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Comparative Postnatal Determination of Absolute Brain Weight and Size using Body Morphometric Parameters in the African Giant Rat (*Cricetomys gambianus*)

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ABSTRACT

One neuroanatomical measure found to allometrically scale the body is brain's size. Species with larger brains relative to body are better complex information processors. We compared absolute brain weight (ABW), generated regression formulae and determined intelligence level in each age group of African giant rat (AGR) using encephalization quotient (EQ). Twelve rats in each age group, neonates (1-70 g), juveniles (70-450 g) and adults (≥700 g) were used. Positive linear relationships existed between live body weight (LBW) and ABW in neonates ($r^2 = 0.58$; $p<0.05$) and juveniles ($r^2 = 0.46$; $p<0.05$) with regression formulae $y = 0.479 + 0.048x$ and $y = 3.729 + 0.006x$ deduced for neonates and juveniles, respectively. Positive linear relationship existed between nose-rump length (NRL) and ABW in neonates ($r^2 = 0.68$; $p<0.05$); with regression formula $y = 1.168 + 0.158x$. Positive linear relationships existed between tail length (TL) and ABW in neonates ($r^2 = 0.57$; $p<0.05$); juveniles ($r^2 = 0.69$; $p<0.05$) and adults ($r^2 = 0.41$; $p<0.05$) with regression formulae $y = 2.303 + 0.081x$; $y = 2.549 + 0.097x$ and $y = 2.656 + 0.085x$ deduced for neonates, juveniles and adults, respectively, with correlation being statistically significant ($p<0.05$) in all age groups. The mean values of EQ were $2.58±0.08^a$, $1.03±0.03^b$ and $0.59±0.01^c$ for neonates, juveniles and adults, respectively. Best parameters to quantifying ABW are LBW, NRL and TL for neonates; TL followed by LBW for juveniles and TL for adults. Neonates and juveniles will have better intelligence than adults, although their intelligence is generally less than average.

Keywords: African giant rat, brain, correlation, encephalisation quotient, regression analysis

INTRODUCTION

The biology of the African giant rat (AGR, *Cricetomys gambianus*) is currently receiving more and more attention in Nigeria. This is not shocking given the significance of this wild rodent, which led to the idea of its domestication in the first place. Their scientific properties include serving as a reservoir host for the monkey pox virus[1] and, detecting tuberculosis, which is useful in medicine[2-5]. This rodent is also useful in detecting landmines[2-5], serves as exotic pets[6] and has been proposed as laboratory model of investigation into many physiologic and pathological processes[7]. The brain's size is one neuroanatomical measure that has been found to scale allometrically to the body, and variations from this connection have been used to gauge an animal's relative cognitive aptitude[8].

According to established theory, species with larger brains relative to body mass are better able to process and make use of complex information. For instance, larger brains have been associated with enhanced motor, cognitive, and sensory abilities[9,10]. Additionally, it has been hypothesized that memory storage is correlated with brain size and that memory and intelligence may be linked[8]. Once again, it has been contended that having a large brain compared to one's size can benefit people by enhancing their behavioral flexibility[11]. Several of these observations have also been noted in birds in addition to mammals[12]. The benefits of animals with larger brains have been explained by theories such the brain-environment change[11]. According to this idea, a large brain can be advantageous in novel contexts by supporting adaptive behavioral responses to uncommon or unexpected ecological changes through cognitive processes like invention, learning, and decision-making[13]. Another theory is known as the cognitive buffer hypothesis, which contends that larger, more complicated brain activity may help people behave in a way that protects them from the vagaries (that is, sudden, unpredicted changes) of their environment. Birds give the strongest evidence that an expanded brain offers a survival advantage when faced with fresh problems[14]. Additionally, recent studies[15,16] have demonstrated that young animals possess superior learning abilities compared to adult animals; hence, it is recommended that juveniles be utilized in cognitively-focused experimental research.

