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**Comparing One-Mile Run Time and Perceived Exertion  
of College-Aged Females in an Outdoor Environment  
versus an Indoor Environment**

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**ABSTRACT**

**PURPOSE:**

This study examined the effects of an indoor environment versus an outdoor environment on a one-mile time performance.

**METHODS:**

Sixteen female runners were requested to run two, one-mile timed trials in an indoor environment and outdoor environment. Before both trials, runners completed a barriers to exercise survey to investigate common, uncommon, and neutral perceived barriers to exercise. After the first timed one-mile run trial, runners were instructed to abstain from any exercise until their second day of data collection. Resting heart rate and blood pressure was recorded before and after each timed mile run. RPE (rate of perceived exertion) was also collected after each trial. To assess the factor of limitations, temperature was recorded of each environment.

**RESULTS:**

A paired samples t-test revealed that participants completed the one mile run faster when they performed the run inside ( $8.2 \pm 3.0$  minutes) compared to outside ( $8.4 \pm 3.0$  minutes). Although the participants ran faster indoors, 47% ( $n=7$ ) of them preferred running in an outdoor environment. The RPE of the participants also increased when they ran outdoors by 1 point (RPE inside:  $13 \pm 2$ ; RPE outside:  $14 \pm 1$ ). The post run heart rate of the

participants was significantly higher (approximately 10bpm) after the outdoor run opposed to the indoor run.

## **CONCLUSION:**

Participants performed faster on a one-mile timed trial in an indoor condition, even though nearly half of them preferred running outdoors. These findings indicate that an indoor environment can result in a faster performance time in young college-aged females.

## **INTRODUCTION**

In a recent study, it was found that 30–35% of college students are overweight or obese and are not leading a physically active lifestyle (Harrington & Ickes, 2016). With an increase in sedentary lifestyles of young Americans, it is important to educate the public on the options they are able to partake in regarding physical activity. People who are sedentary have an increased risk of heart attack; however, physical activity has been shown to offset this risk. Specifically, women who were physically active three hours or more per week (half an hour daily) reduced their risk of heart attack by 50% (Rimmer, 2016). In addition to increased risk of heart attack, people who are not regularly physically active are also more likely to gain excess weight. One study showed that an hour of walking daily cut the risk of obesity by 24% (Rimmer, 2016). Physical activity is important especially for young Americans because they often become less physically active in the transition from high-school to college (Curry, Jenkins, & Weatherford, 2015). Thus, it is prudent that individuals participate in physical activity to ward off the negative health consequences that can come from an inactive lifestyle.

There are numerous options for modalities of physical activity as well as the venue in which it can occur. Performing aerobic physical activity in an indoor and outdoor environment each can provide unique benefits regarding aerobic performance. However, it is debatable as to which environment provides the individual with optimal aerobic performance. Research findings suggest that running outdoors may reduce anxiety and tension (Puett et. al, 2014) as well as increasing cognitive function and creating a more moti-

vating environment compared to indoor physical activity (Roger-son & Barton, 2015). Despite these positive benefits, performing physical activity outdoors can present a variety of concerns such as wind speed, altitude, and other inclement weather conditions. Additionally, it has been found that running outdoors with poor air quality reduces overall aerobic performance (Grabow & Spak, 2012). Indoor running can provide a more controlled environment regarding weather and climate concerns. However, performing physical activity in an indoor environment possesses its own set of negative aspects. Specifically, Hollings, Hopkins & Hume (2012) found when running on an indoor smaller sized track the ability for racers to maintain balance and stride lengths during the bends of the curves was more difficult compared to when running on a standard sized track (2012). Collectively, these findings suggest that there is still much uncertainty about which environment it is best to perform physical activity.

In addition to environmental concerns, an individual's personal motivation and perceived barriers to participate in physical activity is also important to consider when trying promoting a physically active lifestyle. It is logical that individuals would benefit from learning what their barriers to physical activity are as well as what factors are enjoyable to them regarding physical activity in hopes that they will then be more favorable to adopt an active lifestyle. It is important to discover what environmental-related barriers towards physical activity people have in order to determine which setting may be more suitable for them to engage in physical activity. In a recent study that tested students running indoors and outdoors, the researchers found that in addition to helping students feel comfortable and motivated in the testing environment, a choice between the two formats would provide a confidential environment for those who do not want their performances scrutinized by others (Latham, Hill, & Petray, 2013). This finding builds on the need for further research in performance and barriers to exercise in order obtain optimal benefits to both subject matters.

