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Correlation of body weight and other morphometric measurements in Albino rats *(Rattus Norvegicus)*

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Relationship between body weight and other morphometric measurements in Albino rats *(Rattus norvegicus)* was investigated. Morphometric data such as body weight (BDYWT), tail length (TL), body length from nose to anus (BLNA), body length from nose to tail tip (BLNT), tail circumference (TC), tail diameter (TD), and ear length (EL) were collected from fifty live Albino rats involving 28 females and 22 males. The collected data were evaluated using regression analysis, correlation and independent-sample t-test. There was high significant ($P < 0.001$) positive correlation between BDYWT and TL, BDYWT and BLNA, BDYWT and BLNT, BDYWT and HL, BDYWT and TC, BDYWT and TD, TC and TL, BLNA and TL, TC and BLNA, TC and BLNT, but the correlation between BDYWT and EL was low. The regression analysis had coefficient of determination (r^2) values ranging from 0.264 to 0.81. Regression analysis with high r^2 value could be exploited in predicting many morphometric traits with great accuracy with the body weight serving as the explanatory or predictor variable. This research also suggested that male and female Albino rats have very similar morphometric characters as the results of independent-samples t-test showed.

1. Introduction

Laboratory albino rat *(Rattus norvegicus)* is bred and kept for scientific research. Laboratory rats have served as an important animal model for research in psychology, medicine, and other fields. Over the years, rats have been used in many experimental studies, which have added to our understanding of genetics, diseases, the effects of drugs, and other topics in health and medicine. Laboratory rats have also proved valuable in psychological studies of learning and other mental processes. The historical importance of this species to scientific research is reflected by the amount of literature on it, roughly 50% more than that on mice (Krinke, 2000).

Wistar *rats* are an outbred strain of albino rats belonging to the species *Rattus norvegicus*. This strain was developed at the Wistar Institute in 1906 for use in biological and medical research, and is notably the first rat strain developed to serve as a model organism at a time when laboratories primarily used *Mus musculus*, or the common House mouse. More than half of all laboratory rat strains are descended from the original colony established by physiologist Henry Donaldson, scientific administrator Milton J. Greenman, and genetic researcher/embryologist Helen Dean King (Clause, 1998; The Wistar Institute, 2007).

Correlation provides a numerical measure of the linear or "straight-line" relationship between two continuous variables X and Y. The resulting correlation coefficient or "*r* value" is more formally known as the Pearson product moment correlation coefficient after the mathematician who first described it. X is known as the independent or explanatory variable while Y is known as the dependent or response variable. A significant advantage of the correlation coefficient is that it does not depend on the units of X and Y and can therefore be used to compare any two variables regardless of their units (Orlando Health Surgical Critical Care Fellowship, 2005).

Regression uses the existing data to define a mathematical equation which can be used to predict the value of one variable based on the value of one or more other variables and can therefore be used to extrapolate between the existing data. The regression equation can therefore be used to predict the outcome of observations not previously seen or tested (Orlando Health Surgical Critical Care Fellowship, 2005).

Morphometric analyses lengths, widths, masses, angles, ratios and areas (Marcus, 1990). In general, traditional morphometric data are measurements of size. Traditional morphometric data are nonetheless useful when either absolute or relative sizes are of particular interest, such as in studies of growth. These data are also useful when size measurements are of theoretical importance such as body mass and limb cross-sectional area and length in studies of functional morphology. However, these measurements have one important limitation: they contain little information about the spatial distribution of shape changes across the organism.

A study conducted by Jimmy, *et al*., (2010) to determine variability in body morphometric measurements in goats in Uganda, concluded that live body weight could be predicted with accuracy from linear body measurements especially; heart girth, height at wither, corpus length and rump height. Length measurements would be more suitable for predicting shoulder height than using width measurements of the long bone. On the other hand, body and carcass weights and chest circle would be determined more efficiently by measuring the width of long bones in Morkaraman sheep (Alpak, *et al*., 2007). Okoro *et al*., (2010) reported that there is a positive correlation between body weight and linear body measurements (LBM) in Chinchilla rabbits (*Orycotolagus cuniculus)* implying that a particular LBM or a combination of it can be used to determine the body weight or another LBM of a Chinchilla rabbit.

