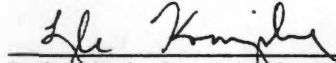
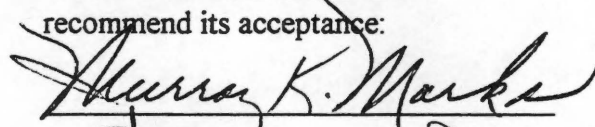
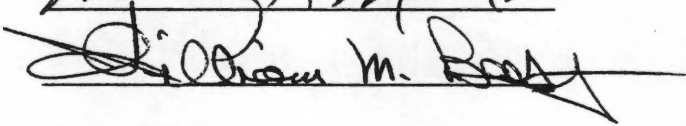


To the Graduate Council:

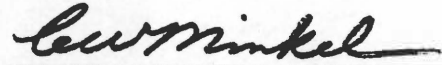
I am submitting herewith a thesis written by Eldred L. Pierce entitled "Multiple Regression of Body Weight on Stature and Waist for Estimation in Forensic Anthropology." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.


Lyle Konigsberg, Major Professor

We have read this thesis and
recommend its acceptance:

Accepted for the Council:


Associate Vice Chancellor and
Dean of the Graduate School

**Multiple Regression Of Weight On
Stature And Waist For Estimation
In Forensic Anthropology**

**A Thesis
Presented for the
Master of Arts
Degree
The University of Tennessee, Knoxville**

**Eldred L. Pierce, Jr.
August 1999**

DEDICATION

This thesis is dedicated to my wife

Melinda Barrett Pierce

and my daughter

Amanda Lea Pierce

both of whom bring great joy to my life

ACKNOWLEDGEMENTS

There have been many people who had an early influence on my career as an anthropologist. First I would like to thank Dr. Harry Holstein, Dr. James Sewastanowicz, and Chris Hill for their guidance and patience with me as a young undergraduate. I would also like to thank Ms. Linda Hopkins and Dr. Ron Young for passing on their knowledge in my undergraduate major, which was the Biological Sciences.

For my graduate training in Anthropology, I owe a debt to Dr. Lyle Konigsberg, Dr. Murry Marks, and Dr. William Bass. I also appreciate all of the training in archaeology that I gained from Dr. William Faulkner and Dr. Walter Klippel. I hope that my career in Anthropology and Forensic Science will be a credit to both my undergraduate and graduate departments.

ABSTRACT

Questions have been present in the forensic literature for many years about the most proper and accurate method for calculation of human body weight. Many have tried and failed to measure aspects of the human skeleton and find some correlation with body weight at the time of death. This has never been possible and selected skeletal measurements regressed against known weight will bear this out. Simple measurements of the femur were regressed with weight and with stature to show that skeletal measurements in general have a higher correlation with stature than with weight. The bulk of this thesis will deal with comparison of five methods of weight regression. Body weight from a skeletal data set, the Terry collection, and a living data set, was regressed with five sets of parameters to see which method would prove to be most accurate. The multiple regression of weight on stature and waist proved to be superior and more accurate than regression with stature alone, waist alone, age, or a more obscure parameter called the index of obesity. Multiple regression proved to have the highest R^2 overall for the five regression methods.

PREFACE

Originally it was hoped that data from the William M. Bass III donated skeletal collection could be used in this thesis. Many of the skeletons have had autopsies and have a recorded body weight. Most have race, age, and other vital data as well. The one missing element, which was not found on any data sheet from this collection, was a recorded waist circumference measurement. Because of this, no data from the Bass donated collection could be used.

Chapter I is the introduction to this thesis and will begin discussion of the central question at hand, how do you estimate body weight from the human skeleton? An explanation of how I started my investigation of the problem and how I found a solution will be presented. Objectives for how the problem of weight estimation will be accomplished will be presented.

Chapter II will present a brief review of the literature surrounding estimation of human body weight. Sources from the Anthropological, Forensic, and Medical literature are mentioned to give the reader a feel for what has been done in the past and perhaps where the research seems to be headed. A brief formal definition of waist will be further added to in the materials and methods on how waist was measured.

Chapter III will give the materials and methods used in this thesis to obtain the needed measurements, analysis, and conclusions. The two data sets will be presented in this section along with why each was used. The Terry skeletal collection provides measurements from cadavers and a data set from the living serves as a comparison.

Both sets of data will show that forensic weight can be estimated using the same methods on two very different types of samples.

Chapter IV is the results section and will show how the data was analyzed, graphed, and grouped for comparison. This chapter is subdivided into three sections: Terry skeletal measurements, Terry cadaver measurements, and Living body measurements. All analysis of the results will be summed up in Chapter V, the conclusions. Raw data for both of the data sets is located in appendices at the end of this thesis.

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CHAPTER I

INTRODUCTION

We have all seen the gentleman in the carnival side show who, for a small fee, will guess your age within a given range of years and your weight to the nearest, let us say 10 pounds. If he gets it right, he keeps your money. If he gets it wrong, you get some sort of prize. As campy as this example sounds, he really has it easy when he makes his estimate.

He has all of the flesh, hair, wrinkles, and other clues to help make an accurate guess. What would he say if you asked him to do the same thing on a skeleton? He could not be anywhere near as accurate on the dead as he could be on the living. But, a physical anthropologist could tell you a lot from just a skeleton. This is not to suggest that an anthropologist should be equated with a carnival side show performer.

For all of the things that a physical anthropologist can predict with reasonable accuracy from the skeleton, the statistic of human body weight has continued to be elusive. The ideal situation would be to find a single bone or measurements on that bone which changes in response to changes in body weight. This would mean that bone would have to remodel at a fast enough rate to keep up with loss and gain of weight. However, this will not work because bone remodels and reshapes itself much too slowly to ever be reliable in this manner. Just because the skeleton has yet to offer a reliable correlation with weight does not mean that it will never be done, but it is not likely.

When this study began, I used a more traditional approach in my attempt to estimate forensic weight from the skeleton. It seemed logical that all weight in a standing

human body rests on the legs and feet. If measurements of these bones could be found to correlate reasonably well with weight, then the objective would be accomplished.

Unfortunately, all attempts to derive an accurate regression line between measurements of the femur, talus, and calcaneus with weight were unsuccessful. The first part of the conclusions will demonstrate this using measurements from the femur.

After becoming convinced that skeletal measurements would not provide a weight estimate, I was lead to try a statistical method involving the regression of body weight on stature and waist. The second part of the conclusions will discuss comparisons of several weight estimation methods. The statistical parameter R^2 was used to show which method is the most accurate. R^2 is a parameter that shows how well the generated regression line fits the data points, and must be between -1.0 and 1.0, with 0.0 indicating no correlation and 1.0 indicating perfect positive correlation. The square root of R^2 is the correlation coefficient (Iman, 1994). The method with the highest R^2 will be shown to be the best and most accurate method for estimation of forensic weight.

The estimation of weight is not the most exciting topic of discussion in forensic anthropology. Some laypersons may even avoid the discussion for fear that they may end up being asked to reveal their own body weight. One of the data sets in this thesis involved asking many ordinary people not only their weight, but a number of other potentially "taboo" personal statistics. In any case, the more widely researched topics of race, age, sex, and skeletal pathology have much more bearing on how an unknown body is identified. The body weight of a deceased individual is seldom discussed in the literature, but enough has been written to give a brief overview of past research.

CHAPTER II

REVIEW OF THE LITERATURE

Many of the initial weight estimates from the human skeleton have been based on simple stature regression. The idea is to simply assume that as people get taller, they also get heavier. This has led to standardized charts constructed to show what a person should weigh for a given stature. Some have even used anthropological stature estimates based on skeletal remains to predict a given weight for an individual (Wells, 1969). Stature regression has also been used for hominid weight estimation (McHenry, 1992). This may work well as long as one assumes that the hominids in question had very little body fat and were very active. A variation of stature regression relies on an exponential equation with constants that change from one human racial group to another (Henneberg et al., 1989). The regression equation takes the form of :

$$\text{weight} = (\text{Constant 1})e^{(\text{Constant 2} * (\text{Stature}))} \text{ or } Y = ae^{bx}$$

This formula has been used on archaeological remains to calculate the body weight of pre-Roman skeletons in southern Italy (Henneberg et al., 1992).

The ideal regression formula for forensic weight of an individual would come from measurements taken directly from the skeleton. Most attempts have focused attention on the bones of the lower limbs. The femur has been recognized as one of the major weight bearing bones of the body and has thus been the subject of most studies. Efforts to correlate femoral head diameter, femoral neck width, and femoral shaft width have all met

with limited results. Simple regression of each of these variables in one study yielded correlation coefficients between 0.48 and 0.62 (Ruff et al., 1991). Femoral shaft width has also been studied in a forensic context to estimate the weight of children (Sciulli and Pfau, 1994). In archaeological contexts, femoral shaft width has been used to estimate weight and body size in prehistoric native Americans. This in turn has been used to comment on subsistence patterns (Larson et al., 1992). Moving inferiorly in the lower limbs, the feet have also been the focus of one study. Results to predict weight were found to have correlation coefficients between 0.17 and 0.48 based on measurements from the talus. Further, measurements were found to correlate more closely with stature (Huxley, 1992).

Dry weight estimates are done on dessicated or cremated remains. Mummies found in either cold or hot climates can fall into the former category. In all living organisms, the tissues are composed of about 70% water by weight (Lehninger et al., 1993). All or most of what remains of the body are the solid organic and inorganic tissues. From this assumption, mummified remains are assumed to represent the rest of the weight. Egyptian mummies have been given forensic weight estimates by assuming that the corpse is about 25- 30 % of the living weight (Reyman et al., 1998). The living weight of the Tyrolean Iceman of the European Alps was calculated using similar assumptions (Spindler, 1994). Dry weight estimates in one study of cremated remains found that cremains represent about 3.5% of total body weight in adults and about 2.5% in children (Warren and Maples, 1997).

Other weight estimation studies have recognized that tissue measurements are important in addition to skeletal measurements. The tissue measurement that seems to

work best for weight estimation comes from the waist region. One study (Kannel and Gordon, 1980) states that waist circumference is highly correlated with weight/stature². This relationship is referred to as a general index of obesity. Other waist measurements that may have been used to estimate weight have come from articles of clothing. Studies have been attempted to correlate pants and belt size to weight directly, but sources in the literature are scarce (Bass, pc 1999).

The problem with using waist as a variable in weight estimation is that the definition of waist measurement is somewhat unclear. Waist is defined as "the part of the body between the ribs and the hips". For our purposes the specific region that is measured as waist is actually the waistline, defined as " the line at the narrowest part of the waist " (Webster's, 1984: 671). The United States Army defines waist as the full circumference around the torso at the navel (Gordon et al., 1989). One anthropometric standards manual defines the 'waist circumference' measurement as the area of the narrowest part of the waist (Lohman et. al, 1991). The area that most people think of as waist is the highest point at which they wear a pair of pants or where they would put on a belt. This area of the waist region is referred to as the "natural waist"(Garret and Kennedy, 1971). More specifics on what constitutes a waist will be presented in the chapter on materials and methods.

CHAPTER III

METHODS AND MATERIALS

Two groups of data were used in this thesis, one taken from the living and the other from the dead. The Terry collection (Terry, 1940) contains data for the dead group. Data from the living group was taken for comparison with the same statistical methods. Most data was measured similarly to the Terry collection, but the method for obtaining waist measurement by Terry is unknown.

THE TERRY COLLECTION

In the early part of the twentieth century Robert J. Terry gathered a collection of donated bodies for anatomical and skeletal research. Most of the individuals that comprise this collection come from lower socio-economic classes (Kelley et al., 1994). This collection bears his name and is today housed in the Smithsonian Institution Museum of Natural History in Washington D.C.. Initially, measurements were made on the cadavers, then the bodies were macerated and the skeletal remains collected for storage. Each body was catalogued as to cause of death, age at death, occupation, and any other relevant life history information. Racial group, sex, stature, and even post-mortem weight were recorded on data sheets for most bodies.

The relevant information for this study are the categories of age, race, sex, stature,

weight, and waist circumference. Of the over 1600 bodies in the collection, a few hundred had body weights recorded. Only 201 of the bodies had a waist circumference recorded on data sheets. For the most part, all had stature, sex, and race recorded. Most bodies have age recorded, but in three categories: chronological, morgue, and anatomical age. For this thesis, only chronological age was used.

Only those individuals with a weight recorded were considered for use in this study. Of that number, the individuals with recorded waist circumferences were chosen for final consideration. The individuals with waist circumferences break down as 10 white females, 23 black females, 91 white males, and 76 black males. Unfortunately, Dr. Terry never clearly defines how he measured "waist circum" (Terry, 1940). Instead, we must assume that 'waist circum' was measured in the same way as waist circumference defined in standard anthropometric measurements. All data in its raw form is in metric units, so no conversion was necessary. The useful Terry collection data will be presented in the results section, then compared to data from living groups in the conclusions.

Information in each of the desired categories was obtained from either data sheets or computer files. In addition to this information, selected measurements were taken on the femurs of each of the 200 selected individuals. The femoral head widths and the femoral condyle widths were chosen for comparison to weight and stature. All measurements were made with standard calipers and an osteometric board according to standard data collection procedures (Moore-Jansen and Jantz, 1990). This was done to show that measurements taken on the skeleton will yield little or no correlation with weight, but may correlate better with stature.

DATA FROM LIVING PERSONS

After gathering usable data from the Terry collection, it was decided that data from contemporary living persons would be needed as well. This was done for two reasons. First of all, the birthdates of the people from the Terry collection are anywhere from the middle nineteenth to early twentieth century (Ubelaker, 1992). Any conclusions reached from data taken from the Terry collection would not be entirely applicable to people today. The second reason is that measurement of the waist is different for both data sets. As explained earlier, the method of waist measurement for the Terry collection is in question. Waist for the living data set was determined by the individual in question.

It was also made clear to each respondent in the living data set that if they could not provide truthful information, they should not participate in the study. Males were easy enough to get data from without too much explanation. Females on the other hand were given a full description of the purpose for this data. Everyone was assured that no names would appear in this thesis. Each individual was asked to provide four pieces of information. These included: age, weight, stature, and waist. Age was given as the current age in years on the day the person was asked. Weight was given to the nearest five pounds. If the person did not know, a simple bathroom scale measurement was sufficient.

Waist was determined by handing the person a tape measure and asking them to measure. When a few individuals asked exactly where to measure waist, they were told to measure it where they would wear a belt. When asked where they might put on a belt or pants, males and females will give differing answers. Personal conversations with female

participants revealed that they tend to wear pants up to the navel, while males tend to wear pants much lower. In the case of stature, most people knew it readily without consulting a driver's license or measuring.

Data for living individuals is presented in the same order as data for the Terry collection. All raw data was collected in feet, inches, and pounds. Data was converted to metric for direct comparison with Terry Collection data. Weight is the dependent variable, and the other three parameters are each used as the independent variable to show which of them best correlates with weight. All graphs of data and some of the calculations were done using Lotus 1-2-3 release 5. Additional calculations were done using SAS release 6.12, version 4.0.95. Statistics from each of the graphic representations will be compared to one another in the results section.

CHAPTER IV

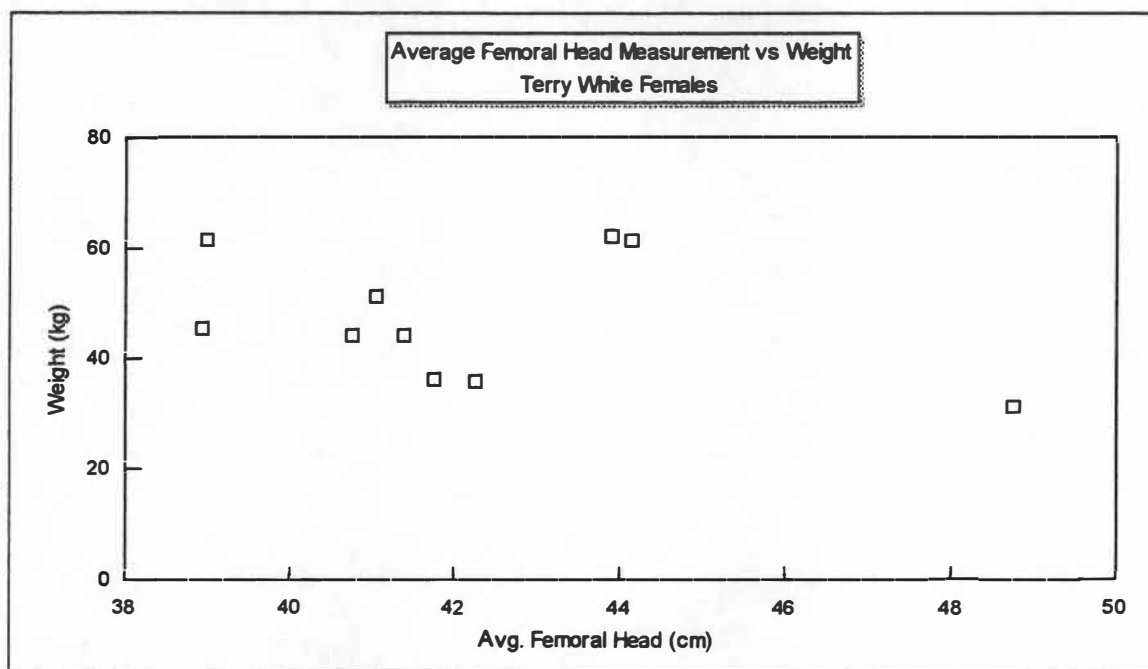
RESULTS

This chapter is subdivided into four major sections: Terry skeletal data, Terry cadaver measurements, Living body measurements, and Summary of statistics. Graphs and regression equations will constitute the bulk of what is presented in this chapter. The Terry skeletal measurements of femoral head and femoral condyle are regressed against body weight and stature separately. This was done to illustrate how effective, or ineffective, skeletal measurements are at estimating body weight. The purpose of the Terry cadaver measurement and Living body measurement graphs is to show how each of the parameters of waist, stature, and age regress against human body weight. All raw data for the Terry collection and for living persons is presented in appendices at the end of this thesis.

The first section is the Terry skeletal data. It will become apparent from the way the data points line up with weight and again with stature that skeletal measurements are not good estimators of human body weight. The graphic representations of each regression for femoral head measurements will be shown in Figures 1A through 1J. Graphic representations for femoral condyle measurements will be shown in Figures 2A through 2J. Terry skeletal data is available in appendix A at the end of this thesis. All measurements appear in centimeters.

TERRY SKELETAL MEASUREMENTS

Average femoral head measurement regressions



Model Equation

$$\text{Weight} = 95.4002 - 1.1376 * \text{Avg Head}$$

Summary of Fit

Mean of Response	47.4000	R-Square	0.0830
Root MSE	11.5554	Adj R-Sq	0.0

Analysis of Variance

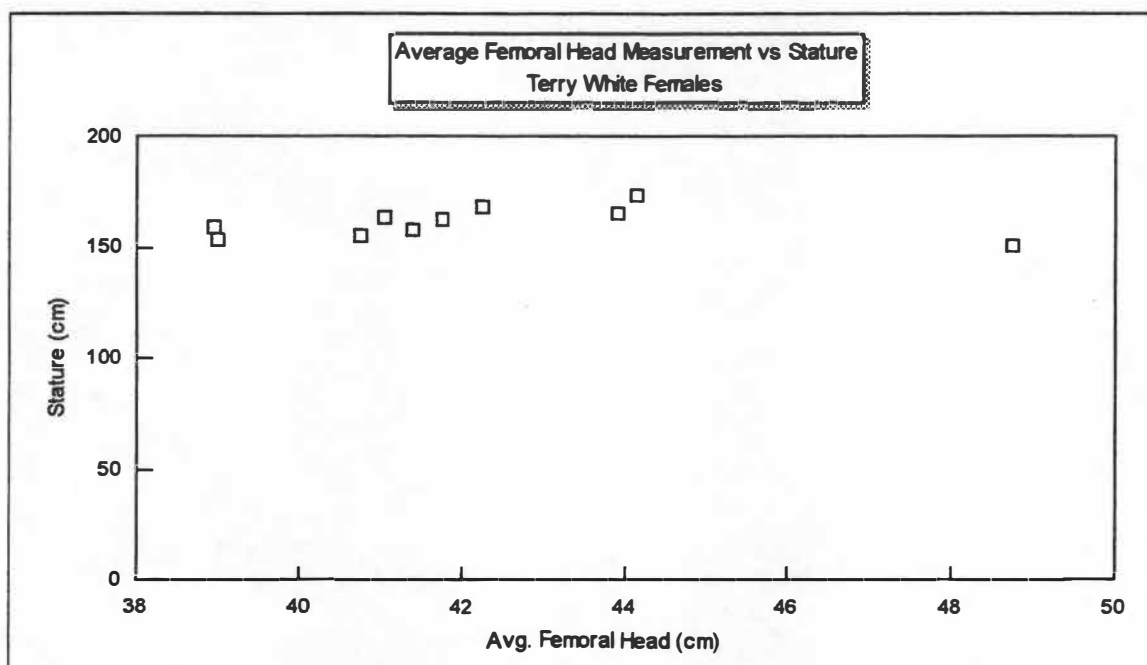
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	96.6261	96.6261	0.7236	0.4197
Error	8	1068.2139	133.5267		
C Total	9	1164.8400			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	95.4002	56.5443	1.6872	0.1301	-	0
Avg Head	1	-1.1376	1.3373	-0.8507	0.4197	1.0000	1.0000

A. Regression on weight for Terry white females

Figure 1. Average femoral head measurement against weight and stature.



Model Equation

$$\text{Stature} = 161.122 + 0.0042 * \text{Avg Head}$$

Summary of Fit

Mean of Response	161.3000	R-Square	3.1E -6
Root MSE	7.3109	Adj R-Sq	0.0

Analysis of Variance

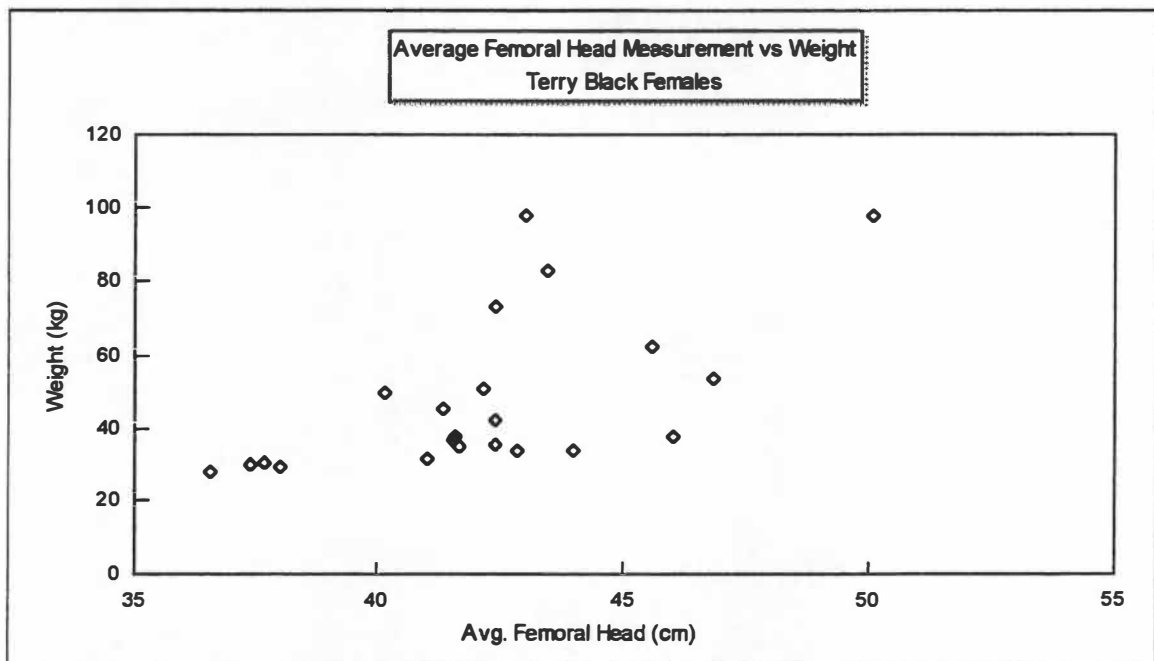
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	0.0013	0.0013	2.486E -5	0.9961
Error	8	427.5987	53.4498		
C Total	9	427.6000			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	161.1220	35.7749	4.5038	0.0020	-	0
Avg Head	1	0.0042	0.8461	0.0050	0.9961	1.0000	1.0000

B. Regression on stature for Terry white females

Figure 1 (Continued).



Model Equation

$$\text{Weight} = -121.996 + 4.0316 * \text{Avg Femoral Head}$$

Summary of Fit

Mean of Response	48.0818	R-Square	0.3596
Root MSE	17.7459	Adj R-Sq	0.3276

Analysis of Variance

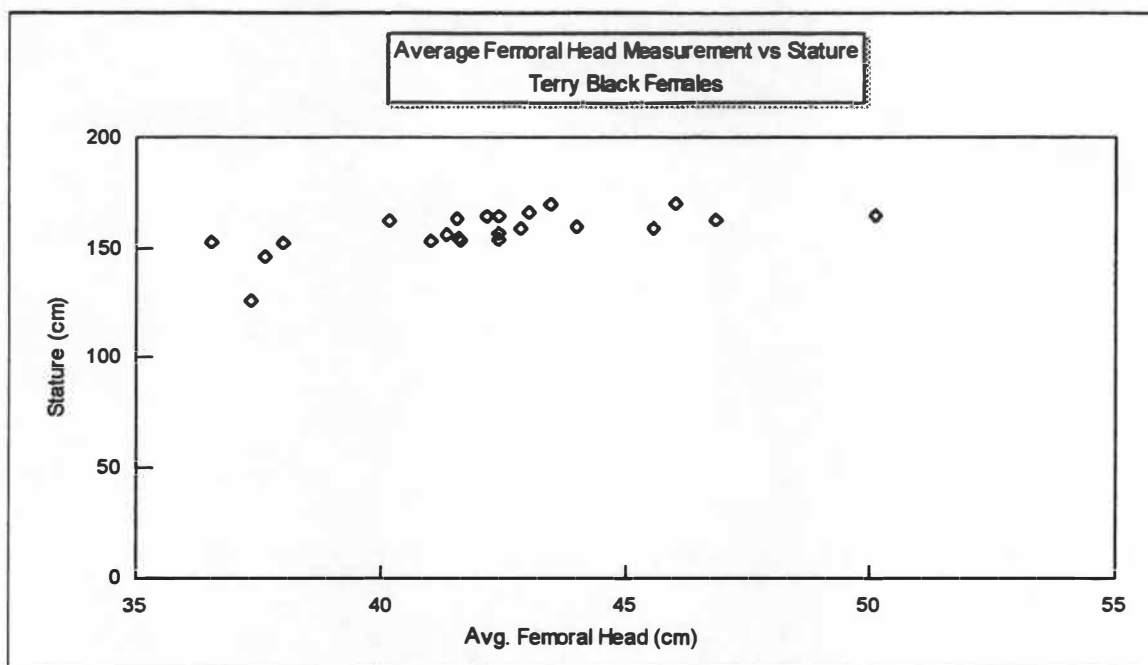
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	3537.3991	3537.3991	11.2327	0.0032
Error	20	6298.3737	314.9187		
C Total	21	9835.7727			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-121.9965	50.8873	-2.3974	0.0264	-	0
Avg Head	1	4.0316	1.2029	3.3515	0.0032	1.0000	1.0000

C. Regression on weight for Terry black females

Figure 1 (Continued).



Model Equation

$$\text{Weight} = 77.4885 + 1.8986 * \text{Avg Femoral Head}$$

Summary of Fit

Mean of Response	157.5818	R-Square 0.4250
Root MSE	7.2846	Adj R-Sq 0.3963

Analysis of Variance

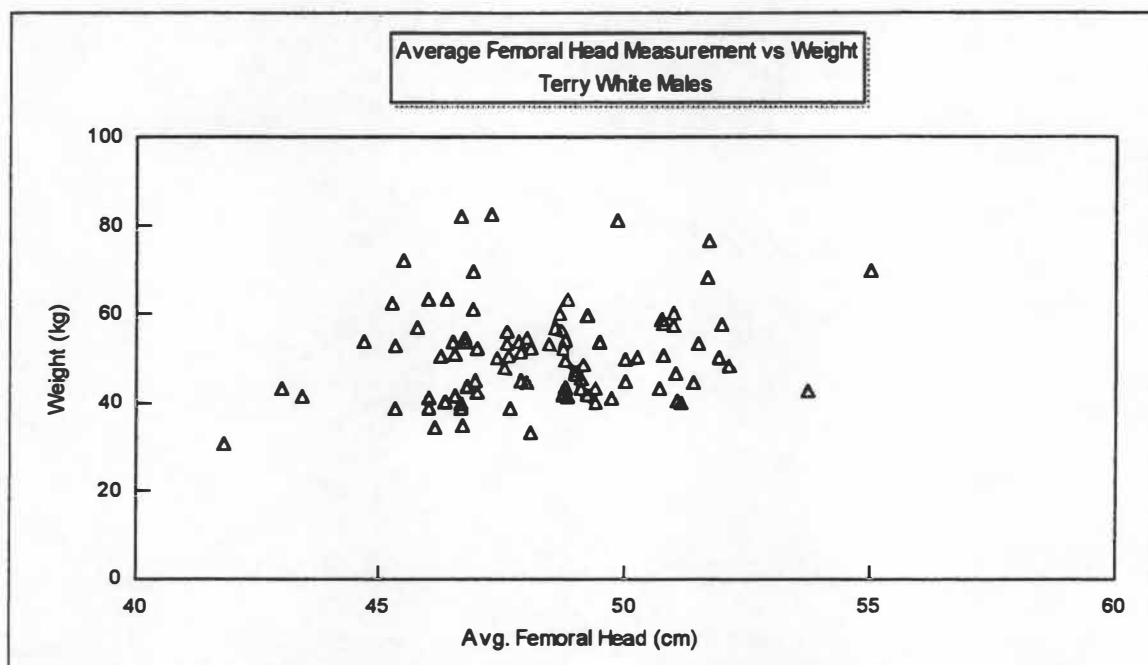
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	784.4741	784.4741	14.7830	0.0010
Error	20	1061.3186	53.0659		
C Total	21	1845.7927			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	77.4885	20.8890	3.7095	0.0014	-	0
Avg Head	1	1.8986	0.4938	3.8449	0.0010	1.0000	1.0000

D. Regression on stature for Terry black females

Figure 1 (Continued).



