bass 1971, Martin 1956, Montagu 1960, Olivier 1969) distance from gonion to gonion.

Bicondylar Breadth (Bass 1971, Martin 1956, Olivier 1969) distance between lateral point of two condyles.

Chin Height: (Bass 1971, Hrdlicka 1952, Martin 1956, Montagu 1960, Olivier 1969) distance from infradentale to gnathion.

**DESCRIBING GEOGRAPHIC AND TEMPORAL
VARIATION IN HUMAN SKULLS**

ESKIMO SKULLS

Sample size, latitude, cranial breadth, cranial height and breadth height index for a sample of male eskimos.

N	Latitude	Max. Cranial Breadth	Basion-Bregma Height	Breadth-Height Index
17	57.63	14.57	13.39	
8	59.05	14.40	13.50	
4	59.07	14.15	13.35	
3	59.12	14.10	13.37	
40	60.00	14.12	13.72	
2	60.03	13.80	13.65	
18	60.50	14.14	13.51	
7	60.67	14.41	13.56	
19	61.00	13.81	14.18	
12	62.52	14.18	13.53	
25	62.52	14.04	13.75	
7	63.47	13.79	13.69	
6	63.87	14.20	14.02	
20	63.87	13.72	13.89	
4	64.47	13.70	13.95	
5	64.48	13.70	13.96	
4	64.50	13.93	13.80	
9	65.25	13.94	13.83	
17	65.62	13.69	13.96	
11	66.25	13.56	13.49	
21	68.25	14.00	14.12	
10	70.42	13.57	14.07	
34	71.28	13.34	13.95	

Clinal Analysis of Vault Height.

Notes:

Jantz, Richard L. and Patrick Willey 1983 Temporal and Geographic Patterning of Relative Head Height in the Central Plains and Middle Missouri Areas. Plains Anthropologist 28(99):59-67.

Stewart was the first to note temporal change and spatial variation in relative head height among north american indians (Stewart, 1940).

He noted a lower of vault height through time and an east-west gradient from high to low values.

Bass (1964) also showed temporal patterning on the Plains.

Using the large samples from the Coalescent sites in South Dakota, Jantz (1973) showed a decrease in vault height over a 200 year period. He suggests that the lowering of the Arikara vault may be due to gene flow from the lower vaulted Mandan.

Jantz (1983, 59) notes that head height has been shown to have to have factorial relevance by Howells (1957) and Key and Jantz (1981). "...[H]ead height measurements are among the most important indicators of interpopulation differences..." on the Plains. (Jantz 1983, 59). It appears to be an independent dimension of cranial variation (Jantz 1983, 59).

Jantz (1983) presents a regression analysis of reliably dated samples of Woodland through historic samples from the Central Plains and Middle Missouri areas.

Sites were divided into two groups. The Central Plains-Caddoan group of Coalescent sites represented the ancestral and historic, Caddoan speaking, Arikara. The Middle Missouri-Mandan group represents the ancestral and historic Mandan from the Middle Missouri area.

Woodland sites from each area were included in their respective groups "... to determine, whether Woodland crania participate in trends established by the later material" (Jantz, 1983, 60).

The inclusion of Woodland samples in the Central Plains-Caddoan group is warranted as there is independent evidence for continuity populations (Phenice 1969) and culture (Hughes 1968) in this area (Jantz, 1983, 60)

The situation is less clear within the Middle Missouri-Mandan area. (Jantz, 1983, 60).

Jantz (1983) measured vault height using a new measure he terms the "auricular mean height index (AMHI)

Jantz (1983, 60-61) chose auricular height for this index over basion-bregma height, as is used in Stewart's mean height index (1965) for two reasons. Auricular height may be taken when basion is missing as is often the case in damaged crania. In addition, Key (1982) has

demonstrated that vault height and base height are independent characters and that the latter contributes little to intergroup differences in the Plains. (Jantz (1983, 61)

AMHI does not show a sex difference, so the sexes were pooled in this analysis.

AMHI was regressed against time and latitude and an ANOCOVA was performed to test for a difference between the groups after the effects of time and space had been controlled.

The regression results showed that both time and latitude were related to vault height decrease, but time is, by far a greater factor.

When the Woodland samples were included in the Central Plains-Coalescent analysis, latitude dropped out as a significant covariate and the slope of the relation with time was halved.

There were no significant slopes of time or latitude against the dependent variable for the Middle Missouri-Mandan group, but with the Woodland samples were included a significant slope against time appeared.

As with the Coalescent group analysis the slope was halved by the addition of Woodland samples. (Jantz 1983, 62)

The ANOCOVA results were similar with and without the Woodland samples and are reported for the analysis in which they are included.

Regression slopes are similar and significant for both groups.

When covariation with time and latitude are controlled the difference between the group means remains significant.

The time and space adjusted means for the groups including the Woodland samples are 74.09 for the Central Plains-Coalescent group and 73.97 for the Middle Missouri-Mandan group.

The Mandan at any time or latitude have significantly lower vault heights.

Gene flow from Mandan to Arikara populations has been suggested as a mechanism by which the Arikara vault was lowered (Jantz 1973), but the simultaneous lowering of Mandan vault has no such ready explanation.

Flow from outside the area is also a possibility.

The high vaulted Oneota are not likely candidates as a source of gene flow.

Low headed Athapaskan (Neuman, 1969) and Dakota groups (Hrdlicka, 1927) are not good candidates because the Pawnee have some of the lowest vaults on the Central Plains and if the source of flow was to the north it would be expected that we would find the lower vaults there.

Jantz (1983, 64) turns to climatic selection for an explanation consistently lower vaults of the Middle Missouri-Mandan samples and the maintenance of this difference over time.

Jantz fails to suggest a mechanism of the climate-selection hypothesis and notes that "**Among living groups, head height has not been shown to be related to climate.**" (Jantz, 1983, 64)

Jantz's (1983) analysis points to two lineages maintaining morphological differences through time.

References

Bass, William M. 1964 The Variation in Physical Types of the Prehistoric Plains Indians. *Plains Anthropologist* 9:65-145.

