Lab 8: Hypothesis Testing I

Data

Today we look at data from a paper studying the effect that light at night has on weight gain and other variables in mice. According to the paper, “The global increase in the prevalence of obesity and metabolic disorders coincides with the increase of exposure to light at night and shift work”. This study is determining whether light at night plays a causal role in the obesity epidemic. The paper is available here.

The study took \( n = 30 \) mice and randomized them to three different treatment groups. All mice spent 16 hours in light, and the explanatory variable was the level of light during the remaining 8 hours. Some of the mice were randomized to darkness during those 8 hours (as is typical for regular mice), some were randomized to a dim light (equivalent to a TV on in the room for humans), and the remaining mice were exposed to bright light for all 24 hours. Mice are nocturnal, and typically most of their activity and eating happen at night. The hypothesis of this study was that having a light on at night may alter mouse eating habits and/or metabolism, and so increase body mass.

The data can be downloaded here. There are some missing values because one mouse died, and one mouse did not receive the full glucose injection for it’s glucose tolerance test. These missing values are coded with NA, and exclude these rows when copy and pasting into either StatKey or Minitab (or else you will get an error). Here is a description of the variables:

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>Treatment group (dark, dim, bright)</td>
</tr>
<tr>
<td>BodyMass0</td>
<td>Body mass at the beginning of the experiment (week 0)</td>
</tr>
<tr>
<td>BodyMass8</td>
<td>Body mass after 8 weeks of the experiment</td>
</tr>
<tr>
<td>BMChange</td>
<td>Change in body mass (BodyMass8 - BodyMass0)</td>
</tr>
<tr>
<td>Corticosterone</td>
<td>Blood corticosterene level (a measure of stress)</td>
</tr>
<tr>
<td>DayPct</td>
<td>Percentage of calories consumed during the day</td>
</tr>
<tr>
<td>Consumption</td>
<td>Average daily consumption (in grams)</td>
</tr>
<tr>
<td>GlucoseInt</td>
<td>Glucose intolerant at end of study? (Yes or No)</td>
</tr>
<tr>
<td>GTT15</td>
<td>Glucose level in the blood 15 minutes after a glucose injection</td>
</tr>
<tr>
<td>GTT120</td>
<td>Glucose level in the blood 120 minutes after a glucose injection</td>
</tr>
<tr>
<td>Activity</td>
<td>A measure of physical activity level</td>
</tr>
</tbody>
</table>

So far we’ve only learned how to compare two groups, so for this lab we will just compare the mice exposed to darkness to the mice exposed to bright light overnight. (So when you copy and paste the data, ignore the dim light mice.) The paper uses all three groups, so you may get different results from what is published.

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Does being exposed to light at night increase body mass in mice?

Exercise 1: Study design: Does the study design support causal conclusions? Why or why not?

Exercise 2: Exploring the data:
(a) What is the explanatory variable?
(b) What should the response variable be?
(c) Plot the response variable by the explanatory variable. (You can use Minitab or the Descriptive Statistics column in StatKey).
(d) Does being exposed to light at night appear to increase body mass in mice? (The goal of this lab is to formalize the answer to this question).

Exercise 3: Hypotheses and statistic:
(a) Define the relevant parameters.
(b) State the null and alternative hypotheses (Check with your TA or LA to make sure you have these correct before proceeding).
(c) Calculate the relevant observed statistic (you can use either StatKey or Minitab).

Exercise 4: We want to see what kinds of statistics we would see, just by random chance, if the null hypothesis were true. Use the handout to generate one such statistic. (This only needs to be done by each group, not each individual - divvy up the breaking of the paper!)
(a) Rip the sheet in half to break the association between the explanatory variable (light condition) and the response variable (change in body mass). Ensuring no association between the two ensures the null hypothesis is true.
(b) Break up the different values of body mass change and shuffle them.
(c) Randomly deal them out into two piles, one pile representing the bright light group (how many mice?) and one pile representing the dark group. This mimics the random assignment used in the actual experiment, so allows us to see what would happen just by random chance.
(d) Calculate the difference in means for your simulated sample.
(e) Why did you keep the response values fixed? Why did you deal the values randomly into two piles? Make sure you understand why you are doing what you did before proceeding.
(f) You just calculated one statistic for the randomization distribution! Report your value to the TA, who will create a randomization distribution for the class.
(g) NOTE: You do not really care about the value you just calculated (it would just be one dot in the randomization distribution), and will not use this number for the rest of lab. The point is not the value you got, but understanding the process of how you got that value and why you did what you did.

**Exercise 5:** Go to “Randomization Test for Difference in Means,” copy and paste in your data (the data from the original experiment, not your simulated data), and click “Generate one sample”. Explain in detail what StatKey is doing when it generates one sample. HINT: StatKey is doing the same thing you just did!

**Exercise 6:** Generate a randomization distribution by clicking “Generate 1000 samples,” (you can click this several times, if you like).

(a) Explain what each dot in the randomization distribution represents.

(b) Explain what the randomization distribution represents, and why you care about this distribution.

(c) Does your actual statistic (the one from the actual experiment, not your simulated statistic) look very extreme? (Formalizing the answer to this question is the topic of Friday’s class!)

(d) Do you think the null hypothesis is a plausible explanation here? (Formalizing the answer to this question is the topic of Monday’s class!)

*Next week’s lab will pick up here and further explore this data, so save your answers to this lab to have handy for next week.*