Data collected on 86 goats of different age groups, 44 male and 42 female showed bodyweight was correlated with body length, height at withers and heart girth. Male were also found to be heavier and longer than female in all age groups. Similarly the heart girth as well as height at withers was also bigger in male than those of the female (Khan, *et al.,* 2006).

Egena *et al*., (2006) in their work ''Effect of Sex on Linear Body Measurements of Guinea Pig (*Cavia porcellus*)" showed that significant differences exist between male and female body weight, body length, heart girth, trunk length, hind leg length and length of ear. Correlation analysis revealed that all the parameters studied were positively and significantly correlated in males. In females, negative correlation was observed between body weight and body length, fore leg length and body weight as well as between fore leg length and trunk length. They concluded that sex had an effect on the interrelationship between body weight and linear body measurements in guinea pigs.

Momoh *et al*., (2008) established relationships between body weight and body measurements in local chickens and applied the data to predict body weight from body measurements. Results indicated that males showed higher values for body weight (BW) and body measurements than the females. The chest circumference and linear body length are the body measurements that are most appropriate for the prediction of body weight in local chickens.

This study was designed to obtain some morphometric information from *R. norvegicus* and relate it to its body weight and also to find out whether any trait is unique to any sex.

Plate1: The albino laboratory rat with its red eyes and white fur is an iconic model organism for scientific research in a variety of fields.

2. Materials and methods

2.1. Source of experimental animals

The laboratory rats were obtained from animal house of the Department of Pharmacology and Therapeutic, Ahmadu Bello University, Zaria. The animals were all weaned and in good health. This research was carried out in accordance with the rules governing the use of laboratory animals as accepted internationally.

2.2. Data collection

Measurements were taken from a total of 50 Albino rats comprising 28 females and 22 males. The rat to be measured was placed with its back in the palm of the two hands, the thumb and forefinger of the left hand grasping the tail firmly near its base, the thumb and forefinger of the right hand holding the ears and part of the loose skin of the neck. By the use of callipers, tail diameter (TD) which is the breadth of tail at its base was determined. Using measuring ruler and tape, the following were measured; Tail length (TL), taken as the distance between the tail base and the its tapered end, Body length from the nose to the tail tip (BLNT), Body length from the nose to the anus (BLNA) was taken as the distance between the nose tip to the anus, Head length (HL) was taken as the distance from the nose tip to the back the ear pinna, Tail circumference (TC) is the perimeter of the tail at its base, Ear length (EL) is the length of the pinna from its origin to its end. A weighing scale was used to the take the live body weight of the laboratory rat. Approximately the same amount of stretching of the body for measurement was obtained in all cases as one person held the rat throughout the data collections. All linear morphometric measurements were recorded in centimetres and weight measurements were recorded in kilograms.

2.3. Statistical analysis

The data generated from this experiment was be entered in Microsoft Excel worksheet and organized and processed for further analysis. These data were then subjected to analysis using t-test. Pearson's correlation coefficients were estimated between body weight and linear body measurements. Regression equations of linear body measurements with body weight were also generated. All the analysis were done using SPSS version 14.0 statistical package.

3. Results and discussion

The result of the correlation analyses are shown in table 1. In all the comparisons, the correlation coefficient *(r)* values were all positive which means that as any one of linear morphometric measurements or body weight is increasing, a corresponding increase is expressed in the other. Body weights significantly (P < 0.001) correlated with TL (.827), BLNA (.879), BLNT (.9), HL (.514), TC (.860), and TD (.856) except for EL (.194).

Correlation between TC and TL were significant (P < 0.001) with correlation coefficient of .833. There exist also a strong positive correlation (P < 0.001, r = .808) between BLNA and TL. A significant (P < 0.001) positive linear relationship was observed between TC and BLNA (.727), TC and BLNT (.813) respectively.

Table 2 shows predictive regression equations, the R^2 values range from .264 to .81. BLNT had the best fit (.81) followed closely by BLNA (.773), TC (.74), TD (.73), TL (.684), HL (.264) with these traits having BW as the predictor variable. TL, BLNA and BLNT had best fit of .693, 529 and .66 respectively with TC being the predictor variable. TL had a best fit of .653 on BLNA.