Glenn, Elizabeth J. 1975 Physical Affiliations of the Oneota Peoples. Report 7. Office of the State Archaeologist, Iowa City.

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OSTEOMETRICS OF THE POSTCRANIAL SKELETON

OSTEOMETRIC DATAFORM

Specimen _____

Observer _____

Date _____

CRANIAL MEASUREMENTS

- _____ Alveolar Length, External
- _____ Alveolus Radius (at M1)
- _____ Basion Angle, nasion to bregma (in degrees)
- _____ Basion Angle, nasion to prosthion (in degrees)
- _____ Basion Bregma Height
- _____ Basion Prosthion Length
- _____ Basion Nasion Length
- _____ Basion Radius
- _____ Biasterionic Breadth
- _____ Biauricular Breadth
- _____ Bifrontal Breadth
- _____ Bijugal Breadth (approximate)
- _____ Bimaxillary Breadth
- _____ Biorbital Breadth
- _____ Bistephanic Angle (in degrees)
- _____ Bistephanic Breadth
- _____ Bizygomatic Breadth
- _____ Bregma-Lambda Chord
- _____ Bregma-Lambda Subtense
- _____ Bregma Radius
- _____ Bregma-Subtense Fraction
- _____ Cheek Height
- _____ Cranial Base Angle (in degrees)
- _____ Cranial Breadth Maximum
- _____ Cranial Breadth Minimum
- _____ Dacryal Angle (in degrees)
- _____ Dacryon Radius
- _____ Dacryon Subtense
- _____ Ectoconchion Radius
- _____ Foramen Magnum Breadth
- _____ Foramen Magnum Length
- _____ Frontal Angle (in degrees)
- _____ Frontomalare Radius
- _____ Glabello-Occipital Length
- _____ Glabella Projection
- _____ Interorbital Breadth
- _____ Lambda-Opisthion Chord
- _____ Lambda-Opisthion Subtense
- _____ Lambda Radius
- _____ Lambda-Subtense Fraction

_____ Malar Length Inferior
_____ Malar Length Maximum
_____ Malar Subtense
_____ Mastoid Height Left
_____ Mastoid Height Right
_____ Mastoid Width, Left
_____ Mastoid Width, Right
_____ Nasal Breadth
_____ Nasal Height
_____ Nasio-Frontal Angle (in degrees)
_____ Nasio-Frontal Subtense
_____ Nasion n Angle, basion to bregma (in degrees)
_____ Nasion Angle, basion to prosthion (in degrees)
_____ Naion-Bregma Chord
_____ Nasion-Bregma Subtense
_____ Nasion Radius
_____ Nasion Subtense Fraction
_____ Nasio-Occipital Length
_____ Naso-Dacryal Angle (in degrees)
_____ Naso-Dacryal Subtense
_____ Occipital Angle (in degrees)
_____ Opisthion Radius
_____ Orbital Breadth, Left
_____ Orbital Height, Left
_____ Palate Breadth, external
_____ Parietal Angle, (in degrees)
_____ Prosthion Angle, nasion to basion (in degrees)
_____ Prosthion Radius
_____ Simotic Angle (in degrees)
_____ Simotic Chord
_____ Simotic Subtense
_____ Stephanic Subtense
_____ Subspinale Radius
_____ Supraorbital Projection
_____ Vertex Radius
_____ Zygomaxillare Radius
_____ Zygomaxillary Angle (in degrees)
_____ Zygomaxillary Subtense (also called Bimaxillary Subtense)
_____ Zygoorbitale Radius

DENTAL MEASUREMENT, MAXILLA

L: _____ R: _____ Mesio-distal diameter, 3rd Molar

L: _____ R: _____ Bucco-lingual diameter, 3rd Molar

L: _____ R: _____ Crown Index (B-L/M-D)

L: _____ R: _____ Mesio-distal diameter, 2nd Molar

L: _____ R: _____ Bucco-lingual diameter, 2nd Molar

L: _____ R: _____ Crown Index, 2nd Molar

L: _____ R: _____ Mesio-distal diameter, 1st Molar

L: _____ R: _____ Bucco-lingual diameter, 1st Molar

L: _____ R: _____ Crown Index, 1st Molar

L: _____ R: _____ Mesio-distal diameter, 2nd Premolar

L: _____ R: _____ Bucco-lingual diameter, 2nd Premolar

L: _____ R: _____ Crown Index, 2nd Premolar

L: _____ R: _____ Mesio-distal diameter, 1st Premolar

L: _____ R: _____ Bucco-lingual diameter, 1st Premolar

L: _____ R: _____ Crown Index, 1st Premolar

L: _____ R: _____ Mesio-distal diameter, Canine

L: _____ R: _____ Bucco-lingual diameter, Canine

L: _____ R: _____ Crown Index

L: _____ R: _____ Mesio-distal diameter, Lateral Incisor

L: _____ R: _____ Bucco-lingual diameter, Lateral Incisor

L: _____ R: _____ Crown Index

L: _____ R: _____ Mesio-distal diameter, Medial Incisor

L: _____ R: _____ Bucco-lingual diameter, Medial Incisor

L: _____ R: _____ Crown Index

L: _____ R: _____ Mesio-distal diameter,

L: _____ R: _____ Bucco-lingual diameter,

L: _____ R: _____ Crown Index

MANDIBULAR MEASUREMENTS

L: _____ R: _____ Height of the Mandibular Body

L: _____ R: _____ Breadth of Mandibular Body

L: _____ R: _____ Minimum Ramus Breadth

L: _____ R: _____ Maximum Ramus Height

_____ Bigonial Width

_____ Bicondylar Breadth

_____ Chin Height

DENTAL MEASSUREMENTS, MANDIBLE

L: _____ R: _____ Mesio-distal diameter, 3rd Molar
L: _____ R: _____ Bucco-lingual diameter, 3rd Molar
L: _____ R: _____ Crown Index, 3 Molar

L: _____ R: _____ Mesio-distal diameter, 2nd Molar
L: _____ R: _____ Bucco-lingual diameter, 2nd Molar
L: _____ R: _____ Crown Index, 2nd Molar

