IB Biology HL: Heart Rate Internal Assessment
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**Design**

**Question** - Which yoga pose, if any, lowers heart rate the most after strenuous exercise?

**Hypothesis** - If the experiment is carried out correctly, then the child’s pose should lower heart rate the most.

**Background Info** - Yoga originated in India to increase spiritual and mental tranquility, but is now used around the world as a method to help with relaxation and flexibility. It is also known to have beneficial effects on the heart because it involves deep breathing, controlled movements, and exercise (if done at a fast pace). It lowers blood pressure, increases lung capacity, improves respiratory function, and boosts circulation. Not only that, but it aids in creating a stable heart rate and is good for toning muscles. The calming effects of yoga are also beneficial for those recovering from a heart attack, cardiac arrest, or other heart problems. Long-term, sustained yoga is especially beneficial for the health of the body. It is a lifestyle choice. (“Yoga and Heart Health, 2013)

One of the most important parts of yoga is breathing deeply and controlling movements. The easiest pose that is often used to relax after a particularly difficult yoga set is the child’s pose, since it allows for deep breathing and stretching of limbs. (McCall, 2014)

**Variables**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Units</th>
<th>Uncertainties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent Variable</td>
<td>Poses (standing, child’s pose, downward facing dog, warrior pose, cobra)</td>
<td>N/A</td>
</tr>
<tr>
<td>Dependent Variable</td>
<td>Time it takes to return to resting heart rate</td>
<td>seconds</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Controlled Variables</th>
<th>Units</th>
<th>Possible effect(s) on results</th>
<th>Method for Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature of room</td>
<td>°C</td>
<td>an increased temperature would</td>
<td>room temperature (21° C)</td>
</tr>
<tr>
<td>Time to do jumping jacks</td>
<td>seconds</td>
<td>More or less time allotted for jumping jacks would increase a person’s heart rate even more, taking more time to bring it down to resting.</td>
<td>30 seconds of jumping jacks</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Type of floor used</td>
<td>N/A</td>
<td>Some floors are difficult to do yoga on because they are hard. This is uncomfortable and can result in improper form of poses and may affect the efficiency of the pose in reducing heart rate</td>
<td>All subjects did poses on carpeted floor</td>
</tr>
</tbody>
</table>

**Protocol Diagram**

- **resting heart rate** → **jumping jacks 30 secs** → **control** → **time how long it takes to reach resting heart rate**
- **jumping jacks 30 secs** → **Child’s Pose** → **time how long it takes to reach resting heart rate**
- **jumping jacks 30 secs** → **Downward Facing Dog** → **time how long it takes to reach resting heart rate**
Photograph of Lab Setup
**Materials** - 2 timers, photographs of poses, pencil, paper

**Procedure**
- First, a subject was found and asked to sign the consent form.
- Subject was then asked to find his/her resting heart rate in 15 seconds.
- Subject then proceeded to do jumping jacks for 30 seconds.
- Subject then stood still in one area, and the subject’s heart rate was taken until it returned to resting.
- The first timer was used to time 15 second intervals used to calculate heart rate.
- The second timer was used to record the overall time it took for the heart rate to return to resting.
- Subject then did jumping jacks for 30 more seconds.
- Subject went immediately into the first yoga pose.
- Subject’s heart rate was taken and the time it took to return to resting was recorded.
- The procedure was repeated for the remaining yoga poses.
- 10 subjects were used in the experiment.
- T-tests, standard deviations, and means were used to evaluate the results.
Data Collection

Table 1: Raw Data Table on Effects of Yoga Poses’ Ability to Bring Down Heart Rate

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Resting Heart Rate (beats per 15 seconds) (+/- 1 beat per 15 seconds)*</th>
<th>Control (standing still in one place) (seconds) (+/- 0.01 s)**</th>
<th>Child’s Pose (seconds) (+/- 0.01 s)**</th>
<th>Downward Facing Dog (seconds) (+/- 0.01 s)**</th>
<th>Warrior Pose (seconds) (+/- 0.01 s)**</th>
<th>Cobra (seconds) (+/- 0.01 s)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17 20.00 15.12 17.64 20.53 12.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>17 140.40 89.62 141.72 176.69 200.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>15 53.96 39.69 51.66 42.84 52.41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>15 151.19 118.86 80.69 129.25 75.62</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>16 85.40 97.70 48.24 80.31 50.26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>20 88.81 83.36 65.31 81.52 84.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>26 68.13 47.68 89.76 117.64 114.36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>18 190.42 88.45 79.37 71.55 95.34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>23 78.02 60.32 125.39 59.62 98.42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>19 80.82 55.67 120.80 50.66 55.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Uncertainty is due to impreciseness of counting. Heartbeats per 15 seconds were counted manually, so it is fairly probable that a heart beat was missed, or counted twice when recording data.

** Uncertainty is due to the impreciseness of the timer. The timer measured accurately to a hundredth of a second.

Qualitative Data includes how the subjects felt while doing their poses. Subjects complained of inability to breathe properly while doing the Child’s Pose and Downward Facing Dog. Subjects also said they had a difficult time keeping their hands steady, straight, and up during the Warrior Pose.
Data Processing and Presentation

Overview

The means of the data were presented in the form of a bar graph with variability bars shown with standard deviations. This gave the general trend of the data while still showing the viewer how much the rest of the data points varied from the mean. T-tests were conducted to see if the data was statistically different from the control, and if the null hypothesis should be rejected or accepted for specific trials.

