**Black Wheatear Carrying Mass and Immune Response**

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The black wheatear is a bird native to Spain and Morocco. Males of the species demonstrate an exaggerated sexual display by carrying heavy stones to nesting cavities. Different male birds will carry different sized stones. Based on the average stone mass in grams carried by each black wheatear, along with t-cell response measurements, we are interested in investigating an association between strength, our explanatory variable, and health, our response variable.

In order to investigate whether or not a relationship between health and strength is apparent in black wheatears, we gather observational data from 21 black wheatears on t-cell volumes and average carrying mass per trip to the bird’s nesting cavity.

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Based on initial visual inspection a linear relationship can be inferred (1). Indeed, a correlation coefficient of 0.58 indicates a moderate relationship. Thus, we assume the relationship between mass carried and tcell (strength and health) can be modeled by simple linear regression.

Based on a linear regression analysis modeling mass as the explanatory variable and tcell volume (mm) as the response variable, we arrive at a regression equation of:



An F(1,19) of 9.51, proves the overall regression model is significant at p = 0.0061. Further, from a slope p value of p = 0.0061, we determine the slope (0.0328) and relationship between mass and tcell volume is statistically significant. For each gram of average mass, we expect tcell volume to increase by 0.0328mm (2) with an error of 0.106 and a 95% confidence interval of [0.0106, 0.0551].

Mass carried explains roughly 33% of the variability in our linear regression model.

A distribution of residuals (3) ensures all fitted responses at each value of x in the model is normally distributed, confirming the use of linear regression as a viable model for predicting the wheatear’s tcell volume from the average mass of stones carried.

**Conclusion:**

Given exploratory data analysis and model assumption confirmations, the relationship between average carrying mass in grams and t-cell volume (health) is valid and can be modeled with linear regression. For every one-gram increase in average weight carried, we expect t-cell volume to increase by 0.0328mm with a starting t-cell volume of 0.0875 based on the 21 birds studied:



Causality cannot be assumed in this model, however, as the data are observational. There is a moderate association between mass and t-cell volume. 33% of the variance in t-cell volume is explained by mass carried, leading us to believe we do not hold the entire picture and the regression model could be enhanced by adding significant, non-co-linear variables to our model.