Model Equation

$$\text{Weight} = 14.0027 + 0.7660 * \text{Avg Head}$$

Summary of Fit

Mean of Response	51.0315	R-Square	0.0271
Root MSE	10.7139	Adj R-Sq	0.0160

Analysis of Variance

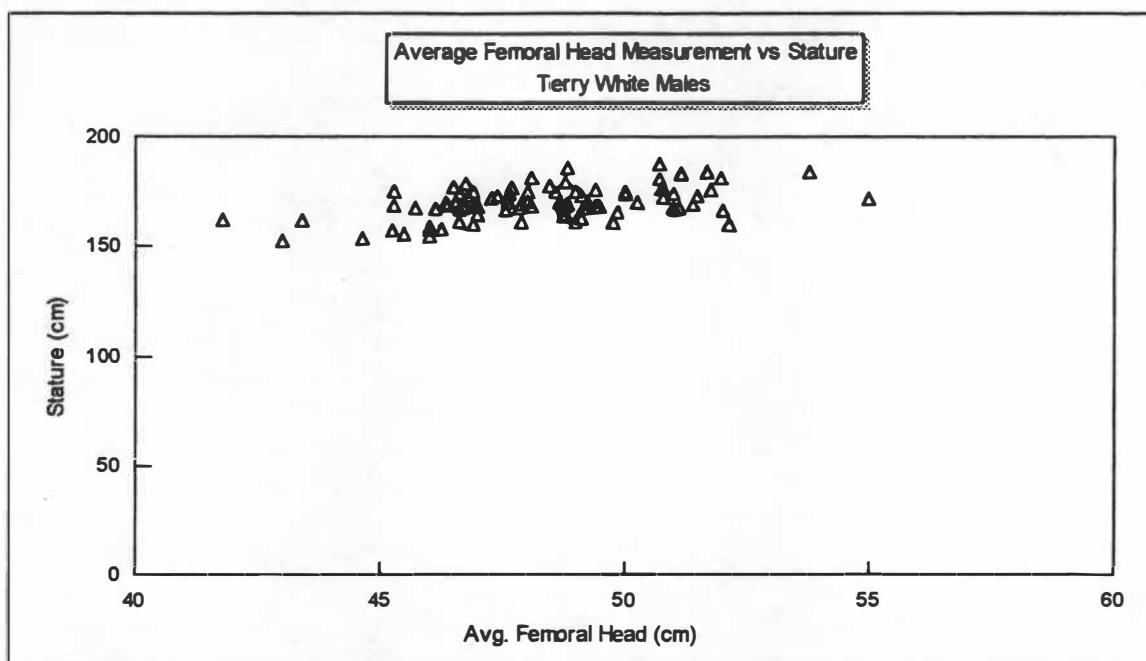
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	278.5536	278.5536	2.4267	0.1229
Error	87	9986.5583	114.7880		
C Total	88	10265.1119			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > [T]	Tolerance	Var Inflation
Intercept	1	14.0027	23.7974	0.5884	0.5578	-	0
Avg Head	1	0.7660	0.4917	1.5578	0.1229	1.0000	1.0000

E. Regression on weight for Terry white males

Figure 1 (Continued).



Model Equation

$$\text{Stature} = 97.3169 + 1.5020 * \text{Avg Head}$$

Summary of Fit

Mean of Response	169.9258	R-Square	0.2279
Root MSE	6.4589	Adj R-Sq	0.2190

Analysis of Variance

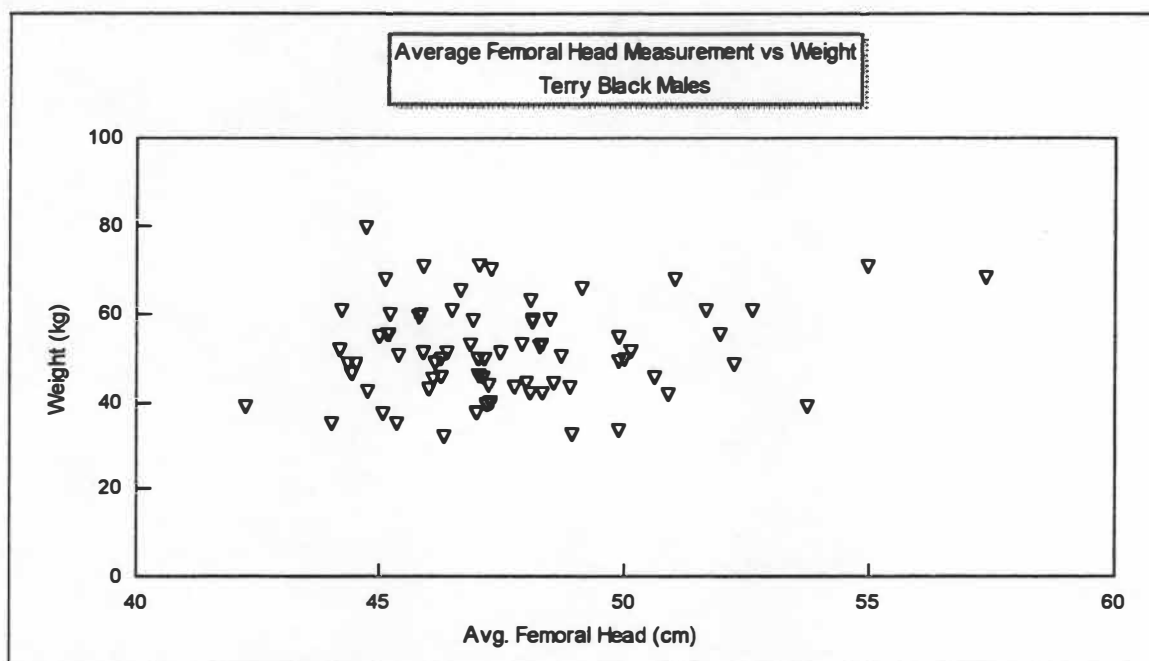
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	1071.0505	1071.0505	25.6736	0.0001
Error	87	3629.4601	41.7179		
C Total	88	4700.5106			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	97.3169	14.3464	6.7834	0.0001	-	0
Avg Head	1	1.5020	0.2964	5.0669	0.0001	1.0000	1.0000

F. Regression on stature for Terry white males

Figure 1 (Continued).



Model Equation
Weight = 25.0374 + 0.5580 * Avg Head

Summary of Fit

Mean of Response	51.5986	R-Square 0.0206
Root MSE	10.4678	Adj R-Sq 0.0070

Analysis of Variance

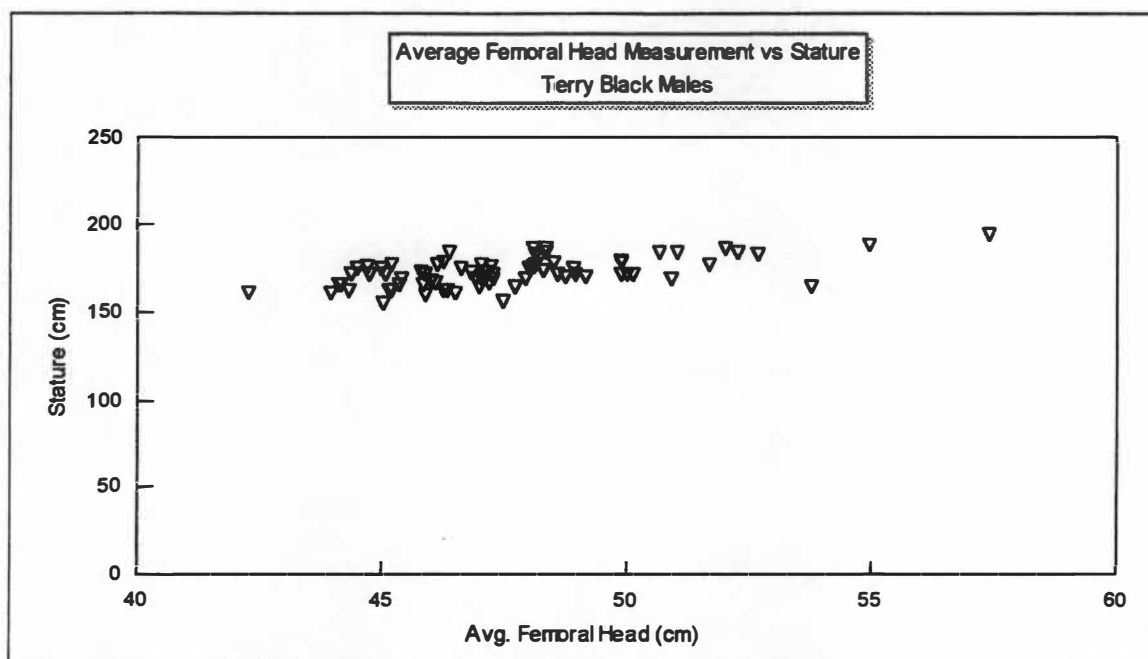
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	166.0555	166.0555	1.5154	0.2223
Error	72	7889.4344	109.5755		
C Total	73	8055.4899			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	25.0374	21.6106	1.1586	0.2505	-	0
Avg Head	1	0.5580	0.4532	1.2310	0.2223	1.0000	1.0000

G. Regression on weight for Terry black males

Figure 1 (Continued).



Model Equation
Stature = 88.4723 + 1.7715 * Avg Head

Summary of Fit

Mean of Response 172.8054	R-Square 0.3609
Root MSE 6.4169	Adj R-Sq 0.3520

Analysis of Variance

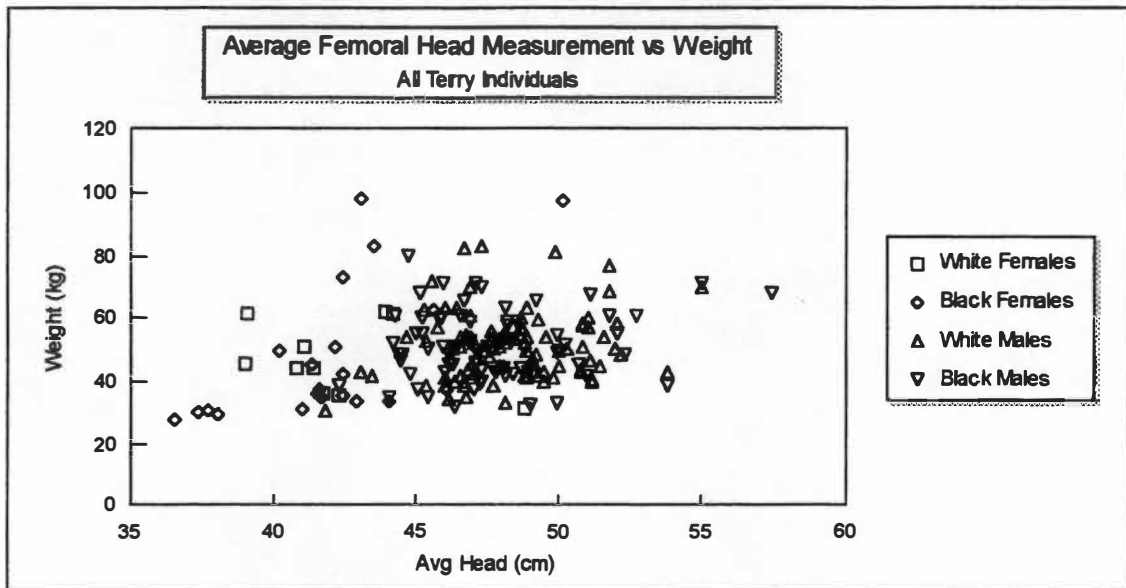
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	1673.9927	1673.9927	40.6541	0.0001
Error	72	2964.7052	41.1765		
C Total	73	4638.6978			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	88.4723	13.2475	6.6784	0.0001	-	0
Avg Head	1	1.7715	0.2778	6.3761	0.0001	1.0000	1.0000

H. Regression on stature for Terry black males

Figure 1 (Continued).



Model Equation

$$\text{Weight} = 9.1359 + 0.8840 * \text{Avg Head}$$

Summary of Fit

Mean of Response 50.7277

Root MSE 12.0254

R-Square 0.0587

Adj R-Sq 0.0538

Analysis of Variance

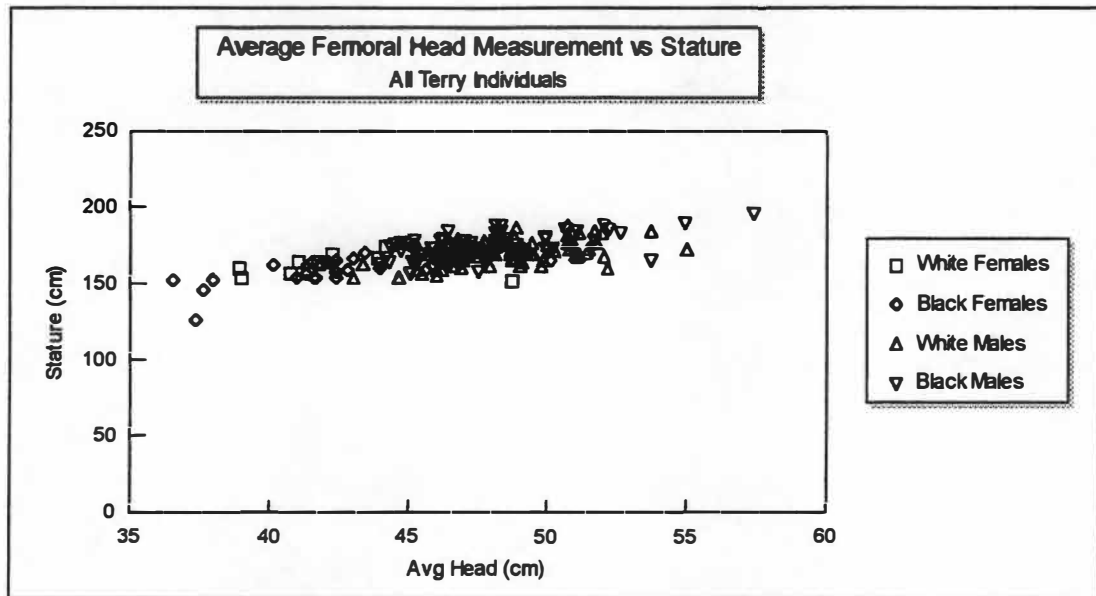
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	1740.5550	1740.5550	12.0362	0.0006
Error	193	27909.7555	144.6101		
C Total	194	29650.3105			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	9.1359	12.0193	0.7601	0.4481	-	0
Avg Head	1	0.8840	0.2548	3.4693	0.0006	1.0000	1.0000

I. Regression on weight for all Terry individuals

Figure 1 (Continued).



Model Equation

$$\text{Stature} = 86.1801 + 1.7641 * \text{Avg Head}$$

Summary of Fit

Mean of Response 169.1836

R-Square 0.4275

Root MSE 6.9353

Adj R-Sq 0.4245

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	6932.1277	6932.1277	144.1247	0.0001
Error	193	9282.9397	48.0981		
C Total	194	16215.0675			

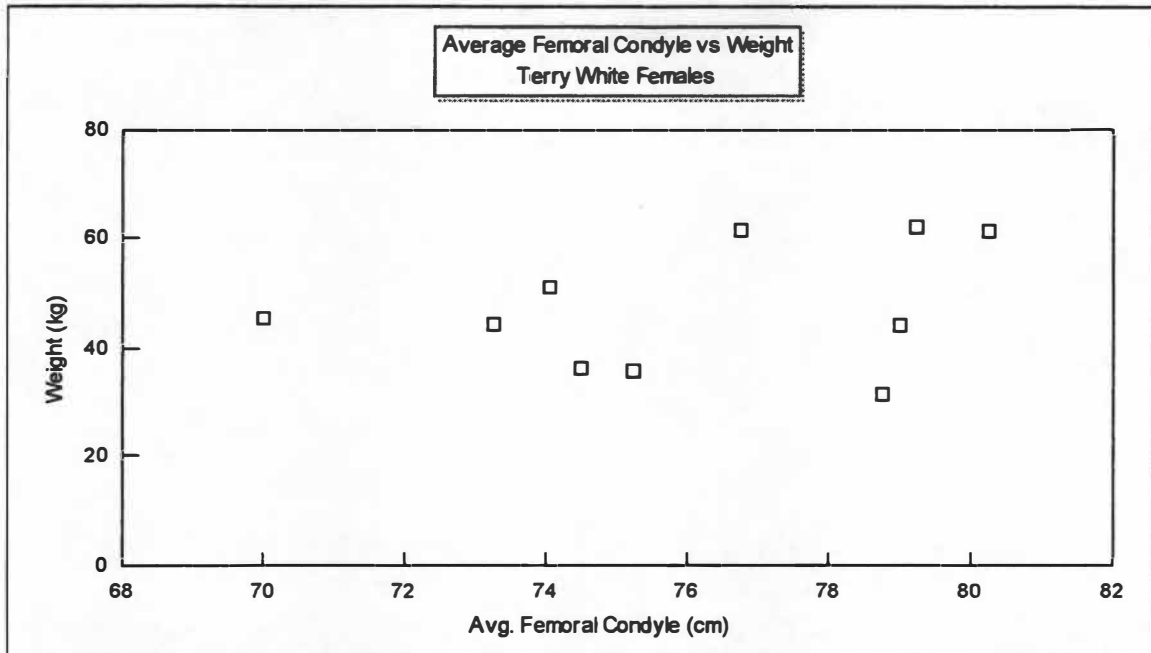
Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	86.1801	6.9318	12.4326	0.0001	-	0
Avg Head	1	1.7641	0.1469	12.0052	0.0001	1.0000	1.0000

J. Regression on stature for all Terry individuals

Figure 1 (Continued).

Average femoral condyle measurement regressions



Model Equation

$$\text{Weight} = -33.7905 + 1.0668 * \text{Condyle}$$

Summary of Fit

Mean of Response	47.4000	R-Square	0.0936
Root MSE	11.4880	Adj R-Sq	0.0

Analysis of Variance

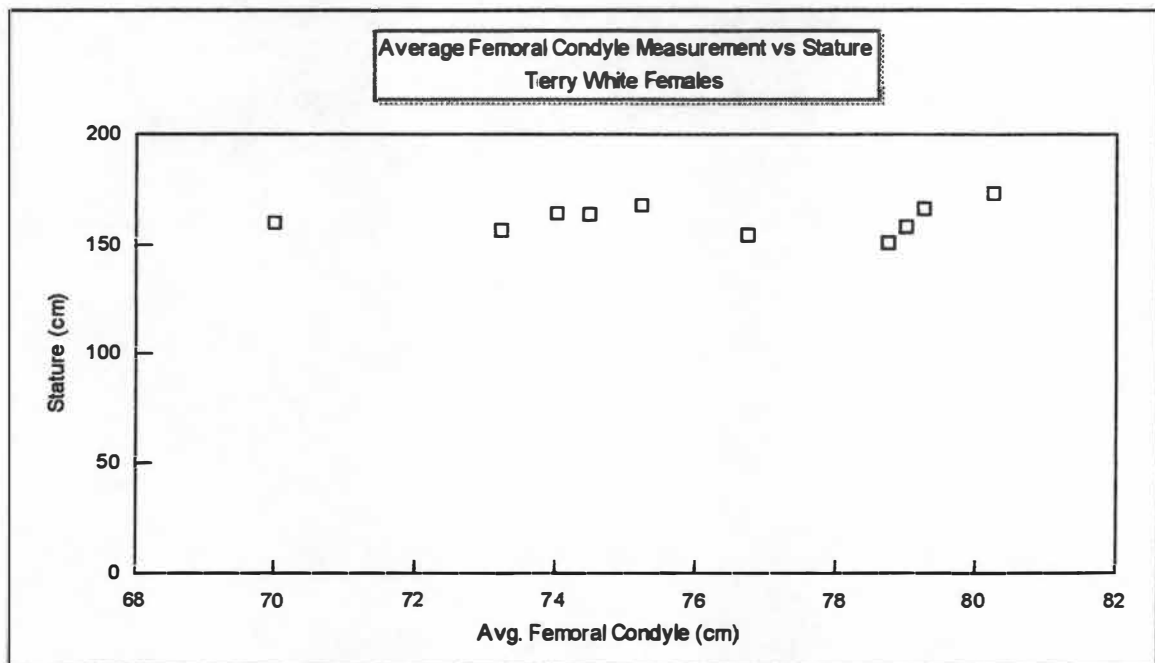
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	109.0506	109.0506	0.8263	0.3899
Error	8	1055.7894	131.9737		
C Total	9	1164.8400			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-33.7905	89.3910	-0.3780	0.7153	-	0
Avg Cond	1	1.0668	1.1736	0.9090	0.3899	1.0000	1.0000

A. Regression on weight for Terry white females

Figure 2. Average femoral condyle measurement against weight and stature.



Model Equation
Stature = 132.738 + 0.3753 * Condyle

Summary of Fit

Mean of Response 161.3000	R-Square 0.0316
Root MSE 7.1947	Adj R-Sq 0.0

Analysis of Variance

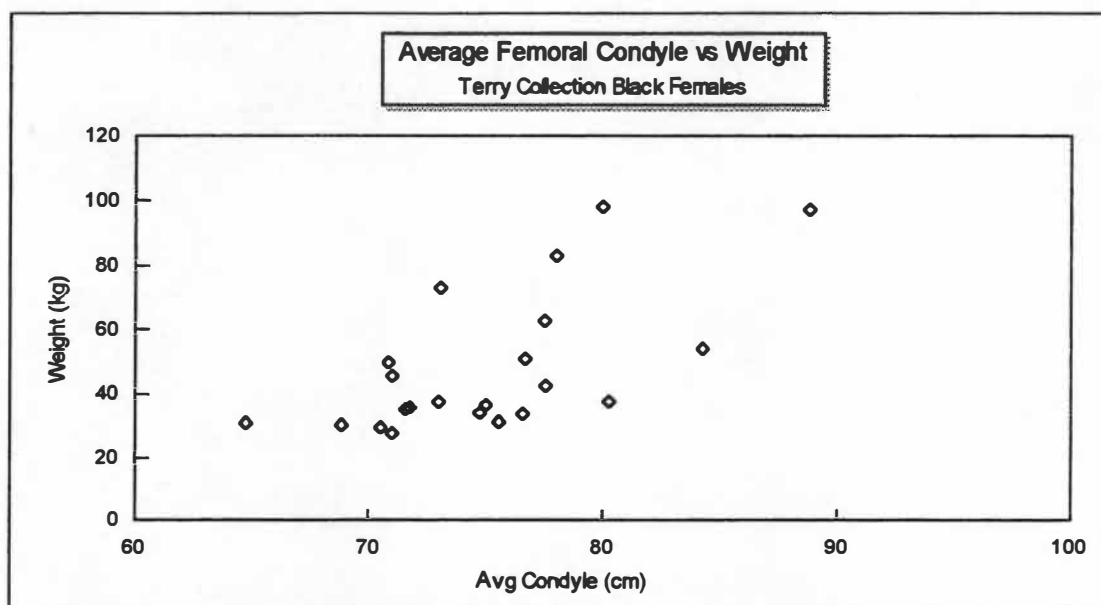
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	13.4957	13.4957	0.2607	0.6234
Error	8	414.1043	51.7630		
C Total	9	427.6000			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	132.7380	55.9835	2.3710	0.0452	-	0
Avg Cond	1	0.3753	0.7350	0.5106	0.6234	1.0000	1.0000

B. Regression on stature for Terry white females

Figure 2 (Continued).



Model Equation

$$\text{Weight} = -146.005 + 2.5852 * \text{Avg Condyle}$$

Summary of Fit

Mean of Response 48.0818

Root MSE 17.0514

R-Square 0.4088

Adj R-Sq 0.3792

Analysis of Variance

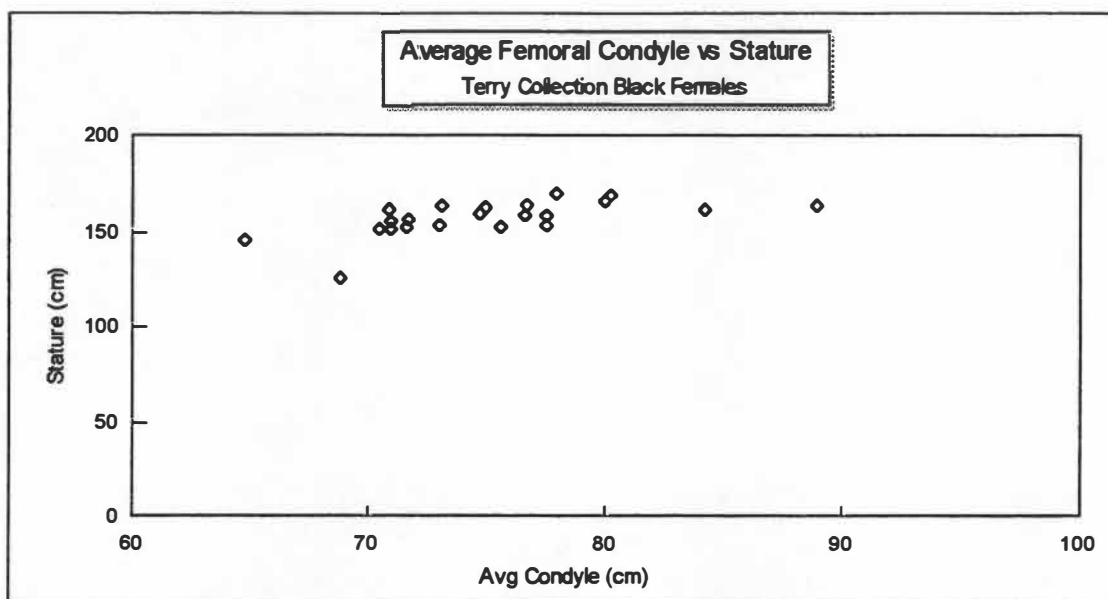
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	4020.7794	4020.7794	13.8290	0.0014
Error	20	5814.9933	290.7497		
C Total	21	9835.7727			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-146.0054	52.3182	-2.7907	0.0113	-	0
Avg Cond	1	2.5852	0.6952	3.7187	0.0014	1.0000	1.0000

C. Regresssion on weight for Terry black females

Figure 2 (Continued).



Model Equation
Weight = 77.4481 + 1.0668 * Avg Condyle

Summary of Fit

Mean of Response	157.5818	R-Square	0.3710
Root MSE	7.6193	Adj R-Sq	0.3395

Analysis of Variance

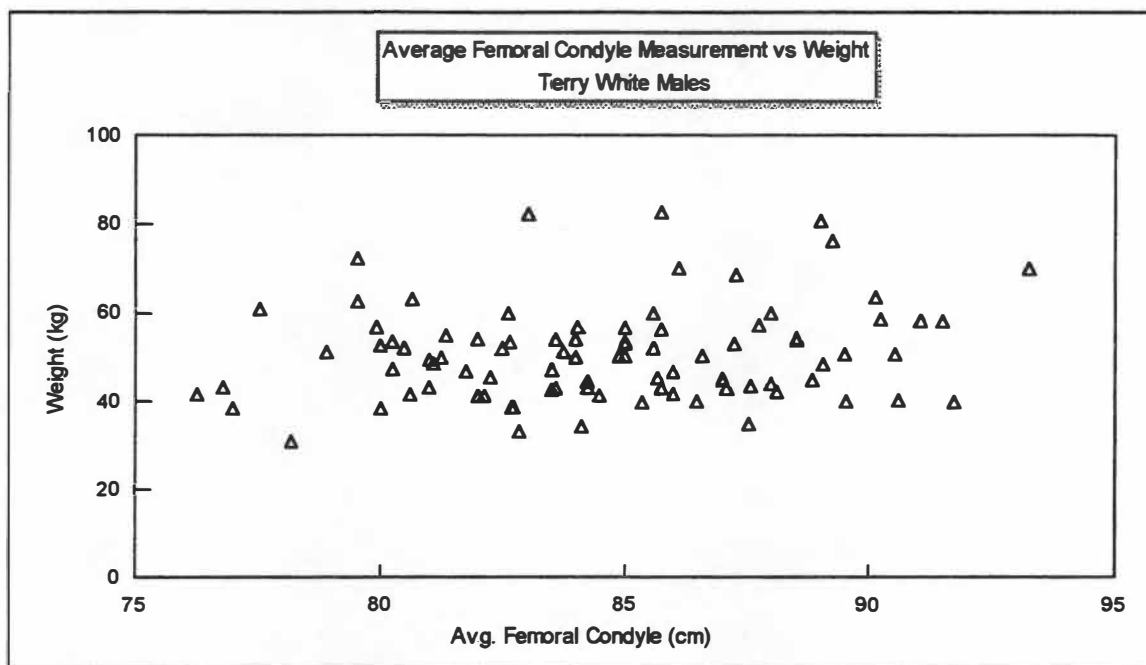
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	684.7197	684.7197	11.7946	0.0026
Error	20	1161.0731	58.0537		
C Total	21	1845.7927			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	77.4881	23.3780	3.3146	0.0035	-	0
Avg Cond	1	1.0668	0.03106	3.4343	0.0026	1.0000	1.0000

D. Regression on stature for Terry black females

Figure 2 (Continued).