Sample Calculations

Mean

\[
\text{sum of data / \# of data} = \frac{20.00 + 140.40 + 53.96 + 151.19 + 85.40 + 88.81 + 68.13 + 190.42 + 78.02 + 80.82}{10} = 95.72
\]

Standard Deviation

\[
s_x = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1}}
\]

- \(n\) is the number of data points
- \(\bar{x}\) is the mean of the \(x_i\)
- \(x_i\) is each of the values of the data

\[
= \sqrt{(20.00-95.72)^2 + (140.40-95.72)^2 + (53.96-95.72)^2 + (151.19-95.72)^2 + (85.40-95.72)^2 + (88.81-95.72)^2 + (68.13-95.72)^2 + (190.42-95.72)^2 + (78.02-95.72)^2 + (80.82-95.72)^2 / (10-1)}
\]

\[
= \sqrt{(5733.52 + 1996.30 + 1743.90 + 3076.92 + 106.50 + 47.75 + 761.21 + 8968.09 + 313.29 + 222.01) / 9}
\]

\[
= \sqrt{2552.17}
\]

\[
= 50.52
\]
Table 2: Mean and Standard Deviation of the Ability of Yoga Poses to Bring Down Heart Rate

<table>
<thead>
<tr>
<th>Pose</th>
<th>Control</th>
<th>Child’s Pose</th>
<th>Downward Facing Dog</th>
<th>Warrior Pose</th>
<th>Cobra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average time to reach resting heart rate (s) (+/- 0.01 s)*</td>
<td>95.72</td>
<td>69.65</td>
<td>82.06</td>
<td>83.06</td>
<td>84.08</td>
</tr>
<tr>
<td>Standard Deviation (+/- 0.01)**</td>
<td>50.52</td>
<td>31.24</td>
<td>38.74</td>
<td>46.39</td>
<td>50.55</td>
</tr>
</tbody>
</table>

*Uncertainty is due to the imprecision of the timer. The timer measured accurately to a hundredth of a second.

**Uncertainty is due to the imprecision of the timer. The timer measured accurately to a hundredth of a second.

Null Hypothesis: Yoga poses will have no difference in lowering heart rate to resting when compared to the control.

Table 3: T-Tests of Yoga Poses’ Times Compared with Control

<table>
<thead>
<tr>
<th>Pose</th>
<th>T-Test Value</th>
<th>Statistically Different or Not</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child’s Pose</td>
<td>0.0100255</td>
<td>statistically different</td>
</tr>
<tr>
<td>Downward Facing Dog</td>
<td>0.2009597</td>
<td>statistically similar</td>
</tr>
<tr>
<td>Warrior Pose</td>
<td>0.1985400</td>
<td>statistically similar</td>
</tr>
<tr>
<td>Cobra</td>
<td>0.2355454</td>
<td>statistically similar</td>
</tr>
</tbody>
</table>
Conclusion and Evaluation

The hypothesis was supported because the child’s pose allowed the subjects to reach their resting heart rate the fastest. However it was not supported to the degree where the hypothesis can be considered as reliable. The standard deviations were extremely high for all independent variables, indicating that there was a lot of deviation from the mean that cannot be ignored. However, high variability was to be expected since every person takes a different amount of time to reach resting heart rate. A lot of the high standard deviations had to do with the fact that some people are more physically fit than others, and therefore it takes some less time to reach their resting heart rate, with or without the help of yoga.

The means of the data show that the child’s pose allowed the subjects to reach their resting heart rate at a faster time. The averages also show that all yoga poses are more effective than just standing still and doing nothing, but some poses are more effective than others. This corresponds with existing data that states that yoga poses lower heart rate faster. (“Yoga and Heart Health, 2013). The t-tests conducted also convey that the child’s pose was the only one that was statistically different from the control, meaning that the null hypothesis could be rejected.
for that variable. However for all other variables, the poses were statistically similar to the control, meaning there was little difference in the time it took to reach resting heart rate doing nothing, and doing the other 3 yoga poses. One aspect of yoga that may have had a role in lowering heart rate in the subjects was deep breathing. Controlled, deep breathing is a vital part of yoga, and may be one of the contributing factors to the results of the data.

Because the subjects all had different physical abilities, and therefore different times it took their heart beats to reach resting, the standard deviation was high within the data. This affected the results by skewing the mean and rendering the data unreliable. This high standard deviation was due mainly to poor design. Next time, instead of pulling out 10 random people for testing, I should pick out 10 people who take a similar amount of time to reach their resting heart rate while standing around doing nothing. Or another way to add a little more order to the procedure is by picking 10 people who either all participate in sports, or who all do not participate in any sports. This will bring together people of similar physique, and will hopefully lower the variability associated with the design.

Another way to fix the design is to have a separate person take the heart rate for the subjects while they are doing the poses. It was difficult for the subject to simultaneously keep the yoga pose and measure heart rate accurately by placing their fingers on their necks, so an assigned person to do that for them would allow the subject to focus only on keeping the yoga pose.

To develop this experiment for further study and expand upon the results, it would be interesting to see if the yoga pose itself lowers heart rate, or the continuous practice of yoga over a period of months lowers the resting heart rate. To measure this, the heart rate of group of yoga students who practice on a regular basis would be compared against the heart rate of those who do not engage in physical exercise. Or, the resting heart rate of a regular group of individuals would be measured over the course of a couple of months as they begin to practice yoga on a regular basis. This way, the effect of yoga as a lifestyle would be measured.
Sources