L: _____ R: _____ Mesio-distal diameter, 1st Molar
L: _____ R: _____ Bucco-lingual diameter, 1st Molar
L: _____ R: _____ Crown Index, 1st Molar

L: _____ R: _____ Mesio-distal diameter, 2nd Premolar
L: _____ R: _____ Bucco-lingual diameter, 2nd Premolar
L: _____ R: _____ Crown Index, 2nd Premolar

L: _____ R: _____ Mesio-distal diameter, 1st Premolar
L: _____ R: _____ Bucco-lingual diameter, 1st Premolar
L: _____ R: _____ Crown Index, 1st Premolar

L: _____ R: _____ Mesio-distal diameter, Canine
L: _____ R: _____ Bucco-lingual diameter, Canine
L: _____ R: _____ Crown Index, Canine

L: _____ R: _____ Mesio-distal diameter, Lateral Incisor
L: _____ R: _____ Bucco-lingual diameter, Lateral Incisor
L: _____ R: _____ Crown Index, Lateral Incisor

L: _____ R: _____ Mesio-distal diameter, Medial Incisor
L: _____ R: _____ Bucco-lingual diameter, Medial Incisor
L: _____ R: _____ Crown Index, Medial Incisor

POST-CRANIAL MEASUREMENTS

Humerus

- L: _____ R: _____ Maximum Length
L: _____ R: _____ Breadth of Upper Epiphysis
L: _____ R: _____ Maximum Diameter at Midshaft
L: _____ R: _____ Minimum Diameter at Midshaft
L: _____ R: _____ Maximum Diameter of Shaft
L: _____ R: _____ Minimum Diameter of Shaft
L: _____ R: _____ Maximum Diameter of Head (articular surface)
L: _____ R: _____ Transverse Diameter of Head (articular surf.)
L: _____ R: _____ Vertical Diameter of Head (articular surface)
L: _____ R: _____ Biepicondylar Breadth
L: _____ R: _____ Width of Distal Articular Surface
L: _____ R: _____ Least Circumference of Shaft
L: _____ R: _____ Circumference at Midshaft
L: _____ R: _____ Supra-Condylod Fossa

Radius

- L: _____ R: _____ Maximum Length
L: _____ R: _____ Maximum Diameter of Head
L: _____ R: _____ Maximum Circumference of Shaft
L: _____ R: _____ Cicrcumference at Midshaft
L: _____ R: _____ Distal Medio-Lateral Diameter
L: _____ R: _____ Minimum Diameter of Shaft
L: _____ R: _____ Minimum Diameter at Midshaft
L: _____ R: _____ Maximum Diameter at Midshaft

Ulna

- L: _____ R: _____ Maximum Length
L: _____ R: _____ Maximum Breadth of Olecranon Process
L: _____ R: _____ Minimum Breadth of Entire Olecranon Process
L: _____ R: _____ Miniimum Breadth of Articular Surface of
Olecranon Process
L: _____ R: _____ Olecranon Process to Radial Notch Length
L: _____ R: _____ Olecranon Process to Coronoid Process Length
L: _____ R: _____ Physiological Length
L: _____ R: _____ Least Circumference of Shaft
L: _____ R: _____ Circumference of Midshaft

Femur

- L: _____ R: _____ Maximum Length
L: _____ R: _____ Oblique Length (Bicondylar Length)
L: _____ R: _____ Trochanteric Length
L: _____ R: _____ Subtrochanteric Anterior-Posterior Diameter
L: _____ R: _____ Subtrochanteric Medial-Lateral Diameter

L: _____ R: _____ Anterior-Posterior Diameter of Midshaft
L: _____ R: _____ Medial-Lateral Diameter of Midshaft
L: _____ R: _____ Circumference of Midshaft
L: _____ R: _____ Vertical Head Diameter

L:_____ R:_____ Horizontal Diameter of Head
L:_____ R:_____ Maximum Diameter of Head
L:_____ R:_____ Anterior-Posterior Diameter of Lateral Condyle
L:_____ R:_____ Anterior-Posterior Diameter of Medial Condyle
L:_____ R:_____ Epicondylar Breadth
L:_____ R:_____ Bicondylar Breadth
L:_____ R:_____ Vertical Diameter of Neck
L:_____ R:_____ Capito-Collar Length
L:_____ R:_____ Neck Angle (medio-inferior angle, in degrees)
L:_____ R:_____ Femoral Condyle Angle (medial angle, degrees)

Tibia

L:_____ R:_____ Maximum Length
L:_____ R:_____ Maximum Breadth of Proximal Epiphysis
L:_____ R:_____ Maximum Breadth of Distal Epiphysis
L:_____ R:_____ Anterior-Posterior Diameter at Nutrient Foramen
L:_____ R:_____ Medio-Laateral Diameter at Nutrient Foramen
L:_____ R:_____ Position of Nutrient Foramen
L:_____ R:_____ Circumference at Midshaft

Fibula

L:_____ R:_____ Maximum Length
L:_____ R:_____ Maximum Diameter at Midshaft
L:_____ R:_____ Circumference at Midshaft

Clavicle

L:_____ R:_____ Maximum Length
L:_____ R:_____ Sagittal Diameter at Midshaft
L:_____ R:_____ Vertical Diameter at Midshaft
L:_____ R:_____ Circumference at Midshaft

Scapula

L:_____ R:_____ Maximum Length
L:_____ R:_____ Maximum Breadth
L:_____ R:_____ Length of Spine
L:_____ R:_____ Length of Supra-Spinous Line
L:_____ R:_____ Length of Infra-Spinous Line
L:_____ R:_____ Glenoid Cavity Breadth
L:_____ R:_____ Glenoid Cavity Height
L:_____ R:_____ Mid-Glenoid to Inferior Anglt Length
L:_____ R:_____ Border Angle
L:_____ R:_____ Vertebral Border Angle
L:_____ R:_____ Inferior Angle
L:_____ R:_____ Superior Angle
L:_____ R:_____ Caudal Angle
L:_____ R:_____ Medial Angle