Encephalization Quotient (EQ), cortical neuron number, cortical gray matter thickness, and relative brain size are examples of cognitive brain indicators; however, cortical neuron number and EQ are more trustworthy markers[17-19]. Even in people, intelligence is incredibly challenging to assess, let alone in animals. The EQ, first proposed by Jerison[20], has been used as one of the indicators of animal intelligence or its capacity to deal with environmental problems and hurdles that have recently arisen. According to Jerison[20], the EQ is the ratio of actual to expected brain size for a particular body weight. This was explained by the fact that in this paradigm, a mammal with a brain/body size ratio of 1.0 is regarded as having average EQ[20]. A lower than average level of characteristics that could be perceived as "intelligent" may be associated with an EQ value less than 1.0; on the other hand, a greater than average level of characteristics may be associated with an EQ value higher than 1.0. Elephants and primates, who have EQ values close to or over two, have been recorded using and making tools[21]. The ability of an animal to deal with recently developed challenges and obstacles in the environment was thought to be represented by the EQ[8]. Byanet and Dzenda's[22] research on the EQ of AGR only included adults. According to a theory, "brain size normally increases with an increase in animal body size" (positive correlation), meaning that larger animals often have larger brains than smaller animals[23]. Values for the EQ have been recorded for both humans and a variety of animals. The EQ of the elephant, horse, sheep, rat, mouse, rabbit, European cat, ring-tailed lemur, gorilla, chimpanzees and humans are 1.12, 0.9, 0.8, 0.0.4, 0.5, 0.4, 1.14, 1.449,1.40 to 1.68; 2.18 to 2.45 and 7.33 to 7.69, respectively[24].

There is no information comparing the absolute brain weight (ABW) using body morphometric parameters like Live Body weight (LBW), Tail length (TL), and Nose-rump length (NRL) among neonates, juveniles and adults of AGR. As stated above, because of the importance of this animal to science as currently being used as animal model for research, preserving this animal should be a priority. Therefore, this study aimed to compare postnatally, the ABW using correlation and to generate regression formulae that will prevent their extinction at any stage of development before their ABW can be determined.

MATERIALS AND METHODS

Experimental animals and management

Thirty-six apparently healthy AGR consisting of twelve neonates, twelve juveniles and twelve adults were used for this study. The adults and juveniles were captured live using a 1.3m by 0.3m by 0.1m size locally constructed galvanized metal traps while the neonates were captured from tunnels inside the ground by digging them out. For convenience purpose, all the rats were captured live around Uturu village in Isuikwuato Local Government Area of Abia state. The rats were then transported by road in standard laboratory cages to the Department of Veterinary Anatomy laboratory, Michael Okpara University of Agriculture, Umudike, Abia State.

Ethical approval: Ethical approval was obtained from the Research Ethics Committee of the College of Veterinary Medicine, Michael Okpara University of Agriculture Umudike. The Ethical Approval Reference Number is MOUAU/CVM/REC/202117.

Brain extraction of the rats

The rats were sedated with a cotton wool mildly soaked with chloroform placed in a white transparent bucket. When sedation was achieved, the LBW of each of the adults and juveniles were obtained using a kilogram (kg) graduated manual weighing balance (Putex plastic Baby Weight Machine, Analogue, Multicolor, Golden Star Surgical Industry Private Limited) and the results obtained converted to gram (g) while, each of the neonate was weighed using a digital electronic balance (Citizen Scales (1) PVT Ltd., South Patel Nagar, New Delhi, sensitivity: 0.01 g) graduated in grams. Those rats that were blind from birth and weighed between 1-70 g were regarded as neonates; and according to Ali *et al*.[25], those that weighed between 70-450 g as juveniles, and ≥700g as adults. The NRL and the TL were measured using centimeter (cm) calibrated meter rule. Each animal was placed on dorsal recumbency on a dissection table, and perfused, via the left ventricle, with 4% paraformaldehyde fixative, as described by Gage *et al*.[26]. Once perfusion fixation was achieved, the animal was decapitated at the atlanto-axial joint, using a rongeur and pair of scissors. The skin, some cervical vertebrae, muscles of head and neck were removed as much as possible till the skull was exposed. The head was then placed in 10% formalin for 3 days. This was followed by separation of lower jaw containing the mandible, associated muscles and skin, tongue, part of trachea and esophagus from the rest of the head. The brain was extracted from the skull by gradual and careful removal of cranial and facial bones using thumb forceps and a pair of scissors. The meninges and underlying blood vessels were gently removed to expose the intact brain before it was weighed using sensitive electronic balance to obtain the ABW in grams (g).

The relative brain weight (RBW) and encephalisation quotient (EQ) were determined using the proposed formula by Ibe *et al*.[16]; relative brain weight (RBW) $\frac{\text{absolute brain weight (ABW)}}{\text{Live Body weight (LBW)}}$ X $\frac{100}{1}$(%) and proposed formula by Martin[27], for Encephalisation quotient (EQ) = $\frac{\text{absolute brain weight (ABW)}}{0.059\ \text{(Live body weight) (LBW)}^{0.76}}$

Statistical Analysis

Data were expressed as mean ± standard error of the mean (SEM) and presented in tables and graphs. The values were subjected to one-way analysis of variance, followed by Tukey's post-hoc test to determine significance of the mean. The association between the values of body parameters (LBW, TL and NRL) and ABW was determined using Pearson's coefficient of correlation, at 95% confidence interval. Values of $P < 0.05$ were considered significant.

