THE PHYSIOLOGICIAL DIFFERENCES OF OUTDOOR TRAIL RUNNING VERSUS INDOOR TREADMILL RUNNING

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ABSTRACT

Abstract. Abramczak, J.R., Hayes, L.M., Johnson, C.A. The Physiological Differences of Outdoor Trail Running versus Indoor Treadmill Running. *J. Undergrad. Kin. Res.* 2005;1(1):23-29. The different effects of outdoor trail running compared with indoor treadmill running are currently unclear. To study this issue we studied the physiological responses of outdoor trail running verses indoor treadmill running. Eight male and female division III college cross country runners aging from eighteen to twenty-six years of age participated in our study. The resting heart rates of all the subjects were recorded prior to testing. All subjects were required to wear a heart rate monitor during the outdoor trail run and the indoor treadmill run. The subjects ran one mile outdoors on a trail that marked off at a comfortable running pace. There heart rates and RPE were recorded at the conclusion of there run. On a different day the subjects ran one mile on the indoor treadmill at the same pace as they ran there outdoor trail mile. Again we recorded the subjects heart rate and RPE at the conclusion of there run. The mean heart rate for outdoor trail running (173±19.7) when compared to mean heart rate for indoor treadmill running (164±18.9) did not show a significant difference using paired *t*-test where $p < 0.05$ ($p = 0.07$, $t = 2.1$). There was not a significant difference in RPE when comparing the mean outdoor RPE (6.1±0.4) to the mean indoor RPE (6.5±1.2) using a paired *t*-test where $p < 0.05$ to show significance ($p = 0.4$). This study does not show a significant difference in heart rate or RPE, but there is enough information showing that there is a difference between the heart rates of outdoor trail running compared to indoor treadmill running. However, there was a large enough difference to still benefit athletes and coaches when designing a training program.

KEY WORDS: Trail running, Treadmill running, Heart rate

INTRODUCTION

Many people engage in aerobic activities to improve their overall health status, reduce disease risk, modify body composition, and improve their all around physical fitness [1]. Heart rate is likely the most frequently used method for prescribing aerobic exercise intensity[2]. The ACSM has published guidelines for healthy aerobic activity that a person should follow. These guidelines state that aerobic activity should be done 3-5 days per week at an intensity that can be maintained for 30-45 minutes [3]. Cardiovascular disease has now become the leading cause of death in the United States. Slightly less than 1.5 million people will have a heart attack this year and out of that number one-third of them

will die. Aerobic exercise has been shown to be one of the greatest tools in prevent cardiovascular disease at any age level [4].

Running is a very popular physical activity that many people participate in because of the fact that it is an activity that takes very little skill. It also provides a consistent intensity and energy expenditure that are completely independent to the person's skill level [1]. Today presently, about 22% of adults in the United States are exercising for 30 minutes or more per day [5]. Due to the weather changes experienced in the Northern United States many runners are unable to run outside all year long. Since the first home treadmill was produced in 1968, treadmill running has is often thought of as a solution when the weather conditions are not favorable for running outside [6,7]. Trail running though is thought to increase physiological demands on the body because the uneven surface is consistently requiring our body to regulate neuromuscular function as well as coordination [6]. Little research has been done showing if there are significant differences between outdoor trail running and indoor treadmill running. The purpose of this study was to compare the physiological responses of outdoor trail running versus indoor treadmill running. The data we collect: heart rate and RPE will help us determine the physiological changes in our subjects in the two different environments. This information will help our subjects with there training protocols. Our hypothesis for this study is that our subjects will have a greater heart rate and RPE with outdoor trail running compared to indoor treadmill running.

METHODS

Subjects

Subjects	Age (yrs)	Resting Heart Rate (bpm)	Running Experience (yrs)
All	20.6 ± 2.6	57.8 ± 7.7	5.88 ± 3.4
Female	18.8 ± 1.0	62.8 ± 3.8	3.25 ± 2.6
Male	22.5 ± 2.4	52.8 ± 7.6	8.5 ± 1.3

Table 1. Mean ± SD.