Model Equation

$$\text{Weight} = 14.6961 + 0.4295 * \text{Avg Condyle}$$

Summary of Fit

Mean of Response	50.9911	R-Square	0.0232
Root MSE	10.6810	Adj R-Sq	0.0121

Analysis of Variance

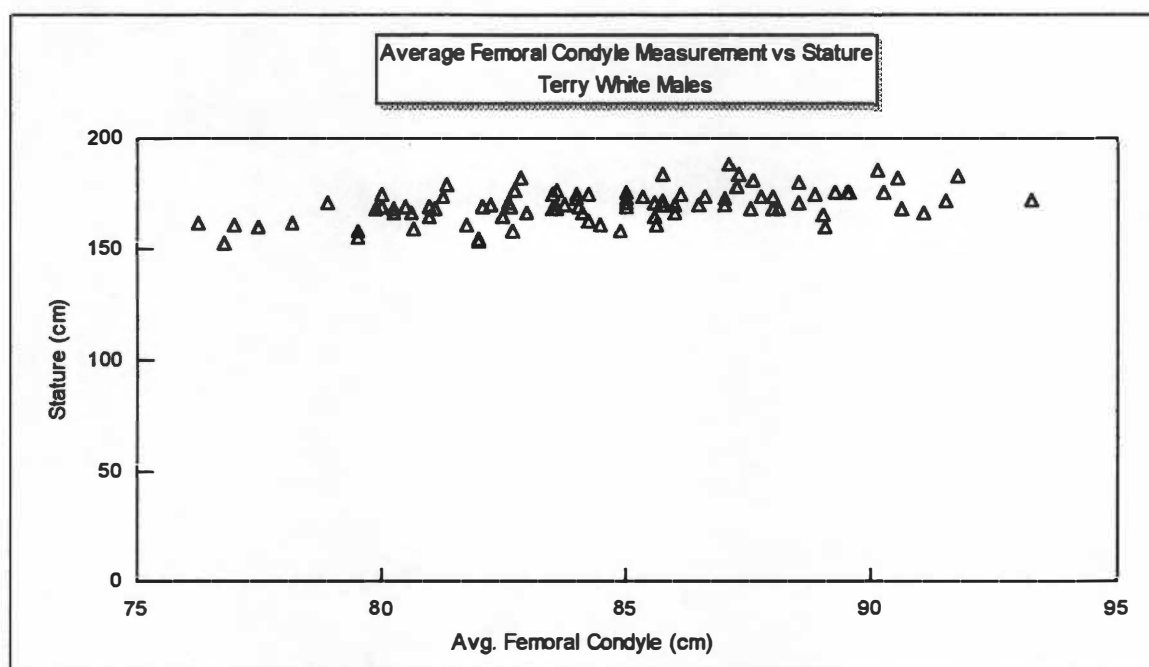
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	238.7072	238.7072	2.0924	0.1516
Error	88	10039.4457	114.0846		
C Total	89	10278.1529			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	14.6961	25.1168	0.5851	0.5600	-	0
Avg Cond	1	0.4295	0.2969	1.4465	0.1516	1.0000	1.0000

E. Regression on weight for Terry white males

Figure 2 (Continued).



Model Equation

$$\text{Stature} = 90.1652 + 0.9444 * \text{Avg Condyle}$$

Summary of Fit

Mean of Response	168.9822	R-Square	0.2443
Root MSE	6.3707	Adj R-Sq	0.2357

Analysis of Variance

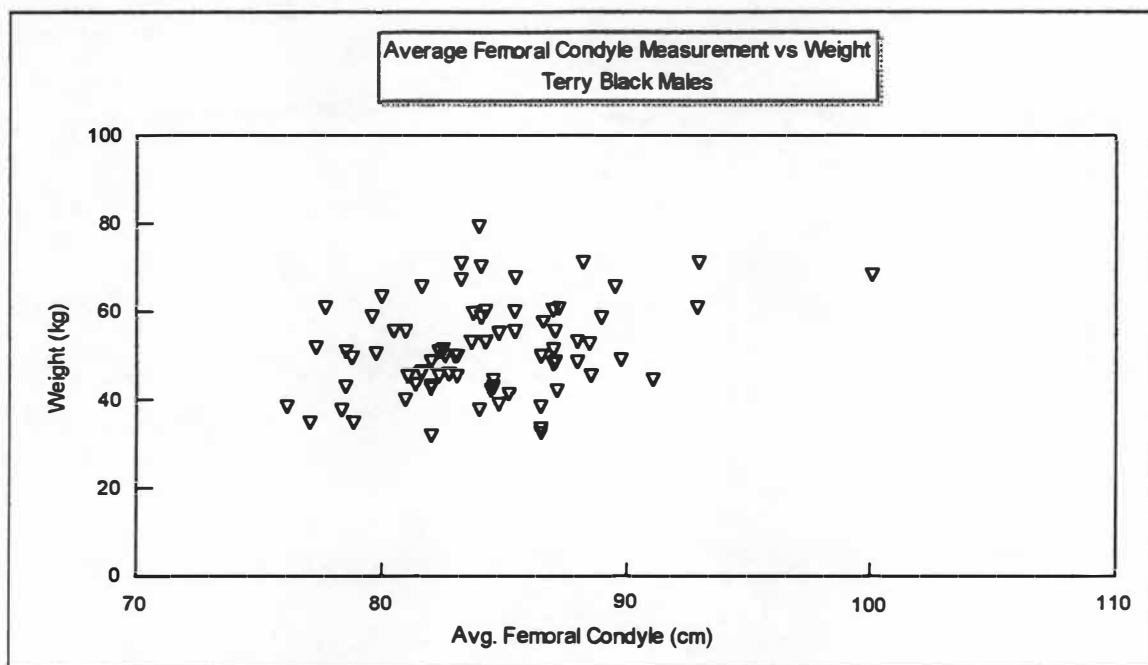
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	1154.4171	1154.4171	28.4438	0.0001
Error	88	3571.5544	40.5858		
C Total	89	4725.9716			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > [T]	Tolerance	Var Inflation
Intercept	1	90.1652	14.9809	6.0187	0.0001	-	0
Avg Cond	1	0.9444	0.1771	5.3333	0.0001	1.0000	1.0000

F. Regression on stature for Terry white males

Figure 2 (Continued).



Model Equation

$$\text{Weight} = -13.5622 + 0.7738 * \text{Avg Condyle}$$

Summary of Fit

Mean of Response 51.5986

R-Square 0.0917

Root MSE 10.0808

Adj R-Sq 0.0791

Analysis of Variance

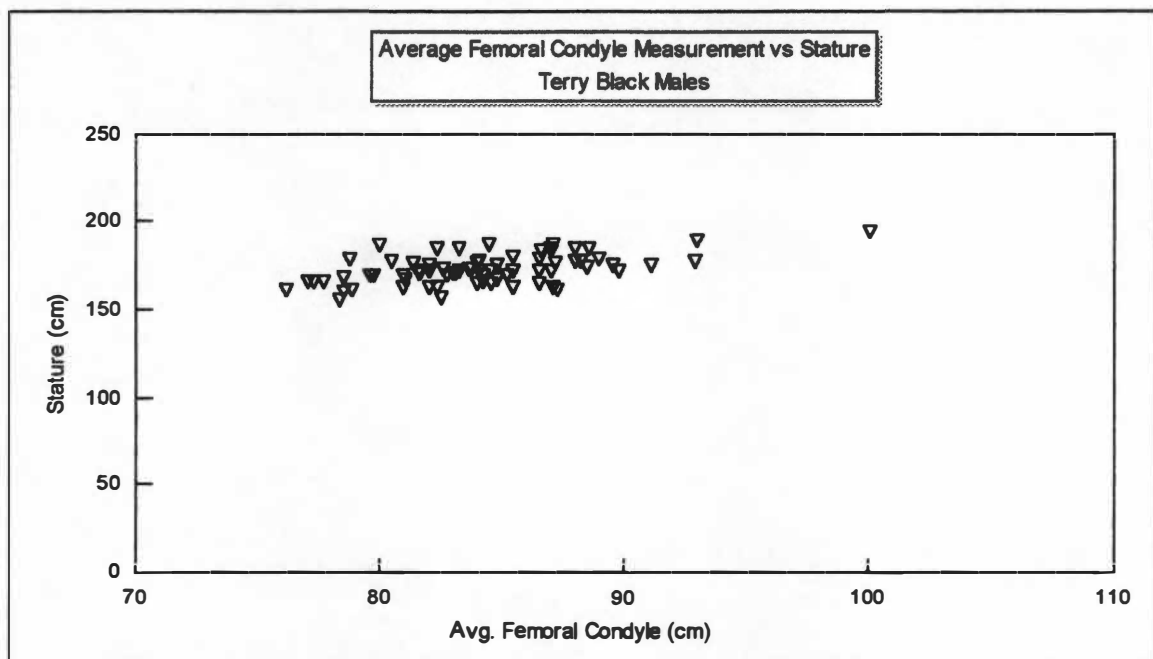
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	738.6728	738.6728	7.2688	0.0087
Error	72	7316.8171	101.6225		
C Total	73	8055.4899			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-13.5622	24.1972	-0.5605	0.5769	-	0
Avg Cond	1	0.7738	0.2870	2.6961	0.0087	1.0000	1.0000

G. Regression on weight for Terry black males

Figure 2 (Continued).



Model Equation

$$\text{Stature} = 85.2627 + 1.0396 * \text{Avg Condyle}$$

Summary of Fit

Mean of Response 172.8054

Root MSE 6.7756

R-Square 0.2874

Adj R-Sq 0.2775

Analysis of Variance

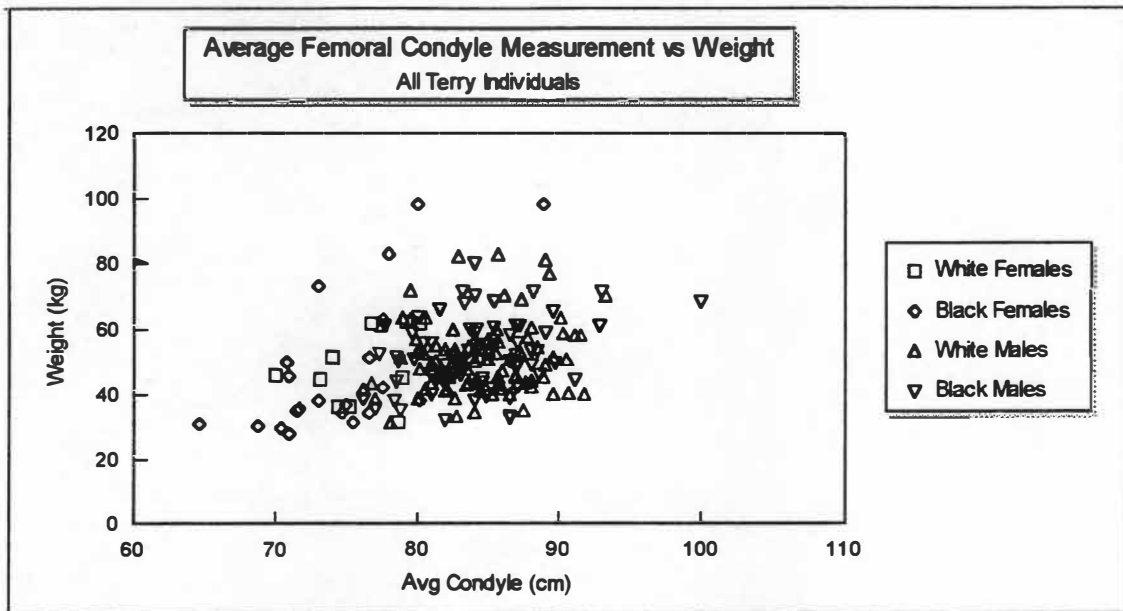
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	1333.2741	1333.2741	29.0419	0.0001
Error	72	3305.4238	45.9087		
C Total	73	4638.6978			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	85.2627	16.2636	5.2425	0.0001	-	0
Waist	1	1.0396	0.1929	5.3891	0.0001	1.0000	1.0000

H. Regression on stature for Terry black males

Figure 2 (Continued).



Model Equation

$$\text{Weight} = -10.5790 + 0.7392 * \text{Avg Condyle}$$

Summary of Fit

Mean of Response	50.7116	R-Square	0.1001
Root MSE	11.6806	Adj R-Sq	0.0956

Analysis of Variance

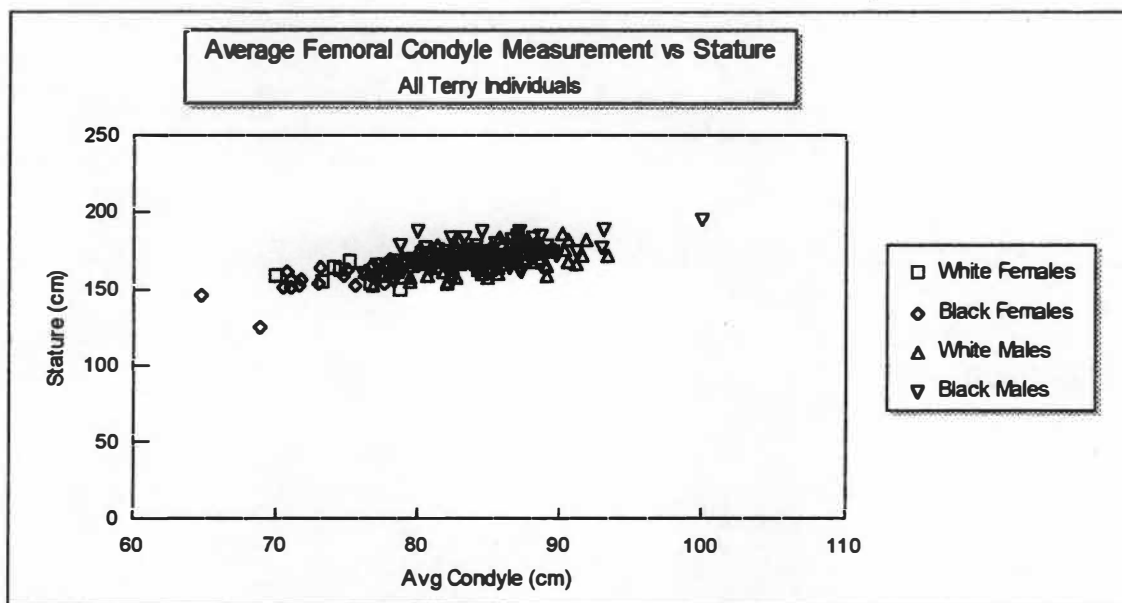
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	2976.0111	2976.0111	21.8125	0.0001
Error	196	26741.5122	136.4363		
C Total	197	29717.5233			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-10.5790	13.1495	-0.8045	0.4221	-	0
Avg Cond	1	0.7392	0.1583	4.6704	0.0001	1.0000	1.0000

I. Regression on weight for all Terry individuals

Figure 2 (Continued).



Model Equation

$$\text{Stature} = 73.8600 + 1.1497 * \text{Avg Condyle}$$

Summary of Fit

Mean of Response	169.1808	R-Square 0.4390
Root MSE	6.8508	Adj R-Sq 0.4361

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	7198.1661	7198.1661	153.3689	0.0001
Error	196	9199.0009	46.9337		
C Total	197	16397.1671			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	73.8600	7.7123	9.5769	0.0001	-	0
Avg Cond	1	1.1497	0.0928	12.3842	0.0001	1.0000	1.0000

J. Regression on stature for all Terry individuals

Figure 2 (Continued).

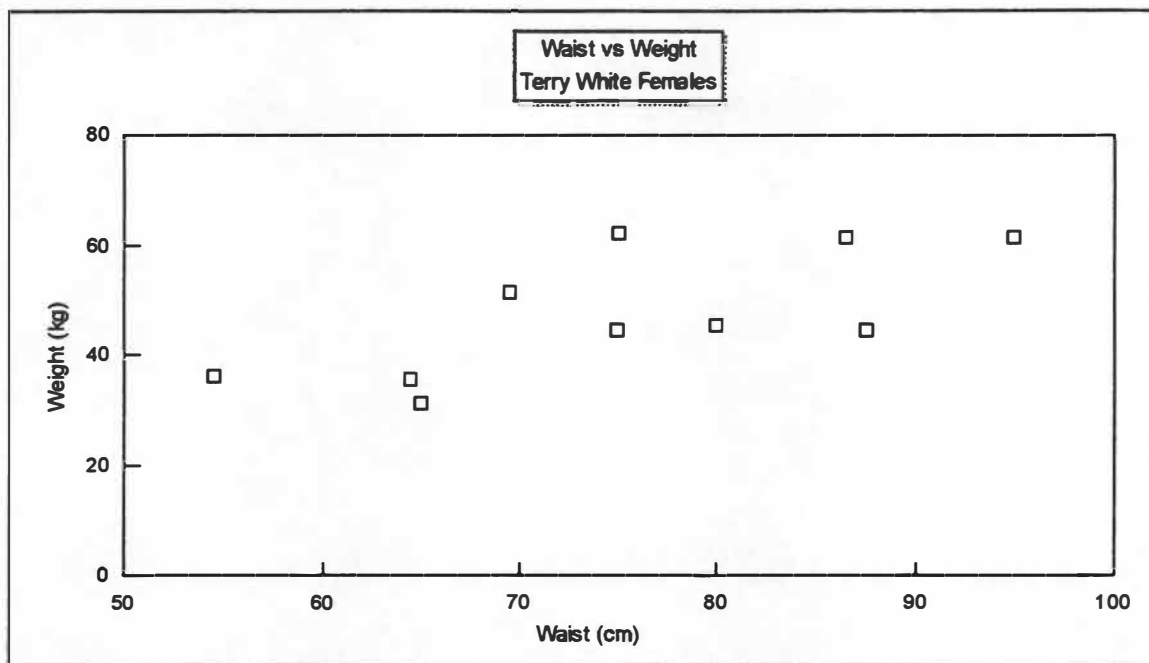
TERRY CADAVER MEASUREMENTS

White females

The white females make up the smallest group in the Terry collection. They also make up the smallest group for which waist circumference was recorded on the collections data sheets. There are only 10 white females total; too small of a group to have much statistical significance. The average age for this group is 64.4 years, with a high of 84 years and a low of 30 years. The average weight is 47.4 kilograms (kg), with a high of 62.2 kg and a low of 31.3 kg. The average waist is 75.2 centimeters (cm), with a high of 95 cm and a low of 54.5 cm. The average stature is 161.3 cm, with a high of 173.5 cm and a low of 154 cm. Graphic representations of the parameters age, waist, and stature regressed separately and together on body weight are presented in Figures 3A through 3E.

Black females

Black females make up the second smallest group for which " waist circum " is recorded in the Terry collection. There are 23 individuals listed below; again too small for statistical significance. The average age for this group is 40.8 years, with a high of 101 years and a low of 17 years. The average weight is 47.4 kg, with a high of 98.0 kg and a low of 27.8 kg. The average waist measurement is 72.0 cm, with a high of 127.0 cm and a low of 52.0 cm. The average stature is 157.8 cm, with a high of 170.0 cm and a low of 126.0 cm. Graphic representations of the parameters age, waist, and stature regressed separately and together on body weight are presented in Figures 4A through 4E.



Model Equation

$$\text{Weight} = -0.9750 + 0.6429 * \text{Waist}$$

Summary of Fit

Mean of Response	47.4000	R-Square	0.4875
Root MSE	8.6385	Adj R-Sq	0.4234

Analysis of Variance

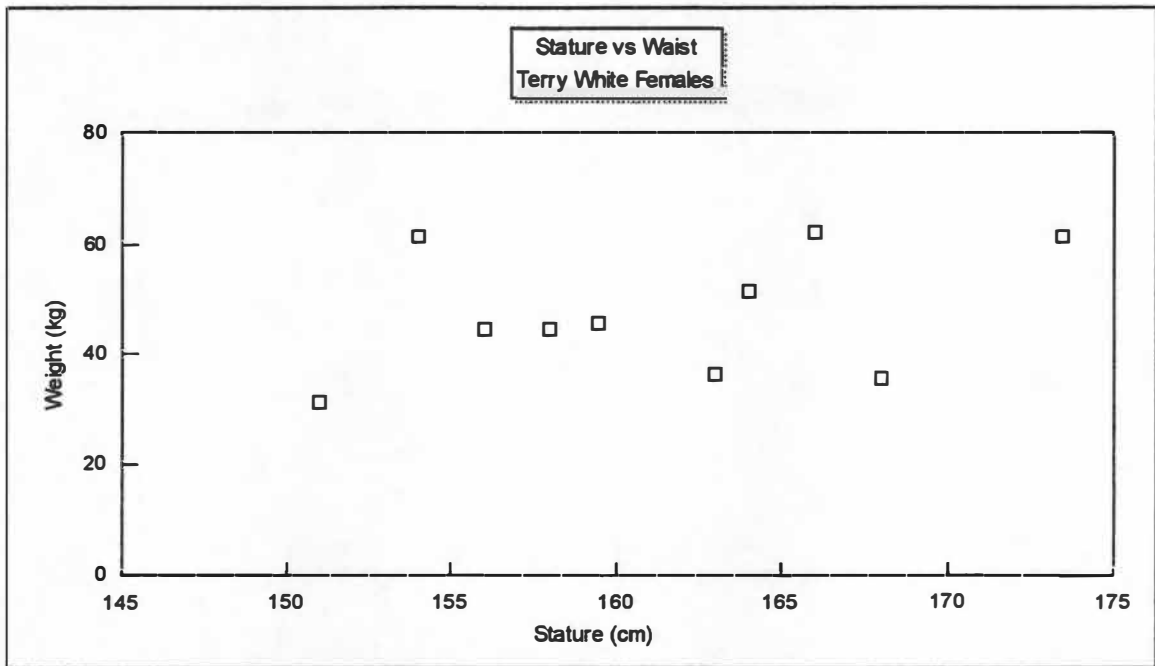
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	567.8469	567.8469	7.6094	0.0247
Error	8	596.9931	74.6241		
C Total	9	1164.8400			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-0.9750	17.7481	-0.0549	0.9575	-	0
Waist	1	0.6429	0.2331	2.7585	0.0247	1.0000	1.0000

A. Waist regressed on weight

Figure 3. Weight Estimation For Terry White Females.



Model Equation
Weight = - 45.8303 + 0.5780 * Stature

Summary of Fit

Mean of Response	47.4000	R-Square	0.1226
Root MSE	11.3026	Adj R-Sq	0.0130

Analysis of Variance

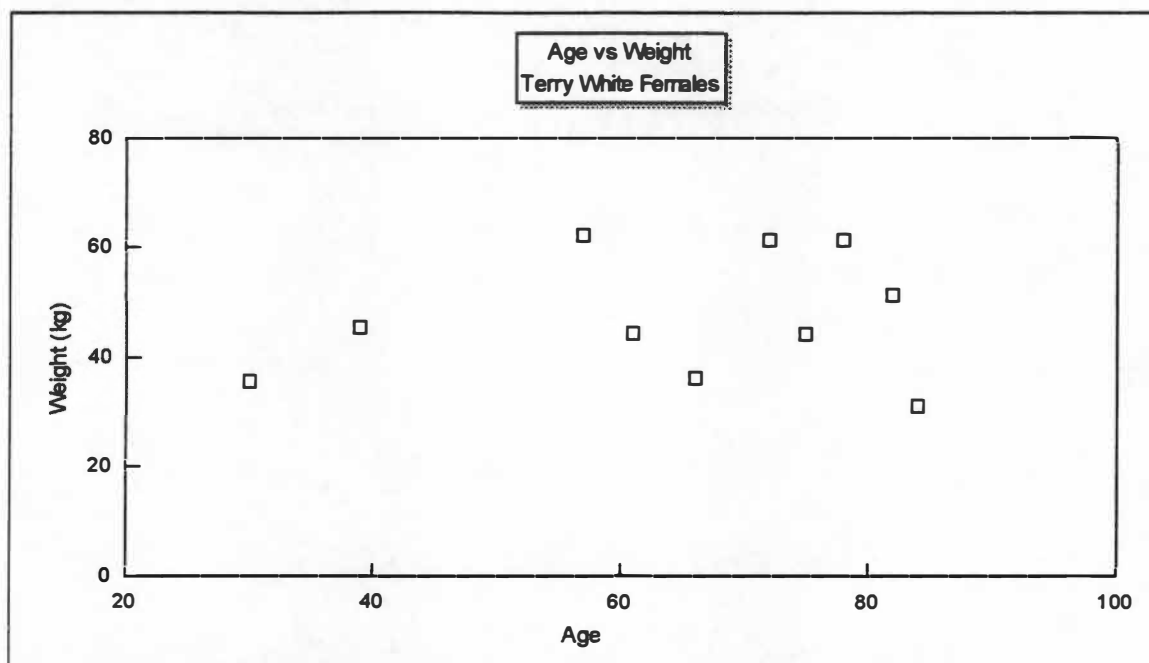
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	142.8511	142.8511	1.1182	0.3212
Error	8	1021.9889	127.7486		
C Total	9	1164.8400			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > [T]	Tolerance	Var Inflation
Intercept	1	-45.8303	88.2369	-0.5194	0.6175	-	0
Stature	1	0.5780	0.5466	1.0575	0.3212	1.0000	1.0000

B. Stature regressed on weight

Figure 3 (Continued).



Model Equation
Weight = 39.7871 + 0.1182 * Age

Summary of Fit

Mean of Response	47.4000	R-Square	0.0353
Root MSE	11.8515	Adj R-Sq	0.0

Analysis of Variance

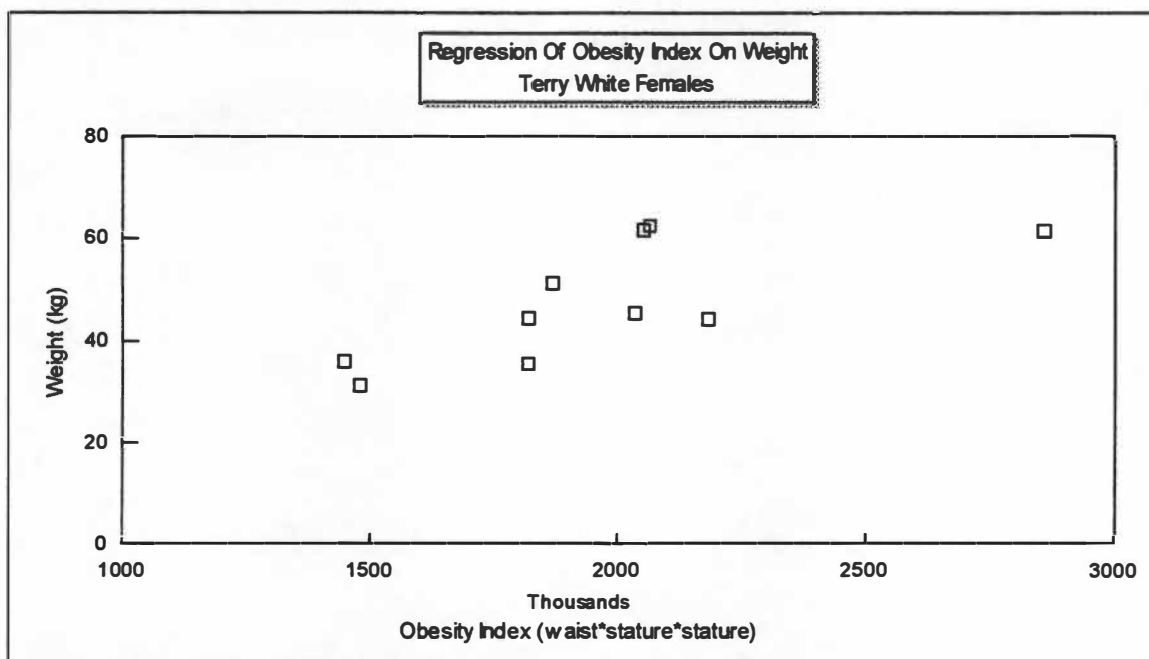
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	41.1733	41.1733	0.2931	0.6030
Error	8	1123.6667	140.4583		
C Total	9	1164.8400			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	39.7871	14.5518	2.7342	0.0257	-	0
Age	1	0.1182	0.2183	0.5414	0.6030	1.0000	1.0000

C. Age regressed on weight

Figure 3 (Continued).



Obesity Index
Index = Waist * (Stature)²

Model Equation
Weight = 6.3929 + 2.1E -5 * Index

Summary of Fit

Mean of Response	47.4000	R-Square	0.5323
Root MSE	8.2527	Adj R-Sq	0.4738

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	619.9881	619.9881	9.1032	0.0166
Error	8	544.8519	68.1065		
C Total	9	1164.8400			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	6.3929	16.8396	0.04619	0.6564	-	0
Index	1	2.088E -5	6.92E -5	3.0172	0.0166	1.0000	1.0000

D. Obesity index regressed on weight

Figure 3 (Continued).