L:_____ R:_____ Suprascapular notch

Patella

L:_____ R:_____ Maximum Cranio-Caudal Diameter

L:_____ R:_____ Maximum Medio-Lateral Diameter

Sternum

_____ Length of Manubrium(from jugular notch)
_____ Length of Body
_____ Length of Xiphoid
_____ Greatest Width of Manubrium

Innominate

L:_____ R:_____ Maximum Height

L:_____ R:_____ Maximum Width

L:_____ R:_____ Maximum Isthio-Pubic Diameter

L:_____ R:_____ Minimum Ilium Width

L:_____ R:_____ Height of Pubic Symphysis

L:_____ R:_____ Pubic Symphysis to Anterior Superior Spine

L:_____ R:_____ Pubic Symphysis to Anterior Inferior Spine

L:_____ R:_____ Pubic Symphysis to Auricular Surface

L:_____ R:_____ Pubic Symphysis to Terminal Tip of Auricular

Facet

L:_____ R:_____ Pubic Symphysis to Posterior Superior Spine

L:_____ R:_____ Pubic Symphysis to Nearest Acetabular Border

L:_____ R:_____ Pubic Symphysis to Inferior Ischial Tuberosity

L:_____ R:_____ Pubic Length

L:_____ R:_____ Ischial Length

L:_____ R:_____ Acetabulum to Posterior Superior Line

L:_____ R:_____ Acetabulum to Posterior Inferior Spine

L:_____ R:_____ Acetabulum to Anterior Superior Spine

L:_____ R:_____ Acetabulum to Anterior Inferior Spine

L:_____ R:_____ Maximum Diameter of Acetabulum

L:_____ R:_____ Maximum Length of Auricular Surface

L:_____ R:_____ Auricular Surface to Mid-Sciatic Notch

L:_____ R:_____ Auricular Surface to Acetabular Border

L:_____ R:_____ Auricular Surface to Anterior Superior Spine

L:_____ R:_____ Auricular Surface to Anterior Inferior Spine

L:_____ R:_____ Auricular Surface to Posterior Superior Spine

L:_____ R:_____ Auricular Surface to Term. Tip of Auricular

Surface

L:_____ R:_____ Inferior Iliac Breadth

L:_____ R:_____ Superior Iliac Breadth

L:_____ R:_____ Middle Width of Pubis

L:_____ R:_____ Height of Obturator Foramen

L: _____ R: _____ Width of Obturator Foramen
L: _____ R: _____ Length of Ischial Tuberosity
L: _____ R: _____ Breadth of Ischial Tuberosity
L: _____ R: _____ Sciatic Notch Subtense
L: _____ R: _____ Sciatic Notch Fraction
L: _____ R: _____ Anterior Border Breadth (Ant. Border Chord)

L: _____ R: _____ Anterior Border Subtense

L: _____ R: _____ Anterior Border Fraction

Articulated Pelvis Measurements

Sacrum

_____	Mid-Ventral Straight Length
_____	Sacral Subtense
_____	Sacral Fraction
_____	Anterior Straight Breadth
_____	Transverse Diameter of First Sacral Vertebra
_____	Anteroposterior Diameter of First Sacral Vertebra
_____	Basal Width

(String stretched across proximal and distal anterior borders for Sacral Subtense and Sacral Fractions)

NON-METRIC CRANIAL TRAITS

"A" = Absent "P" = Present "NA" = Not Available

- L: _____ R: _____ Accessory Infraorbital Foramen
L: _____ R: _____ Accessory Lesser Palatine Foramen
L: _____ R: _____ Accessory Mandibular Foramen
L: _____ R: _____ Accessory Zygo-Facial Foramen
L: _____ R: _____ Anterior Condylar Canal Double (Hypoglossal
Canal Double)
L: _____ R: _____ Anterior Ethmoid Foramen Extra-Sutural
L: _____ R: _____ Asterionic Ossicle
L: _____ R: _____ Auditory Torus
_____ Bregmatic Ossicle (Bregmatic Bone)
L: _____ R: _____ Canaliculus Innominatus
L: _____ R: _____ Carotico-Clinoid Foramen
L: _____ R: _____ Clino-Clinoid Bridge
L: _____ R: _____ Condylar Facet Double
L: _____ R: _____ Coronal Ossicle
L: _____ R: _____ Digastric Groove Double
L: _____ R: _____ Double Mental Foramen
L: _____ R: _____ Epiteric Bones
L: _____ R: _____ External Frontal Sulcus
L: _____ R: _____ Foramen of Huschke (Dehiscence)
L: _____ R: _____ Foramen Ovale Incomplete
L: _____ R: _____ Foramen Ovale Open
L: _____ R: _____ Foramen Spinosum Open
L: _____ R: _____ Foramen of Vesalius
L: _____ R: _____ Frontal Foramen
L: _____ R: _____ Frontal Notch/Foramen (are actual foramina)
L: _____ R: _____ Fronto-Temporal Articulation
L: _____ R: _____ Highest Nuchal Line
L: _____ R: _____ Infra-Orbital Foramen
L: _____ R: _____ Lacrimal Foramen
L: _____ R: _____ Lambdoid Ossicle
L: _____ R: _____ Mandibular Foramen Double
L: _____ R: _____ Mandibular Torus
L: _____ R: _____ Mastoid Foramen
L: _____ R: _____ Mastoid Foramen Extra-Sutural
L: _____ R: _____ Maxillary Torus (Malar Tubercle)
_____ Metopic Suture
L: _____ R: _____ Mylo-Hyoid Bridge
_____ Os Inca
L: _____ R: _____ Os Japonicum
_____ Ossicle at Lambda
L: _____ R: _____ Ossicle in Mastoid Suture (Riolan's Ossicle)
L: _____ R: _____ Oval Window (Visible= V, Not Visible= NV)
_____ Palatal Suture Shape