With the alarming rates of sedentarism and lack of adequate physical activity in young-adult populations, it is imperative that measures be taken to promote a physical active lifestyle. Research

has shown that both perceived barriers to physical activity as well as the physical environment in which the activity takes place can play a significant role in the success of a physical activity program. Therefore, the purpose of our study was to assess the perceived barriers of physical activity in college-aged females, and furthermore assess the difference in aerobic performance and perceived efforts of an exercise bout outdoors compared to indoors. Encouraging young adult populations to participate in an active lifestyle will be a factor in preventing diseases associated with sedentary behavior such as cardiovascular disease and other chronic diseases. With increasing obesity rates, this research is significant in the fight against sedentary lifestyles. Based upon the reviewed literature, it is hypothesized that individuals will physically perform better on an outdoor track compared to an indoor track and that they will a lesser degree of perceived exertion associated with the physical activity bout.

## **METHODS**

### ***Overview of the Study***

This research study was conducted on a group of aerobically fit females 19 years or older. The women were separated into two random groups, one group who first ran a one-mile timed trial indoors, and the other group who first ran a one-mile timed trial outdoors. Researchers took preliminary heart rate and blood pressure, had the participants take part in an active warm-up, and then kept time while the participants performed their timed one-mile time trial. Afterwards, the researchers assessed the participants' rate of perceived exertion [RPE], and administered the participants a post-run cognitive survey after their cool down. After the first day, the participants waited 48 hours before participating in their next mile run at the remaining venue (indoor or outdoor). This research was conducted to assess the perceived barriers of exercise and to assess the difference in performance and perceived efforts of a one-mile run outdoors compared to indoors.

### ***Subjects***

Participants targeted for this study were healthy, col-

lege-aged females 19 years old and older that are not currently injured or ill; those excluded were individuals who had been injured in the past 6 months or were currently recovering from an illness or injury.

### ***Procedures and Data Collection***

Interested individuals contacted the investigators of the project via the email address or phone number listed on the advertising materials. Investigators then responded to interested individuals to initiate a health screening process to ensure that it was safe and eligible for the individual to participate in the study. Investigators sent an electronic copy of the *American College of Sports Medicine (ACSM) Health/Fitness Facility Pre-participation Screening Questionnaire* (American College of Sports Medicine & Pescatello, 2014) and requested that individuals complete the form and return it to the investigator. This questionnaire identified any major signs/symptoms/conditions that would contraindicate exercise for an individual and consequently exclude the individual from participation in the research study. After investigators reviewed the questionnaire and ensured that it was safe for the individual to participate, the investigators then contacted the individual to set up an appointment for them to report to the testing facility for their day-one data collection.

The eligible participants were assigned to either participate in an outdoor condition or indoor condition for their day-one data collection. All participants were given a numerical identification code to be utilized on all data collection documents. Odd numbers were guided through the outdoor condition first and all even numbers were guided through the indoor condition first. On day-two of data collection participants underwent the remaining test condition (outdoor or indoor). The exercise bout in both conditions on separate days was the same and consisted of a one-mile time trial to be completed as fast as possible. Participants were asked to arrive to the testing location having done the following: completed a three-hour fast (no food or beverage, with the exception of water), avoided the use of alcohol and nicotine for at least 24 hours, and avoided strenuous exercise for at least 24 hours. Participants were

also asked to be well rested and adequately hydrated prior to their research visit. Participants were asked to wear athletic shoes and loose comfortable clothing to all data collection visits.

Upon arrival to the testing site, participants were given the opportunity to express any questions or concerns regarding their involvement in the study. After all question and concerns were addressed by the investigators, participants were then asked to sign two informed consent documents. One form was given to the investigator and the other consent form was given to the participants for their records. All procedures were approved by the Georgia College Institutional Review Board (IRB).

After completion of the informed consent, participants completed a survey about perceived exercise barriers that they face and had their vital signs (heart rate [HR] and blood pressure [BP]) assessed for a baseline. Prior to starting their test, subjects completed approximately five minutes of walking around the track for a brief warm up. Participants then completed a distance of one mile as quickly as possible. Rate of perceived exertion (RPE) was obtained after the mile was completed, using a standard 6-20 Borg RPE scale. Following the one mile test, subjects completed a cool-down consisting of a slow walk for approximately five minutes around the track and static stretching for approximately five more minutes. Subjects then completed a psychological survey after the run to evaluate the cognitive expressions of each participant's experience, allowing them to give commentary on each location of the exercise and their opinion of how they felt during the test, as well as rating their experience on several prompts. Following the completion of the survey, the individuals had their vital signs reassessed to ensure that HR and BP levels returned to the approximate baseline. If HR or BP was still excessively elevated, the participants were asked to continue cool down procedures by walking at a slow pace until acceptable levels are achieved for both HR and BP. Participants were then dismissed and scheduled for their day-two appointment in which they completed the same protocol outlined above, with the exception of the run environment (indoor versus outdoor).