RESULTS

The result of the brain size indices as presented in Table 1 showed that in addition to LBW; ABW, NRL and TL increased ($p< 0.05$) statistically. However, LBW, NRL and TL were all statistically significant in juveniles and adults, but only ABW was significant in neonates (Table 1). While the ABW of the adult and the juvenile AGR were statistically insignificant ($P<0.05$), they correspondingly weighed heavier than the ABW of the neonate. The RBW and the EQ of neonates were higher ($P<0.05$) than in juveniles and adults, suggesting that as the AGRs developed, the RBW and EQ becomes smaller. For neonates, the mean EQ was 0.08, 0.03 in juveniles and 0.01 in adults and statistically significant ($p<0.05$) among the three age groups (Table 1).

Table 1: Morphometric values (mean ± SEM) of the live body and absolute brain weights; nose-rump and tail lengths and; Encephalization quotient in the African giant rat; for each column n = 36.

Brain/Body parameter	Neonate	Juvenile	Adult
Live body weight (g)	$58.71±2.29^{c}$	$375.00±23.43^{b}$	$855.83±42.91^{a}$
Absolute Brain weight (g)	$3.31±0.14^{b}$	$5.37±0.19^{a}$	$5.85±0.14^{a}$
Relative brain weight (%)	$5.63±0.17^{a}$	$1.47±0.07^{b}$	$0.69±0.02^{c}$
Nose-Rump length (cm)	$13.55±0.75^{c}$	$24.95±0.76^{b}$	$31.01±0.57^{a}$
Tail length (cm)	$12.52±1.36^{c}$	$29.07±1.65^{b}$	$37.67±1.07^{a}$
Encephalisation quotient	$2.58±0.08^{a}$	$1.03±0.03^{b}$	$0.59±0.01^{c}$

Note: Different superscript letters along columns are significantly ($p<0.05$) different.

The values RBW of 5.63%, 1.47% and 0.69% respectively obtained for the neonate, juvenile and adult AGR. Again, the EQ for neonates, juveniles and adults were 2.58, 1.03 and 0.59, respectively.

There was a positive linear relationship between LBW and ABW in the neonate AGR ($r^2 = 0.58$; $p<0.05$). Subjecting this to a regression analysis, a regression formula was deduced from the graph as $y = 0.479 + 0.048x$, where y is the ABW and x is the LBW which is already known. There was a very high positive correlation ($r = 0.76$; $P<0.05$) between LBW and ABW of the neonate AGR. The variation in the ABW of the neonate AGR is accounted for or predicted by 58% ($r^2 = 0.58$) of the LBW. The regression formula predicts that increase in cm of the neonate LBW is associated with a 0.05 increase in ABW (Figure 1).

There was a positive linear relationship between the LBW and ABW in juvenile AGR ($r^2 = 0.46$; $p<0.05$). Subjecting this to a regression analysis, a regression formula was deduced from the graph as $y = 3.729 + 0.006x$, where y is the ABW and x is LBW which is already known. There was a high positive correlation ($r = 0.68$; $P<0.05$) between LBW and ABW of the neonate AGR. The variation in the ABW of the juvenile AGR is accounted for or predicted by 46% ($r^2 = 0.46$) of the LBW. The regression formula predicts that increase in cm of the juvenile LBW is associated with a 0.01 increase in ABW (Figure 2).

There was a positive linear relationship between the LBW and ABW in the adult AGR ($r^2 = 0.16$; $p<0.05$). Subjecting this to a regression analysis, a regression formula was deduced from the graph as $y = 4.733 +$

0.001x, where y is the ABW and x is the LBW which is already known. There was a very high positive correlation ($r = 0.39$; $P<0.05$) between LBW and ABW of the adult AGR. The variation in the ABW of the adult AGR is accounted for or predicted by 16% ($r^2 = 0.16$) of the LBW. The regression formula predicts that increase in cm of the adult LBW is associated with a 0.001% increase in ABW (Figure 3).

There was a positive linear relationship between the NRL and ABW neonate AGR ($r^2 = 0.68$; $p<0.05$). Subjecting this to a regression analysis, a regression formula was deduced from the graph as $y = 1.168 + 0.158x$, where y is the ABW and x is the NRL which is already known. There was a very high positive correlation ($r = 0.82$; $P<0.05$) between ABW and NRL of the neonate AGR. The variation in the ABW of the neonate AGR is accounted for or predicted by 68% (the $r^2 = 0.68$) of the NRL. The regression formula predicts that increase in cm of the neonate NRL is associated with a 0.16 increase of ABW (Figure 4).