_____ Palatine Torus

L: _____ R: _____ Para-Mastoid Process

L: _____ R: _____ Parietal Foramen

L: _____ R: _____ Parietal Notch Bone

L: _____ R: _____ Petrosquamous Suture

_____ Pharyngeal Fossa

L: _____ R: _____ Posterior Condylar Canal

L: _____ R: _____ Posterior Ethmoid Foramen

L: _____ R: _____ Posterior Malar Foramen

L: _____ R: _____ Precondylar Tubercle

L: _____ R: _____ Pterion Form

L: _____ R: _____ Pterygo-Alar Foramen of Hyrtl

_____ Sagittal Ossicles

L: _____ R: _____ Spine of Henle

L: _____ R: _____ Stylomastoid Foramen

_____ Superior Sagittal Sinus Turns Left

L: _____ R: _____ Supraorbital Foramen

L: _____ R: _____ Supraorbital Notch

L: _____ R: _____ Supratrochlear Spur

L: _____ R: _____ Sutures into the Infraorbital Foramen

L: _____ R: _____ Temporo-squamous Ossicles

L: _____ R: _____ Zygomatico-facial Foramen

L: _____ R: _____ Zygo-maxillary Tuberosity

L: _____ R: _____ Zygo-Root Foramen

HERITABILITY

The concept of heritability was originally developed by Jay L. Lush and Kenneth Mather (Lerner and Libby, 1976: 180-181). It has carried three different meanings. Heritability has been considered as the degree of genetic control of the development of a character, as the ratio of genetically caused variability to total variability of a character in a population, and as a measure of genetic response to selection.

The variability of a quantitative character measured in a population will come from two, and possibly three, sources

Hartl (1985: 404) distinguishes between narrow-sense heritability and broad-sense heritability thusly:

... the broad-sense heritability refers to the proportion of the phenotypic variation in a population that can be attributed to all genetic differences among individuals; the narrow-sense heritability refers only to the proportion of the phenotypic variation that is transmissible and so is reflected in the offspring-midparent similarity. (Midparent refers to the average of the phenotypes of the parents.) Consequently, for purposes of partitioning phenotypic variation into genetic (including both transmissible and nontransmissible sources) and environmental components, the broad-sense heritability is important. On the other hand, for purposes of predicting the offspring mean based on the parental mean, the narrow-sense heritability is important.

Hartl, Daniel L. 1985 Our Uncertain Heritage: Genetics and Human Diversity. Harper & Row, Publishers, New York.

NARROW SENSE

BROAD SENSE

STATURE

CONCEPTUAL AND OPERATIONAL DEFINITIONS

COMPONENTS OF STATURE

HERITABILITY OF STATURE

MEASURING STATURE

SOURCES OF MEASUREMENT ERROR

THE HUMAN GROWTH CURVE

PRENATAL
POSTNATAL
ADOLESCENCE
STATURE AND AGING

FACTORS INFLUENCING GROWTH

THE SECULAR TREND IN STATURE

Trotter and Gleser (1951) looked at temporal changes in stature using the Terry Collection and data on military personnel.

WORLD WAR II STUDIES

POPULATION VARIATION IN STATURE

STATURE AND BODY PROPORTIONS

PREDICTING STATURE

The estimation of stature from long bone measurements began in 1888 when Rollet

Rollet, F. 1899 De la mensuration de os longs du membres. Thesis pour le doc. en med., 1st series, 43:1-128, Paris.

reported tables for estimating stature from the lengths of the humerus, radius, ulna, femur, tibia and fibula. The sample consisted of 50 male and 50 female French cadavera. Rollet reports a 2mm difference in repeated measures of bones in the fresh state and in the dry state.

Manouvrier,

Manouvrier, L 1892 Determination de la taille d'apres les grands os des membres. Rev. Mem. de L'Ecole d'Anthr. 2:227-233.

Manouvrier, L. 1893 Determination de la taille d'apres les grands os des membres. Mem. Soc. d'Anthr 2e ser. 4:347-402.

reanalyzed Rollet's data, excluding subjects (26 males and 25 females) over 60 years old. Manouvrier's analysis differed from Rollet's in that Manouvrier " ... determined the average stature of individuals who presented the same length for a given long bone; Rollet determined the average length of a given long bone from individuals with the same stature.

Pearson (1899) used Rollet's data to produce his regression equations.

Pearson, Karl 1899 mathematical contributions to the theory of evolution. V On the reconstruction of the stature of prehistoric races. Phil. Trans. Roy. Soc. London., 192:169-244.

These are reproduced in the following table.

Pearson's Equations for Estimating Living Stature from Dead Long Bones. (Probable errors (cm.) in parentheses)

White (French) Males

Stature (.3047)= 81.306 + 1.880 F

(.3056)= 70.641 + 2.894 H

(.3275)= 78.664 + 2.376 T

(.3728)= 85.925 + 3.271 R

(.2835)= 71.272 + 1.159 (F + T)

(.2845)= 71.443 + 1.120 F + 1.080 T

(.3139)= 66.855 + 1.730 (H + R)

(.3054)= 69.788 + 2.769 H + .195 R

(.2750)= 68.397 + 1.030 F + 1.557 H

(.2748)= 67.049 + .913 F + .600 T + 1.225 H - .187 R

White (French) Females

Stature (.3058)= 72.844 + 1.945 F

(.3284)= 71.474 + 2.754 H

(.3146)= 74.774 + 2.353 T

(.3816)= 81.224 + 3.343 R

(.2898)= 69.154 + 1.126 (F + T)

(.2922)= 69.561 + 1.117 F + 1.125 T

(.3380)= 69.911 + 1.628 (H + R)

(.3279)= 70.542 + 2.582 H + .281 R

(.2971)= 67.435 + 1.339 F + 1.027 H

(.2836)= 67.469 + .782 F + 1.120 T + 1.059 H - .711 R

DUPERTIUS

TROTTER AND GLESER

Means (standard errors), standard deviations, and coefficients of correlation (with standard errors) of stature and long bone measurements (cm) of military Whites males*

	Mean (s.e)	S.D.	r (.s.e)
Age	23.140 (.180)	4.31	
Stature	174.035 (.244)	6.510	
Humerus	33.652 (.062)	1.653	.783 (.015)
Radius	25.139 (.048)	1.287	.748 (.017)
Ulna	27.024 (.052)	1.317	.749 (.016)
Femur	46.971 (.087)	2.328	.865 (.009)
Femur (max)	47.322 (.089)	2.365	.865 (.009)
Tibia (max)	37.865 (.083)	2.214	.856 (.010)
Tibia	36.897 (.082)	2.162	.862 (.010)
Fibula	38.153 (.087)	2.095	.863 (.010)
For ulna, N=644; fibula N=580; all others N=710.			