The indoor run was held on indoor college campus facilities

and the outdoor run was held at a nearby outdoor athletic track facility. In the event of inclement weather (rain or severe weather) on an outdoor data collection day, the participants were rescheduled.

### Statistical Analysis

All dependent variables, including one-mile run time, RPE, BP, and HR, are presented as mean  $\pm$  standard deviation. A dependent t-test was conducted to determine if there was a statistically significant effect of running environments on perceived exertion and one-mile run times. For all analyses, the alpha level was set at  $p < 0.05$ . Data were analyzed using SPSS Version 23.

## RESULTS

This study consisted of 16 female college-age participants ranging from ages 19-22. All were eligible to engage in this study, however only 15 of the participants' results were included in the data analysis due to extrapolating circumstances that prevented one subject from being able to complete the data collection process.

As indicated by **Figure 1**, results from the paired sample t-test showed that the average time of the one-mile inside run ( $8.2 \pm 3$  minutes) was significantly faster than the outside run ( $8.4 \pm 3$  minutes),  $p = 0.019$ . Similarly, **Figure 2** represented the subjects' responses to ratings of perceived exertion (RPE) after the indoor and outdoor run. This also used a paired sample t-test and displayed that subjects perceived significantly higher ratings of efforts during the outside condition (RPE= $14 \pm 1$ ) compared to the indoor condition (RPE= $13 \pm 2$ ),  $p = 0.042$ .

**Table 1** displays results from a dependent t-test for post run questions, indicating a significant difference between the quickness of the run inside (Score  $2.4 \pm 0.5$ ) and the quickness of the run outside ( $2.0 \pm 0.4$ ),  $p = 0.009$ . Furthermore, the subjects indicated a significant difference in how the quantity of laps affected their attentiveness inside ( $0.9 \pm 0.5$ ) versus their attentiveness during their run outside ( $1.3 \pm 0.7$ ),  $p = 0.054$ . Scores were based upon a likert-scale with 0= Strongly Disagree, 1=Disagree, 2=Agree, and 3=Strongly Agree.



**Table 1: Post 1-Mile Run Questionnaire**

Survey Question	Post Inside Run	Post Outside Run
Q1: The run felt like it went by fast	2.4 ± 0.5*	2.0 ± 0.4
Q2: I felt encouraged by my running environment	2.3 ± 0.8	2.0 ± 0.7
Q3: The temperature inhibited my performance	0.8 ± 0.7	1.0 ± 0.8
Q4: I lost interest while running	0.8 ± 0.6	1.0 ± 0.8
Q5: I felt fatigued at any point during the run	1.3 ± 0.8	1.7 ± 0.8
Q6: The surface of the ground affected my run (hardness or softness)	0.8 ± 0.6	1.3 ± 0.8
Q7: Quantity of laps affected my attentiveness towards the run	0.9 ± 0.5*	1.3 ± 0.7
Q8: I felt dehydrated at any point during or after the run	0.9 ± 0.6	1.1 ± 0.7
Q9: The quality of the scenery affected my run	1.3 ± 1.1	1.3 ± 0.7
Q10: Environment did not affect my run in any way	1.6 ± 0.7	1.4 ± 0.6

\*Denotes significantly different responses between inside and outside one-mile run,  $p < 0.05$ .

Results of the post run survey are scored as 0=strongly disagree, 1=disagree, 2=agree and 3=strongly agree.