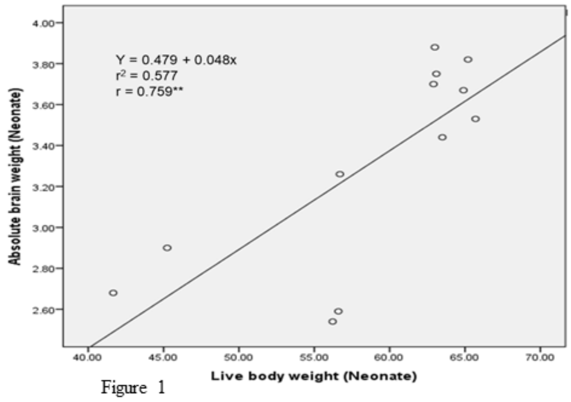
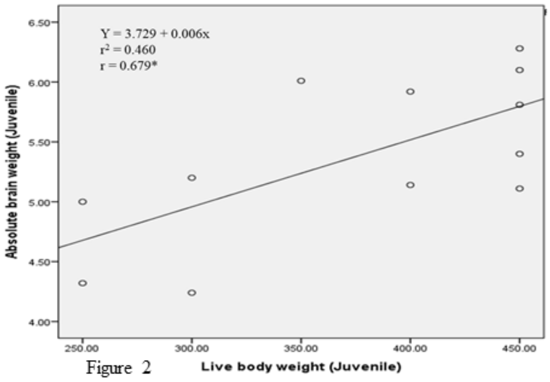


Figure 1



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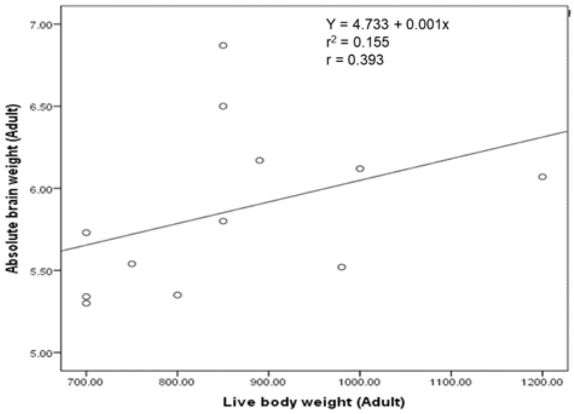

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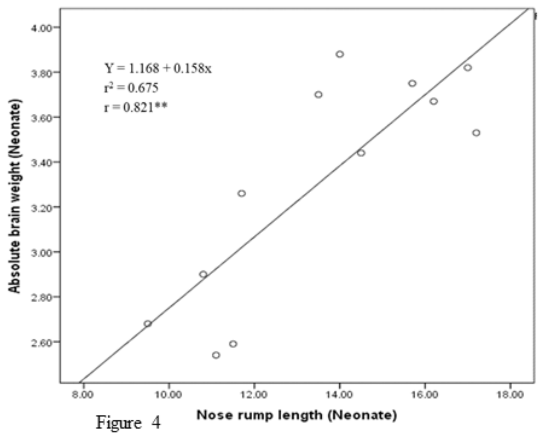


Figure 4

Figure 1: Correlation of the live body weight and absolute brain weight in the neonate African giant rat. Note: ** Correlation (r) is significant at the 0.05 level.

Figure 2: Correlation of the live body weight and absolute brain weight in the juvenile African giant rat. Note: *Correlation (r) is significant at the 0.05 level.

Figure 3: Correlation of the live body weight and absolute brain weight in the adult African giant rat**.** **Note:** ** Correlation (r) is significant at the 0.05 level.

Figure 4: Correlation of the nose-rump length and absolute brain weight in the neonate African giant rat. Note: ** Correlation (r) is significant at the 0.01 level.

There was a positive linear relationship between the NRL and ABW juvenile AGR ($r^2 = 0.09$; $p<0.05$). Subjecting this to a regression analysis, a regression formula was deduced from the graph as $y = 3.481 + 0.076x$, where y is the ABW and x is the NRL which is already known. There was a very high positive correlation ($r = 0.30$; $P<0.05$) between ABW and NRL of the juvenile AGR. The variation in the ABW of the juvenile AGR is accounted for or predicted by 9% (the $r^2 = 0.09$) of the NRL. The regression formula predicts that increase in cm of the juvenile NRL is associated with a 0.08 increase of ABW (Figure 5).