Eight healthy Division III male and female cross country athletes ranging from ages 18 to 26 were used as subjects in our study. All subjects were from the University Wisconsin-Eau Claire. The study was approved by the University Human Subjects Institutional Review Board and all subjects had signed a written informed consent form. None of the subjects reported any heart abnormalities or orthopedic injuries that would limit their participation in our study. All subjects participate in aerobic activity ranging from six to seven days per week. There were no restrictions placed on the athlete's diet and hydration. All subjects had not previously run on the days that we conducted both the outdoor trail running and indoor treadmill running tests.

Instrumentation

The instruments used in this study were heart rate monitors, treadmills, and RPE charts. The make of the heart rate monitors is Polar and the model is E600. Participants were asked to fill out a questionnaire regarding age, resting heart rate, years of competitive

running experience, and gender. All of the subjects ran on a Woodway DESMO-S treadmill in the athletic training room.

Rate of perceived exertion (RPE) is a scale from zero to ten. It was explained to subjects that one is comparable to the feeling of rest and ten being comparable to the end of a race or not being able to run any more (very fatigued). For our statistical analysis we used the computer program SPSS 12.0.

Data Collection Procedures

Outdoor Trail

The subjects were instructed to run one mile on an outdoor trail while wearing the heart rate monitors. Resting heart rates and RPEs before the mile run were recorded as well as their final heart rates and RPEs when they finished. The subject's time was also recorded at the conclusion of the trail run. The female subjects ran the mile first at Bollinger field and the male subjects run the on Putnam trail. Both of these tests were conducted on the same day.

Indoor Treadmill

The subjects then ran one mile on the indoor treadmill an average of four days after their initial outdoor run. Again resting heart rates and RPEs were taken before the mile run and were recorded. At the conclusion of the one mile indoor treadmill run the subject's heart rate and RPE were recorded. The subjects speed on the indoor treadmill was determined by an equation:

$$\frac{5280 \text{ ft.}}{\text{Trail Time (sec.)}} \times \frac{1 \text{ Mile}}{5280 \text{ ft.}} \times \frac{60 \text{ sec}}{1 \text{ minute}} \times \frac{60 \text{ min}}{1 \text{ hour}} = \text{MPH}$$

We used this as the participants baseline speed for the treadmill so that they ran the same speed for the outdoor trail running test as on the indoor treadmill running test.

Statistical Analysis

We calculated the differences of heart rates between outdoor trail running and indoor treadmill running. Paired *t*-tests were calculated to determine the difference between heart rate during outdoor trail running versus indoor treadmill running. We set the level of significance at $p < 0.05$. The dependent variables will be heart rates and RPEs and the independent variables will be the outdoor trail running versus the indoor treadmill running.

RESULTS

Surface	Mean Heart Rate (BPM)	Mean RPE
Trail	173 ± 19.7	6.1 ± 0.4
Treadmill	164 ± 18.9	6.5 ± 1.2