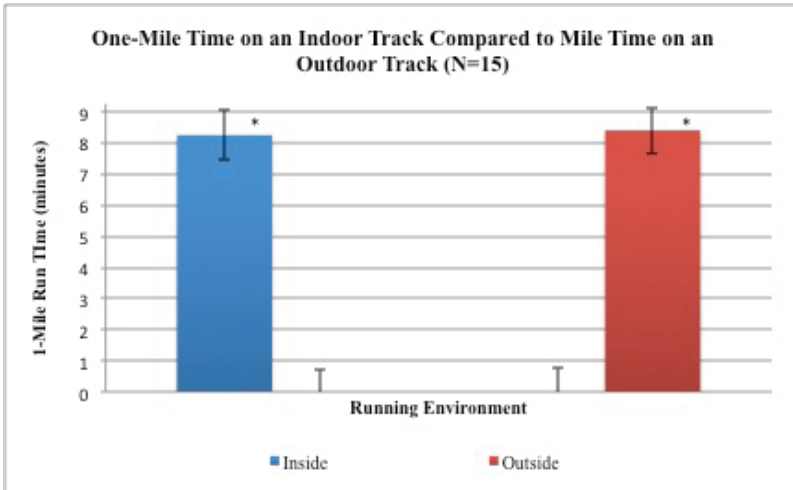


Figure 1: \* Denotes significant difference between one-mile run performances between conditions,  $p < 0.0$

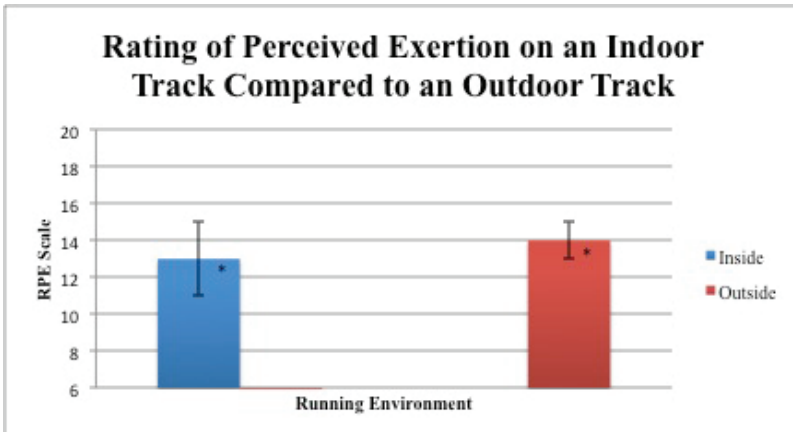


Figure 2: \* Denotes significant difference between one-mile run performances between conditions,  $p < 0.05$

## DISCUSSION

The main objective of this study involved assessing performance differences for two separate data collections of a one-mile timed trial in an indoor environment versus an outdoor environment. Additional objectives included collecting the perceived barriers to exercise from each participant prior to both trials and the assessment of the difference in perceived efforts (RPE) of an exercise bout in an outdoor environment compared to an indoor environment after each trial. The purpose of the study was to find information that supports the belief that running in an outdoor environment would improve performance opposed to running in an indoor environment. The focus of the study was on how quickly each participant finished the mile outside compared to inside while monitoring their heart rate, blood pressure and RPE. RPE is the rating of perceived exertion, which is used as an indicator of how tired an individual felt during physical activity and how hard they exhausted themselves.

The qualitative and quantitative results of the study support the rejection of the research hypothesis that an outdoor environment would elicit significantly better running performances. The most impactful findings were that the one-mile time performance in the inside environment was faster compared to the outdoor one-mile time, and out of the 15 subjects tested, 8 preferred running inside. Results also showed that participants had a higher post-run heart rate outdoors compared to indoors as well as an increased post-run RPE in outdoor conditions by 1.2 points (Mean RPE Inside:  $12.867 \pm 1.9223$ , Mean RPE Outside:  $14.067 \pm 1.1629$ ). It is believed that the outside post-run increase in heart rate and RPE may have been due to temperature; as the average temperature for outside was 75 degrees Fahrenheit whereas the inside average temperature was 71 degrees Fahrenheit. An increase in temperature can create problems for athletes that compete and train under hot conditions. Muscle glycogen depletion and hypoglycemia are thought to be involved in fatigue, which can be exacerbated by higher temperatures (Hargreaves, 1998). Previous research of testing indoor versus outdoor training there is shown to be a higher

self-chosen pace for outdoor training (Dasilva et al., 2011; Teas et al., 2007). However another study refutes this and states that indoor training is associated with higher intensities and decreased time to fatigue (Lacharite-Lemieux, M., and Dionne, I. J., 2016). With this in mind, the indoor times of our study were significantly higher than the outdoor time, which requires the rejection of the original research hypothesis. Similarly, a study comparing indoor environments such as a gym, home or exercise club to outdoor environments revealed an ability to train at a higher intensity would likely take place in indoor environments (Dunton, et al., 2009). In similar a genre, RPE is lower indoors; this could mean that less effort is exerted when performing the same activity inside rather than outside. The conditions of an inside environment display less of a strain on the body which allow one to work at a higher intensity without feeling overexertion