Multiple Regression of Weight on Stature and Waist

Model Equation

$$\text{Weight} = -70.3735 + 0.4443 * \text{Stature} + 0.6128 * \text{Waist}$$

Summary of Fit

Mean of Response	47.4000	R-Square	0.5589
Root MSE	8.5676	Adj. R-Sq	0.4329

Analysis of Variance

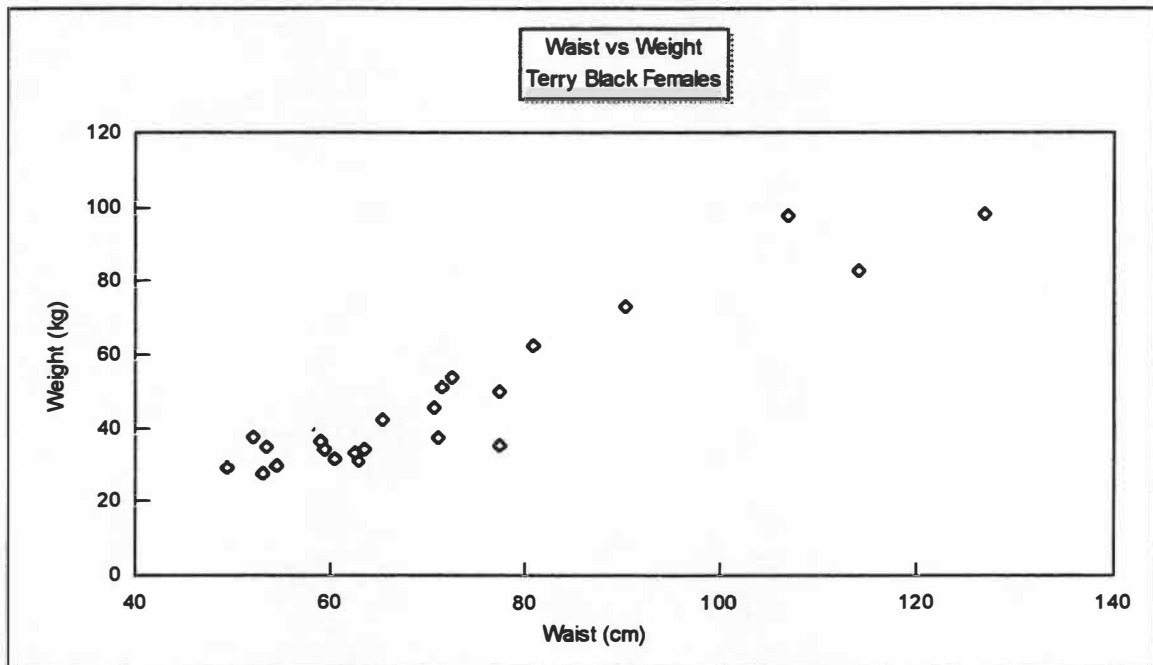
Source	Df	Sum of Squares	Mean Square	F Stat	Prob > F
Model	2	651.0129	325.5064	4.4345	0.0570
Error	7	513.8271	73.4039		
C Total	9	1164.8400			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-70.3735	67.5328	-1.0421	0.3320	-	0
Stature	1	0.4443	0.4174	1.0644	0.3225	0.9852	1.0150
Waist	1	0.6128	0.2329	2.6311	0.0339	0.9852	1.0150

E. Multiple regression of stature and waist on weight

Figure 3 (Continued).



Model Equation
Weight = -23.6321 + 0.9874 * Waist

Summary of Fit

Mean of Response	47.4435	R-Square	0.8875
Root MSE	7.3343	Adj R-Sq	0.8822

Analysis of Variance

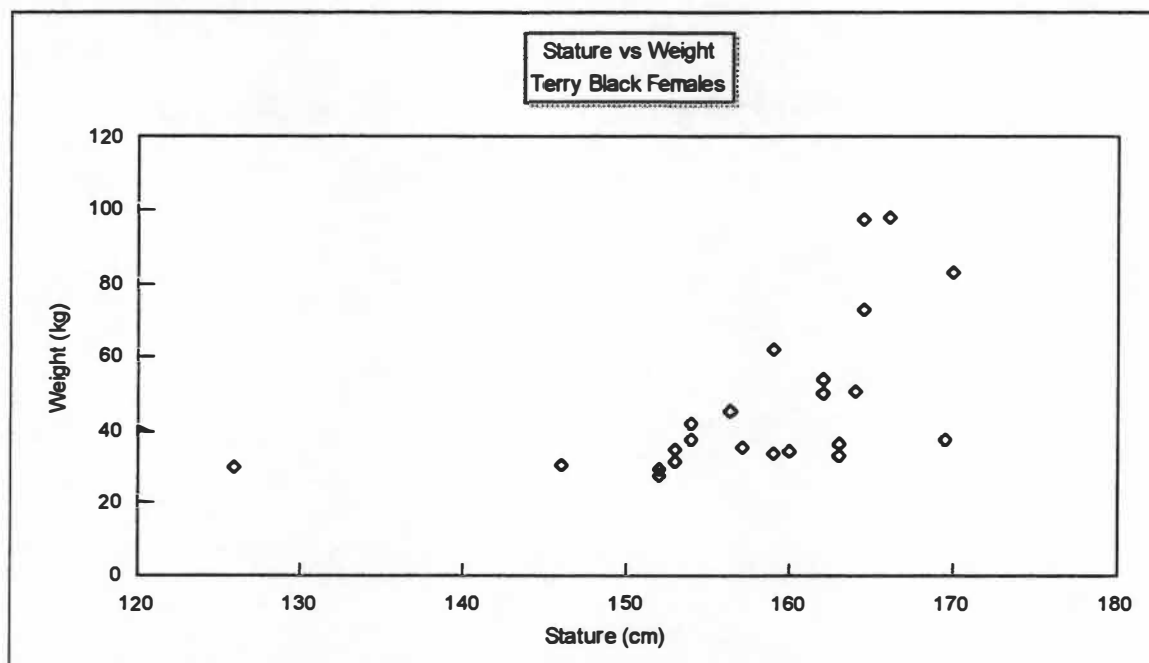
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	8912.3332	8912.3332	165.6827	0.0001
Error	21	1129.6234	53.7916		
C Total	22	10041.9565			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-23.6321	5.7297	-4.1245	0.0005	-	0
Waist	1	0.9874	0.0767	12.8718	0.0001	1.0000	1.0000

A. Waist regressed on weight.

Figure 4. Weight estimation for Terry black females



Model Equation
Weight = -148.289 + 1.2402 * Stature

Summary of Fit

Mean of Response	47.4435	R-Square 0.2870
Root MSE	18.4643	Adj R-Sq 0.2531

Analysis of Variance

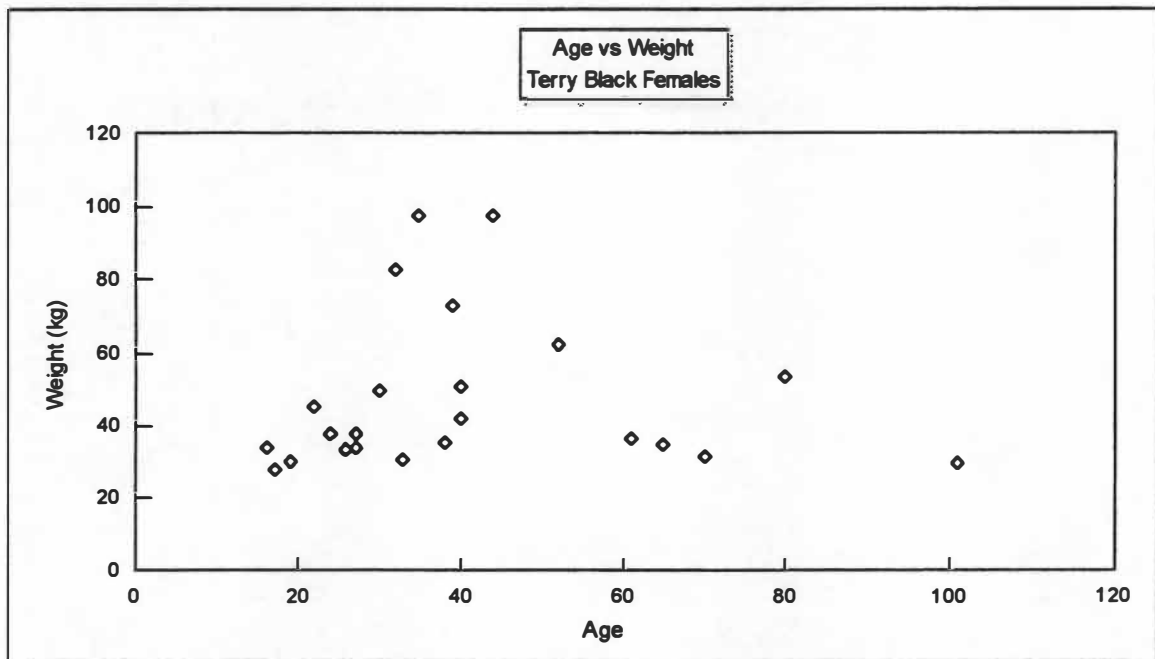
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	2882.4082	2882.4082	8.4545	0.0084
Error	21	7159.5483	340.9309		
C Total	22	10041.9565			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-148.2888	67.4260	-2.1993	0.0392	-	0
Stature	1	1.2402	0.4265	2.9077	0.0084	1.0000	1.0000

B. Stature regressed on weight

Figure 4 (Continued).



Model Equation

$$\text{Weight} = 47.8013 - 0.0088 * \text{Age}$$

Summary of Fit

Mean of Response	47.4435	R-Square	7.9E -5
Root MSE	21.8667	Adj R-Sq	0.0

Analysis of Variance

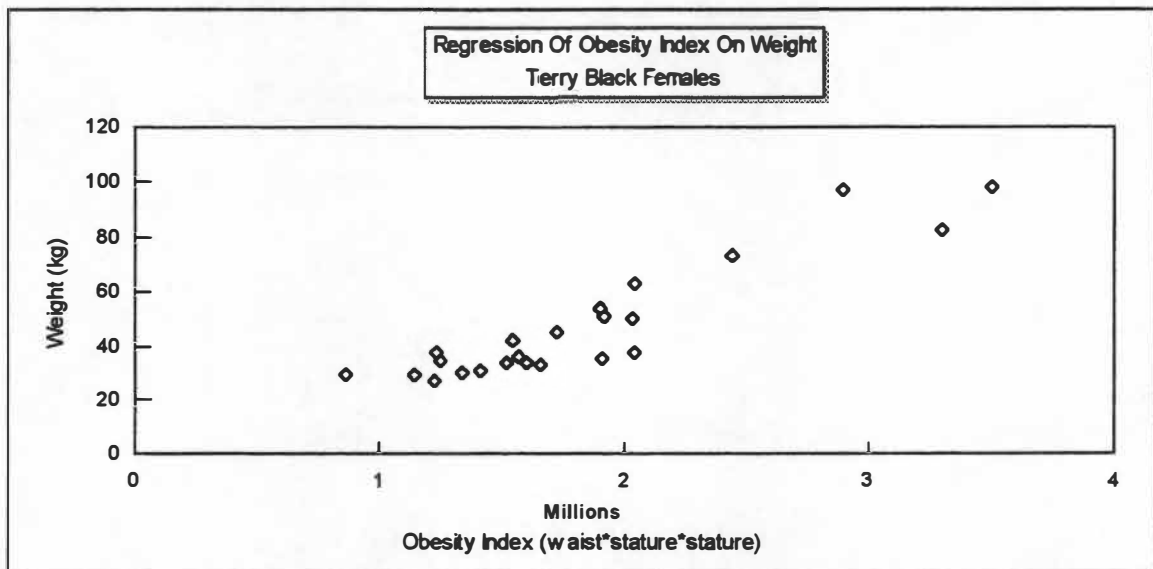
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	0.7956	0.7956	0.0017	0.9678
Error	21	10041.1609	478.1505		
C Total	22	10041.9565			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > [T]	Tolerance	Var Inflation
Intercept	1	47.8013	9.8859	4.8353	0.0001	-	0
Age	1	-0.0088	0.2151	-0.0408	0.9678	1.0000	1.0000

C. Age regressed on weight

Figure 4 (Continued).



Obesity Index

$$\text{Index} = \text{Waist} * (\text{Stature})^2$$

Model Equation

$$\text{Weight} = -6.8084 + 3.0\text{E}-5 * \text{Index}$$

Summary of Fit

Mean of Response	47.4435	R-Square	0.8561
Root MSE	8.2947	Adj R-Sq	0.8493

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	8597.1213	8597.1213	124.9551	0.0001
Error	21	1444.8352	68.8017		
C Total	22	10041.9565			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-6.8084	5.1523	-1.3214	0.2006	-	0
Index	1	2.964E-5	2.652E-5	11.1783	0.0001	1.0000	1.0000

D. Obesity index regressed on weight

Figure 4 (Continued).

Multiple Regression of Weight on Stature and Waist

Model Equation

$$\text{Weight} = -25.9614 + 0.0167 * \text{Stature} + 0.9831 * \text{Waist}$$

Summary of Fit

Mean of Response	47.4435	R-Square	0.8875
Root MSE	7.5142	Adj. R-Sq	0.8763

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F Stat	Prob > F
Model	1	8912.6899	4456.3450	78.9246	0.0001
Error	27	1129.2666	56.4633		
C Total	29	10041.9565			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-25.9614	29.8838	-0.8687	0.3953	-	0
Stature	1	0.0167	0.2101	0.0795	0.9374	0.6825	1.4652
Waist	1	0.9831	0.0951	10.3344	0.0001	0.6825	1.4652

E. Multiple regression of stature and waist regressed on weight

Figure 4 (Continued).

White males

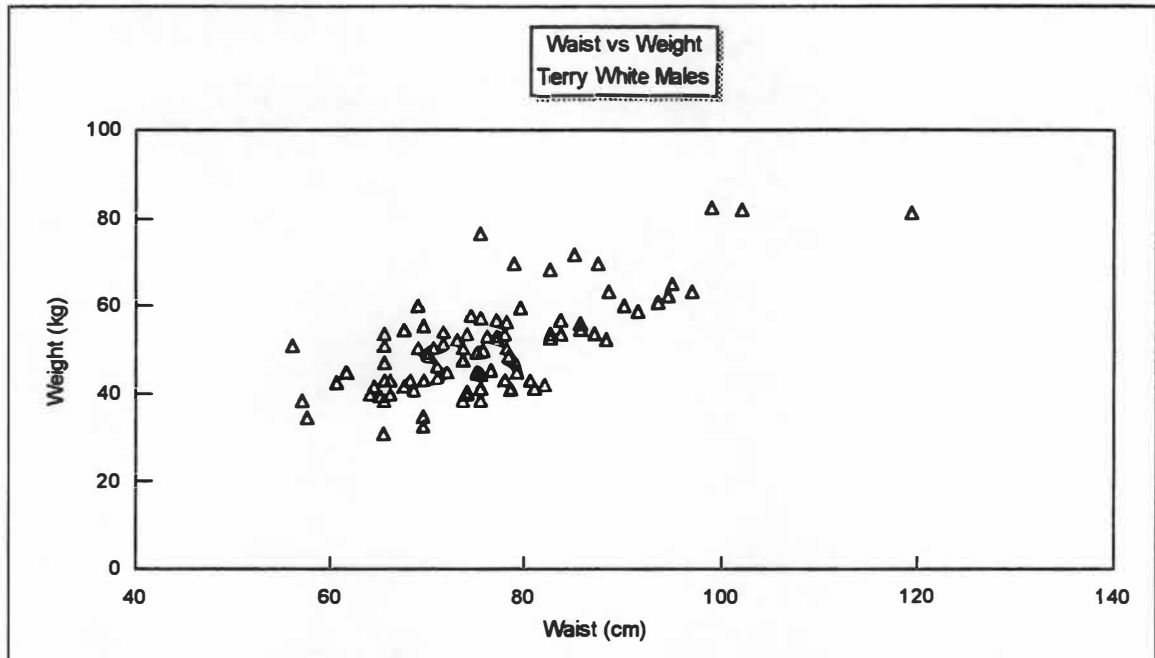
White males constitute the largest group in the Terry collection for which a waist circumference measurement is recorded; there are 91 individuals. The average age for the group is 58.9 years, with a high of 85 years and a low of 28 years. The average weight is 51.1 kg, with a high of 82.8 kg and a low of 31.0 kg. The average waist measurement is 76.1 cm, with a high of 119.5 cm and a low of 57.0 cm. The average stature is 170.0 cm, with a high of 186.0 cm and a low of 153.0 cm. Graphic representations of the parameters age, waist, and stature regressed separately and together on body weight are presented in Figures 5A through 5E.

Black males

There are 76 individuals in this group for which waist circum was recorded. The average age is 46.5 years, with a high of 88 years and a low of 17 years. The average weight is 51.5 kg, with a high of 79.6 kg and a low of 32.4 kg. The average waist measurement is 71.9 cm, with a high of 96.0 cm and a low of 48.5 cm. The average stature is 172.8 cm, with a high of 195.0 cm and a low of 156.0 cm. Graphic representations of the parameters age, waist, and stature regressed separately and together on body weight are presented in Figures 6A through 6E.

All Terry individuals

The following series of graphs contain all data from the four Terry collection groups combined. It can be argued that each individual Terry group may have a peculiar influence on how the regression methods compare to one another. Several reasons such as number of data points, sex differences, or racial differences in physical



Model Equation

$$\text{Weight} = -3.8373 + 0.7221 * \text{Waist}$$

Summary of Fit

Mean of Response	51.1946	R-Square	0.4893
Root MSE	7.7182	Adj R-Sq	0.4836

Analysis of Variance

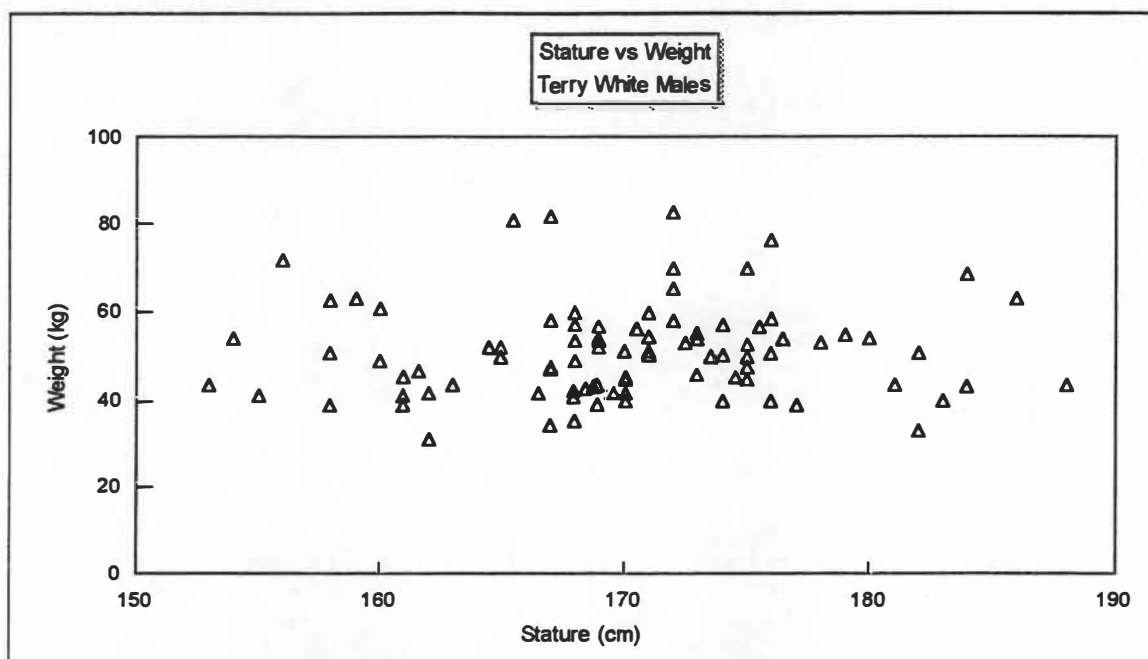
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	5137.1390	5137.1390	86.5326	0.0001
Error	90	5361.3883	59.5710		
C Total	91	10498.5273			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-3.8373	5.9805	-0.6416	0.5227	-	0
Waist	1	0.7221	0.0778	9.2863	0.0001	1.0000	1.0000

A. Waist regressed on weight

Figure 5. Weight estimate for Terry white males.



Model Equation
Weight = 40.2049 + 0.0646 * Stature

Summary of Fit

Mean of Response	51.1946	R-Square	0.0019
Root MSE	10.7903	Adj R-Sq	0.0

Analysis of Variance

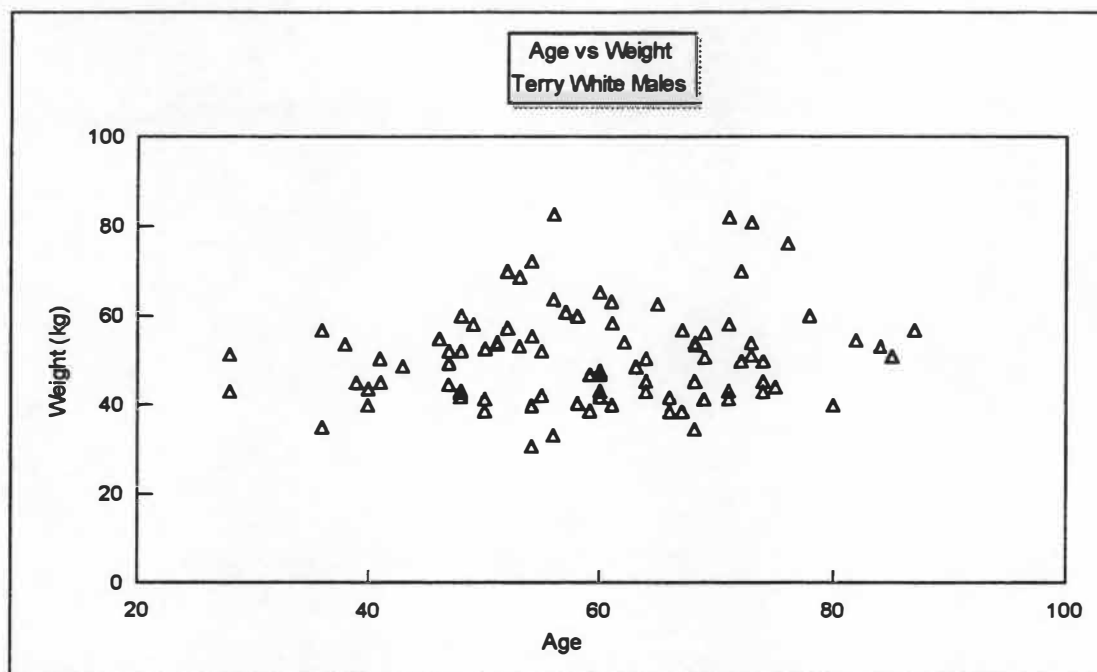
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	19.7951	19.7951	0.1700	0.6811
Error	90	10478.7322	116.4304		
C Total	91	10498.5273			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	40.2049	26.6763	1.5071	0.1353	-	0
Stature	1	0.0646	0.1567	0.4123	0.6811	1.0000	1.0000

B. Stature regressed on weight

Figure 5 (Continued).



Model Equation

$$\text{Weight} = 43.6960 + 0.1250 * \text{Age}$$

Summary of Fit

Mean of Response	51.0615	R-Square	0.0225
Root MSE	10.6618	Adj R-Sq	0.0116

Analysis of Variance

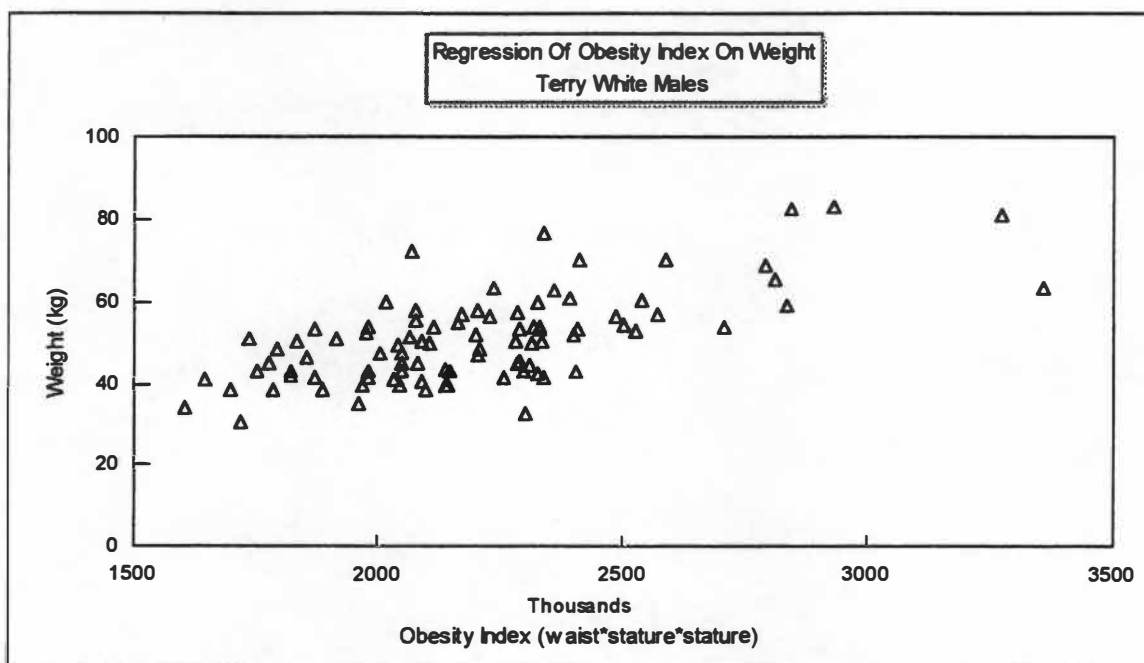
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	233.3743	233.3743	2.0530	0.1554
Error	90	10117.0011	113.6742		
C Total	91	10350.3754			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	43.6960	5.2607	8.3062	0.0001	-	0
Age	1	0.1250	0.0873	1.4328	0.1554	1.0000	1.0000

C. Age regressed on weight

Figure 5 (Continued).



Obesity Index

$$\text{Index} = \text{Waist} * (\text{Stature})^2$$

Model Equation

$$\text{Weight} = 2.9168 + 2.2\text{E-}5 * \text{Index}$$

Summary of Fit

Mean of Response	51.1946	R-Square	0.4429
Root MSE	8.0615	Adj R-Sq	0.4367

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	4649.6355	4649.6355	71.5464	0.0001
Error	90	5848.8918	64.9877		
C Total	91	10498.5273			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	2.9168	5.7691	0.5056	0.6144	-	0
Index	1	2.192E-05	2.591E-06	8.4585	0.0001	1.0000	1.0000

D. Obesity index regressed on weight

Figure 5 (Continued).

Multiple Regression of Weight on Stature and Waist

Model Equation

$$\text{Weight} = -49.8249 + 0.2564 * \text{Stature} + 0.7535 * \text{Waist}$$

Summary of Fit

Mean of Response	51.1946	R-Square	0.5181
Root MSE	7.5398	Adj. R-Sq	0.5072

Analysis of Variance

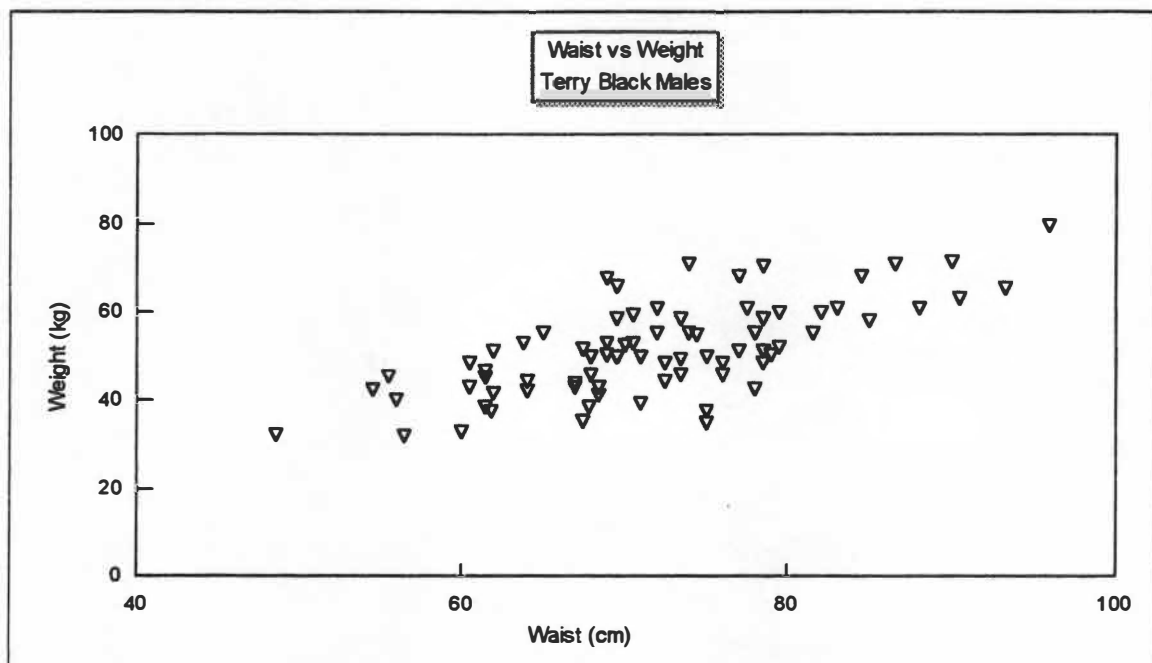
Source	Df	Sum of Squares	Mean Square	F Stat	Prob > F
Model	2	5438.9467	2719.4734	47.8366	0.0001
Error	89	5059.5806	56.8492		
C Total	91	10498.5273			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-49.8249	20.7964	-2.3958	0.0187	-	0
Stature	1	0.2564	0.1113	2.3041	0.0235	0.9668	1.0322
Waist	1	0.7535	0.0772	9.7635	0.0001	0.9668	1.0322

E. Multiple regression of stature and waist on weight

Figure 5 (Continued).