Table 2

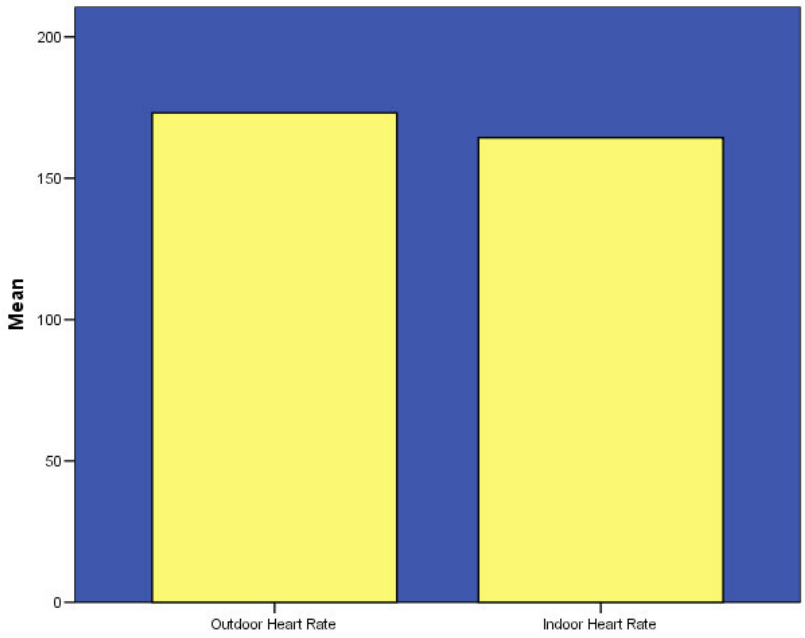

Figure 1

The mean heart rate for outdoor trail running (173 ± 19.7) when compared to mean heart rate for indoor treadmill running (164 ± 18.9) did not show a significant difference using a paired *t*-test with $p < 0.05$ ($p = 0.073$, $t = 2.107$). The range for indoor heart rate was between 134-180 beats per minute compared to outdoor range of 131-199 beats per minute. Table 2 above and Figure 1 to the left compare the mean heart rates at the conclusion of the subject's indoor and outdoor runs.

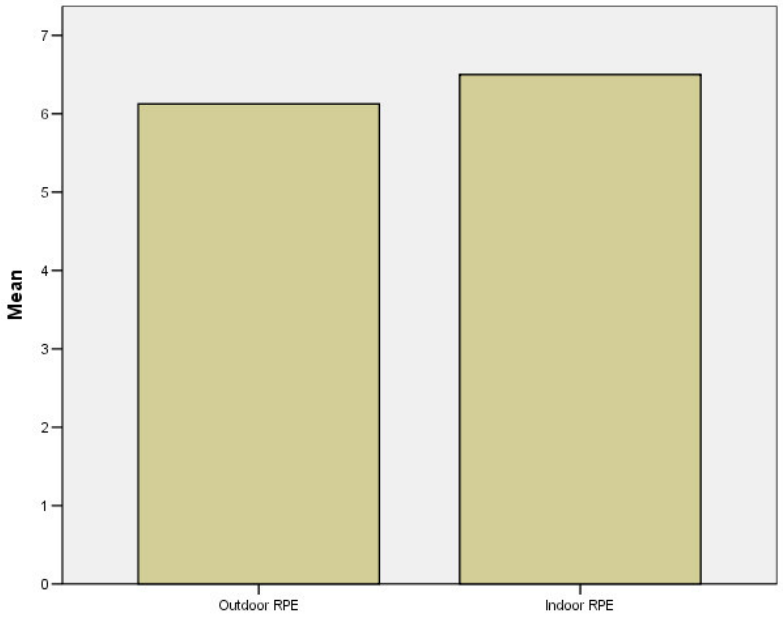

Figure 2

There was not a significant difference in mean RPE between outdoor trail running and indoor treadmill running when comparing outdoor (6.1±0.4) to indoor running (6.5±1.2) in a paired samples test in which *p* had to be <0.05 to show significance ($p = 0.4$, $t = -0.9$). The range for outdoor RPE was between six and seven while indoor range was from five to eight on a scale from zero to ten. Table 2 above and Figure 2 to the left show the comparison of the mean values of RPE.

DISCUSSION

Our study compared heart rate and RPE in trail and treadmill running in collegiate runners. There was no significant difference between trail and treadmill running for both heart rate and RPE.