There was a positive linear relationship between the NRL and ABW adult AGR (r^2 = 0.31; p<0.05). Subjecting this to a regression analysis, a regression formula was deduced from the graph as y = 1.594 + 0.138x, where y is the ABW and x is the NRL which is already known. There was a very high positive correlation (r = 0.55; P<0.05) between ABW and NRL of the adult AGR. The variation in the ABW of the adult AGR is accounted for or predicted by 31% (the r^2 = 0.31) of the NRL. The regression formula predicts that increase in cm of the adult NRL is associated with a 0.14 increase of ABW (Figure 6).

There was a positive linear relationship between the TL and ABW neonate AGR (r^2 = 0.57; p<0.05). Subjecting this to a regression analysis, a regression formula was deduced from the graph as y = 2.303 + 0.081x, where y is the ABW and x is the TL which is already known. There was a very high positive correlation (r = 0.75; P<0.05) between ABW and TL of the neonate AGR. The variation in the ABW of the neonate AGR is accounted for or predicted by 57% (r^2 = 0.57) of the TL. The regression formula predicts that increase in cm of the TL is associated with a 0.08 increase of ABW (Figure 7).

There was a positive linear relationship between in the TL and ABW in juvenile AGR (r^2 = 0.69; p<0.05). Subjecting this to a regression analysis, a regression formula was deduced from the graph as y = 2.549 + 0.097x, where y is the ABW and x is the TL which is already known. There was a very high positive correlation (r = 0.83; P<0.05) between ABW and TL of the juvenile AGR. The variation in the ABW of the juvenile AGR is accounted for or predicted by 69% (r^2 = 0.69) of the TL. The regression formula predicts that increase in cm of the TL is associated with a 0.10 increase of ABW (Figure 8).

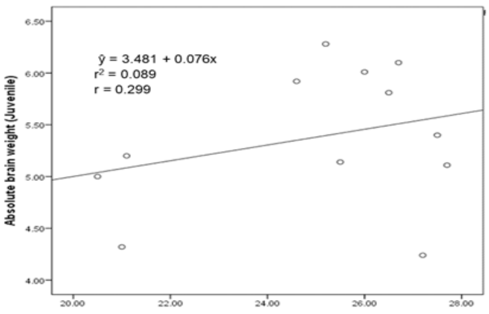
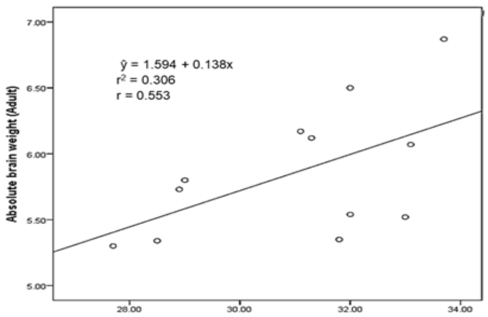


Figure 5



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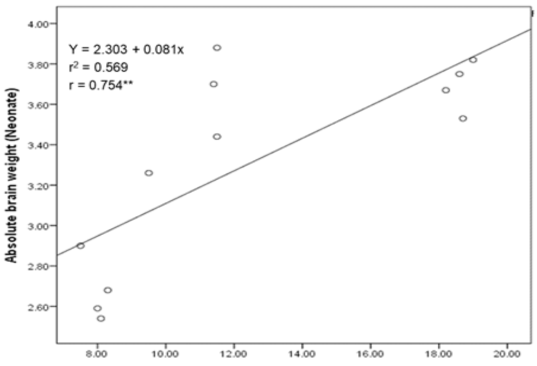

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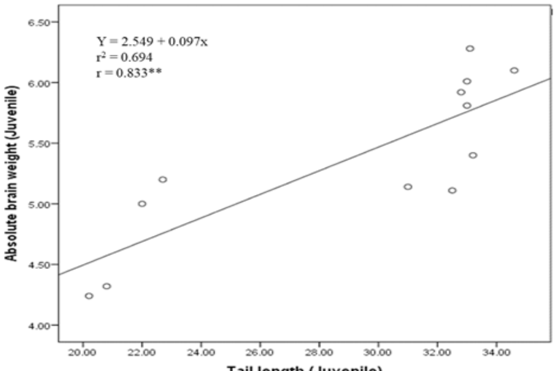


Figure 8

Figure 5: Correlation of the nose-rump length and absolute brain weight in the juvenile African giant rat. Note: ** Correlation (r) is significant at the 0.01 level.

Figure 6: Correlation of the nose-rump length and absolute brain weight in the adult African giant rat. Note: ** Correlation (r) is significant at the 0.01 level.

Figure 7: Correlation of the tail length and absolute brain weight in the neonate African giant rat. Note: ** Correlation (r) is significant at the 0.01 level.