Model Equation
Weight = - 4.4588 + 0.7782 * Waist

Summary of Fit

Mean of Response	51.5118	R-Square	0.4811
Root MSE	7.5740	Adj R-Sq	0.4741

Analysis of Variance

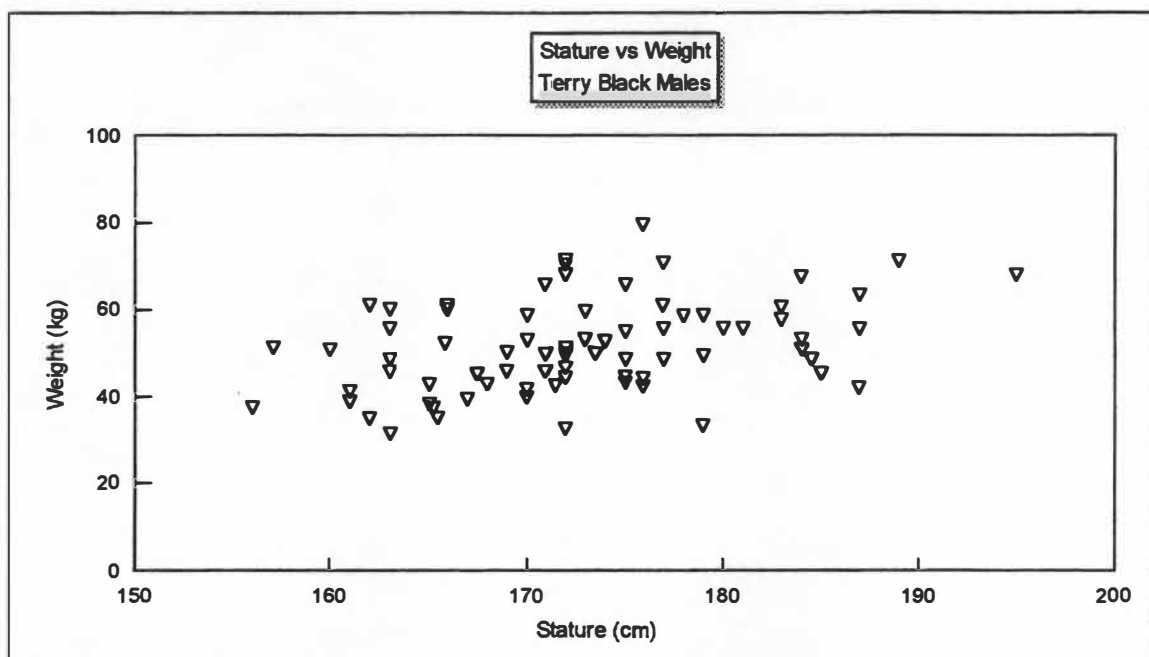
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	3935.3039	3935.3039	68.6004	0.0001
Error	74	4245.0555	57.3656		
C Total	75	8180.3593			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	- 4.4588	6.8133	- 0.6544	0.5149	-	0
Waist	1	0.7782	0.0940	8.2825	0.0001	1.0000	1.0000

A. Waist regressed on weight

Figure 6. Weight estimate for Terry black males.



Model Equation

$$\text{Weight} = -34.0155 + 0.4951 * \text{Stature}$$

Summary of Fit

Mean of Response	51.5118	R-Square	0.1452
Root MSE	9.7210	Adj R-Sq	0.1336

Analysis of Variance

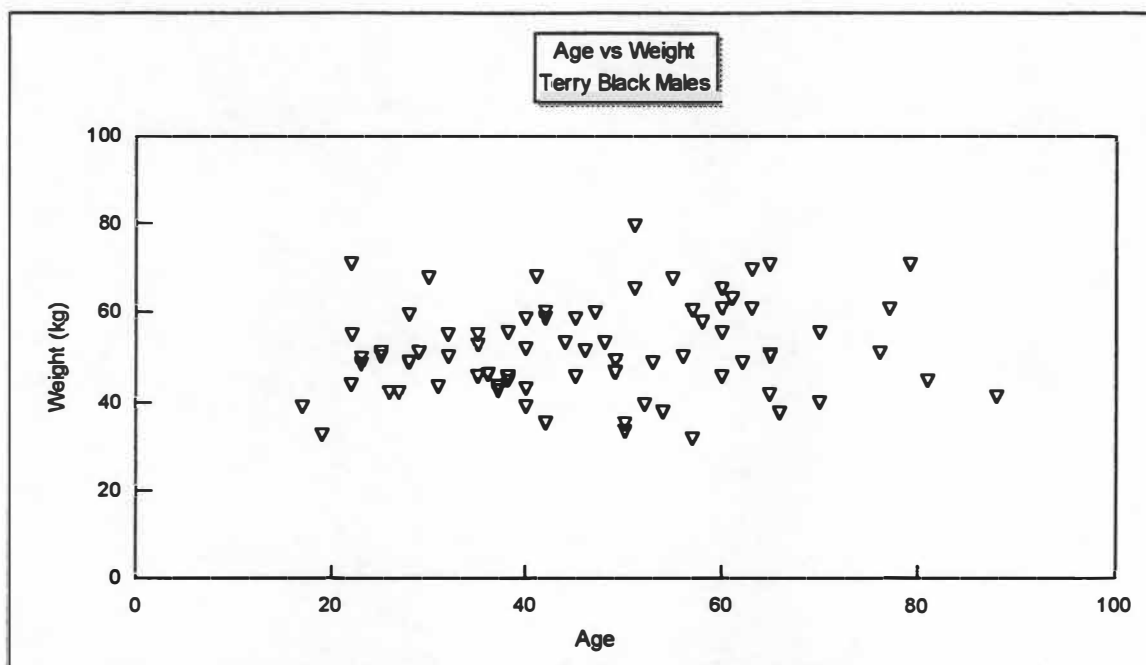
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	1187.4943	1187.4943	12.5663	0.0007
Error	74	6992.8650	94.4982		
C Total	75	8180.3593			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-34.0155	24.1526	-1.4084	0.1632	-	0
Stature	1	0.4951	0.1397	3.5449	0.0007	1.0000	1.0000

B. Stature regressed on weight

Figure 6 (Continued).



Model Equation
Weight = 47.2453 + 0.0916 * Age

Summary of Fit

Mean of Response	51.5053	R-Square	0.0210
Root MSE	10.4008	Adj R-Sq	0.0077

Analysis of Variance

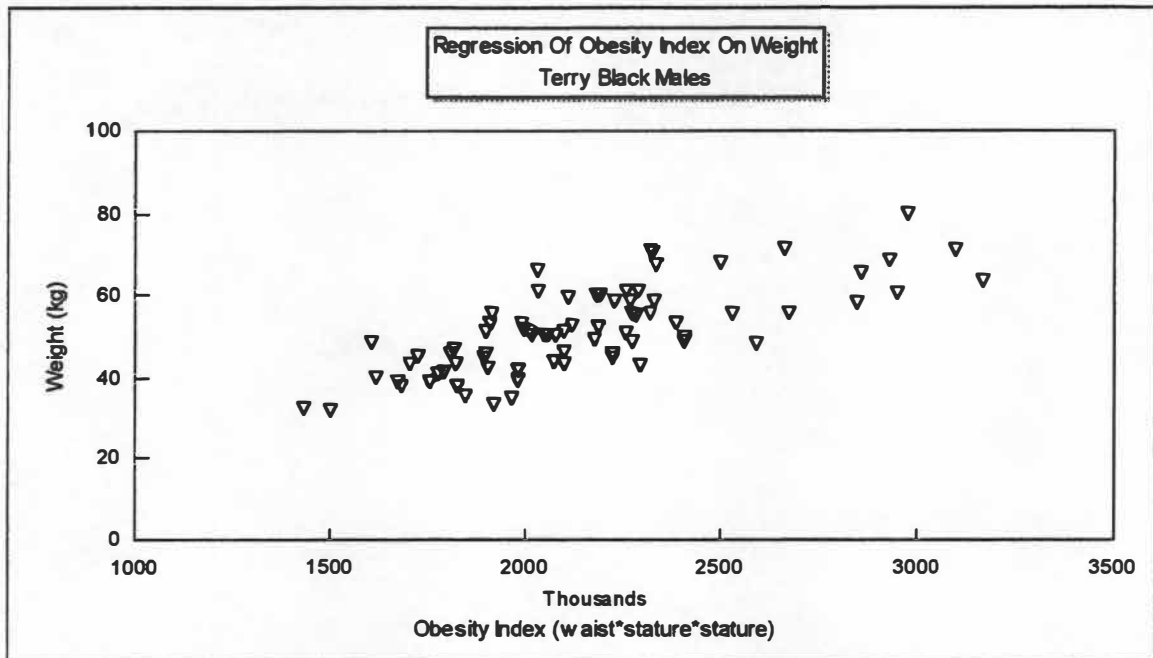
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	171.4878	171.4878	1.5852	0.2120
Error	74	8005.1301	108.1774		
C Total	75	8176.6179			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	47.2453	3.5876	13.1691	0.0001	-	0
Age	1	0.0916	0.0728	1.2591	0.2120	1.0000	1.0000

C. Age regressed on weight

Figure 6 (Continued).



Obesity Index
Index = Waist * (Stature)²

Model Equation
Weight = - 3.0408 + 0.0044 * Index

Summary of Fit

Mean of Response	51.5118	R-Square	0.5657
Root MSE	6.9291	Adj R-Sq	0.5598

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	4627.4508	4627.4508	96.3806	0.0001
Error	74	2325.1085	77.5036		
C Total	75	15309.9010			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-3.0408	5.6133	-0.5417	0.5896	-	0
Index	1	0.0044	0.0004	9.8174	0.0001	1.0000	1.0000

D. Obesity index regressed on weight

Figure 6 (Continued).

Multiple Regression of Stature and Waist on Weight

Model Equation

$$\text{Weight} = - 71.3197 + 0.4026 * \text{Stature} + 0.7407 * \text{Waist}$$

Summary of Fit

Mean of Response	51.5118	R-Square	0.5760
Root MSE	6.8933	Adj. R-Sq	0.5643

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F Stat	Prob > F
Model	2	4711.5744	2355.7872	49.5771	0.0001
Error	73	3468.7849	47.5176		
C Total	75	8180.3593			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	- 71.3197	17.6662	- 4.0371	0.0001	-	0
Stature	1	0.7137	0.0996	4.0418	0.0001	0.9884	1.0118
Waist	1	0.7407	0.0860	8.6118	0.0001	0.9884	1.0118

E. Multiple regression of stature and waist on weight

Figure 6 (Continued).

measurements may play a part in determining how accurate a particular regression method is at estimating forensic weight. Differences in sex are more obvious because males and females differ in both average stature and general body fat distribution. Racial differences may be less useful, although there are known differences in fat distribution of the hips for one group of southern African females (Molinar, 1992). Putting all data points together will help to show the generalized trends in overall comparison of weight regression methods. Figures 7A through 7E will show the data in the same graphic detail as the figures for each of the four groups individually.

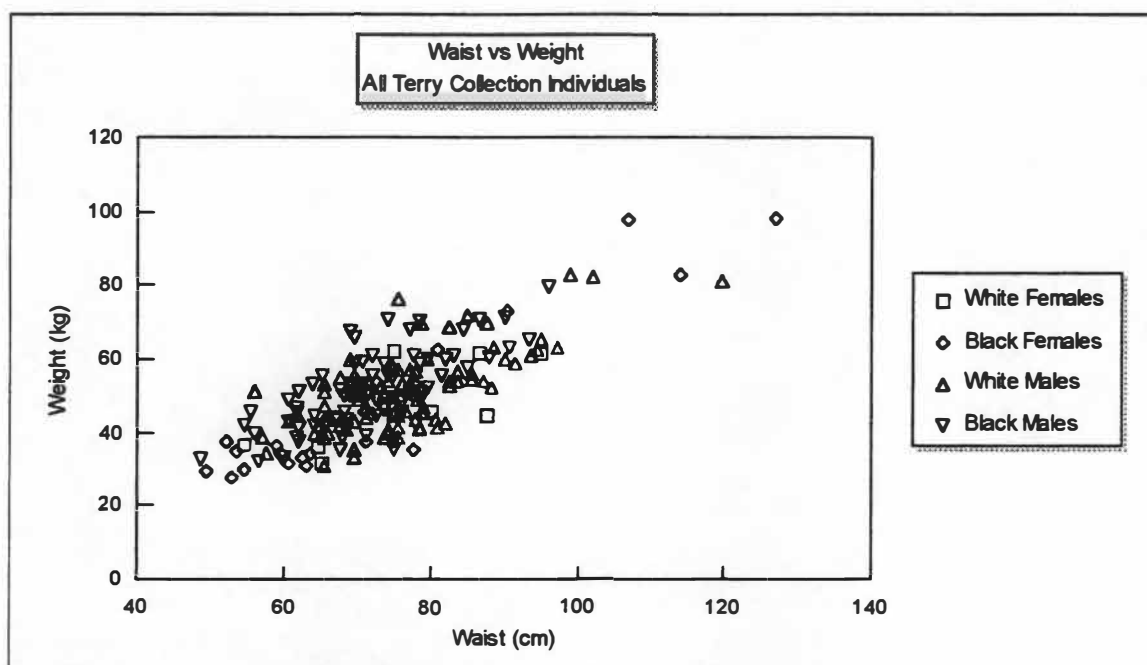
LIVING BODY MEASUREMENTS

White Females

Data for the living white females consists of a total of 30 individuals. The average age is 35.3 years, with a high of 74 and a low of 20. The average weight is 77.06 kg, with a high of 121.6 kg and a low of 53.97 kg. The average waist is 84.5 cm, with a high of 132.1 cm and a low of 59.69 cm. The average stature is 167.3 cm, with a high of 177.8 cm and a low of 152.4 cm. All data in its raw form and in the metric conversion will appear in appendix C at the end of this thesis. Graphic representations of the parameters age, waist, and stature regressed separately and together on body weight are presented in Figures 8A through 8E.

Black Females

Data for the living black females consists of 31 individuals. The average age is 29.8 years, with a high of 54 and a low of 18. The average weight is 70.8 kg, with a high of



Model Equation

$$\text{Weight} = -8.1917 + 0.7959 * \text{Waist}$$

Summary of Fit

Mean of Response	50.6975	R-Square	0.5808
Root MSE	7.9585	Adj R-Sq	0.5787

Analysis of Variance

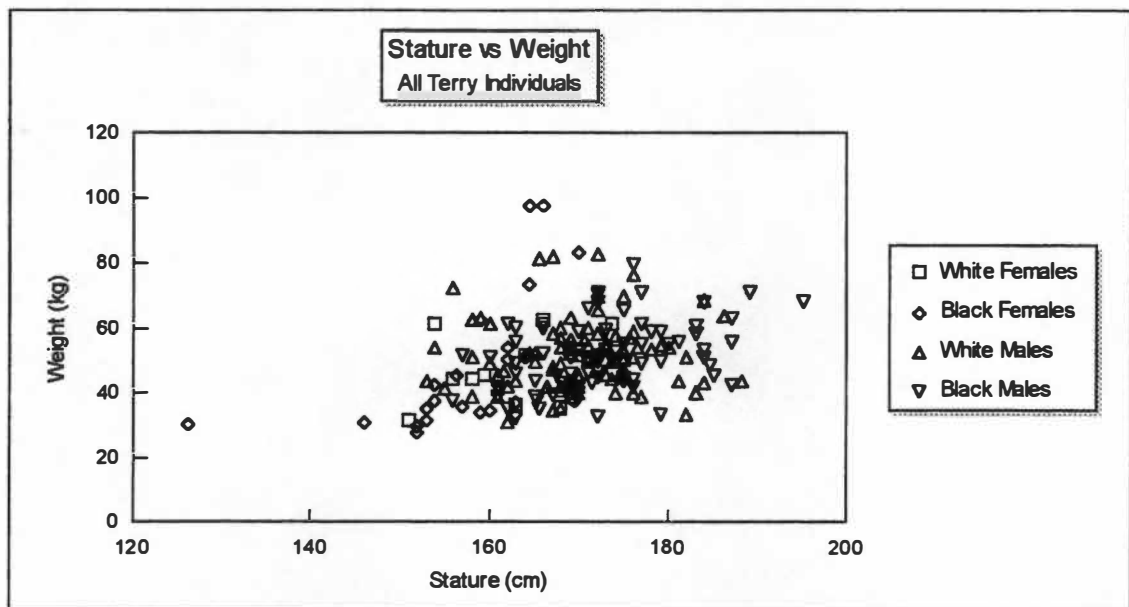
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	17636.4161	17636.4161	278.4506	0.0001
Error	201	12730.8726	63.3377		
C Total	202	30367.2888			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-8.1917	3.5730	-2.2927	0.0229	-	0
Waist	1	0.7959	0.0477	16.6868	0.0001	1.0000	1.0000

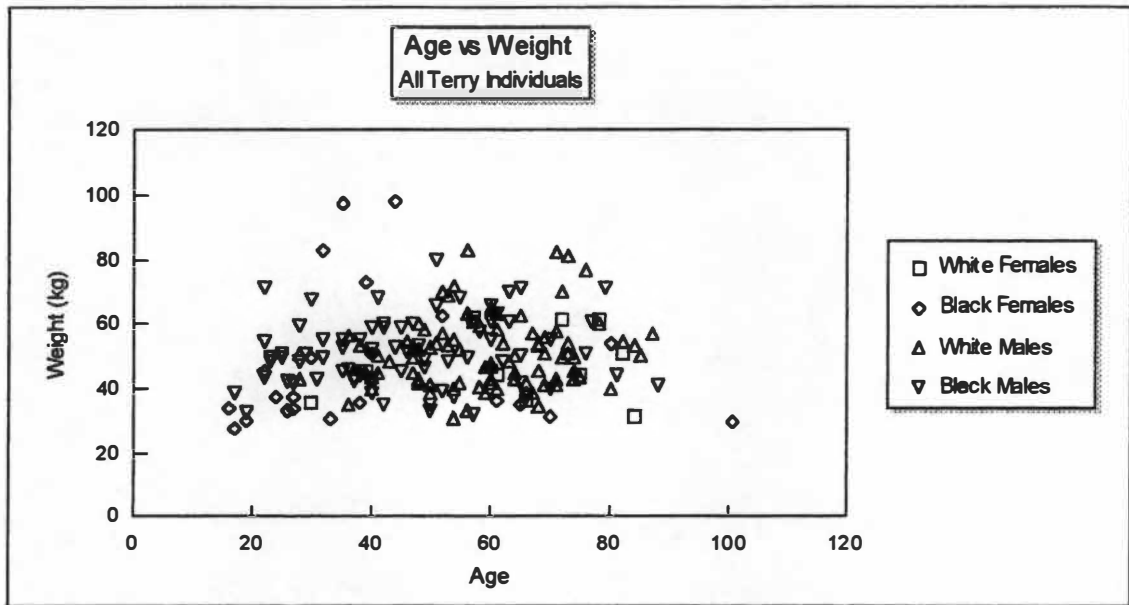
A. Waist regressed on weight

Figure 7. Weight estimation for all Terry individuals collectively.



B. Stature regressed on weight

Figure 7 (Continued).



Model Equation

$$\text{Weight} = 46.8370 + 0.0724 * \text{Age}$$

Summary of Fit

Mean of Response	50.6310	R-Square	0.0104
Root MSE	12.2750	Adj R-Sq	0.0054

Analysis of Variance

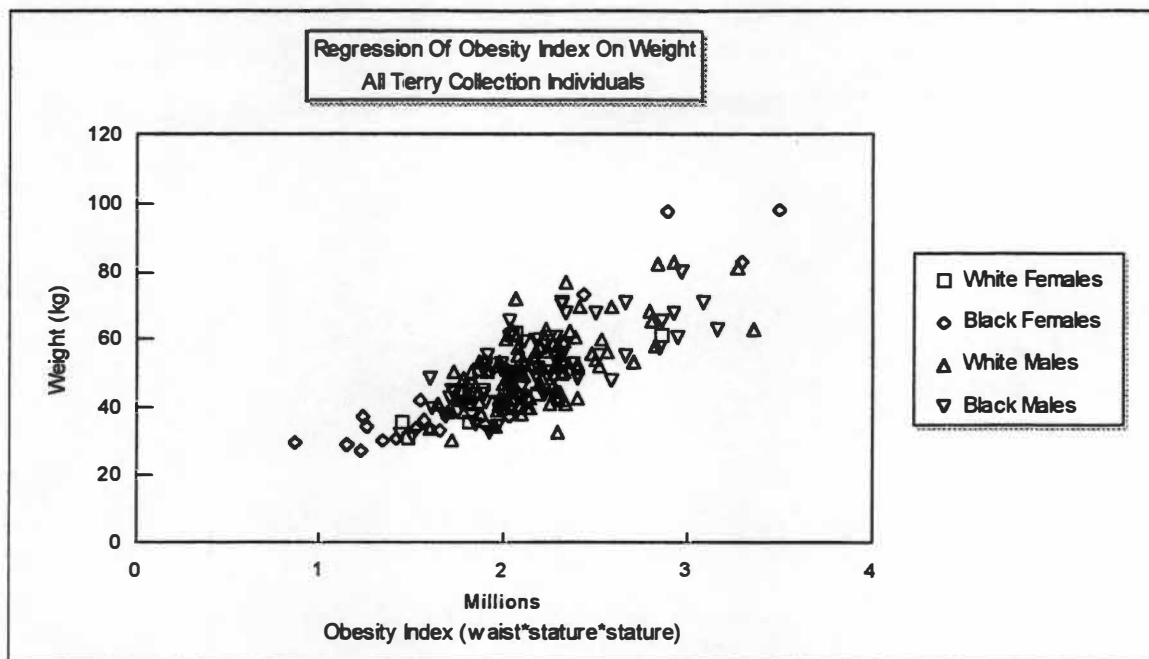
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	313.0873	313.0873	2.0779	0.1510
Error	198				
C Total	199				

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	46.8370	2.7715	16.8998	0.0001	-	0
Age	1	0.0724	0.0502	1.4415	0.1510	1.0000	1.0000

C. Age regressed on weight

Figure 7 (Continued).



Obesity Index
Index = Waist * (Stature)²

Model Equation
Weight = 1.0603 + 6.9E - 07 * Index

Summary of Fit

Mean of Response	25.0408	R-Square	0.5867
Root MSE	3.9030	Adj R-Sq	0.5846

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	4346.4788	4346.4788	285.3199	0.0001
Error	201	3061.9707	15.2337		
C Total	202	7408.4534			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	1.0603	1.4459	0.7333	0.4642	-	0
Index	1	6.88E - 07	4.073E - 08	16.8914	0.0001	1.0000	1.0000

D. Obesity index regressed on weight.

Figure 7 (Continued).

Multiple Regression of Stature and Waist on Weight

Model Equation

$$\text{Weight} = - 29.6288 + 0.6014 * \text{Stature} + 0.1506 * \text{Waist}$$

Summary of Fit

Mean of Response	25.0408	R-Square	0.6350
Root MSE	6.8933	Adj. R-Sq	0.6313

Analysis of Variance

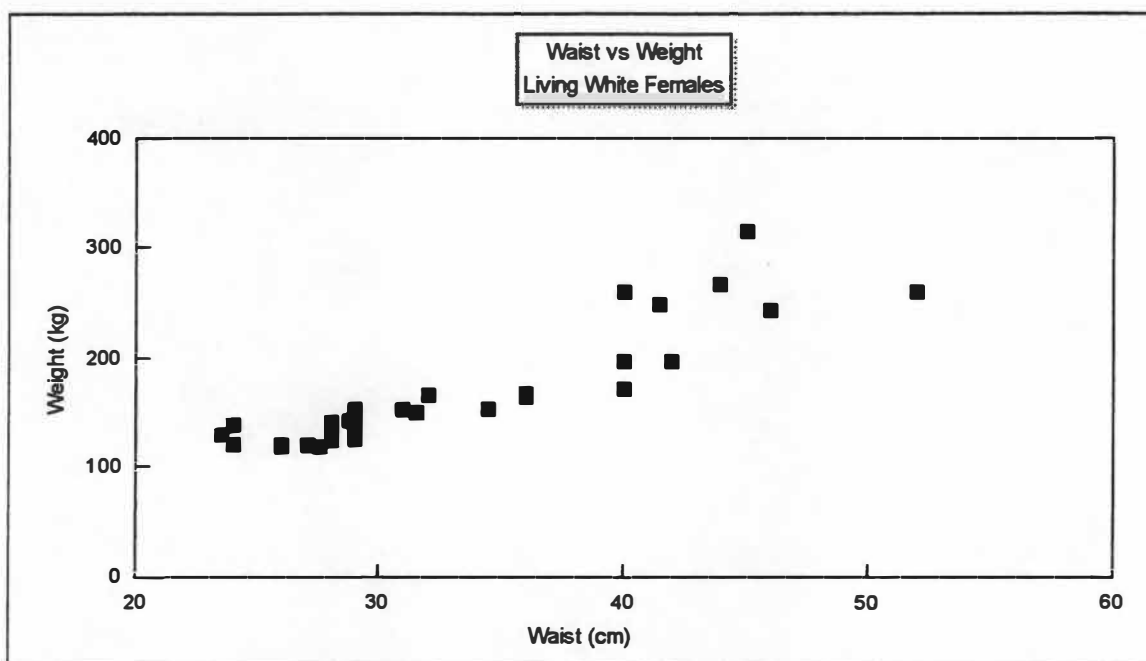
Source	Df	Sum of Squares	Mean Square	F Stat	Prob > F
Model	2	4704.2371	2352.1186	173.9594	0.0001
Error	201	2704.2163	13.5211		
C Total	202	7408.4543			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > [T]	Tolerance	Var Inflation
Intercept	1	- 29.6288	4.9758	- 5.9546	0.0001	-	0
Stature	1	0.0614	0.0113	5.4501	0.0001	0.9922	1.0079
Waist	1	0.1506	0.0087	17.2876	0.0001	0.9922	1.0079

E. Multiple regression of stature and waist on weight

Figure 7 (Continued).



Model Equation

$$\text{Weight} = -19.0501 + 1.1371 * \text{Waist}$$

Summary of Fit

Mean of Response	77.0586	R-Square	0.8078
Root MSE	10.9570	Adj R-Sq	0.8010

Analysis of Variance

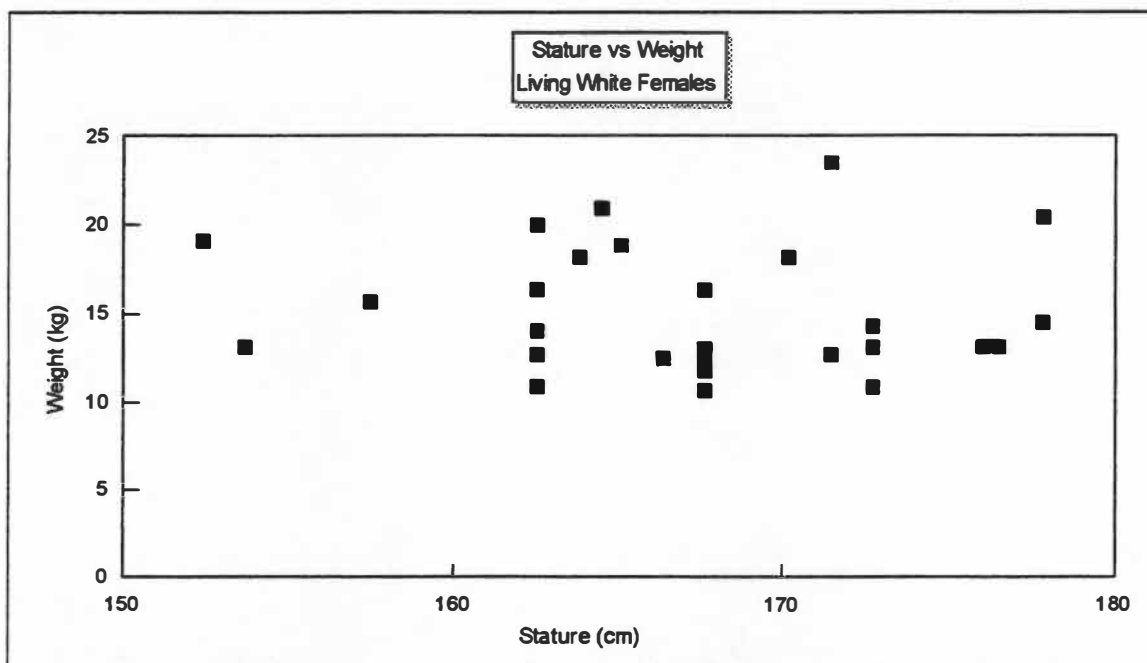
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	14132.3411	14132.3411	117.7155	0.0001
Error	28	3361.5423	120.0551		
C Total	29	17493.8833			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-19.0501	9.0813	-2.0977	0.0451	-	0
Waist	1	1.1371	0.1048	10.8497	0.0001	1.0000	1.0000

A. Waist regressed on weight.

Figure 8. Weight estimate for living white females.