Trail HR and RPE

The trail HR was found to be higher in all but one of our subjects. This agrees with our hypothesis which stated that since trail running places a higher physiological demand on the body the HR would be higher during the trail run. All of our subjects use trail running as their primary form of training. This may explain why the mean trail heart rate (173.13±19.7) was not as high as we had originally expected. RPE was expected to be between six and eight on a scale of one to ten since the runners were instructed to be run at a comfortable pace. This may have left to much room for error since we did not specify a specific speed to run at. With every runner being a unique individual it is hard to compare one runner's RPE to the next. For example, if two runners are running side by side through the entire mile, one runner may think they are running at an RPE of six while the other may think they are running at an eight. This makes it difficult as researchers to clarify to the subjects at what pace they want them to perform at. If we had asked everyone to finish the mile in less than seven minutes we would have had some drastically different data to report, but since we let the runners pick their own pace with only minimal regulation on our part there will always be that speculation that the subjects did not give a consistent effort. A way to avoid this problem in the future is to figure out the speed in which you would like the runners to be running at and then mathematically figure out the time in which they should finish. In other words tell them they have to finish the mile with a time between 7:10 and 7:20.

The weather on the day that we conducted the outdoor portion of our research was cold and windy with rain. The women ran their mile at Bollinger field and had little shelter from the weather. The men, however, ran on Putnam trail which blocked most of the wind and rain. The outdoor HR and RPE data was taken from two different weather conditions and locations which allows for error in our representation of the data and results. If more time would have been allowed we would have liked to have tested the men and women on the same trail in the same weather conditions.

Indoor HR and RPE

All but one of our subjects had a lower heart rate during the indoor treadmill run, though no significant difference was found. RPEs in all of the subjects also found to have no significant difference when compared to the outdoor trail run. The lack of difference in RPE can be explained by the fact that the subjects should have been running at close to the same pace that they ran the outdoor mile at. The problem with this is that during the outdoor trail run there was no way to monitor the speed at which they were running and chances are the subjects did not maintain a consistent speed through out the entire mile. The changing of speeds would effect ones heart rate, for instance if a runner began to slow down towards the end of the run, before the finish, the heart rate that was collected at the end of the run would not be an accurate representation of what their HR would have been if they had given a consistent effort throughout the entire run. If this did occur, it could explain why the difference between indoor and outdoor running was not significant. During the treadmill run the subjected is forced to stay at a constant speed

throughout the entire run giving us a good representation of what their actual heart rate was through out the test. This may explain why the mean treadmill HR (164.38 ± 18.9) was higher then expected since the runners were forced to run at one speed for the entire mile. In future studies runners should be kept at a constant speed during the trail run to allow for more accurate HR to be collected.

Unlike the outdoor trail run weather was not a factor for the indoor portion of our study. All indoor running was performed in the McPhee Center in a climate controlled environment with a temperature at 73 degrees Fahrenheit.

If this study was performed again, it should include more subjects to allow for more accurate data. This study could also be done with non-runners or recreational runners. There are other variables that we could have analyzed such as Maximum Oxygen uptake, lactic acid levels, and energy expenditure.

CONCLUSION

This study compared the physiological responses between outdoor trail running and indoor treadmill running. This study showed that there is no significant difference between the mean heart rate in outdoor trail running compared to indoor treadmill running. There is enough evidence showing that during outdoor trail running the subjects heart rate was higher compared to the subject running on an indoor treadmill at that same pace. Even though our data does not show a significant difference between the two different runs, there is enough evidence that will be useful to runners and coaches when devising a training program. There was not a significant difference in relative perceived exertion when comparing outdoor trail running versus indoor treadmill running. There has been no research previously done to compare our study to other similar studies. This is why we believe our data is useful for runners and coaches.

Along with runners and coaches the findings of this study can benefit athletic trainers. When an athlete gets injured many of them have to be able to get there heart rate up to be able to return to play. Having the athlete run outdoors will get there heart rate up higher, which in turn will give the athlete a greater workout. The information from this study can aid in designing a training program to fit an individuals needs based on there overall fitness level.

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