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# Namaste to Wellbeing? The Effect of Yoga on the Health of African American High School Students

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**Summary**

**This study examined the potential psychological and physiological benefits of yoga for African American high school students who attended a rigorous college preparatory program. We hypothesized that yoga exercises would improve perceived stress levels, lower resting heart rate and blood pressure, and increase blood oxygen saturation. Our sample consisted of twenty-two students who participated in yoga or track (the control), with eleven in each group. The yoga group was a pre-existing afterschool program, while the track control group was matched as closely as possible to the yoga group by gender, age and blood pressure levels. We measured the perceived stress, resting heart rate, blood pressure, and blood oxygen saturation levels prior to the first class and after the last class. We found that the perceived stress levels of yoga participants decreased 13% compared to the control group, which only decreased 1%; however, this was not a statistically significant difference. There were no significant differences between or within the groups' resting heart rate, blood oxygen saturation, and systolic and diastolic blood pressures. Our results suggest that yoga does not have a significant effect on healthy high school students, possibly due to a lack of motivation among participants, although the generalizability of our findings are limited by the small sample size.**

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## Introduction

High school students in college-preparatory schools frequently face significant psychological and physical stress due to the challenging curricula (1). Repeated long-term stress can lead to physical and health problems, such as cardiovascular disease, diabetes, and depression (2). Studying the impact of yoga on stress in high school students is important because some research has shown that yoga only benefits those who are college-aged and older; however, there has been little research on the health benefits of yoga in high school students (3). A study evaluating the mental health benefits of yoga in a secondary school, which was conducted on high school students, failed to find significant improvements in participants' perceived stress levels (3). Our experiment will investigate the benefits of yoga on high school students. In particular, this study investigated an underrepresented ethnic group, African Americans, who are not typical yoga participants (4).

Yoga refers to the union of body, mind, and spirit. It was developed to create a path to quiet the mind for meditation (5). It generally consists of physical postures (asanas), breathing exercises (pranayama), and a final relaxation (shavasana), although the exact combination varies across styles of yoga. This physical activity is a potentially useful alternative therapy for some individuals because it may improve anxiety, stress, heart rate, and blood pressure (2, 5). The purpose of this study is to investigate the potential benefits of yoga in healthy African American high school students enrolled in a high-stress college preparatory program as measured by the participants' perceived stress levels, resting heart rate, systolic and diastolic blood pressures, and blood oxygen saturation.

Many studies have demonstrated improvements in stress levels after yoga participation due to its effect on the nervous system (2, 5). When a person experiences stress, the hypothalamic pituitary adrenal (HPA) axis and sympathetic nervous system (SNS) are activated. These systems are responsible for a discharge of multiple hormones that affect the heart, lungs, circulation, and the immune system, and also assist with organizing the body's response to threats or stressful events, including the further release of additional hormones such as cortisol from the adrenal cortex (6, 7). In response to a stressor, the parasympathetic nervous system (PNS) is responsible for returning the body to a state of rest. The PNS encourages one's heart rate to decrease and returns the body to its state of calm after the resolution of a stressful event or threat (6).

In previous studies, yoga and other forms of exercise were shown to have a positive effect on how the body

responds to stress (2, 5, 8, 9, 10, 11). Yoga acts as a positive influence on the body and reverses the negative impact of stress on the immune system (2); this means that the self-imposed stress from yoga or other physical activities allows the body to adjust more effectively when future stress occurs (5). One meta-analysis on the effects of yoga versus exercise found yoga more effective in improving heart rate, blood glucose, salivary cortisol, pain, and fatigue when compared to aerobic exercise (2).