Model Equation

$$\text{Weight} = 12.3067 + 0.3870 * \text{Stature}$$

Summary of Fit

Mean of Response	77.0586	R-Square	0.0100
Root MSE	24.8707	Adj R-Sq	0.0

Analysis of Variance

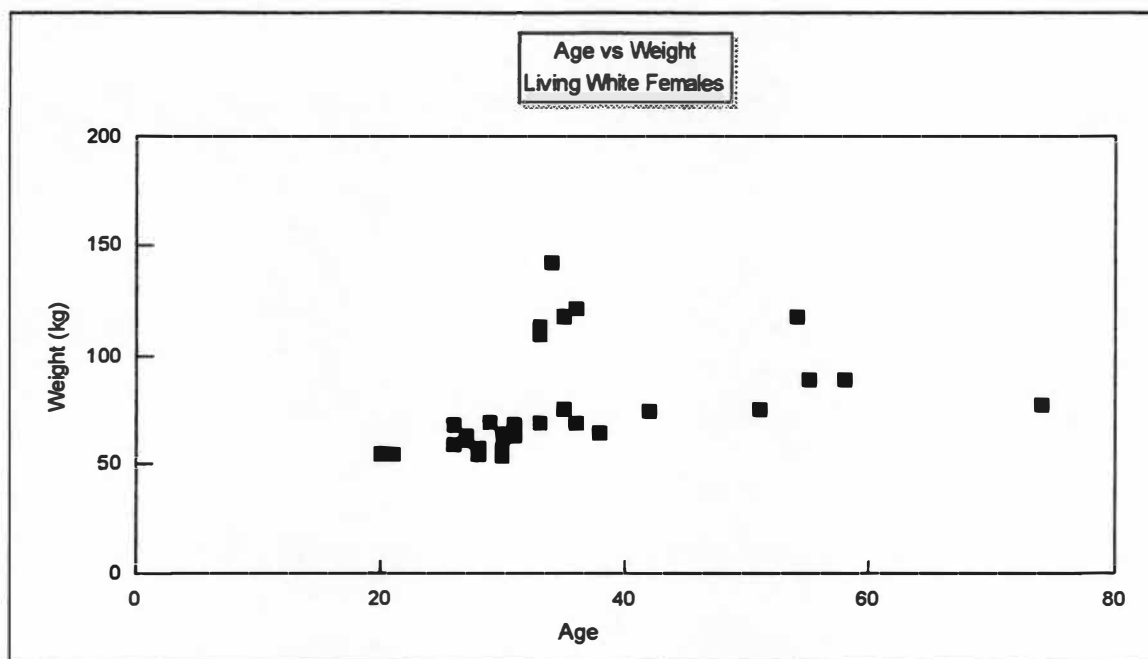
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	174.3678	174.3678	0.2819	0.5996
Error	28	17319.5155	618.5541		
C Total	29	17493.8833			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	12.3067	122.0419	0.1008	0.9204	-	0
Waist	1	0.3870	0.7290	0.5309	0.5996	1.0000	1.0000

B. Stature regressed on weight

Figure 8 (Continued).



Model Equation
Weight = 50.3007 + 0.7566 * Age

Summary of Fit

Mean of Response	77.0586	R-Square	0.1346
Root MSE	23.2529	Adj R-Sq	0.1037

Analysis of Variance

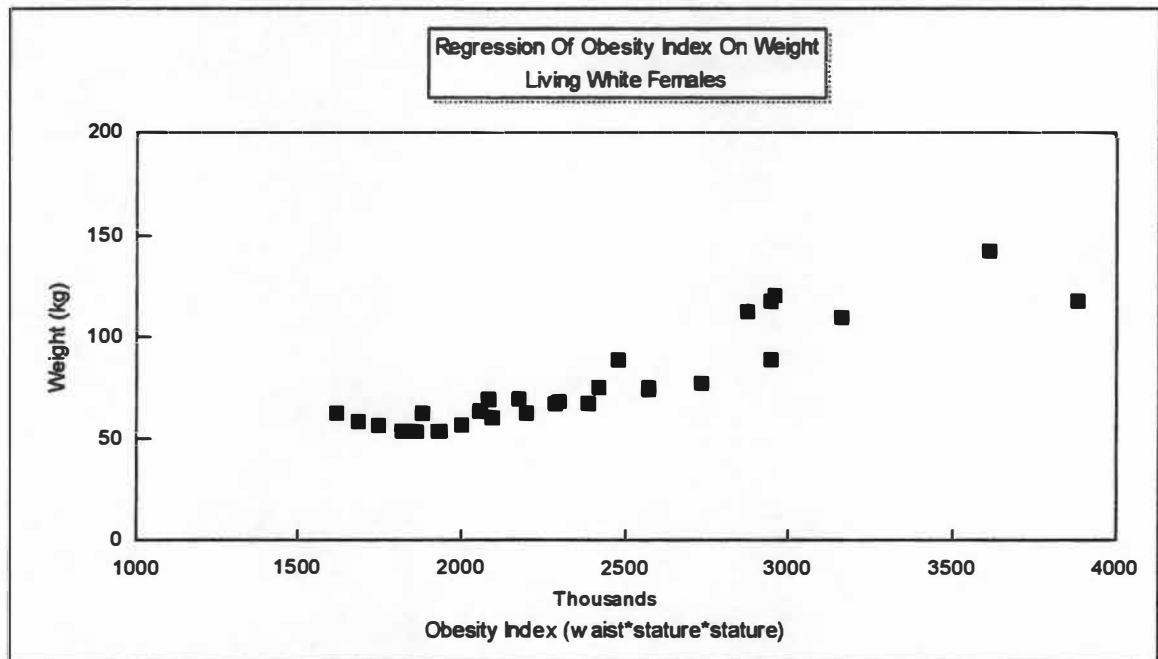
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	2354.3407	2354.3407	4.3543	0.04061
Error	28	15139.5426	540.6980		
C Total	29	17493.8833			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	50.3007	13.5076	3.7239	0.0009	-	0
Age	1	0.7566	0.3626	2.0867	0.0461	1.0000	1.0000

C. Age regressed on weight

Figure 8 (Continued).



Obesity Index
Index = Waist * (Stature)²

Model Equation
Weight = - 16.1917 + 0.000039 * Index

Summary of Fit

Mean of Response	77.0586	R-Square	0.8278
Root MSE	10.3727	Adj R-Sq	0.8216

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	14481.2597	14481.2597	134.5921	0.0001
Error	28	3012.6236	107.5937		
C Total	29	17493.8833			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	- 16.1917	8.2579	- 1.9607	0.0599	-	0
Index	1	3.3941E - 05	3.397E - 5	11.6014	0.0001	1.0000	1.0000

D. Obesity index regressed on weight.

Figure 8 (Continued).

Multiple Regression of Weight on Stature and Waist

Model Equation

$$\text{Weight} = -130.792 + 0.6595 * \text{Stature} + 1.1537 * \text{Waist}$$

Summary of Fit

Mean of Response	77.0586	R-Square	0.8366
Root MSE	10.2899	Adj. R-Sq	0.8245

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F Stat	Prob > F
Model	2	14635.6511	7317.8255	69.1271	0.0001
Error	27	2858.2322	105.8605		
C Total	29	17493.8833			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-130.7918	51.9512	-2.5176	0.0181	-	0
Stature	1	0.6595	0.3025	2.1805	0.0381	0.9941	1.0060
Waist	1	1.1537	0.0987	11.6879	0.0001	0.9941	1.0060

E. Multiple regression of stature and waist on weight

Figure 8 (Continued).

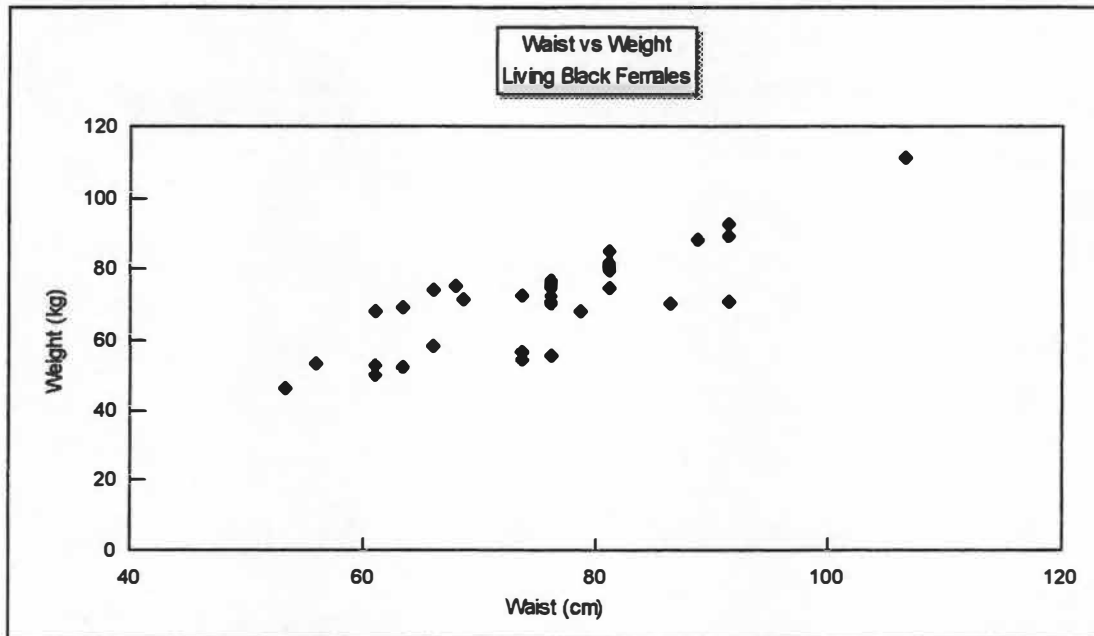
111.1 kg and a low of 46.3 kg. The average waist is 74.5 cm, with a high of 106.7 cm and a low of 53.3 cm. The average stature is 168.5 cm, with a high of 180.3 cm and a low of 157.5 cm. It should also be noted that at least 10 of the 30 black females questioned were born in various countries of the continent of Africa. The data in its raw form and in metric conversion, appears in appendix C at the end of this thesis. Graphic representations of the parameters age, waist, and stature regressed separately and together on body weight are presented in Figures 9A through 9E.

White males

Data for living white males was gathered from a total of 32 individuals. The average age is 33.7 years, with a high of 57 and a low of 18. The average weight is 93.2 kg, with a high of 152.4 kg and a low of 68.0 kg. The average waist is 94.2 cm, with a high of 137.2 cm and a low of 76.2 cm. The average stature is 180.4 cm, with a high of 193.0 cm and a low of 165.1 cm. The raw data and the metric conversion appear in appendix C at the end of this thesis. Graphic representations of the parameters age, waist, and stature regressed separately and together on body weight are presented in Figures 10A through 10E.

Black males

Data for living black males was gathered from a total of 32 individuals. The average age is 42.2 years, with a high of 80 and a low of 19. The average weight is 98.1 kg, with a high of 165.5 kg and a low of 64.2 kg. The average waist is 94.9 cm, with a high of 142.2 cm and a low of 73.7 cm. The average stature is 179.0 cm, with a high of 193.0 cm and a low of 165.1 cm. The raw data and the metric conversion appear in



Model Equation
Weight = - 4.8866 + 1.0903 * Waist

Summary of Fit

Mean of Response	77.3568	R-Square	0.6809
Root MSE	8.7411	Adj R-Sq	0.6706

Analysis of Variance

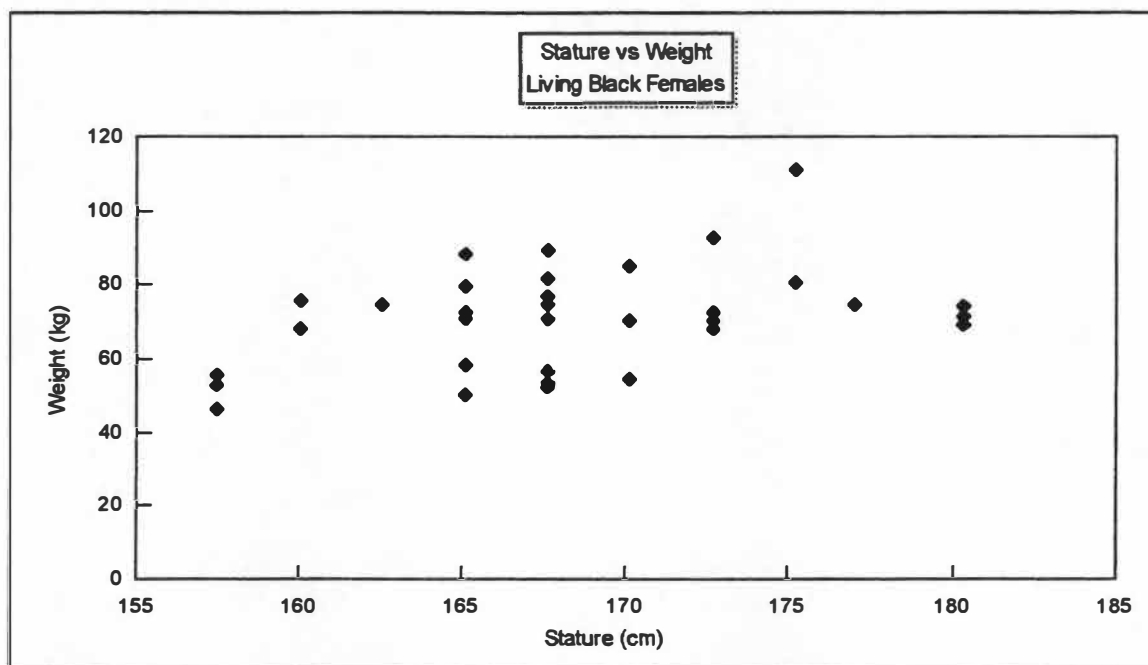
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	5054.0868	5054.0868	66.1463	0.0001
Error	31	2368.6377	76.4077		
C Total	32	7422.7245			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > [T]	Tolerance	Var Inflation
Intercept	1	- 4.8866	10.2261	- 0.4779	0.6361	-	0
Waist	1	1.0903	0.1341	8.1330	0.0001	1.0000	1.0000

A. Waist regressed on weight

Figure 9. Weight estimate for living black females.



Model Equation
Weight = - 85.3451 + 0.9679 * Stature

Summary of Fit

Mean of Response	77.3568	R-Square	0.1522
Root MSE	14.2479	Adj R-Sq	0.1248

Analysis of Variance

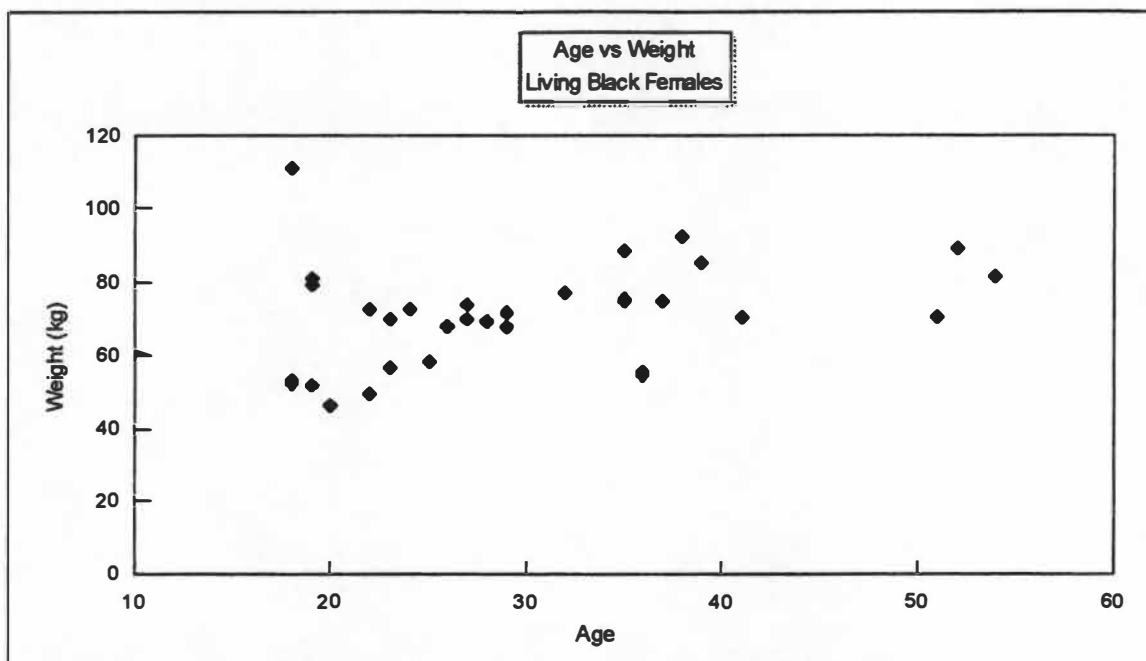
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	1129.6346	1129.6346	5.5646	0.0248
Error	31	6293.0899	203.0029		
C Total	32	7422.7245			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	- 85.3451	69.0169	-1.2366	0.2255	-	0
Stature	1	0.9679	0.4103	2.3589	0.0248	1.0000	1.0000

B. Stature regressed on weight

Figure 9 (Continued).



Model Equation

$$\text{Weight} = 62.2842 + 0.5004 * \text{Age}$$

Summary of Fit

Mean of Response	77.3568	R-Square	0.1092
Root MSE	14.6045	Adj R-Sq	0.0805

Analysis of Variance

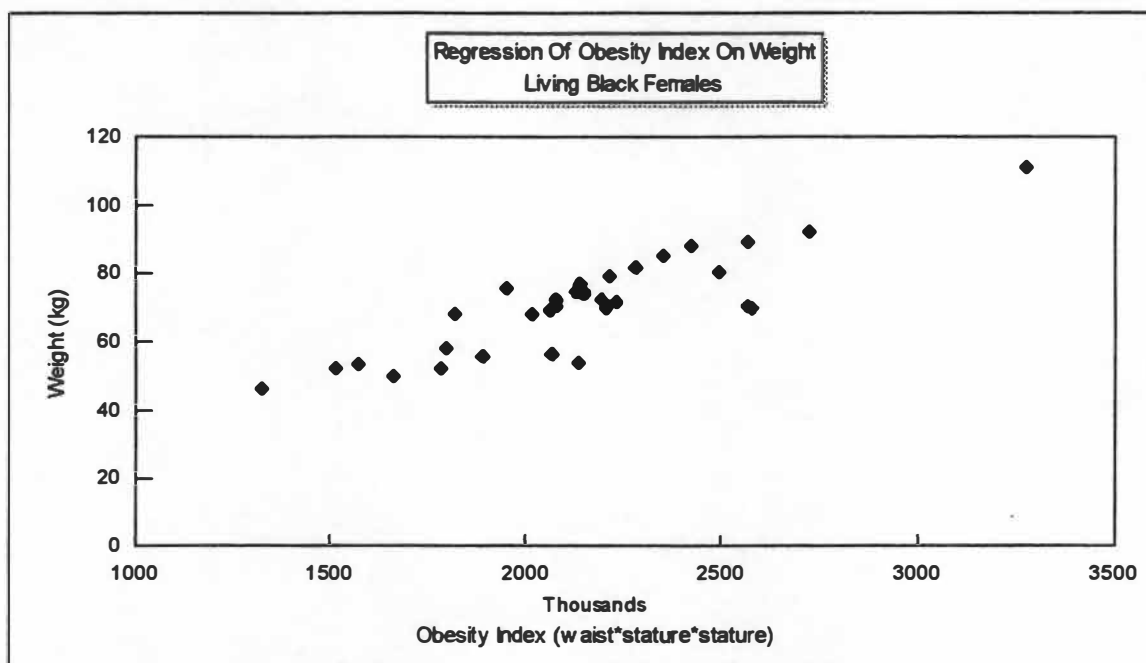
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	810.6696	810.6696	3.8007	0.0603
Error	31	6612.0549	213.2921		
C Total	32	7422.7245			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	62.2842	8.1386	7.6529	0.0001	-	0
Age	1	0.5004	0.2527	1.9496	0.0603	1.0000	1.0000

C. Age regressed on weight.

Figure 9 (Continued).



Obesity Index

$$\text{Index} = \text{Waist} * (\text{Stature})^2$$

Model Equation

$$\text{Weight} = 2.6258 + 0.00035 * \text{Index}$$

Summary of Fit

Mean of Response	77.3568	R-Square	0.7562
Root MSE	7.6402	Adj R-Sq	0.7484

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	5613.1771	5613.1771	96.1613	0.0001
Error	31	1809.5474	58.3725		
C Total	32	7422.7245			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	2.6248	7.7360	0.3394	0.7366	-	0
Index	1	3.497E - 05	3.566E - 05	9.8062	0.0001	1.0000	1.0000

D. Obesity index regressed on weight

Figure 9 (Continued).

Multiple Regression of Stature and Waist on Weight

$$\text{Weight} = -120.003 + 0.7074 * \text{Stature} + 1.0401 * \text{Waist}$$

Summary of Fit

Mean of Response	77.3568	R-Square	0.7607
Root MSE	7.6942	Adj. R-Sq	0.7448

Analysis of Variance

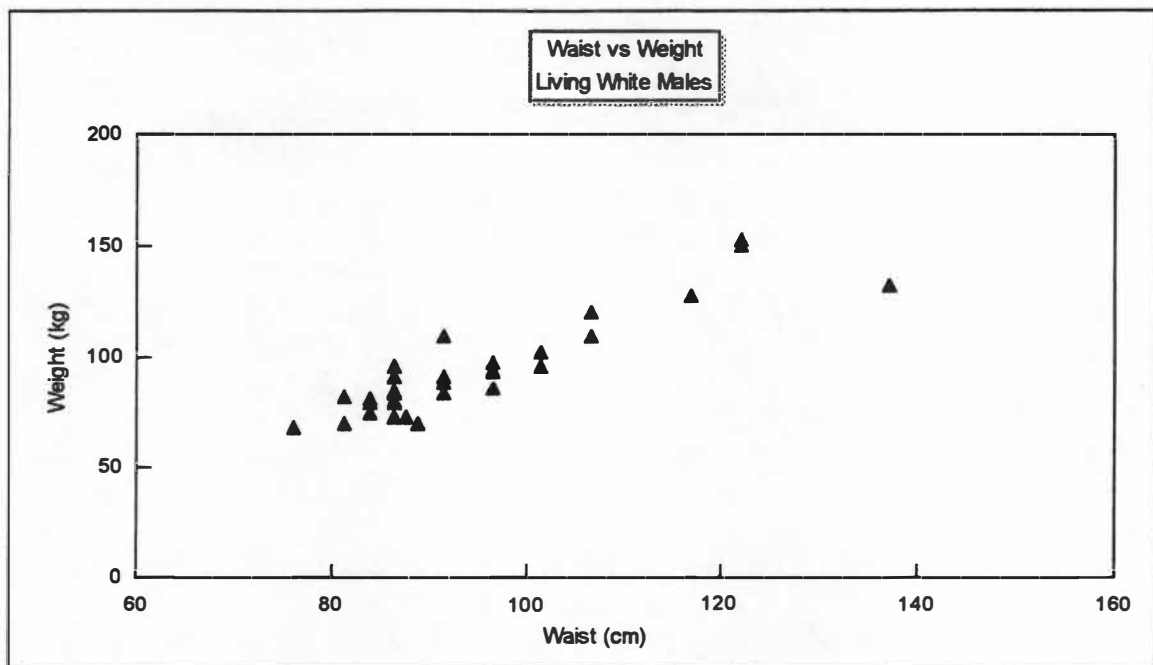
Source	Df	Sum of Squares	Mean Square	F Stat	Prob > F
Model	2	5646.7028	2823.3514	47.6912	0.0001
Error	30	1776.0217	59.2007		
C Total	32	7422.7245			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-120.003	37.4813	-3.2017	0.0032	-	0
Stature	1	0.7074	0.2236	3.1639	0.0036	0.9822	1.0181
Waist	1	1.0401	0.1191	8.7350	0.0001	0.9822	1.0181

E. Multiple regression of stature and waist on weight

Figure 9 (Continued).



Model Equation

$$\text{Weight} = - 44.3733 + 1.5369 * \text{Waist}$$

Summary of Fit

Mean of Response	100.3712	R-Square	0.8205
Root MSE	10.3126	Adj R-Sq	0.8145

Analysis of Variance

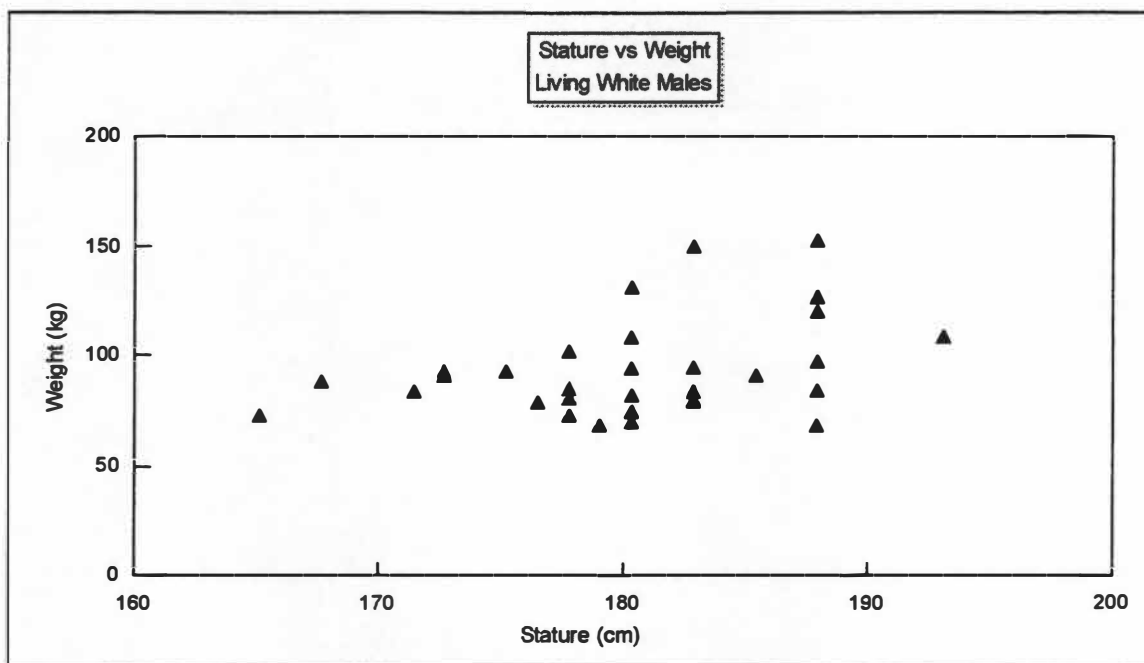
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	14584.9480	14584.9480	137.1407	0.0001
Error	30	3190.5072	106.3502		
C Total	31	17775.4551			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > [T]	Tolerance	Var Inflation
Intercept	1	- 44.3733	12.4937	-3.5516	0.0013	-	0
Waist	1	1.5369	0.1312	11.7107	0.0001	1.0000	1.0000

A. Waist regressed on weight

Figure 10. Weight estimate for living white males.



Model Equation
Weight = - 150.337 + 1.3893 * Stature

Summary of Fit

Mean of Response	100.371	R-Square	0.1329
Root MSE	22.6668	Adj R-Sq	0.1040

Analysis of Variance

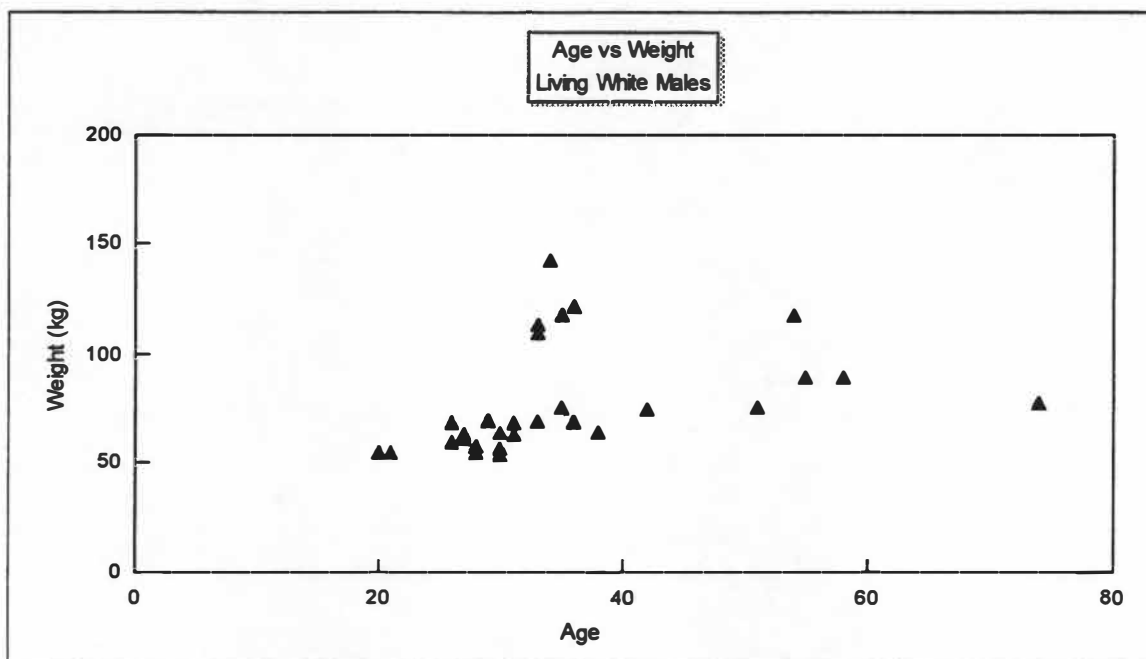
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	2361.9310	2361.9310	4.5971	0.0402
Error	30	15413.5421	513.7841		
C Total	31	17775.4551			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	- 150.3368	116.9984	-1.2849	0.2086	1	0
Stature	1	1.3893	0.6480	2.1441	0.0402	1.0000	1.0000

B. Stature regressed on weight

Figure 10 (Continued).



