The relationship between Body Mass and Basal Metabolic Rate in non-subterranean mammals

Katelyn Skaggs

**Introduction**

Mammals rely on physiological processes to complete everyday activities to find food, metabolize food, reproduce, find habitat, defend the habitat, along with many others to survive. One important process is the basal metabolic rate (BMR). This is the minimum rate of energy that is needed in order to maintain the endothermic animal’s homeostatic level. Endothermic animals are animals that maintain a consistent body temperature in a wide variety of different environmental temperatures (Naya et al. 2018). Animals go through an energy chain, first is the gross energy consumption which is turned into net energy which is turned into available energy for use in the animals systems (Lovegrove 2003). BMR is measured in a resting state of postabsorptive quiescent mammals (Lovegrove).

Basal metabolic rate is important because it can affect the animals fitness and survival through effective energy conversion that increases longevity and decreases mortality (Lovegrove 2003). In this paper, the body mass and the BMR readings of 459 mammals were taken into consideration to study the relationship between the two. There is a positive correlation between basal metabolic rate and body mass in these mammals.

Basal metabolic rate can differ depending on multiple things including taxonomic organization, body mass, food availability, habitat, life-history, and/or temperature (Lovegrove). Understanding the variations in energy metabolic rate like BMR will be beneficial for ecology, evolutionary, and animal behavior to develop theses and to further study the fitness of animals (Lovegrove)

**Methods and Materials**

We know that species are not independent of one another, so in order to compare multiple species it is beneficial to use the phylogenetically corrected data. This corrected data allows the species to be viewed as independent, but on the grounds that we are assuming the traits evolved under a specific model. An example of a model would be Brownian motion where the time since the common ancestor and the variation between two species is linearly proportional. I used Vertlife.com to download the phylogeny subsets for the species included in the data set. For this study, data was used from literature paper (Naya et al. 2018). The body mass measured in grams and basal metabolic rate measured in ml O2 h-1 was recorded on 458 small mammals with some overall guidelines. These animals were non-armored animals that live in above ground habitats. To test this hypothesis, the data was analyzed through R version 4.03 GUI 1.73 Catalina to build resulting in a phylogenetic linear regression. The phylogenetic tree for the mammals included in this study has 390 tips and 389 internal nodes using read.nexus(‘output.nex”) in R. To test this hypothesis, I first obtained the log10 body mass and log10 basal metabolic rate data excel sheet. In this study, I used the log10 data for both body mass and basal metabolic to study the individual effects to prevent skewed results based on the wide mass range. I then used the package phytools, nlme, and RRphylo to analyze the relationship between body mass (g) and basal metabolic rate (O2 h-1).

**Results**

The graph below includes the 458 organisms placed according to their body mass which is represented on the y axis and basal metabolic rate which is represented on the x axis. Looking at the graph, we can see that there is in fact a positive correlation between basal metabolic rate and body mass of the small mammals that were included in this study. The blue regression line that is found on the graph represents the phylogenetic correct line. This takes into consideration the phylogenetic nature of the species. Each dot on the graph represents an organism. The red line represents the non-phylogenetic data. In this study, the phylogenetic correct regression, which is represented by the blue regression line, was used to conclude the relationship between body mass and basal metabolic rate. There does not seem to be much of a change when looking at these two regression lines.

Figure : Relationship between body mass (g) and basal metabolic rate (O2 h-1). For 458 small mammals.

**Discussion**

This study shows that as body mass increases in small mammals, the basal metabolic rate also increase. The organism’s high basal metabolic rate can increase the efficiency of feeding, guarding offspring. These of which decrease mortality in young offspring which increases the parent organisms fitness (Brz k et al. 2014).

Although this study proved that there is a positive correlation between body mass and basal metabolic rate in this data set, there are outlying conditions that could skew the results. The basal metabolic rate included in this data does not take into consideration the seasonal differences. Research in specific seasons could potentially be a solution to this condition. Studying the basal metabolic rate and what affects it could help determine the fitness of the organism and also help determine the best environments for the organisms.

**Works Cited**

Brz k P, Ksi zek A, O dakowski ukasz, Konarzewski M. 2014. High basal metabolic rate does not elevate oxidative stress during reproduction in laboratory mice. Journal of Experimental Biology. 217(9):1504–1509. doi:10.1242/jeb.100073.

Lovegrove BG. 2003. The influence of climate on the basal metabolic rate of small mammals: a slow-fast metabolic continuum. J Comp Physiol B. 173(2):87–112. doi:10.1007/s00360-002-0309-5.

Lovegrove BG. The Zoogeography of Mammalian Basal Metabolic Rate. :19.

Naya DE, Naya H, White CR. 2018. On the Interplay among Ambient Temperature, Basal Metabolic Rate, and Body Mass. The American Naturalist. 192(4):518–524. doi:10.1086/698372.