Figure 8: Correlation of the tail length and absolute brain weight in the juvenile African giant rat. Note: ** Correlation (r) is significant at the 0.01 level.

There was a positive linear relationship between the TL and ABW adult AGR (r^2 = 0.41; $p<0.05$). Subjecting this to a regression analysis, a regression formula was deduced from the graph as y = 2.656 + 0.085x, where y is the ABW and x is the TL which is already known. There was a high positive correlation (r = 0.64; $P<0.05$) between ABW and TL of the adult AGR. The variation in the ABW of the adult AGR is accounted for or predicted by 41% (r^2 = 0.41) of the TL. The regression formula predicts that increase in cm of the TL is associated with a 0.09 increase of ABW (Figure 9).

It was observed that both the NRL and TL were statistically significant in all the three age groups ($p<0.05$). However, on comparing the NRL and TL in the individual age groups, the NRL and TL in neonates were statistically significant ($p<0.05$) with the NRL being slightly longer than the TL. In juveniles, the TL was statistically longer than the NRL whereas in adults, the TL were statistically longer than the NRL ($p<0.05$) (Figure 10).

It was observed that both the RBW and ABW were statistically significant in all the three age groups ($p<0.05$). However, on comparing the RBW and ABW in the individual age groups, the RBW weighed statistically higher than the ABW in neonates. In juveniles and adults however, the ABW weighed statistically higher than the RBW ($p<0.05$) (Figure 11).

It was observed that the ABW was statistically significant in neonates only ($p<0.05$). However, on comparing the ABW and LBW in the individual age groups, the LBW was statistically significant and weighed statistically heavier in adults, heavy in juveniles and less heavy in neonates than the ABW ($p<0.05$) (Figure 12).

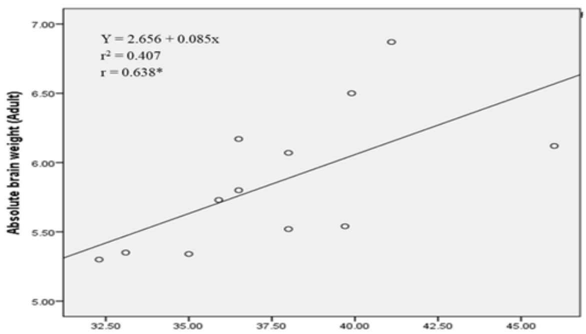
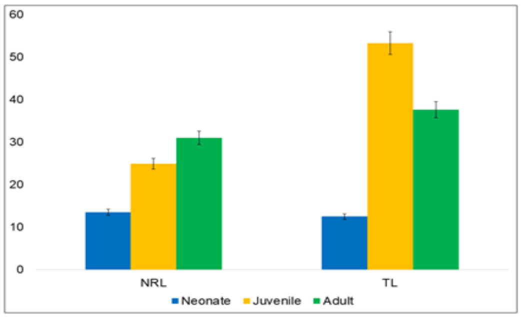


Figure 9



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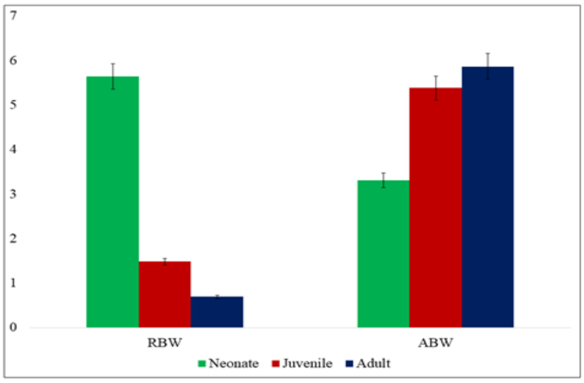


Figure 11

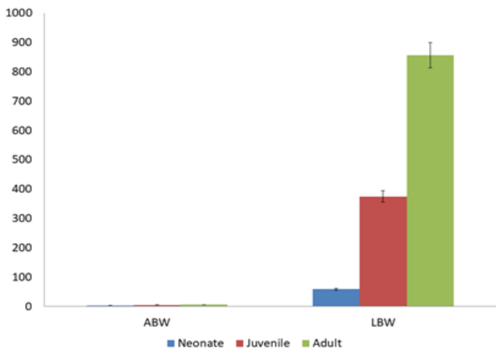


Figure 12

Figure 9: Correlation of the tail length and absolute brain weight in the juvenile African giant rat. Note: ** Correlation (r) is significant at the 0.01 level.