Model Equation

$$\text{Weight} = 100.016 + 0.0105 * \text{Age}$$

Summary of Fit

Mean of Response	100.371	R-Square	2.05E -5
Root MSE	24.341	Adj R-Sq	0.0

Analysis of Variance

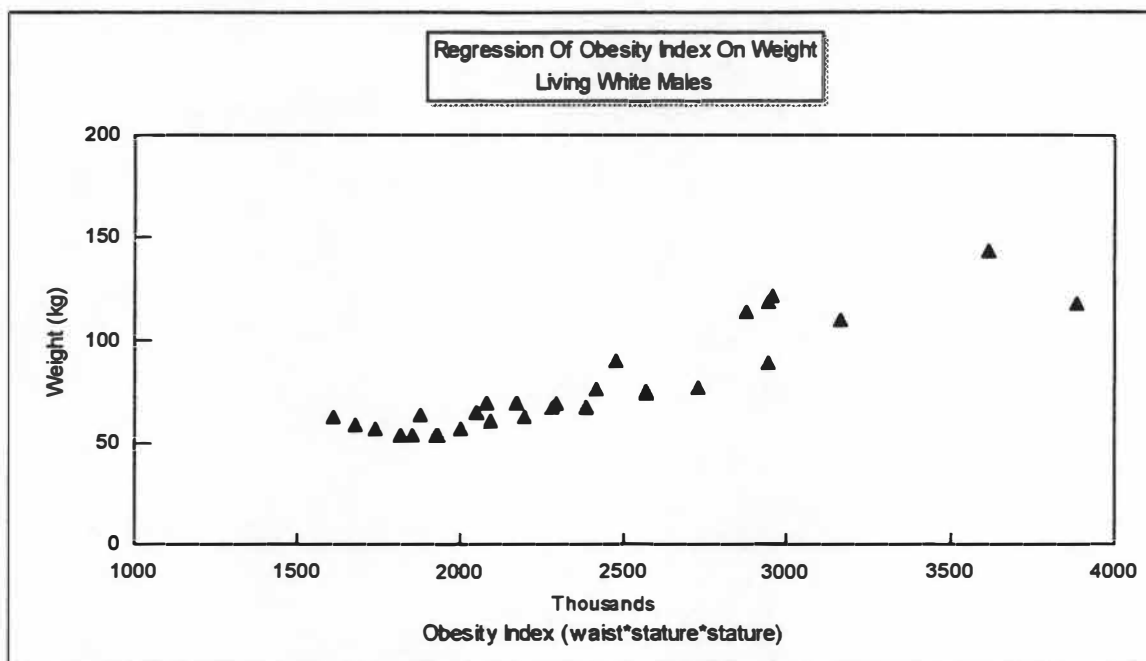
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	0.3537	0.3537	0.0006	0.9807
Error	30	17775.1014	592.5034		
C Total	31	17775.4551			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	100.0161	15.1545	6.5997	0.0001	-	0
Age	1	0.0105	0.4309	0.0244	0.9807	1.0000	1.0000

C. Age regressed on weight

Figure 10 (Continued).



Obesity Index

$$\text{Index} = \text{Waist} * (\text{Stature})^2$$

Model Equation

$$\text{Weight} = - 22.8816 + 0.00004 * \text{Index}$$

Summary of Fit

Mean of Response	100.3712	R-Square	0.8481
Root MSE	9.4860	Adj R-Sq	0.8431

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	15075.9039	15075.9039	167.5379	0.0001
Error	30	2699.5512	89.9850		
C Total	31	17775.4551			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	- 22.8816	9.6688	- 2.3665	0.0246	-	0
Index	1	4.006E -05	3.095E -06	12.9436	0.0001	1.0000	1.0000

C. Obesity index regressed on weight.

Figure 10 (Continued).

Multiple Regression of Stature and Waist on Weight

$$\text{Weight} = -177.109 + 0.7690 * \text{Stature} + 1.4797 * \text{Waist}$$

Summary of Fit

Mean of Response	100.3712	R-Square	0.8598
Root MSE	9.2703	Adj. R-Sq	0.8501

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F Stat	Prob > F
Model	2	15283.2644	7641.6322	88.9207	0.0001
Error	29	2492.1908	85.9376		
C Total	31	17775.4551			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-177.1093	47.8997	-3.6975	0.0009	-	0
Stature	1	0.7690	0.2698	2.8506	0.0080	0.9648	1.0364
Waist	1	1.4727	0.1201	12.2620	0.0001	0.9648	1.0364

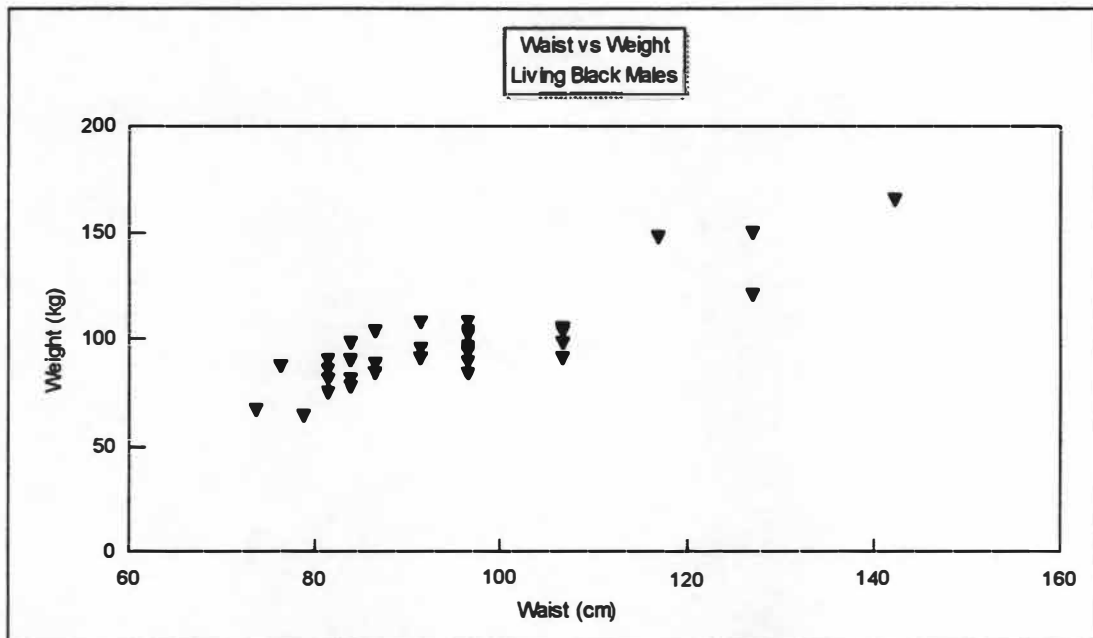
E. Multiple regression of stature and waist on weight.

Figure 10 (Continued).

appendix C at the end of this thesis. Graphic representations of the parameters age, waist, and stature regressed separately and together on body weight are presented in Figures 11A through 11E.

SUMMARY OF STATISTICS

This section of the thesis will present data from the Terry collection, and data collected from living persons together to show how each group compares to the other. The purpose of this is to provide better context for the conclusions which will be discussed later. The comparisons presented here will be divided into two parts. The first comparison will attempt to show that skeletal measurements do not correlate well with body weight and in fact correlate instead with stature. The second comparison will attempt to show which regression equation or method is the most accurate at predicting weight from the parameters measured. Figure 12A through 12K will present a summary of the important statistics from the previous figures. The multiple regression method is abbreviated as MR, but all other regression methods are written out.



Model Equation
Weight = -17.2124 + 1.2039 * Waist

Summary of Fit

Mean of Response	97.0797	R-Square	0.7613
Root MSE	10.9446	Adj R-Sq	0.7533

Analysis of Variance

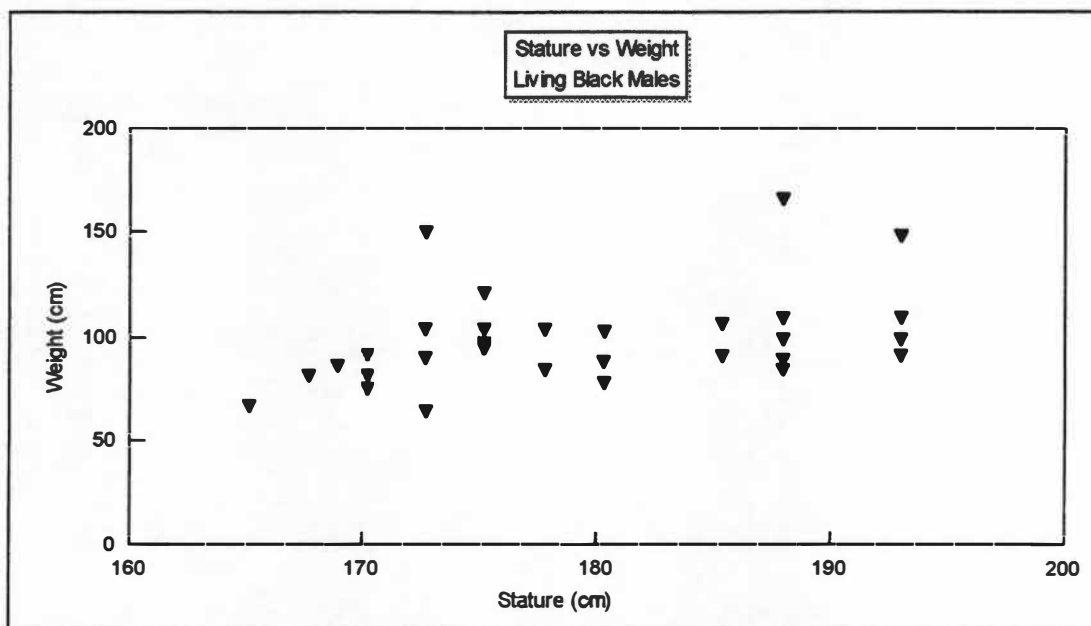
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	11459.9572	11459.9572	95.6725	0.0001
Error	30	3593.4957	119.7832		
C Total	31	15053.4529			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-17.2124	11.8439	-1.4533	0.1565	-	0
Waist	1	1.2039	0.1231	9.7812	0.0001	1000	1000

A. Waist regressed on weight

Figure 11. Weight estimate for living black males.



Model Equation

$$\text{Weight} = -81.4208 + 0.9770 * \text{Stature}$$

Summary of Fit

Mean of Response	97.0797	R-Square	0.1482
Root MSE	20.6746	Adj R-Sq	0.1198

Analysis of Variance

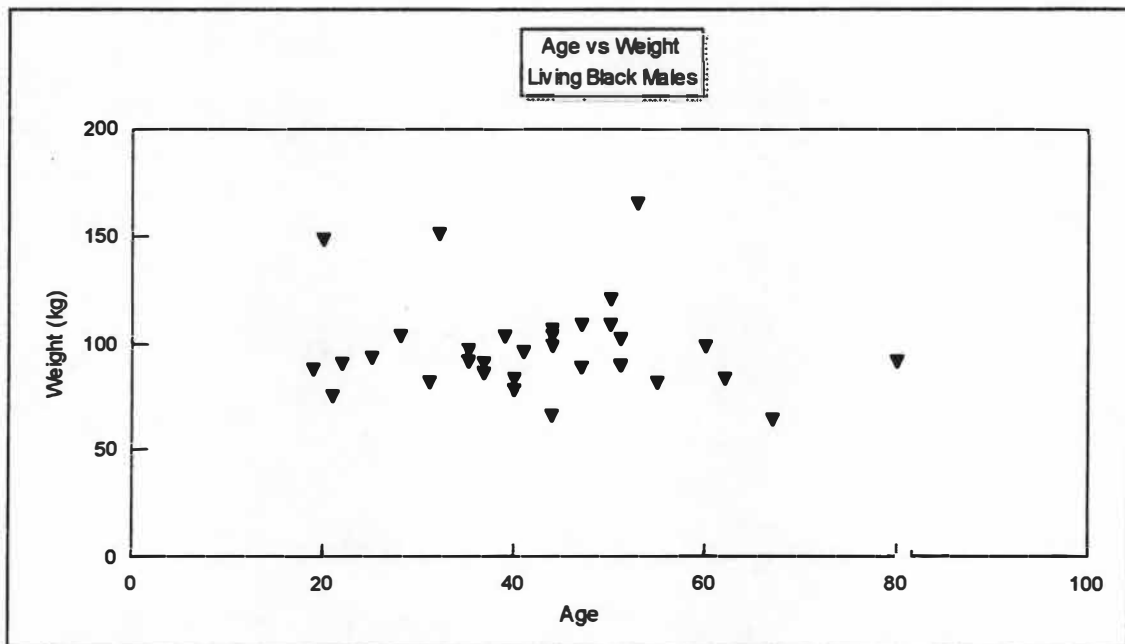
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	2230.2346	2230.2346	5.2176	0.0296
Error	30	12863.2183	427.4406		
C Total	31	15053.4529			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-81.4208	78.2306	-1.0408	0.3063	-	0
Waist	1	0.9970	0.4365	2.2842	0.0296	1000	1000

B. Stature regressed on weight

Figure 11 (Continued).



Model Equation

$$\text{Weight} = 104.008 - 0.1641 * \text{Age}$$

Summary of Fit

Mean of Response	97.0797	R-Square	0.0110
Root MSE	22.2767	Adj R-Sq	0.0

Analysis of Variance

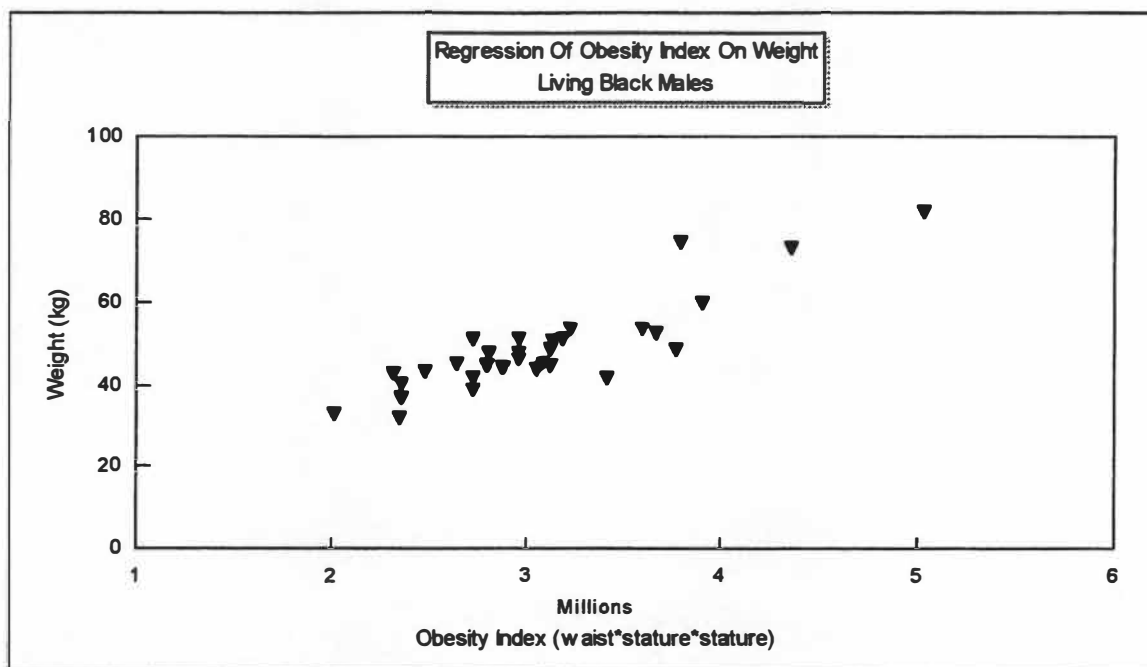
Source	Df	Sum of Squares	Mean Square	F-Stat	Prob > F
Model	1	165.9747	165.9747	0.3345	0.0001
Error	30	14887.4782	496.2493		
C Total		15053.4529			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > [T]	Tolerance	Var Inflation
Intercept	1	104.0078	12.6103	8.2479	0.0001	-	0
Waist	1	-0.1641	0.2338	-0.5783	0.5674	1000	1000

C. Age regressed on weight.

Figure 11 (Continued).



Obesity Index
Waist * (Stature)²

Model Equation

$$\text{Weight} = 4.7126 + 0.00003 * \text{Index}$$

Mean of Response	97.0797	R-Sq.	0.7755
Root MSE	10.6137	Adj. R-Sq.	0.7680

Analysis of Variance

Source	Df	Sum of Sq.	Mean Sq.	F-Stat.	Prob > F
Model	1	11673.9510	11673.9510	103.6302	0.0001
Error	30	3379.5019	112.6501		
C-Total	31	15053.4529			

Parameter Estimates

Variable	Df	Estimate	Std. Error	T-Stat.	Prob > [T]	Tolerance	Var. Inflation
Intercept	1	4.7126	9.2654	0.5086	0.6147	-	0
Index	1	3.020E - 05	2.966E - 06	10.1799	0.0001	1000	1000

D. Obesity index regressed on weight.

Figure 11 (Continued).

Multiple Regression of Stature and Waist on Weight

Model Equation

$$\text{Weight} = -113.036 + 0.5673 * \text{Stature} + 1.1434 * \text{Waist}$$

Summary of Fit

Mean of Response	97.0797	R-Square	0.8073
Root MSE	10.0006	Adj. R-Sq	0.7940

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F Stat	Prob > F
Model	2	12153.0907	6076.5454	60.7579	0.0001
Error	29	2900.3622	100.0125		
C Total	31	15053.4529			

Parameter Estimates

Variable	Df	Estimate	Std Error	T Stat	Prob > T	Tolerance	Var Inflation
Intercept	1	-113.0365	37.9742	-3.3975	0.0058	-	0
Stature	1	0.5673	0.2155	2.8506	0.0134	0.9599	1.0418
Waist	1	1.1434	0.1148	12.2620	0.0001	0.9599	1.0418

E. Multiple regression of stature and waist on weight.

Figure 11 (Continued).

Group	Dep. Var.	Sample Size	R-Sq.	Root MSE	Std. Error of Coefficients	Prob > F
Terry WF	Stature	10	3.1E - 6	7.3109	0.8451	0.9961
	Weight	10	0.0830	11.5554	1.3373	0.4197
Terry BF	Stature	22	0.3963	7.2846	0.4938	0.0010
	Weight	22	0.3276	17.7459	1.2029	0.0032
Terry WM	Stature	89	0.2190	6.4589	1.5020	0.0001
	Weight	89	0.0160	10.7139	0.4917	0.1229
Terry BM	Stature	74	0.3520	6.4169	0.2778	0.0001
	Weight	74	0.0070	10.4678	0.4532	0.2223
All Terry Indv.	Stature	195	0.4245	6.9353	0.1469	0.0001
	Weight	195	0.0538	12.0254	0.2548	0.0006

A. Average femoral head regressed on stature and on weight separately

Figure 12. Comparison of statistics

Group	Dep. Var.	Sample Size	R-Sq.	Root MSE	Std. Error of Coefficients	Prob > F
Terry WF	Stature	10	0.0316	7.1947	0.7350	0.6234
	Weight	10	0.0936	11.4880	1.1736	0.3899
Terry BF	Stature	22	0.3395	7.6193	0.03106	0.0026
	Weight	22	0.3792	17.0514	0.6952	0.0014
Terry WM	Stature	89	0.2357	6.3707	0.1771	0.0001
	Weight	89	0.0121	10.6810	0.2969	0.1516
Terry BM	Stature	74	0.2770	6.7756	0.1929	0.0001
	Weight	74	0.0791	10.0808	0.2870	0.0087
All Terry Indv.	Stature	195	0.4361	6.8508	0.0928	0.0001
	Weight	195	0.0956	11.6806	0.7392	0.0001

B. Average femoral condyle regressed on stature and on weight separately

Figure 12 (Continued).

Regression Method	Sample Size	R-Sq	Root MSE	Std. Error of Coefficients	Prob > F
MR	10	0.5589	8.5676	0.4174(waist) 0.2329(stature)	0.0570
Obes. Index	10	0.5323	8.2527	6.92E -5	0.0166
Waist	10	0.4875	8.6385	0.2331	0.0247
Stature	10	0.1226	11.3026	0.5466	0.321
Age	10	0.0353	11.8515	0.2183	0.6030
Avg. Head	10	0.0830	11.5554	1.3373	0.4197
Avg. Condyl	10	0.0936	17.7459	1.2029	0.0032

C. Weight estimation for Terry white female

Figure 12 (Continued).

Regression Method	Sample Size	R-Sq	Root MSE	Std. Error of Coefficients	Prob > F
MR	30	0.8366	10.2899	0.3025(waist) 0.0987(stature)	0.0001
Obes. Index	30	0.8278	10.3727	5.567E -5	0.0001
Waist	30	0.8078	10.9570	0.1048	0.0001
Stature	30	0.0100	24.8707	0.7290	0.5996
Age	30	0.1346	23.2529	0.3626	0.04061

D. Weight estimation for living white females

Figure 12 (Continued).

Regression Method	Sample Size	R-Sq	Root MSE	Std Error of Coefficients	Prob > F
Waist	23	0.8875	7.3343	0.0767	0.0001
MR	23	0.8875	7.5142	0.2101(waist) 0.0951(stature)	0.0001
Obes. Index	23	0.8561	8.2947	2.652E -5	0.0001
Stature	23	0.2870	18.4643	0.4265	0.0084
Age	23	7.9E - 5	21.8667	0.2151	0.9678
Avg. Condyl	22	0.4088	17.0514	0.6952	0.0014
Avg. Head	22	0.3596	17.7459	1.2029	0.0032

E. Weight estimate for Terry black females

Figure 12 (Continued).

Regression Method	Sample Size	R-Sq	Root MSE	Std Error of Coefficients	Prob > F
MR	31	0.7607	7.6942	0.2236(waist) 0.1191(stature)	0.0001
Obes. Index	31	0.7562	7.6402	5.843E - 05	0.0001
Waist	31	0.6809	8.7411	0.1341	0.0001
Stature	31	0.1522	14.2479	0.4103	0.0248
Age	31	0.1092	14.6045	0.2527	0.0603

F. Weight estimate for living black females.

Figure 12 (Continued).

Regression Method	Sample Size	R-Sq	Root MSE	Std Error of Coefficients	Prob > F
MR	91	0.5181	7.5398	0.1113(waist) 0.0772(stature)	0.0001
Waist	91	0.4893	7.7182	0.7721	0.0001
Obes. Index	91	0.4429	8.0615	2.59E -06	0.0001
Age	91	0.0225	10.6618	0.0873	0.1554
Stature	91	0.0019	10.7903	0.1567	0.6811
Avg. Condyl	89	0.0121	10.6810	0.2969	0.1516
Avg. Head	89	0.0160	10.7139	0.4917	0.1229

G. Weight estimate for Terry white males.

Figure 12 (Continued).

Regression Method	Sample Size	R-Sq	Root MSE	Std Error of Coefficients	Prob > F
MR	32	0.8598	9.2703	0.2698(waist) 0.1201(stature)	0.0001
Obes. Index	32	0.8481	9.4860	3.095E - 05	0.0001
Waist	32	0.8205	10.3126	0.1312	0.0001
Stature	32	0.1329	22.6668	0.6480	0.0402
Age	32	2.05E - 5	22.3414	0.4309	0.9807

H. Weight estimate for living white males.

Figure 12 (Continued).

Regression Method	Sample Size	R-Sq	Root MSE	Std Error of Coefficients	Prob > F
MR	76	0.5760	6.8933	0.0996(waist) 0.0860(stature)	0.0001
Obes. Index	76	0.5657	6.9291	0.0004	0.0001
Waist	76	0.4811	7.5398	0.0940	0.0001
Stature	76	0.1452	9.7210	0.1397	0.0007
Age	76	0.0210	10.4008	0.0728	0.2120
Avg. Condyl	74	0.0791	10.0808	0.2870	0.0087
Avg. Head	74	0.0070	10.4678	0.4532	0.2223

I. Weight estimate for Terry black males.

Figure 12 (Continued).

Regression Method	Sample Size	R-Sq	Root MSE	Std Error of Coefficients	Prob > F
MR	32	0.8073	10.0006	0.2155(waist) 0.1148(stature)	0.0001
Obes. Index	32	0.7755	10.6137	9.946E -05	0.0001
Waist	32	0.7613	10.9446	0.1231	0.0001
Stature	32	0.1482	20.6746	0.4365	0.0296
Age	32	0.0110	22.2767	0.2838	0.5674

J. Weight estimate for living black males.

Figure 12 (Continued).

Regression Method	Sample Size	R-Sq	Root MSE	Std Error of Coefficients	Prob > F
MR	200	0.6350	3.6771	0.0113(waist) 0.0087(stature)	0.0001
Obes. Index	200	0.5867	3.9030	4.073E - 08	0.0001
Waist	200	0.5808	7.9585	0.0477	0.0001
Stature	200	0.1452	9.7210	0.1397	0.0007
Age	200	0.0210	10.4008	0.0728	0.2120
Avg. Head	195	0.0587	12.0254	0.2540	0.0006
Avg. Condyl	195	0.1001	11.6806	0.1583	0.0001

K. Weight estimate for all Terry individuals.

Figure 12 (Continued).

CHAPTER VII

CONCLUSIONS

FEMORAL MEASUREMENTS AS ESTIMATORS OF FORENSIC WEIGHT

The statistics for femoral head and condyle measurements regressed with weight and stature are shown in Figure 12.A. and 12.B. of the summary of statistics section. For the two Terry groups with smaller numbers of data points, the white females and the black females, the results are varied. For white females, the R^2 is higher for weight with femoral head and condyle measurements. With the black females, the R^2 is only higher for weight with condylar measurements. I believe that the mixed results may be due to the low number of data points for both groups. If more data were available for each of the female sets of data, I believe that the R^2 would consistently be higher for stature.

The male data groups, white male and black male, are consistent throughout for results. For regression with stature, the R^2 is always higher. When all four groups are combined, again the results are consistent with those for the males. For the combined groups, stature regressed with femoral measurements always produced a higher R^2 . In essence, the lower R^2 for femoral measurements means that there is less correlation with weight. Femoral measurements seemed to be confirmed here to correlate better with stature than with weight. Now that it has been established that one cannot get a weight estimate directly from the skeleton, some other method must be developed and used to obtain weight information when needed.

REGRESSION METHODS AND ESTIMATION OF FORENSIC WEIGHT

For this thesis, five regression formulas were generated from the data collected. These five methods were compared side by side to see which was most accurate. The regression formulas generated against weight included those for waist, stature, age, obesity index, and multiple regression of stature and waist. As stated in the methods and materials section, the criteria for judging the best regression method would be the highest R^2 . A summary of results is recorded in the tables of the summary of statistics in the results section.

Starting with the worst results, age regression against weight performed as expected. There was very little correlation with weight and none was expected. If there were a real correlation between age and weight, then all children should have the least body weight. Conversely, senior citizens would all have to be extremely obese. The data samples used included older people who were thin and younger people who were fat, which I believe reflects a normal distribution in the population. If anything, the age regression serves as a control method to see what a negative correlation would look like.

Surprisingly, the next poorest weight correlation came from the simple stature regression method. The fact that this is the most used and quoted method in the literature makes this even more interesting. The stature regression method was actually surpassed by age regression in two groups, living white females (Figure 12.D.) and Terry white males (Figure 12.G.). Age regression in both cases had a higher R^2 . Even worse, many of the femoral measurements shown in the tables from the Terry collection results also surpass stature regression for estimation of weight. As stated in the review of the literature

previously, stature regression might work better if everyone was lean and devoid of excessive body fat. Proportion of fat on the body in one particular area leads us to a regression method based on width just above the hips.

The waist measurement is of particular interest here because it gives some indicator of how the body distributes fatty tissue in the lower abdomen and upper pelvic region. Simple waist regression seems to have consistently given average results when compared to all the other regression methods. It was almost always the third most accurate method of weight estimation. In the case of Terry black females (Figure 12.E.), it actually turned out to be as good as multiple regression. The R^2 for both methods was identical. In the case of living white males (Figure 12.H.), waist regression was the second best weight estimation method.

Combining weight with stature, we come to the last two methods in this thesis. The first of these is the obesity index, illustrated by the following equation:

$$\text{waist} = \text{weight} / \text{stature}^2$$

As stated earlier in the weight studies section, this method is supposed to be highly correlated with waist (Kannel and Gordon, 1980). In the above equation, an equals sign is substituted for correlation, with the understanding that the two are not the same. For purposes of regression, the equation was rearranged in the following manner:

$$\text{weight} = \text{waist} \times \text{stature}^2$$

It turns out that obesity index was the second best method in this thesis. For the most part it consistently appeared to have a slightly lower R^2 than multiple regression. A notable exception was that for Terry white males (Figure 12.G.), obesity index came in third

behind multiple regression and waist regression. As close as it could come each time, obesity index never had the highest R^2 .

Overall review clearly shows that multiple regression of weight on stature and waist was the best method for estimation of forensic weight. With the notable exceptions that have been mentioned for the other methods, multiple regression nearly always had the highest R^2 for all of the regression methods. This point is made once again by the combination of all the Terry collection data sets (Figure 12.K) for comparison to each of the five weight regression methods. The breakdown in this table is a good summary for the general accuracy of these methods.

What all of this means is that in the future it may be easier to estimate the weight at death of an unknown individual. When some indicator of the waist measurement can be found, such as pants or a belt around the waist, the multiple regression method could be employed. The estimated weight results would have to be compared to some body of weight, waist, and stature data collected for the appropriate sex and racial affiliation of the individual in question. If no waist measurement can be obtained, one is stuck using a stature based estimate for weight. When a weight result is compared to a general regression formula for the appropriate data group, the exact weight for the individual may still not be obtainable, but a much more accurate estimate is possible.