In regards to the perceived barriers test, results showed a direct positive relationship between perceived barrier scores and one-mile time performance ( $r=0.6$ ,  $p=0.02$ ). It was discerned that these scores on the perceived barriers test reveal a rough estimate of the runners' perceived conditioned state; with higher scores (meaning more barriers to exercise) marked as potentially less conditioned and lower scores marked to be more conditioned. Knowing the barriers of exercise can help improve exercise participation because it can provide the population with insight as to why people do not exercise, and help propose new solutions to combat these problems. According to a study involving perceived barriers and university students, the researchers found barriers surveys useful and that they specifically can help individuals "apply creative strategies to overcome them" (Nolan, Sandada, & Surujlal, 2011). With this in mind, coaches, exercise specialists, and university aged students can implement specific tasks and skills to lead to better performance. At the close of the second post run survey, participants were asked to make a brief statement on their opinion of which environment they preferred and why. The statements expressed by the participants who preferred the outdoor track ( $n=7$ ) claimed that the outdoor environment had a familiarity aspect, the "scenery was better," "the running surface was better," they were "the only person on the

track,” and they “had cleaner air to breathe.” The remaining participants (n=8) who preferred running the mile on the indoor track stated that “indoors was better because there was air conditioning and no wind,” “the sun wasn’t beating down like it was outside,” and “the shorter laps made the run go by faster.” This qualitative analysis of the one-mile bouts can be useful to draw conclusions as to why a participant may have performed better indoors or outdoors. The study had a few limitations, one being the location for the outdoor portion of the study was undergoing construction so at times the entrance was prohibited and we had to reschedule a few subjects. This made it difficult to follow the original schedule of the study and sometimes became a burden to find a new time to schedule participants within the constraints of the study. In order to combat this, more in depth planning would be beneficial to be able to plan around the construction and hours of availability of the outdoor track. On several occasions, the outdoor temperature greatly exceeded that of the indoor, which may have had a significant influence on the difference between the time of the outdoor mile and the indoor mile as well as the post-run resting heart rate for each condition.

The most desirable indoor track would equal the same amount of laps and distance of the outdoor track. However this was not the case for this study; the outdoor track included four laps to complete a mile and the indoor track consisted of an eight-lap mile. The scores show that on average, participants felt that the run went by faster inside than it did outside. The results revealed that although there were fewer laps during the outdoor run, participants felt that they were more focused during the indoor run, likely because the laps were much shorter. Knowing these results gives more foundation to refute the hypothesis and will aid future researchers and other health professions when dealing with environmental conditions, performance, and exercise. As mentioned the resulting temperatures differed daily (outdoor=75 deg., indoor=71 deg.) for the outside portion of our study; therefore, it would be beneficial to have the ability to calibrate the temperature of the indoor track to the same temperature outside.

The strengths of the study are shown to contribute to

more understanding for professionals such as coaches, exercise specialists, female college athletes, and normal female college age populations. This is simply due to minimal research surrounding college-aged females and performance in exercise in specific environments. With that being said, there is an abundant need for further research and studies to take place on this subject matter to enhance the wellbeing of the young adult female population. It can provide more knowledge for the population, those surrounding the population, and can further spark an interest in researchers to study other populations under this similar subject matter. Furthermore, it is crucial for all types of athletes and populations- normal and special- to be aware of what environment can enhance performance. Culture is performance-driven, and gaining and continuing research on performance and environment effects will positively allow for more records to be broken, and more victories to be achieved. Specifically, case studies that could be formulated from this research of exercise performance in specific environments including differing populations such as pediatric, geriatric, adolescents, special, Olympic athletes, college male and female athletes, and middle-aged individuals. This will help further evidence on if indoor environments allow for better performance opposed to outdoor environments.

These results can help coaches, athletes, exercise physiologists, and other exercise-related professions determine which running environment is most suitable for special and normal populations. The barriers survey can also aid professionals to get a better insight on the personal perceptions and limitations of their clients and/ or athletes they are training in a specific environment. In return, post-run surveys can be utilized to help plan present and future exercise bouts that can improve performance and wellbeing of the individual. It will essentially give the professional more insight into the client's preference of environment and potentially work as a tool to push the client toward a goal or overcome physical and mental obstacles they may face when performing or engaging in exercise.

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