Previous studies of yoga's effect on perceived stress had mixed results. In a study measuring the stress-relieving differences between hatha yoga and African dance, both yoga and dance improved perceived stress and reduced negative emotional outlook after one session (8). Another study consisting of 14 first-year medical students participating in a 16-week yoga study found that yoga helped with their general perceived health, perceived stress, and personal satisfaction (9). A study on the immediate effects of slow pace bhastrika pranayama (bellows breathing, a component of some yoga practices) found bhastrika breathing improves the function of the PNS. This study's control group had a parasympathetic blocker (drug) which stopped the PNS from working and they experienced no benefits, despite the same breathing exercises (10). Thus, the authors argued that yoga can enhance the PNS and produce a relaxing effect on the body. Furthermore, a study of 51 participants who practiced yoga for 20 sessions over eight weeks found that Bikram yoga improves mindfulness, perceived stress, cardiorespiratory endurance, flexibility, and balance (11). Another study evaluating the mental health benefits of yoga in secondary school students found that yoga had no effect on the participants perceived stress (3); however, the researchers suggested this lack of improvement might be due to attrition.

Research also suggests that practicing yoga improves resting heart rate and blood pressure (12). Heart rate is the number of times a person's heart beats per minute, while blood pressure is the amount of pressure that is observed within the large arteries of the cardiovascular system. Blood pressure is measured by two numbers, systolic and diastolic. Systolic blood pressure, the top number in a reading, measures the pressure in the arteries during the contraction of the heart. Diastolic blood pressure is the bottom number that represents the pressure when the heart is relaxed between beats. Sources have demonstrated yoga's beneficial effects on blood pressure and heart rate (2, 8, 10, 12, 13, 14, 15). A meta-analysis comparing yoga to exercise found that yoga is more beneficial than exercise in improving resting heart rate (2). In addition to activating the PNS, bhastrika pranayama breathing also caused systolic and diastolic blood pressures and heart rate to decrease. However, blood pressure decreases were larger than heart rate improvements (10).

A study compared college-aged normotensive students who participated in yoga for 16 weeks to a control group that watched a lecture (14). This study found that yoga had a significantly greater effect on decreasing systolic blood pressure compared to the control group. In contrast, a study completed in four weeks with healthy participants found that yoga as an overall therapy did not help with heart rate (13). However, this may be because the participants did not participate in traditional forms of yoga, including postures, breathing, and final relaxation and instead practiced yoga with a Nintendo Wii Fit.

In addition to blood pressure improvements, there is some evidence that yoga may lead to improvements in blood oxygen saturation. Oxygen saturation measures the percentage of hemoglobin (a component of red blood cells) in blood carrying oxygen compared to the total hemoglobin. A study measured oxygen and respiration levels in healthy males ages 18 to 48 years participating in either cyclic meditation or shavasana meditation. Cyclic meditation is similar to yoga because it involves yoga postures and deep meditation. Shavasana, also known as corpse pose, is the final pose done in yoga to relax the body and mind so the body can assimilate the benefits of asana practice. Researchers found the practices of cyclic meditation and shavasana meditation reduced oxygen consumption after exercise, which is a sign of relaxation of the nervous system. The blood oxygen saturation levels of participants participating

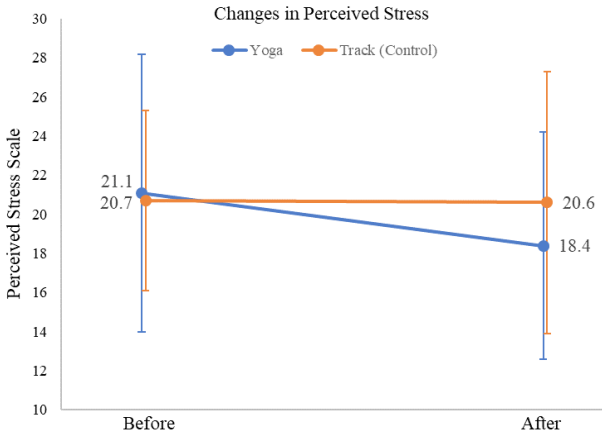


**Figure 1. Changes in Perceived Stress Before and After 11 Sessions of Yoga or Track.** At the beginning of the experiment, the yoga and track participants had similar perceived stress levels. However, at the end of the experiment, yoga participants' levels of stress went down, while the indoor track participants' levels only slightly decreased. The decrease of perceived stress in yoga participants was not statistically significant ($p>0.05$). Error bars denote standard deviations.

in cyclic meditation decreased more than the blood oxygen levels of participants actively doing shavasana meditation (15). This suggests that participants involved in the cyclic meditation had a higher blood oxygen saturation because they consumed less oxygen.

