The effects of cold water fish consumption (salmon) on heart rate and cardiac output

Steven Soelberg

Biology 493

Advisor: Dr. Randy Day
Abstract

The purpose of this study was to investigate the effects of cooked cold water fish consumption on heart rate and cardiac output in college aged males. Heart rate and cardiac output were monitored over a ten week period during which farm raised salmon was consumed two times per week. The test subjects were not normally fish consumers. The paired t-test on heart rate was not significant before and after fish consumption (P=0.6). The paired t-test on cardiac output and stroke volume indicated no significant difference before and after fish consumption (P=0.06, P=0.07). The regression analysis of cardiac output and stroke volume showed a trend of significant increase in cardiac output and stroke volume over the ten week study (P=0.04, P=0.01) (R²=42%, R²=56.3%). This trend suggests that a greater time period of fish consumption may be needed along with a larger test group, to produce significant heart rate effects.
INTRODUCTION

Over twenty years ago, Dyerberg et al. (1978) released a study on the diet of Greenlandic Inuits. Their findings showed a correlation between the low incidence of heart disease (HD) and the consumption of high levels of omega-3 Polyunsaturated Fatty acids (PUFAs). Omega-3 Polyunsaturated Fatty acids are found abundantly in cold water fish such as halibut, salmon, and cod and have been shown to have protective effects against sudden cardiac death (SCD) (Christensen et al. 2001, Villa et al. 2002). An epidemiological study performed by Haper & Jacobson (2003) suggested a significant prevention of HD due to omega-3 PUFAs. Leaf et al. (1999) studied the possible stabilization effects of omega-3 PUFAs on cardiac myocytes in dogs. They found that when dogs with a susceptibility to ventricular fibrillation were given fish oil, ventricular fibrillation was prevented. Pietinen et al. (1997) found a similar association between the intake of omega-3 fatty acids from fish and a reduced risk of coronary death in a cohort of Finnish males.

In a more recent study, 20,551 US male physicians ages 40-84 were queried for 11 years regarding their consumption of fish (Albert et al. 1998). The results of the study showed that those who consumed at least one fish meal per week had a reduced risk of SCD. A similar, more expansive, study involving 84,000 female nurses ages 34-59 showed the heart protective effects of fish consumption (Hu et al. 2002). Hu et al’s (2002) study was accomplished by means of a longitudinal survey over a period of 16 years. Those who
consumed fish often (>1/week) had a lower incidence of HD than those who consumed less often (<1 per/week).

In a study conducted in France and Ireland, 9,758 men ages 50-59 were divided into four groups. Group one consisted of those who ate fish less than once a week, group two included those who ate fish once a week, group three comprised those who ate fish twice a week, and group four was those who ate fish more than twice a week. The study found that those in groups two, three, four recorded a decrease in heart rate. The study concluded that fish consumption is associated with decreased heart rate in middle aged men (Dallongeville et al. 2003).

The purpose of this study was to determine if college age males could reduce their resting heart rate by increasing their consumption of fish. Unlike the study of Dallongeville et al., (2003) which was based on survey results this study attempted to manipulate the heart rate of individuals by increasing their consumption of fish high in omega-3 PUFAs. Additionally, the effect of fish consumption on cardiac output was also investigated.

METHODS

The test subject for this study consisted of eight males ages 21-25 years. The participants were non-smokers who did not consume caffeinated beverages during the study. The participants had baseline heart rate, and cardiac outputs recorded prior to the start of the study. The heart rate and cardiac output for each subject was calculated as a ten minute average with readings taken every fifteen seconds using a Sorba cardiac monitor. Each
participant consumed two fish meals a week for ten weeks. The fish meals were of one 6-8oz farm raised salmon fillet. Once each week at approximately 1400 hours the participants were monitored for resting heart rate and cardiac output. The data were analyzed by using paired t-tests and regression.

RESULTS

The initial mean resting heart rate for the test subjects was 58.9 (± 8.8SD) beats per minute. The mean resting heart rate of the test subjects at the end of the ten week study was 57.3 (± 5.9SD) beats per minute. There was not a statistically significant (P=0.6) decrease in the resting heart rates of the test subjects as a result of fish consumption (figure 1, table.1). The regression analysis of the heart rate data over the ten week test period for the test subjects was not significant (P=0.4, R²=8%).

![Figure 1. The mean heart rates of each test subject over the ten week test period.](image-url)
The mean cardiac output of the test subjects at the beginning of the study was 5.6 Liters (± 1.0SD) per minute. The mean cardiac output of the subjects at the end of the study was 6.2 (± 1.0SD) Liters per minute (table 1). There was not a statistically significant (P=0.06) difference in the mean cardiac outputs as a result of fish consumption in the subjects tested (figure 2). There was however a trend for increasing cardiac output over the course of the study. The regression analysis showed a significant increase in cardiac output over the ten week period (P=0.04, R²=42.0%) (figure 3).