From Trotter and Gleser 1952 Table 5 and Table 8.

Means (standard errors), standard deviations, correlation coefficients, and (standard errors) for male Negro military samples

	Mean (s.e)	s.d.	r (s.e)
Age	25.070 (.680)	4.980	
Stature	172.110 (.843)	6.139	
Humerus (79)	33.757 (.157)	1.392	.716 (.055)
Radius (74)	26.443 (.149)	1.279	.713 (.058)
Ulna (68)	28.426 (.167)	1.377	.712 (.060)
Femur (80)	47.845 (.247)	2.209	.769 (.046)
Femur (m) (80)	48.235 (.251)	2.246	.768 (.046)
Tibia (m) (79)	39.485 (.261)	2.323	.803 (.038)
Tibia (79)	38.554 (.262)	2.331	.799 (.041)

Fibula (68)	39.799 (.265)	2.219	.766 (.050)
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From Trotter and Gleser 1952 Table 7 and p. 484.

Means (standard errors), standard deviations, correlation coefficients, and (standard errors) for male Mongloid military samples

	Mean (s.e)	s.d.	r
Age			
Stature	168.730 (.688)	6.597*	
Humerus	31.768 (.216)	1.857	.756
Radius	24.547 (.182)	1.497	.756
Ulna	26.251 (.190)	1.535	.743
Femur	44.246 (.303)	2.479	.802
Tibia	36.038 (.254)	2.092	.840
Fibula	36.146 (.278)	2.170	.851

* estimated

From Trotter and Gleser 1958 Table 2 and 3
Values in the table are for the right limbs only.

Means (standard errors), standard deviations, correlation coefficients, and (standard errors) for male Mexican military samples.

	Mean (s.e.)	s.d.	r
Age			
Stature	168.650 (.617)	6.534*	
Humerus	32.450 (.236)	1.801	.786
Radius	24.730 (.169)	1.266	.761
Ulna	26.682 (.178)	1.344	.795
Femur	45.138 (.324)	2.316	.874
Tibia	37.300 (.330)	2.356	.833
Fibula	37.154 (.308)	2.221	.856

Tambs, Kristian, Torbjorn Moum, Lindon J. Eaves, Mike C. Neale, Kristian Midthjell, Per G. Lund-Larsen, and Siri Naess 1992 Genetic and Environmental Contributions to the Variance of Body Height in a Sample of First and Second Degree Relatives. *American Journal of Physical Anthropology* 88(3):285-294.

Pearson and Lee's 1903 study of the inheritance of stature in first degree relatives suggested almost perfect additive heredity. Other studies on twins have shown variable results. Some (Feinleb et al., 1977; Fishbein, 1977; Langinvainio et al., 1984) suggest heritabilities close to unity, while others (Clark et al., 1980; Bupae et al., 1982; Pedersen et al., 1984) show significant environmental factors influencing adult stature. Adoption studies (Garn et al., 1976, 1979; Annett et al., 1983), nuclear family studies (Kaur and Singh, 1981; Solomon et al., 1983; Byard et al., 1983a; Province and Rao, 1985; Devor et al., 1986; Hutchinson and Byard, 1987, Byard et al., 198; Kuh and Wadsworth, 1989), and studies including relationships among subjects (Roberts et al., 1978; Hawk and Brook, 1979; Byard et al., 1983b; Byard et al., 1984; Heller et al., 1984; Sharma et al., 1984; Corey et al., 1986) also indicate an effect from individual and/or family environment. On the average a 30% individual (independent of family) variance is indicated.

All studies support the idea of a large effect from additive inheritance and a smaller individual environmental effect. There is, so far, no evidence for sex-specific genes or environmental factors or a genotype environment interaction. (Tambs et al., 1992)

Materials and Methods

The entire adult population of the Norwegian county of Nord-Trondelag was screened between 1984 and 1986 yielding a sample of 74,395 subjects.

First degree relationships (parents, offspring, siblings) were identified for all subjects through the Norwegian Central Bureau of Statistics. Identification of twins was done through the Norwegian Twin Registry. Second degree relationships (avuncular relations, cousins, grandparents, and grandchildren) were identified through knowledge of first degree relationships. Cousins related through MZ parents are related as half-sibs. MZ parents are as related to their cotwins's offspring as their own.

Tambs et al (1992) Table 1 shows the means, standard deviations, and sample sizes for 5 year age cohorts for over a sixty year period. There are large mean increases over the early years sampled (about 2 cm/decade), but the younger age groups show age increases close to zero.

TABLE 1. Means and standard deviations for height (cm) in different age groups.

Birth Year	Males				Females		
	Mean	SD	N	Mean	SD	N	
Before 1900	169.8	6.4	377	155.4	5.8	485	
1900-04		169.9	6.3	811	156.3	5.5	1065

1905-09	170.8	6.0	1506	157.6	5.7	1896
1910-14	171.9	6.0	2321	158.5	5.5	2604
1915-19	173.3	6.1	2787	159.6	5.6	3010
1920-24	173.9	6.0	3237	161.0	5.6	3245
1925-29	174.9	5.9	2956	162.0	5.5	2959
1930-34	176.0	6.0	2659	162.7	5.5	2664
1935-39	177.0	6.1	2596	164.1	5.4	2643
1940-44	177.8	6.1	3316	164.8	5.5	3369
1945-49	178.4	6.4	4166	165.5	5.6	4068
1950-54	178.7	6.2	3853	165.7	5.6	3944
1955-59	179.3	6.2	3344	165.7	5.7	3404
1960-65	179.3	6.5	2608	166.1	5.9	2502
Total	176.2	6.8	36537	162.8	6.4	37858

