Effects of Heat Retention on Gross Metabolism and Perceived Effort During Exercise

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ABSTRACT

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As an athlete and personal trainer, I have frequently encountered individuals who believe that utilizing mechanisms that increase heat retention can improve workouts. However, when heat is not properly released from the body, other mechanisms of body temperature regulation must compensate. The human body has many ways to regulate temperature. Sometimes the temperature state of the body has an impact on which type of energy source is preferentially metabolized. In the present study, we examined the effects of heat retention on human gross metabolism during moderate to intense exercise. Each subject underwent three trials on a cycle ergometer. The first trial was an Astrand protocol, used to find the work load needed to push each subject to 70% maximum heart rate. During the next two trials, subjects pedaled at 60-70 rpm to reach target heart rate for 25 minutes. During one of these two trials, the subject wore a sweatshirt in order to increase heat retention. In the other trial, the subject did not wear the sweatshirt, decreasing heat retention. Gross metabolism was quantified by measuring the subjects' O_2 consumption and CO_2 production. We predict that while wearing the sweatshirt, increasing heat retention, the subjects will have a higher degree of perceived effort. Preliminary data indicates that heat retention shifts energy source utilization from lipid to carbohydrate oxidation at an increased rate. By spending less time burning fat, subjects are predicted to burn fewer calories since fat contains more calories per gram than does carbohydrates.

INTRODUCTION

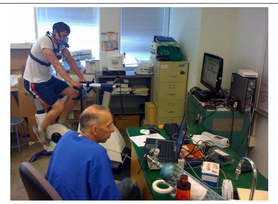
Individuals, both athletes and non-athletes, are always looking for ways to boost the exercise efficiency of their workouts. A common practice for attempting to do this is to increase individual heat retention. This can be done by wearing additional layers of clothes during a workout or by increasing the room temperature. Individuals engaging in such practices believe that this increased heat retention leads to increased weight loss, increased metabolism, and/or increased cardiovascular fitness. Individuals reach this conclusion because they often experience an increase in perceived effort when working out under these altered conditions. An increase in perceived effort is commonly associated with a more efficient workout.

METHODS

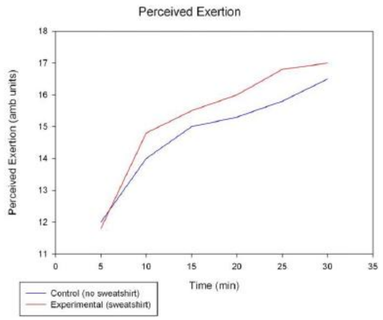
Before entering into the experiment, subjects were required to pass a physical evaluation conducted by a licensed physician and sign a consent form. Subjects underwent three experimental trials apiece. Exercise is conducted on a bike during all trials. During the first trial, subjects become acquainted with the bike and complete a basic Astrand test. This test predicts VO_2 max and the load (wattage) necessary to push each subject to 70% of their maximum heart rate. The length of this trial varies with the fitness level of the subject.

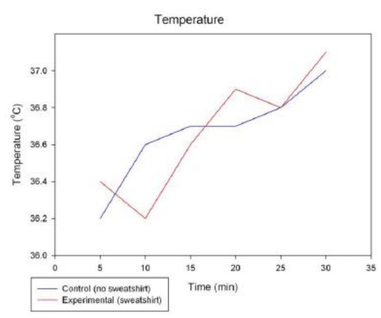
The second and third trials are each 35 minutes in length. Subjects warm up for 5 minutes, pedal 60-70 rpm at their 70% load for 25 minutes, and then cool down for 5 minutes. Subjects are randomly assigned to wear a sweatshirt during one of these last two trials. At this point, the subject is hooked up to a mask that measures O_2 consumption and CO_2 production, both of which are used to calculate metabolic rates and source of fuels. Also being monitored are heart rate, ventilation rate, and ventilation volume. During these last two trials, temperature and perceived effort are taken at 5-minute intervals between the 5-30 minute mark. This is the time the subject is working at 70% load.

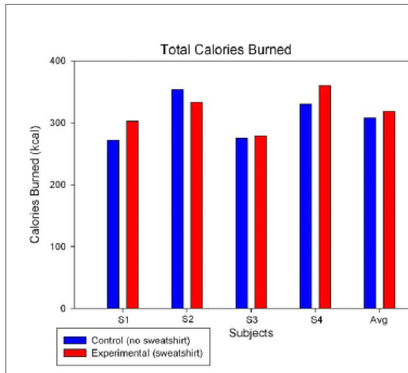
In all three trials, measurements of subjects' weight*, body fat percentage*, hydration level*, blood pressure, and heart rate are taken both before and after the trial (*these data were obtained using a scale with an electrode). At the end of each trial, subjects consume 20 oz of Gatorade in order to rehydrate and replenish electrolytes.