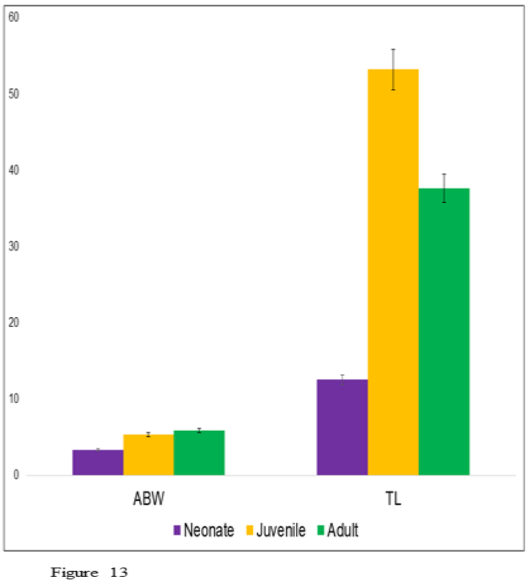
Figure 10: Bar chart of nose-rump and tail lengths in the neonate, juvenile and adult AGR. Abbreviations: NRL, Nose-Rump Length; TL, Tail Length.

Figure 11: Bar chart of the Relative brain and Absolute brain weight in the neonate, juvenile and adult AGR. Abbreviations: RBW, Relative brain weight; ABW, Absolute brain weight.

Figure 12: Bar chart of the absolute brain weight and live body weight in the neonate, juvenile and adult AGR. Abbreviations: ABW, Absolute brain weight; LBW, Live body weight.

It was observed that both the ABW and TL were statistically significant in all the three age groups ($p<0.05$). However, on comparing the ABW and TL in the individual age groups, the TL correspondingly increased as the ABW increased progressively in neonates and juveniles but decreased as the ABW increased in adults. The juveniles having statistically, the longest tail followed by that of adults and lastly in neonates (Figure 13).

It was observed that both the ABW and NRL were statistically significant in all the three age groups ($p<0.05$). However, on comparing the ABW and NRL in the individual ages group, the NRL correspondingly increased as the ABW increased progressively from neonates to juveniles and to adults, with NRL being statistically longer in adults, followed by that of juveniles and the least in neonates (Figure 14).



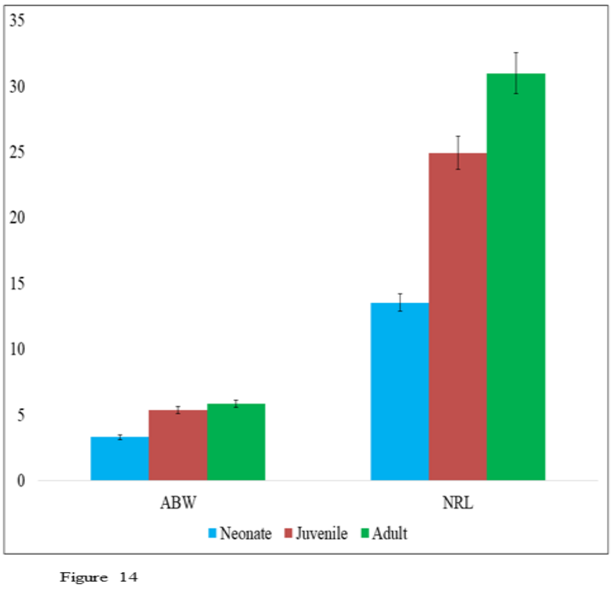


Figure 13: Bar chart of the absolute brain weight and tail length in the neonate, juvenile and adult AGR. Abbreviations: ABW, Absolute brain weight; TL, Tail length.

Figure 14: Bar chart of the absolute brain weight and nose rump length in the neonate, juvenile and adult AGR. Abbreviations: ABW, Absolute brain weight; NRL, Nose rump length.

DISCUSSION

This study attempted to determine ABW using body morphometric parameters including the LBW, NRL and TL comparatively in the neonate, juvenile and adult AGRs. As earlier stated, the brain samples within the skull were fixed in 10% formalin so that the brain samples could be removed completely intact with little or no damage. Therefore, it is important to state clearly that the morphometry was conducted from the results of 3 days fixed brain samples.

In neonates, the very high positive correlations between LBW and ABW; NRL and ABW and; TL and ABW implied that at neonatal stage, the ABW increased at approximately the same rate with the LBW, NRL and TL respectively. For a neonate whose either LBW or NRL or TL is known (x), the approximate ABW (y) can be correspondingly predicted from the regression formulae generated. The formulae will assist in obtaining the estimated ABW of a neonate without sacrificing it.

In juveniles, the high and the very high positive correlations between LBW and ABW and; TL and ABW implied that at juvenile stage, the ABW increased at approximately the same rate with the LBW and TL respectively. For a juvenile whose either LBW or TL is known (x), the approximate ABW (y) can be correspondingly predicted from the regression formulae generated. The formulae will assist in obtaining the estimated ABW of a juvenile without sacrificing it.