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APPENDICES

Appendix A

Terry Collection Skeletal Measurements

White Females

<u>Catalogue</u> <u>Key</u>	<u>Left</u> <u>Head (cm)</u>	<u>Right</u> <u>Head (cm)</u>	<u>Average</u> <u>Head (cm)</u>	<u>Left</u> <u>Condyle (cm)</u>	<u>Right</u> <u>Condyle (cm)</u>	<u>Average</u> <u>Condyle (cm)</u>
P0000580	40.5	41	40.75	72.5	74	73.25
P0000601	41	41.8	41.4	78	80	79
P0000639	41.2	40.9	41.05	74.1	74	74.05
P0000680	42	42.5	42.25	74.5	76	75.25
P0000686	38.5	39.5	39	76.5	77	76.75
P0000692	48.8	48.7	48.75	79	78.5	78.75
P0000736	43.8	44	43.9	78.5	80	79.25
P0000791	41.8	41.7	41.75	75	74	74.5
P0000847	38.9	39	38.95	70	70	70
P0000854	44.5	43.8	44.15	80	80.5	80.25

Black Females

<u>Catalogue</u> <u>Key</u>	<u>Left</u> <u>Head (cm)</u>	<u>Right</u> <u>Head (cm)</u>	<u>Average</u> <u>Head (cm)</u>	<u>Left</u> <u>Condyle (cm)</u>	<u>Right</u> <u>Condyle (cm)</u>	<u>Average</u> <u>Condyle (cm)</u>
P0000561	41.2	41.5	41.35	71	71	71
P0000562	37	36.1	36.55	71	71	71
P0000567	37.7	37	37.35	68.5	69.2	68.85
P0000568	42.5	43.2	42.85	76.1	77.2	76.65
P0000583	41.7	41.5	41.6	73	73	73
P0000584	42	42.8	42.4	77.1	78.1	77.6
P0000586	42	42.3	42.15	77.1	76.3	76.7
P0000587	41.1	42	41.55	75	75	75
P0000610	42.8	42	42.4	73	73.2	73.1
P0000615	50	50.2	50.1	88.5	89.3	88.9
P0000632	45.1	47	46.05	79.5	81	80.25
P0000640	40.9	41.1	41	76	75.2	75.6
P0000666	45.5	45.7	45.6	77.1	78	77.55
P0000679	37.5	37.8	37.65	64.5	65	64.75
P0000706	41.8	43	42.4	71.5	72	71.75
P0000761	46.5	47.2	46.85	84	84.5	84.25
P0000775	37.5	38.5	38	71	70	70.5
P0000815	43	43.9	43.45	77.5	78.5	78
P0000819	41	42.3	41.65	71.2	72	71.6
P0000822	43.2	44.8	44	74.5	75	74.75
P0000824	40	40.3	40.15	71.2	70.5	70.85

P0000831	43	43	43	80	80	80
P0000844	****	****	0.0	****	****	0.0

White Males

<u>Catalogue</u> <u>Key</u>	<u>Left</u> <u>Head (cm)</u>	<u>Right</u> <u>Head (cm)</u>	<u>Average</u> <u>Head (cm)</u>	<u>Left</u> <u>Condyle (cm)</u>	<u>Right</u> <u>Condyle (cm)</u>	<u>Average</u> <u>Condyle (cm)</u>
P0000563	51.6	51.2	51.4	87	87	87
P0000564	42.5	43.5	43	76.5	77.1	76.8
P0000566	48.8	50	49.4	89.1	90	89.55
P0000569	51.5	52.8	52.15	88	90.1	89.05
P0000572	52	50.3	51.15	91.5	92	91.75
P0000573	51	51.1	51.05	85.5	86.5	86
P0000575	48.2	48	48.1	80	81	80.5
P0000577	46.2	47.1	46.65	76.9	77.1	77
P0000585	49	49.8	49.4	83.2	84	83.6
P0000588	48.1	47	47.55	79.5	81	80.25
P0000590	50.8	52.2	51.5	84	84	84
P0000591	46	47.1	46.55	78.8	79	78.9
P0000596	48.2	49.1	48.65	81.2	84	82.6
P0000598	45.5	46.5	46	79.8	81.5	80.65
P0000599	49.1	49.2	49.15	80	82.2	81.1
P0000602	52.5	51.5	52	91	91.1	91.05
P0000608	46.8	47	46.9	86	86.2	86.1
P0000630	50.5	49.5	50	85.5	82.5	84
P0000633	51.7	51.8	51.75	89.5	89	89.25
P0000634	49	49.2	49.1	84	84.5	84.25
P0000636	49	50	49.5	80.8	84.5	82.65
P0000641	47.5	48.2	47.85	79.5	81	80.25
P0000644	41.8	41.8	41.8	78.2	78.1	78.15
P0000645	50.7	50.7	50.7	87.1	87.1	87.1
P0000651	46.5	46	46.25	86.3	83.5	84.9
P0000665	46.8	47.1	46.95	82	82.5	82.25
P0000670	49	49	49	82	81.5	81.75
P0000671	45	45.5	45.25	81	78	79.5
P0000672	50.8	51.2	51	87.5	88	87.75
P0000674	49	49.5	49.25	85	86.2	85.6
P0000681	51.1	52.3	51.7	87.5	87.1	87.3
P0000691	48	48	48	89	88	88.5
P0000693	47	46.8	46.9	77	78	77.5
P0000697	55	55	55	93	93.5	93.25
P0000701	46.2	47.8	47	82	83	82.5
P0000708	46	46.3	46.15	84.2	84	84.1

P0000709	46	46	46	82	82	82
P0000713	50.3	51.3	50.8	89	90	89.5
P0000714	47.8	49.8	48.8	81	81	81
P0000720	46	45	45.5	77	82	79.5
P0000721	53	54.5	53.75	86.5	85	85.75
P0000730	46.5	46.8	46.65	83	83	83
P0000739	50.4	51	50.7	88.1	87.1	87.6
P0000743	48.4	48.5	48.45	88	86.5	87.25
P0000746	50	49.5	49.75	86	83	84.5
P0000748	51.8	52.1	51.95	90	91	90.5
P0000750	47.5	45.8	46.65	84.5	86.2	85.35
P0000751	47.5	47.8	47.65	87	86.2	86.6
P0000752	51.1	50.5	50.8	90	93	91.5
P0000755	49.2	48.2	48.7	83	85.1	84.05
P0000756	49.8	47.8	48.8	81	81	81
P0000758	48.3	47.5	47.9	84	83.5	83.75
P0000762	48.2	47.2	47.7	83.5	82	82.75
P0000763	46.5	47	46.75	81.5	81.2	81.35
P0000764	51.7	50.5	51.1	90.2	91	90.6
P0000772	49.2	48.5	48.85	90.2	90	90.1
P0000778	49	49.5	49.25	88	88.2	88.1
P0000784	46.5	47	46.75	84	86	85
P0000785	****	****	****	****	****	****
P0000787	45.8	44.8	45.3	80	80	80
P0000795	48.8	48.8	48.8	88.5	88.5	88.5
P0000802	46.5	46.9	46.7	87	88.1	87.55
P0000803	48	47.8	47.9	86	85.3	85.65
P0000805	45	46.5	45.75	79.8	80	79.9
P0000806	50.5	51.5	51	87.5	88.5	88
P0000810	46.5	46.2	46.35	86	87	86.5
P0000812	47.8	46.8	47.3	85.5	86	85.75
P0000813	49	****	49	84	83	83.5
P0000827	47.8	47	47.4	82.5	80	81.25
P0000828	49	48.5	48.75	85.2	86	85.6
P0000832	47	48.2	47.6	85	85	85
P0000835	50.5	51	50.75	90.5	90	90.25
P0000838	49	48.2	48.6	85	85	85
P0000839	50	50.5	50.25	85	85	85
P0000841	49	49.2	49.1	86.5	87.5	87
P0000842	49.8	49.9	49.85	88	90	89
P0000846	48	49.5	48.75	80.2	81	80.6
P0000848	49.2	50.8	50	87.2	90.5	88.85
P0000849	47.5	48.5	48	84	84.5	84.25

P0000852	45.6	45	45.3	80	80	80
P0000853	46	47	46.5	83	84.2	83.6
P0000855	46	46	46	82.2	83.2	82.7
P0000857	47.2	48	47.6	84.5	87	85.75
P0000858	44	42.8	43.4	76	76.5	76.25
P0000863	44.5	44.8	44.65	81	83	82
P0000865	48.2	49.5	48.85	81	83.2	82.1
P0000868	****	****	0.0	****	****	0.0
P0000870	46.8	46.3	46.55	87	85	86
P0000871	47.7	48.5	48.1	83.2	82.5	82.85
P0000872	47	47	47	83	84	83.5
P0000874	47.1	46.5	46.8	85	91	88

Black Males

<u>Catalogue</u> <u>Key</u>	<u>Left</u> <u>Head (cm)</u>	<u>Right</u> <u>Head (cm)</u>	<u>Average</u> <u>Head (cm)</u>	<u>Left</u> <u>Condyle (cm)</u>	<u>Right</u> <u>Condyle (cm)</u>	<u>Average</u> <u>Condyle (cm)</u>
P0000565	45.2	45.2	45.2	80	81	80.5
P0000570	48.8	49	48.9	82	82	82
P0000571	48	47.5	47.75	84	85.2	84.6
P0000574	46	46.2	46.1	81	81.2	81.1
P0000576	56.9	57.9	57.4	100	100.1	100.05
P0000578	46.1	48	47.05	82.2	84	83.1
P0000579	42.7	41.8	42.25	75.2	77.2	76.2
P0000581	51.1	51	51.05	83.5	83.1	83.3
P0000582	44	44.8	44.4	81.2	82	81.6
P0000592	46.5	47.8	47.15	83.1	82.2	82.65
P0000593	46.1	47.6	46.85	83	84.3	83.65
P0000594	46.1	48	47.05	88	88.5	88.25
P0000595	46.8	46	46.4	82.5	82.2	82.35
P0000600	51.9	52.1	52	87.2	87	87.1
P0000618	****	****	0.0	****	****	0.0
P0000628	46.3	47	46.65	89	90	89.5
P0000635	46.8	47.2	47	83	85	84
P0000643	50.9	52.5	51.7	93.2	92.5	92.85
P0000646	50	49.8	49.9	87	86	86.5
P0000648	47.1	47.5	47.3	84	84.2	84.1
P0000649	45.2	44.2	44.7	84	84	84
P0000663	48.5	47.4	47.95	84	84.5	84.25
P0000664	48.2	48.5	48.35	87	89	88
P0000673	49.8	51.5	50.65	88	89.2	88.6
P0000675	48	48.2	48.1	87.2	87.1	87.15
P0000676	50.1	50.2	50.15	86	88	87

P0000677	46.5	46	46.25	82.2	82.5	82.35
P0000683	50	50	50	87.1	86	86.55
P0000684	48.8	47.8	48.3	88	89	88.5
P0000690	44.7	44	44.35	87	87.2	87.1
P0000694	47	47.4	47.2	84.2	85.5	84.85
P0000698	49	47.3	48.15	84.1	84	84.05
P0000700	47.1	47.5	47.3	81.5	80.5	81
P0000703	****	****	0.0	****	****	0.0
P0000704	44.3	44	44.15	77.2	77.5	77.35
P0000707	48	48.7	48.35	84	85	84.5
P0000711	48	48.2	48.1	80	80	80
P0000712	45.5	46.2	45.85	83.5	85	84.25
P0000717	45.8	46	45.9	81	76	78.5
P0000718	49.8	50	49.9	86	85	85.5
P0000724	46	47.8	46.9	81	78.2	79.6
P0000725	46	46.7	46.35	82	82	82
P0000726	46	46.3	46.15	87	89	88
P0000731	44.2	44.2	44.2	77.5	78	77.75
P0000735	44.5	45.6	45.05	77.5	79.2	78.35
P0000742	55	54.9	54.95	92	94	93
P0000753	48.5	48.5	48.5	88	90	89
P0000754	52.8	52.5	52.65	86	88	87
P0000760	48.9	49	48.95	87	86.1	86.55
P0000767	45.8	45.8	45.8	82.5	85	83.75
P0000770	45	45.8	45.4	79.5	80	79.75
P0000773	48	47	47.5	83	82	82.5
P0000776	53.7	53.8	53.75	86	87	86.5
P0000786	51	50.8	50.9	86	84.5	85.25
P0000788	49.5	48	48.75	83	83	83
P0000789	45.8	46.2	46	78	79	78.5
P0000790	45.5	47.5	46.5	87	87.5	87.25
P0000793	45.2	45.2	45.2	86	85	85.5
P0000796	48.5	47.5	48	92.2	90	91.1
P0000798	47	47.1	47.05	82	83.5	82.75
P0000799	48.7	48.5	48.6	84	85.2	84.6
P0000801	45.8	46	45.9	83	83.5	83.25
P0000811	48.8	49.5	49.15	81.2	82	81.6
P0000817	44.2	46	45.1	85	86	85.5
P0000823	46.7	47.5	47.1	83.2	83	83.1
P0000825	49.8	50	49.9	89	90.5	89.75
P0000826	44.8	45.5	45.15	81	81	81
P0000829	48	48.3	48.15	86.2	87	86.6
P0000836	45	45	45	84.5	85.2	84.85

P0000850	46	46.5	46.25	78.5	79	78.75
P0000856	44.5	44.5	44.5	81.5	82.5	82
P0000859	52	52.5	52.25	86.5	87.5	87
P0000862	44.5	45	44.75	83	81	82
P0000864	45.5	45.2	45.35	76	78.2	77.1
P0000875	43	45	44	78.2	79.5	78.85
P0000876	47	47.5	47.25	81.2	81.5	81.35

**** = Missing or not measured data

Appendix B

Terry Collection Data

White Females

<u>Catalogue Key</u>	<u>Age</u>	<u>Stature(cm)</u>	<u>Waist (cm)</u>	<u>Weight (kg)</u>
P0000580	61	156	74.9	44.4
P0000601	75	158	87.5	44.4
P0000639	82	164	69.5	51.3
P0000680	30	168	64.5	35.8
P0000686	78	154	86.5	61.4
P0000692	84	151	65	31.3
P0000736	57	166	75	62.2
P0000791	66	163	54.5	36.3
P0000847	39	159.5	80	45.5
P0000854	72	173.5	95	61.4

Black Females

<u>Catalogue Key</u>	<u>Age</u>	<u>Stature (cm)</u>	<u>Waist (cm)</u>	<u>Weight (kg)</u>
P0000561	22	156.3	70.7	45.5
P0000562	17	152	53	27.8
P0000567	19	126	54.5	30
P0000568	27	159	63.5	34
P0000583	24	154	52	37.7
P0000584	40	154	65.3	42.3
P0000586	40	164	71.5	51.1
P0000587	61	163	59	36.6
P0000610	39	164.5	90.3	73.3
P0000615	35	164.5	106.8	97.7
P0000632	27	169.5	71	37.7
P0000640	70	153	60.5	31.5
P0000666	52	159	81	62.6
P0000679	33	146	63	30.8
P0000706	38	157	77.5	35.5
P0000761	80	162	72.5	54
P0000775	101	152	49.5	29.5
P0000815	32	170	114	83
P0000819	65	153	53.5	34.9
P0000822	16	160	59.5	34.2
P0000824	30	162	77.5	50.1
P0000831	44	166	127	98

P0000844	26	163	62.5	33.4
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White Males

<u>Catalogue Key</u>	<u>Age</u>	<u>Stature (cm)</u>	<u>Waist(cm)</u>	<u>Weight (kg)</u>
P0000563	41	170	72	45
P0000564	48	153	77.8	43.3
P0000566	40	176	66	40
P0000569	63	160	70	48.8
P0000572	61	183	64	40
P0000573	59	167	79	47
P0000575	47	169	77	52.2
P0000577	50	161	65.5	38.8
P0000585	64	168.8	69.5	43.1
P0000588	60	167	73.5	47.7
P0000590	68	173	77.8	53.9
P0000591	28	171	65.5	51.1
P0000596	48	171	69	60
P0000598	61	159	88.5	63.3
P0000599	43	168	78.3	48.8
P0000602	49	167	74.5	58.1
P0000608	52	175	78.8	69.9
P0000630	72	175	75.6	50
P0000633	76	176	75.5	76.6
P0000634	74	163	66	43.3
P0000636	51	169	74	53.8
P0000641	38	168	82.5	53.7
P0000644	54	162	65.5	31
P0000645	28	188	68	43.3
P0000651	64	158	73.5	50.6
P0000665	74	170	61.5	45.3
P0000670	60	161.6	71	46.6
P0000671	65	158	94.5	62.7
P0000672	52	174	75.5	57.4
P0000674	58	171	79.5	59.9
P0000681	53	184	82.5	68.6
P0000691	82	171	85.5	54.5
P0000693	57	160	93.5	61
P0000697	72	172	87.5	70
P0000701	55	165	88.2	52.2
P0000708	68	167	57.5	34.4
P0000709	50	155	68.5	41.1
P0000713	69	176	56	51

P0000714	71	169	80.5	43.3
P0000720	54	156	85	72.1
P0000721	60	184	60.5	43
P0000730	71	167	102	82.1
P0000739	40	181	65.5	43.4
P0000743	53	178	76	53.3
P0000746	71	161	78.5	41.1
P0000748	85	182	70.5	50.7
P0000750	80	174	65	39.8
P0000751	41	174	69	50.5
P0000752	71	172	74.5	58
P0000755	36	169	78	56.6
P0000756	47	165	75	49.7
P0000758	73	170	71.5	51.3
P0000762	59	177	57	38.8
P0000763	46	179	67.5	54.8
P0000764	58	168	74	40.6
P0000772	56	186	97	63.4
P0000778	55	168	64.5	42
P0000784	68	169	65.5	53.6
P0000785	54	173	69.5	55.4
P0000787	50	175	82.5	52.8
P0000795	51	180	71.5	54.1
P0000802	36	168	69.5	35.1
P0000803	64	161	79	45.2
P0000805	87	168	77	57
P0000806	78	168	90	60.1
P0000810	54	170	74	39.9
P0000812	56	172	99	82.8
P0000813	60	175	65.5	47.4
P0000827	74	173.5	70	49.9
P0000828	48	164.5	73	52.3
P0000832	84	172.5	77	53.3
P0000835	61	176	91.5	58.7
P0000838	67	175.5	83.5	56.9
P0000839	41	171	78	50.5
P0000841	68	173	76.5	45.6
P0000842	73	165.5	119.5	81
P0000846	48	166.5	67.5	41.7
P0000848	39	174.5	75	45.1
P0000849	47	175	75.5	44.7
P0000852	66	169	73.5	38.7
P0000853	62	176.5	87	54

P0000855	67	158	75.5	38.7
P0000857	69	170.5	85.5	56.2
P0000858	66	162	75.5	41.6
P0000863	73	154	83.5	53.9
P0000865	69	169.5	78.5	41.5
P0000868	60	172	95	65.3
P0000870	60	170	81	41.6
P0000871	56	182	69.5	33
P0000872	48	168.5	82	42.6
P0000874	75	173.5	71	43.9

Black Males

<u>Catalogue Key</u>	<u>Age</u>	<u>Stature(cm)</u>	<u>Waist(cm)</u>	<u>Weight(kg)</u>
P0000565	32	177	74	55.4
P0000570	37	175	68.5	43.3
P0000571	31	165	67	43.3
P0000574	35	167.5	61.5	45.5
P0000576	41	195	77	68.2
P0000578	32	171	71	50
P0000579	17	161	67.8	38.8
P0000581	30	184	69	67.7
P0000582	49	172	61.5	46.6
P0000592	25	173.5	68	50
P0000593	44	173	63.8	53.2
P0000594	22	177	74	71
P0000595	25	184	62	51.1
P0000600	70	187	65	55.5
P0000618	60	181	81.5	55.5
P0000628	60	175	93.3	65.5
P0000635	54	165.2	61.8	37.7
P0000643	60	177	72	61
P0000646	50	179	60	33.3
P0000648	63	172	78.5	70.3
P0000649	51	176	96	79.6
P0000663	44	170	69	53.2
P0000664	48	184	70.5	53.3
P0000673	38	185	55.5	45.6
P0000675	27	176	64	42
P0000676	46	172	67.5	51.6
P0000677	45	163	68	45.8
P0000683	56	172	69.5	50

P0000684	35	174	70	52.8
P0000690	28	163	60.5	48.8
P0000694	52	167	71	39.3
P0000698	40	178	73.5	58.8
P0000700	70	170	56	40
P0000703	88	161	68.5	41.1
P0000704	40	165.9	79.4	52.2
P0000707	26	187	54.5	42.2
P0000711	61	187	90.5	63.3
P0000712	47	166	79.5	60
P0000717	29	160	78.5	51.1
P0000718	22	180	78	55
P0000724	42	170	78.5	58.8
P0000725	57	163	56.5	31.8
P0000726	62	177	72.5	48.8
P0000731	63	166	83	61
P0000735	66	156	75	37.7
P0000742	79	189	86.6	71.1
P0000753	45	179	69.5	58.8
P0000754	57	183	88	60.7
P0000760	19	172	48.5	32.4
P0000767	28	173	70.5	59.6
P0000770	65	169	79	50.6
P0000773	76	157	77	51.3
P0000776	40	165	61.5	38.7
P0000786	65	170	62	41.6
P0000788	65	171	69	50.2
P0000789	40	168	60.5	43.2
P0000790	77	162	77.5	61.1
P0000793	42	163	82	60.1
P0000796	81	175	72.5	44.6
P0000798	36	169	73.5	46.1
P0000799	38	172	64	44.6
P0000801	65	172	90	71.2
P0000811	51	171	69.5	65.8
P0000817	55	172	84.5	68
P0000823	60	171	76	45.8
P0000825	49	172	73.5	49.4
P0000826	38	163	72	55.6
P0000829	58	183	85	58
P0000836	35	175	74.5	55.1
P0000850	23	179	75	49.8
P0000856	53	175	78.5	48.8

P0000859	23	184.5	76	48.5
P0000862	37	171.5	78	42.7
P0000864	42	165.5	67.5	35.3
P0000875	50	162	75	35.1
P0000876	22	176	67	43.9

Appendix C

Living Persons Data

White Females

<u>Age</u>	<u>Stature</u>		<u>Waist</u>		<u>Weight</u>	
	(in.)	(cm)	(in.)	(cm)	(lbs.)	(kg)
36	64	162.56	31	78.7	154	69.85
31	69.3	176.02	29	73.66	150	68.04
38	66	167.64	28.75	73.03	142	64.41
33	69.5	176.53	29	73.66	153	69.4
29	62	157.48	34.5	87.63	154	69.85
30	64	162.56	28	71.12	140	63.5
28	60.5	153.67	29	73.66	126	57.15
20	68	172.72	24	60.96	120	54.43
33	64.75	164.47	46	116.84	243	110.22
26	68	172.72	31.5	80.01	150	68.04
31	64	162.56	24	60.96	138	62.6
21	66	167.64	27	68.58	120	54.43
30	66	167.64	28	71.12	125	56.7
35	67.5	171.45	52	132.08	259.5	117.71
58	67	170.18	40	101.6	197	89.36
34	70	177.8	45	114.3	315	142.88
36	64	162.56	44	111.76	268	121.56
51	70	177.8	32	81.28	167	75.75
42	66	167.64	36	91.44	165	74.84
28	66	167.64	26	66.04	120	54.43
26	66	167.64	23.5	59.69	130	58.97
74	64.5	163.83	40	101.6	172	78.02
30	66	167.64	26	66.04	119	53.98
30	65.5	166.37	27.5	69.85	119	53.98
27	68	172.72	29	73.66	138	62.6
33	65	165.1	41.5	105.41	250	113.4
54	67	170.18	40	101.6	261	118.39
35	64	162.56	36	91.44	168	76.2
27	67.5	171.45	28	71.12	135	61.24
55	60	152.4	42	106.68	198	89.81

Black Females

<u>Age</u>	<u>Stature</u>		<u>Waist</u>		<u>Weight</u>	
	(in.)	(cm)	(in.)	(cm)	(lbs.)	(kg)
36	62	157.48	30	76.2	123	55.79
38	68	172.72	36	91.44	204	92.53
39	67	170.18	32	81.28	188	85.28
41	65	165.1	30	76.2	156	70.76
18	69	175.26	42	106.68	245	111.13
27	68	172.72	34	86.36	155	70.31
52	66	167.64	36	91.44	197	89.36
19	69	175.26	32	81.28	178	80.74
23	67	170.18	30	76.2	155	70.31
19	66	167.64	25	63.5	115	52.16
18	66	167.64	22	55.88	118	53.52
22	65	165.1	24	60.96	110	49.9
20	62	157.48	21	53.34	102	46.27
22	68	172.72	29	73.66	160	72.58
25	65	165.1	26	66.04	129	58.51
54	66	167.64	32	81.28	180	81.65
35	66	167.64	30	76.2	165	74.84
26	68	172.72	24	60.96	150	68.04
28	71	180.34	25	63.5	153	69.4
32	66	167.64	30	76.2	170	77.11
24	65	165.1	30	76.2	160	72.58
29	71	180.34	27	68.58	158	71.67
27	71	180.34	26	66.04	163	73.94
18	62	157.48	24	60.96	116	52.62
37	66	167.64	29	73.66	165.35	75
23	66	167.64	29	73.66	125	56.7
35	65	165.1	35	88.9	195	88.45
35	63	160.02	30	76.2	167	75.75
37	64	162.56	32	81.28	165	74.84
36	67	170.18	29	73.66	120	54.43
29	63	160.02	31	78.74	150	68.04
19	65	165.1	32	81.28	175	79.38
51	66	167.64	36	91.44	156	70.76

White Males

<u>Age</u>	<u>Stature</u>		<u>Waist</u>		<u>Weight</u>	
	(in.)	(cm)	(in.)	(cm)	(lbs.)	(kg)
23	71	180.34	32	81.28	155	70.31
31	67.5	171.45	36	91.44	185	83.92
32	70.5	179.07	30	76.2	150	68.04
26	74	187.96	38	96.52	215	97.52
31	72	182.88	34	86.36	176.5	80.06
56	74	187.96	42	106.68	265	120.2
34	72	182.88	34	86.36	210	95.26
32	65	165.1	34.5	87.6	160	72.58
27	66	167.64	36	91.44	195	88.45
28	71	180.34	54	137.16	290	131.54
57	73	185.42	36	91.44	200	90.72
25	74	187.96	30	76.2	150	68.04
54	71	180.34	33	83.82	165	74.84
18	76	193.04	36	91.44	240	108.86
25	70	177.8	40	101.6	225	102.06
27	70	177.8	33	83.82	179	81.19
36	69.5	176.53	33	83.82	175	79.38
32	69	175.26	38	96.52	204	92.53
27	71	180.34	32	81.28	180	81.65
26	72	182.88	34	86.36	175	79.38
24	72	182.88	48	121.92	330	149.69
34	71	180.34	42	106.68	240	108.86
31	74	187.96	46	116.84	280	127.01
30	72	182.88	34	86.36	185	83.92
38	68	172.72	34	86.36	200	90.72
44	71	180.34	40	101.6	210	95.26
43	70	177.8	34	86.36	160	72.58
38	74	187.96	34	86.36	187	84.82
56	68	172.72	38	96.52	206	93.44
30	70	177.8	38	96.52	188	85.28
37	74	187.96	48	121.92	336	152.41
27	71	180.34	35	88.9	155	70.31

Black Males

<u>Age</u>	<u>Stature</u>		<u>Waist</u>		<u>Weight</u>	
	(in.)	(cm)	(in.)	(cm)	(lbs.)	(kg)
44	70	177.8	34	86.36	210	103.72
22	73	185.42	32	81.28	184	90.88
44	76	193.04	33	83.82	200	98.78
19	71	180.34	30	76.2	178	87.92
47	74	187.96	36	91.44	220	108.66
40	70	177.8	34	86.36	170	83.97
47	74	187.96	34	86.36	180	88.91
60	74	187.96	42	106.68	200	98.78
50	69	175.26	50	127	245	121.01
80	67	170.18	42	106.68	185	91.38
35	67	170.18	36	91.44	185	91.38
40	71	180.34	33	83.82	158	78.04
37	66.5	168.91	32	81.28	175	86.44
44	65	165.1	29	73.66	135	66.68
32	68	172.72	50	127	305	150.65
62	74	187.96	38	96.52	170	83.97
67	68	172.72	31	78.74	130	64.21
20	76	193.04	46	116.84	300	148.18
50	76	193.04	38	96.52	220	108.66
44	73	185.42	42	106.68	210	106.19
28	69	175.26	38	96.52	210	103.72
53	74	187.96	56	142.24	335	165.46
31	66	167.64	33	83.82	165	81.5
37	76	193.04	33	83.82	183	90.39
35	69	175.26	38	96.52	196	96.81
25	69	175.26	38	96.52	190	93.85
41	69	175.26	36	91.44	195	96.32
51	71	180.34	38	96.52	208	102.74
55	67	170.18	32	81.28	165	81.5
51	68	172.72	38	96.52	182	89.89
21	67	170.18	32	81.28	152	75.08
39	68	172.72	42	106.68	210	103.72

VITA

I was born February 17, 1967 in Huntsville, Alabama. I moved around the southeastern United States during my childhood, but ended up back in Huntsville again to attend high school there. I graduated in June 1985 from Grissom High School in Huntsville, Alabama. After a brief two quarters at the University of Alabama in Huntsville, I moved to Weaver, Alabama and began attending Jacksonville State University in Jacksonville, Alabama.

I began taking anthropology classes and quickly found that I liked it a lot. Unfortunately, Jacksonville State did not offer a major in anthropology and I was forced to get my undergraduate degree in another area. I finally settled on biology because I found that I had an interest in it as well. Before long I had two minors in anthropology and history as well. I graduated in April of 1990 with my first bachelor of science in biological sciences. During my time at Jacksonville, Dr. William Bass came to lecture in the forensic science department. It was after hearing his lecture on forensic anthropology that I knew what I wanted to pursue for my graduate studies.

After graduation from Jacksonville State, I went back to the University of Alabama in Huntsville for a brief one year stint as a graduate teaching assistant in biology. I soon found that biological sciences alone could not hold my interest. I had set my mind on attending the University of Tennessee to study physical anthropology because that is what I felt I wanted to do as a career. I did not get into the graduate program immediately, but in the years before I did, I picked up two additional bachelors degrees. I completed a

bachelor of arts in anthropology and another bachelor of science in microbiology. I also added chemistry, biochemistry, and ancient mediterranean civilizations to my list of minors. At the same time, I worked five and one half years in Oak Ridge, Tennessee as a laboratory technician full-time.

During the last three years, I have been a graduate student with the department of anthropology at the University of Tennessee. I have been married to my wife Mendy for the last five years and we have a sixteen month old daughter named Amanda. I have recently been hired as a forensic scientist for the Alabama Department of Forensic Sciences in Montgomery, Alabama. I will be working in forensic biology and eventually learn the skills needed to become an expert with forensic DNA. I may also be helping the medical examiner on cases with skeletal remains from time to time.