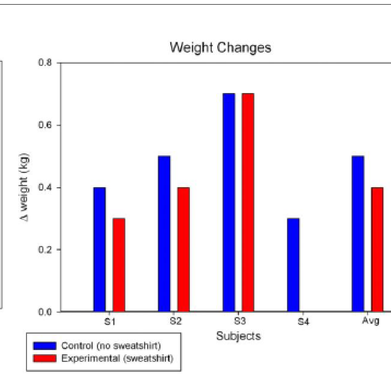


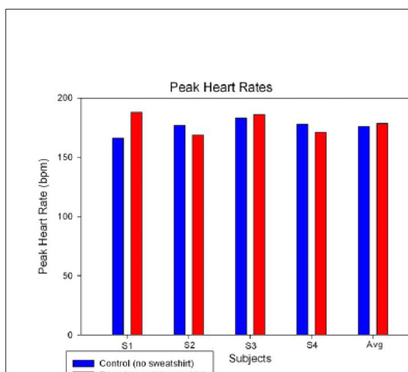
RESULTS

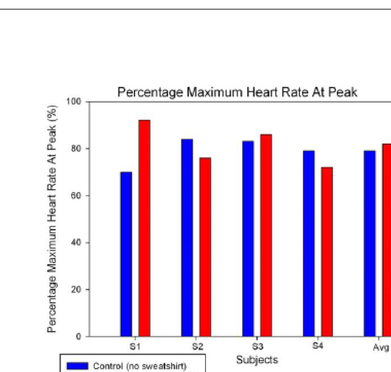












DISCUSSION

We hypothesized that individuals who utilize heat retention practices do not actually achieve a "better" workout (i.e. increased intensity, weight loss….) and that the prevalence of this idea was due to an increased Rating of Perceived Effort (RPE), as opposed to an actual increase in intensity. Thus, we anticipated that there would be a significant difference in RPE, but not many other variables that reflect exercise performance. The data acquired indicates that the RPE of the experimental trials are consistently higher than those of the control, but statistical analysis indicates that these differences are not large enough to be of significance. Thus, our findings do not appear to support the original hypothesis.

One possible explanation for this is that the subjects decreased their intensity of exercise; the RPE remained the same but the "work" being done decreased. This possibility is unlikely, given the fact that the subjects were able to maintain their revolutions per minute between 60 and 70, and the resistance placed on the pedals was the same for each trial. Additionally, other variables (heart rate, calories burned, body temperature, weight loss) indicate that exertion between control and experimental conditions remained similar.

Having stated that the intensity of workout between the conditions has been controlled, one might question whether or not the heat retention itself had any effect. Internal body temperatures seem to be consistent both with and without the increased heat retention. This suggests that either the sweatshirt did not adequately increase heat retention, or that when heat retention increased, the body compensated in some way in order to maintain temperature homeostasis. This compensation could take the form of increased sweating, which should result in more water, and thus weight, loss. As illustrated by the graph, there was no significant difference in the change in weight between the control and experimental trials. In fact, the data trend is less weight (and likely water) loss with increased heat retention. This is in direct opposition to the popular idea that working out under conditions of increased heat retention will lead to a larger amount of weight loss. Our data indicates that there is no such significant difference, in either immediate loss, or in calories burned.

The preliminary data gathered that seemed to support a change from lipid to carbohydrate metabolism at an earlier time frame did not show any significant difference when additional data was included and analyzed using a simple T-test ($p < 0.05$).

Having analyzed our data and finding no significant difference in any of our variables, we are unable to negate any of our hypotheses. The trends seen are not significant, but the number of subjects that have completed the study is small. Perhaps with additional numbers, significance will be established. Alternatively, it may be possible to achieve significance by altering the protocol to include more intense exercise. One of our test subjects seemed to be an outlier in comparison with the other subjects' data. This particular subject was pushed to 92% maximum heart rate during his experimental trial and also varied to a greater extent on other measured variables such as temperature, perceived exertion, and total calories burned. It should be noted that this subject was unintentionally pushed to a higher level, and this subject also demonstrated the greatest deviation between control and experimental trials. It might be suggested then that significant differences could be seen if subjects are pushed to a higher percentage of their maximum heart rate.

SUMMARY

✓ In opposition to our hypothesis, data indicates that there is no significant difference in RPE under conditions of increased heat retention.

✓ In support of our hypothesis, data indicates that there is no significant difference in temperature, total calories burned, or peak heart rate under conditions of increased heat retention.

✓ Larger deviations between control and experimental trials were observed when subjects were pushed to a greater percentage of their maximum heart rate during exercise. This may be of significance for future research.

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