In adults, the high positive correlation between TL and ABW implied that at adult stage, the ABW increased at approximately the same rate with the TL. For an adult whose TL is known (x), the approximate ABW (y) can be predicted from the regression formula. The formula will assist in obtaining the estimated ABW of an adult without sacrificing it. As found, there was no correlation between ABW and adult AGR with the

LBW, this differed to the findings of Byanet & Dzenda[22] in adult AGR.

The values of 5.63%, 1.47% and 0.69% respectively obtained as the RBW for the neonate, juvenile and adult AGR from the present study is comparable to the value obtained from the juvenile age group of this rodent by Olude *et al*.[15] and Ibe *et al*.[28]. The value of juveniles was higher than the value of 0.69% obtained for the adult AGR in this study and 0.60% recorded for the adult AGR by Ibe *et al*.[28], although that of neonate had a higher value of 5.63% above the juveniles and adults. Again, the EQ recorded for neonates 2.58, juveniles 1.03 and adults 0.59 from the present study were higher than in adult African grasscutter and primates 0.27[29]. This corresponded to the findings in juveniles 0.75 by Ibe *et al*.[28] and higher than the value of 0.19 recorded for adults by Byanet & Dzenda[12], although the neonates had highest EQ than both the juveniles and adults. In rats, age-related neuronal loss in the brain starts at the end of adolescence[30]. A great deal of evidence implies that larger EQs or relative brain size endow species with improved cognitive abilities[12], behavioral flexibility, such as the ability to respond successfully to novel environments[31] or to alternate between feeding strategies[32]. These findings seem to agree with the fact that humans, dolphins, and chimpanzees have the largest known EQs[33]. The EQ of Ungulates differs among the species ranging from 0.91 to 0.78 in Perissodactyla (*Equus caballus*)[34,14], to 0.55–0.80 in Cetartiodactyla such as Bovidae[35,36] and Camelidae (*Camelus bactrianus*)[37,38]. In Suidae, it has been reported that the EQ of only one specimen of *Sus scrofa* (un-indicated subspecies) was 0.60[14].

These findings are suggestive of highest, higher and high cognitive abilities in the neonate, juvenile and adult AGR, respectively. But because the neonates have some limitation of blindness, juveniles will be the best for cognitive studies. Neuronal plasticity study in the AGR by Olude *et al*.[15] suggested better cognition in the juveniles and recommended they be used than the adults in experimental studies involving memory and cognition. Neuronal loss due to apoptosis may be one of the reasons for low EQ in adult AGR compared to the juveniles, reason why neonates had the highest EQ because probably apoptosis was yet to start at their age. The juvenile African grasscutter may have a better cognitive ability than juvenile AGR, as the value of RBW (2.49%) and EQ (1.62) recorded for the juvenile African grasscutter by Ibe *et al*.[16] are respectively higher than the values obtained in the present study. Conversely, the neonate AGR will have a better cognitive ability than the neonate grasscutter as the RBW and EQ were higher (5.63) and 2.58, respectively than that of grasscutter (3.84) and 1.89 according to Ibe *et al*.[16]. However, the adult AGR will be better in cognition than the adult grasscutter because of higher RBW in the adult AGR (0.69) and EQ 0.59 than the adult African grasscutter (0.44) and EQ 0.49.

Our finding on EQ disagrees with the hypothesis which states that "brain size usually increases with increase in body size in animals" (positive correlation), that is, large animals usually have larger brain than smaller animals[23]. The progressive decrease in the mean of EQ from neonates to juveniles and then to adults probably implied that the brain size in AGR is indirectly proportional to their age and that, AGR irrespective of age has less than average intelligence, with higher memory and cognition in the neonates and juveniles than to adults.

As all measured brain size indices increased as AGRs developed, the RBW decreased as the rats aged. So, the higher the LBW and the longer the NRL and TL irrespective of age, the higher the ABW; while the RBW being low, lower and lowest in neonates, juveniles and adults respectively. However, the negative but strong correlation between the ABW and RBW; TL and NRL, implied that as these structures developed, the size of the brain of AGR in relation to their body weight decreased at equal proportion and vice versa, irrespective of age.

Therefore, the best body morphometric parameters to quantifying ABW using the generated formulae is any of LBW, NRL and TL in neonates; TL followed by the LBW in juveniles and only the TL in adults. Neonates and Juveniles will have better intelligence than adults even though their intelligence are generally less than average.

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Conflict of interest

There are no conflicts of interest.

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