Table 1
Correlation of body weight and morphometric measurement in Albino rats *(R. norvegicus).*

	BW	TL	BLNA	BLNT	HL	TC	TD	EL
BDYWT	1							
TL	0.827**	1						
BLNA	0.879**	0.808**	1					
BLNT	0.9**	0.937**	0.963**	1				
HL	0.514**	0.507**	0.541**	0.553**	1			
TC	0.860**	0.833**	0.727**	0.813**	0.410**	1		
TD	0.856**	0.831**	0.719**	0.807**	0.421**	0.999**	1	
EL	0.194^{ns}	0.220^{ns}	0.186^{ns}	0.211^{ns}	0.328*	0.228^{ns}	0.249^{ns}	1

** Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed). N = 50 rats, BW = Body weight, TL = Tail length, BLNA = Body length from nose to anus, BLNT = Body length from nose to tail tip, HL = Head length, TC = Tail circumference, TD = Tail diameter, EL = Ear length.

Table 2
The regression formulas between morphometric measurements in the Albino rats (*Rattus norvegicus*).

Regression formulas	Coefficient of determinatation *(R^2)*
TL = 31.2(BW) + 11.966 (TL = dependent variable)	0.684
BLNA = 42.73(BW) + 10.892 (BLNA = dependent variable)	0.773
BLNT = 73.93(BW) + 22.858 (BLNT = dependent variable)	0.81
HL = 7.12(BW) + 3.782 (HL = dependent variable)	0.264
TC = 5.25(BW) + 1.562 (TC = dependent variable)	0.74
TD = 1.659(BW) + 4.99 (TD = dependent variable)	0.73
TL = 5.147(TC) + 4.512 (TL = dependent variable)	0.693
TL = .628(BLNA) + 5.747 (TL = dependent variable)	0.653
BLNA = 5.788(TC) + 3.583 (BLNA = dependent variable)	0.529
BLNT = 10.935(TC) + 8.095 (BLNT = dependent variable)	0.66

BW = Body weight, TL = Tail length, BLNA = Body length from nose to anus, BLNT = Body length from nose to tail tip, HL = Head length, TC = Tail circumference, TD = Tail diameter, EL = Ear length.

The implication of the high R^2 value observed in the regression analysis showed the body weight could be used to predict many morphometric traits of the laboratory animal. Body weight could be used to predict TL, BLNA, BLNT, TC and TD in the animal since 68, 77, 81 74 and 73% of the changes in these traits could be explained by changes in the predictor variable BDYWT. TC could be used to predict TL, BLNA and BLNT with reasonable accuracy as .69, .52, .66% changes in TL, BLNA, and BLNT respectively could be explained by a change in the predictor variable TC. .65% change in BLNA could be explained by a change in TL.

During the present study, females were found heavier, longer in body length with longer tail and bigger tail circumference than the males but these differences are not statistically significant (P > 0.05) (Table 3).

Table 3
Mean values and standard deviation of body weight (BDYWT), tail length (TL), body length from nose to anus (BLNA) measurements and tail circumference (TC).

Sex	N	BW (g)	TL (cm)	BLNA (cm)	TC (cm)
Male	22	.137 ± .025	16.18 ± .67	17.16 ± 1.32	2.26 ± .13
Female	28	.144 ±.034^{ns}	16.49 ± 1.42^{ns}	16.69 ± 1.59^{ns}	2.33 ± .22^{ns}

4. Conclusion

The results of this study indicate that in Albino rats (*Rattus norvegicus*), there is a high and significant positive correlation between the body weight and body morphometric measurements. This implies that the body weight could be used as a predictor variable to predict with reasonable accuracy the criterion variable such as the body morphometric measurements. The results of this study also showed that there are no significant variations in morphometric traits in the two sexes of the laboratory animal.

However, further research is needed to investigate the relationship between the body weights with internal organs such as kidneys, brains, livers, adrenal glands, hearts amongst other, of these laboratory animals as this will go a long way in making for missing data in the course of research with these model organisms.

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