TABLE 2. Age and sex adjusted correlations for height in person mothers and fathers.*

related through

Relationship	r	Pairs
.179	24281	Spouses
MZ Twins Total		.879 41
DZ Twins (like sexed)	.473	92
Parent Offspring Total	.469	43613
Siblings Total	.453	19168
Grandparent-Grandchild Total	.250	1318
Avuncular Total	.217	1218
Cousins		.209 112

*abbreviated from Tambs et al. 1992

Several (17) models of inheritance are fit to the correlations. In the best fitting models "[t]he proportions of additive genetic variances, h-squared or "narrow" heritability, vary from 0.76... to ... 0.83. Proportions of variance due to genetic dominance, d-squared, vary from 0 to 0.138... and proportions of total genetic effect, h-squared + d-squared or "broad" heritability, vary from 0.78... to ...0.90. The estimates of sibling effects, s-squared, never exceed 0.02." (Tambs et al., 1992;291)

"The results demonstrate that even with height, which is fairly stable during adult life, correlations between relatives from different generations may be reduced by age or cohort effects. It is not clear whether and to what extent the reduced correlations reflect stature loss due to environmental or genetic factors not associated with growth, or whether the reduction is entirely due to cohort effect." (Tambs et al. 1992:291-292.)

EXERCISES #3 Mass Parameters and the Anthropometric Fractionization of Body Weight

Behnke (1963) has developed a descriptive technique for mathematically fractionating the human body. The technique relies on a set of circumferences and diameters that are easily obtained with simple anthropometric instruments.

Basically, the technique uses a circumference measure from each of eleven body regions to estimate "mass parameters" for these regions.

Let's begin with the concept of a 'mass parameter' There are several types of mass parameters used in anthropometric research. You are already familiar with the ponderal index. Behnke uses another weight/height ratio he calls **F**, defined as

$$\mathbf{F} = (\mathbf{W}/\mathbf{H})^{.5} \quad (1)$$

where weight is expressed in kilograms and height in decimeters.

This relation yields an easily understood image of total body mass. Rearranging equation 1 by squaring both sides and multiplying by H yields

$$\mathbf{F}^2 * \mathbf{H} = \mathbf{W} \quad (2)$$

In visual terms, the equation represents the mass (or volume) of a rectangular column with a square base of dimension **F** and a height of H decimeters.

The mass of the body may be represent by this column, $\mathbf{F}^2 * \mathbf{H} = \mathbf{W}$, \mathbf{F}^2 is in kg/dm and H is in decimeters.

Behnke's approach utilizes this concept of a mass parameter but assigns an individual mass parameter to each circumference so that the pattern of deviations from symmetry is revealed.

The fractionated mass parameters, called "d-values", are transforms of the circumferences. Specifically, they are quotients obtained by dividing each circumference by a constant which is derived from reference values linking the circumferences to height and weight.

Let's say we want to convert a circumference, c into a mass parameter, d, by division by a constant

$$c/k = d \quad (3)$$

We also want to have d related to weight through height, so that

$$d^2 * H = W \quad (4)$$

and d holds an analogous position to **F** in equation (2).

How do we find these constants. By substituting c/k for d in the new mass relation we get

$$(c^2/k^2) * H = W \quad (5)$$

Rearranging terms yields

$$(\text{Mean}(c)^2 * \text{Mean}(h) / \text{Mean}(W)) = k$$

Another avenue to k is

$$\text{Mean}(c) / \text{Mean}(F) = k \quad (7)$$

Still another view shows k as the percentage a given circumference is of the sum of the eleven measures.

$$\text{Mean}(c) / \text{Sum}(\text{Mean}(c)) = k \quad (9)$$

Behnke (1963) categorizes the eleven d-values into three groups; A, B, and C.

FAT

$$\text{Mean}(d(A)) = d(\text{abd}) + d(\text{but}) + d(\text{chest}) \text{ (for fat persons)} \quad (10)$$

MUSCLE

$$\text{Mean}(d(B)) = d(\text{sh}) + d(\text{bi}) + d(\text{forearm}) + d(\text{calf}) + d(\text{thigh}) + d(\text{chest}) \text{ (in lean people)} \quad (11)$$

BONE

$$\text{Mean}(d(C)) = d(\text{wrist}) + d(\text{knee}) + d(\text{ankle}) \quad (12)$$

PROCEDURES

1. Find four volunteers to serve as subjects. Two males and two females. Describe the project to them and what measurements you will be taking.
2. Measure each of the variables described below on each subject.

Shoulders Maximal protrusion of the bi-deltoid muscles and the prominence of the sternum at the junction of the second rib.

Chest For men about one inch above the nipple line; for women at the axillary level. Tape is placed in position with the subjects arms abducted to the horizontal position. The arms are then lowered. Measurement is recorded at mid-tidal level of respiration.

Abdomen The average of the following two measures:

1. Abdomen 1 Just below the rib cage at minimum value.
2. Abdomen 2 At the level of the iliacs at the navel.

Buttocks Maximal protrusion and, anteriorly at symphysis pubis. Subject stands with heels together.

Thighs Crotch level at the gluteal fold.

Biceps Maximal circumference with the arm flexed and fist clenched.

Forearms Maximal circumference when the arm is extended with palm up.

Wrists The circumference distal to the styloid processes of the radius and ulna.

Knees At the middle of the patella with the knee relaxed in slight flexion.

Ankles Minimal circumference, usually in proximity to the malleoli.

Stature Measured to the nearest decimeter with subject supported from the mastoids.

Weight Measured to the nearest .1 kilogram.

Age To nearest year.

3. Submit results to be assembled into a database for the entire sample.

SOMATOGRAM DATASHEET

DATE:

OBSERVER:

SUBJECT ID:

AGE:

HEIGHT:

WEIGHT: lbs. kg.