![Figure 2](image-url)  
Figure 2. The mean cardiac outputs of each test subject over the course of the ten week study.
Figure 3. The regression of mean cardiac output vs. weeks of fish consumption (P=0.04, R^2=42.0%)

Table 1. The mean heat rates and mean cardiac outputs for the eight test subjects over the course of the ten week study.

<table>
<thead>
<tr>
<th></th>
<th>Heart Rate (bpm)</th>
<th>Cardiac Output (Lpm)</th>
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<tbody>
<tr>
<td>Week1</td>
<td>58.9 (±8.8 SD)</td>
<td>5.5 (± 1.0 SD)</td>
</tr>
<tr>
<td>Week2</td>
<td>57.0 (± 8.5 SD)</td>
<td>5.8 (± 1.1 SD)</td>
</tr>
<tr>
<td>Week3</td>
<td>61.5 (± 7.3 SD)</td>
<td>5.6 (± 1.4 SD)</td>
</tr>
<tr>
<td>Week4</td>
<td>59.0 (± 5.3 SD)</td>
<td>5.3 (± 1.0 SD)</td>
</tr>
<tr>
<td>Week5</td>
<td>59.9 (± 5.1 SD)</td>
<td>6.3 (± 1.2 SD)</td>
</tr>
<tr>
<td>Week6</td>
<td>56.7 (± 6.0 SD)</td>
<td>5.8 (± 1.1 SD)</td>
</tr>
<tr>
<td>Week7</td>
<td>58.7 (± 6.8 SD)</td>
<td>5.7 (± 1.3 SD)</td>
</tr>
<tr>
<td>Week8</td>
<td>59.0 (± 5.5 SD)</td>
<td>5.9 (± 0.8 SD)</td>
</tr>
<tr>
<td>Week9</td>
<td>57.2 (± 4.4 SD)</td>
<td>6.4 (± 1.3 SD)</td>
</tr>
<tr>
<td>Week10</td>
<td>57.3 (± 5.9 SD)</td>
<td>6.2 (± 1.0 SD)</td>
</tr>
</tbody>
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The mean initial stroke volume was 87.8ml (± 37.7SD) and increased to 110.2ml (± 24SD) at the conclusion of the study (figure 4). The paired t-test for stroke volume was not statistically significant, (P=0.07) however the regression analysis displayed a significant increase in the stroke volumes over the course of the study (P=0.01, R$^2=56.3\%$) (figure 5).

Figure 4. The initial and final mean stroke volume of the individuals in the study.

Figure 5. The regression of mean stroke volume of the test subjects vs. the weeks of fish consumption.
DISCUSSION

The data collected from this study differed from the findings of Dallongeville et al. (2003), who showed a decrease in the heart rate of middle aged males who consumed fish. This study focused on the resting heart rate of college aged males and concluded that over a ten week period there was not a statistically significant difference in the heart rate of college aged males due to fish consumption. The difference in these studies may be partially due to the age difference between the two test groups as well as differences in design. The study by Dallongeville et al. (2003) extended over a period of two years and was designed to show a correlation between fish consumption and heart rate. The Dallongeville et al. (2003) study did not attempt to experimentally alter heart rate by increased fish consumption. The sample size of this study was considerably smaller than that of Dallongeville, who studied 9,758 individuals but was experimental not correlative.

In this study aberrancies were noted among the individuals which had an adverse affect on the analysis of the data. For example test subject #2 had an abnormally low initial heart rate when compared to his heart rate for the rest of the nine weeks (figure 1). Test subject #7 reported high levels of stress during week three of the study and his heart rate was elevated above baseline at week three. Statistical power could be increased with a larger sample size. The results of a larger sample size might lead to different conclusions about the effect of fish consumption on heart rate dynamics.
The paired t-test for cardiac output was not significant, however there was significance in the regression of the mean cardiac output over the ten week study (figure 3). The trend for the increase in the mean cardiac output appears to be due to the increase in stroke volume. As cardiac output is a function of both heart rate and stroke volume. The regression analysis of stroke volume proved to be significant as well, providing further assurance that this is indeed the cause for the increasing cardiac output.

An increase in stroke volume would benefit those with congestive heart failure as an increase in ejection fraction is associated with a decrease in mortality for patients with heart failure (Curtis et al. 2003). Cardiac output and increase in stroke volume do merit further study regarding the possible inotropic effects of a fish diet on cardiac muscle allowing greater ventricular filling and greater cardiac output.

In conclusion this study showed a trend toward an increase in cardiac output and stroke volume though the data are not significant at the P<0.05 level for heart rate. There was no significant effect on the resting heart rate due to an increase in fish consumption in this study. Further research is warranted with a larger sample size.
WORKS CITED