GIRTHS (cms):	DIAMETERS (cms):
Shoulders _____	Bi-acromial _____
Chest _____	Chest _____
Upper Waist _____	Biiliac _____
Lower Waist _____	Bitrochanteric _____
Buttocks _____	
R. Thigh _____	R. Knee _____
R. Knee _____	R. Ankle _____
R. Calf _____	
R. Ankle _____	L. Knee _____
	L. Ankle _____
L. Thigh _____	
L. Knee _____	R. Elbow _____
L. Calf _____	R. Wrist _____
L. Ankle _____	
	L. Elbow _____
R. Biceps _____	L. Wrist _____
R. Forearm _____	
R. Wrist _____	
L. Biceps _____	
L. Forearm _____	
L. Wrist _____	

**ANT 230
ANTHROPOMETRICS**

**EVALUATION FORM
EXERCISES #3**

1. TABULATIONS AND DISPLAYS

1.1 Clarity of Labels	1	2	3	4	5	
1.2 Descriptive Quality of Titles	1	2	3	4	5	
1.3 Appropriate Format		1	2	3	4	5

Total _____

2. DESCRIPTIVE STATISTICS

2.1 Accuracy of Means		1	2	3	4	5
2.2 Accuracy of Standard Deviations	1	2	3	4	5	
2.3 Accuracy of Coefficients of Var.	1	2	3	4	5	

Total _____

3. DESCRIPTION OF MEASUREMENT PROTOCOLS

3.1 Quality		1	2	3	4	5
3.2 Completeness		1	2	3	4	5
3.3 Accuracy		1	2	3	4	5

Total _____

4. DESCRIPTIVE SUMMARY

4.1 Quality		1	2	3	4	5
4.2 Completeness		1	2	3	4	5
4.3 Accuracy		1	2	3	4	5

Total _____

5. INTERPRETIVE SUMMARY

5.1 Quality		1	2	3	4	5
5.2 Completeness		1	2	3	4	5
5.3 Accuracy		1	2	3	4	5

Total _____

Grand Total _____

Assessing Sexual Dimorphism in Body Shape

This exercise will compare via t-test the mass parameters of body segments and mass parameter indices of muscle, fat, and bone components between the sexes of the sample data collected in exercise #3.

1. Tabulate the means, standard deviations, and coefficients of variation for each sex for the eleven circumferences, F, D(avg), D(Muscle), D(Fat), D(Bone).
2. Compose a title for the table that describes its contents.
3. Draw a frequency distribution of F incorporating both sexes.
4. Compose text to describe the statistical summaries in these displays.
5. Draw a figure displaying the somatogram for male and female averages.
6. Draw a figure showing means, standard errors, 95% confidence intervals for each sex and the t value for comparisons between the sexes.
7. Compose a summary of these tests.

**ANT 230
ANTHROPOMETRICS**

**EVALUATION FORM
EXERCISE #3**

1. TABULATIONS AND DISPLAYS

1.1 Clarity of Labels	1	2	3	4	5
1.2 Descriptive Quality of Titles	1	2	3	4	5
1.3 Appropriate Format	1	2	3	4	5

Total _____

2. DESCRIPTIVE STATISTICS

2.1 Accuracy of Means	1	2	3	4	5
2.2 Accuracy of Standard Deviations	1	2	3	4	5
2.3 Accuracy of Coefficients of Var.	1	2	3	4	5

Total _____

3. DESCRIPTION OF MEASUREMENT PROTOCOLS

3.1 Quality	1	2	3	4	5
3.2 Completeness	1	2	3	4	5
3.3 Accuracy	1	2	3	4	5

Total _____

4. DESCRIPTIVE SUMMARY

4.1 Quality	1	2	3	4	5
4.2 Completeness	1	2	3	4	5
4.3 Accuracy	1	2	3	4	5

Total _____

5. INTERPRETIVE SUMMARY

5.1 Quality	1	2	3	4	5
5.2 Completeness	1	2	3	4	5
5.3 Accuracy	1	2	3	4	5

Total _____

Grand Total _____

COMMENTS:

ENERGY BUDGET

ENERGY OUTPUT ESTIMATE FORM

DATE: _____

NAME: _____

HEIGHT ___ IN. ___ CM. WEIGHT ___ LBS. ___ KG.

ACTIVITY	KCAL/ MIN/K G					TOT
VERY HEAVY						
RUNNING 8 MIN PER MILE	0.208					
VERY HEAVY SUBTOTAL						
HEAVY						
RACKETBALL	0.178					
CYCLING RACING	0.169					
DANCING LEISURE	0.168					
SWIMMING, BREAST STROKE	0.162					
DIGGING TRENCHES	0.145					
BASKETBALL	0.138					
AEROBICS	0.135					
FOOTBALL	0.132					
CLIMBING HILLS (5KG LOAD)	0.129					
GARDENING DIGGING	0.126					
CLIMBING HILLS (NO LOAD)	0.121					
HEAVY SUBTOTAL						
MODERATE						
GARDENING MOWING	0.112					
SCRUBBING FLOORS (F)	0.109					
TENNIS	0.109					
SCRUBBING FLOORS (M)	0.108					
NAUTILUS	0.092					
FREE WEIGHTS	0.086					
WALKING ASPHALT	0.080					
GARDENING HEDGING	0.077					
MODERATE SUBTOTAL						
LIGHT						
GYMNASTICS	0.066					
CLEANING (F)	0.062					
MOPPING FLOOR (F)	0.062					
FOOD SHOPPING (F)	0.062					
WINDOW CLEANING (F)	0.059					
MOPPING FLOOR (M)	0.058					
CLEANING (M)	0.058					
WINDOW CLEANING (M)	0.058					
FOOD SHOPPING (M)	0.058					

GARDENING RAKING	0.054					
DANCING BALLROOM	0.051					
CARPET SWEEPING (M)	0.048					
COOKING	0.048					
COOKING (F)	0.045					
CARPET SWEEPING (F)	0.045					
BILLIARDS	0.042					
PIANO	0.040					
DRAWING, STANDING	0.036					
WRITING SITTING	0.029					
TYPING	0.027					
STANDING QUIETLY (M)	0.027					
CARD PLAYING	0.025					
STANDING QUIETLY (F)	0.025					
EATING (SITTING)	0.023					
LYING AT EASE	0.022					
SITTING QUIETLY	0.021					
SLEEPING						
LIGHT SUBTOTAL						
TOTALS (MINS=1440), (KCAL/KG)						

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