In this study, a yoga class was held four times a week for three weeks. The participants in the yoga class were compared to those in an after school indoor track program, which acted as the control group. We hypothesized that African American students in a high stress college preparatory program who participate in yoga will improve perceived stress levels, lower resting heart rate, lower systolic and diastolic blood pressure, and increase blood oxygen saturation compared to the control when measured prior to the yoga class and at the end of the three weeks.

## Results

We hypothesized that yoga would decrease perceived stress, decrease heart rate, increase blood oxygen saturation, and decrease blood pressure due to the beneficial effects of breathing exercises, physical postures, and final relaxations. Perceived stress scores of participants were collected for both activities before and after 11 sessions of their chosen activity. A two-way ANOVA with repeated measures on one factor was conducted for each independent variable to test the health scores of the participants before and after the sessions. The means and standard deviations for all hypotheses are summarized in **Table 1**.

There was no significant main effect on the time period for participants' perceived stress ($F(1, 20)=0.19$, $p=0.67$). There was no significant main effect on the activity type ($F(1, 20)=0.97$, $p=0.34$). There was also no significant interaction effect between the two ($F(1, 20)=0.85$, $p=0.37$). Even though there was no significant difference for either type of activity, yoga participants did experience a 13% decline in perceived stress on average, while the indoor track group remained essentially unchanged (**Figure 1**).

There was no significant main effect on the time period for the participants' resting heart rates ($F(1, 20)=1.87$, $p=0.19$). Also, there was not a significant main effect of the activities ($F(1, 20)=3.21$, $p=0.09$), nor was there a significant interaction effect on track, yoga, and time ($F(1, 20)=0.43$, $p=0.52$). Even though there was not a significant difference, **Table 1** shows that heart rate improved more in track participants (10% decrease) than in yoga participants (4% decrease).

There was no significant main effect on the time period for the participants' blood oxygen saturation levels. ($F(1, 20)=1.67$, $p=0.42$). Also, there was no significant main effect on the activity type ($F(1, 20)=3.05$, $p=0.10$). There was also no significant interaction effect on track versus yoga, and time period ($F(1, 20)=0.99$, $p=0.33$). **Table 1** shows that blood oxygen saturation levels were about the same for both track (1% increase) and yoga (0.2% increase).

There was no significant main effect on the time period for the participants' systolic blood pressure ($F(1, 20)=0.45$, $p=0.51$). In addition, there was no significant difference in the main effect of the activities ($F(1, 20)=0.04$, $p=0.84$). There was also no significant interaction effect on track, yoga, and time ($F(1, 20)=2.55$, $p=0.13$). **Table 1** shows that systolic blood pressure levels were about the same for both track (2% decrease) and yoga (3% increase).

There was no significant main effect on the time

| Percieved Stress | Before | After | Total |
|---|---|---|---|
| Track | 20.7 (4.6) | 20.6 (6.7) | 20.7 (5.6) |
| Yoga | 21.1 (7.1) | 18.4 (5.8) | 19.7 (6.5) |
| Total | 20.1 (5.9) | 19.5 (6.2) | |
| **Resting Heart Rate** | **Before** | **After** | **Total** |
| Track | 81.7 (14.6) | 73.9 (10.3) | 77.8 (13) |
| Yoga | 85.2 (13.4) | 81.5 (9.3) | 83.4 (11.4) |
| Total | 83.5 (13.8) | 77.7 (10.4) | |
| **Blood Oxygen Sat. (%)** | **Before** | **After** | **Total** |
| Track | 97.4 (1.6) | 98.4 (0.9) | 97.9 (1.4) |
| Yoga | 97.4 (1.4) | 97.6 (1.4) | 97.5 (1.4) |
| Total | 97.4 (1.5) | 98.0 (1.2) | |
| **Systolic BP** | **Before** | **After** | **Total** |
| Track | 114.5 (7.5) | 112.0 (6.9) | 113.3 (7.2) |
| Yoga | 113.3 (8.5) | 116.5 (5.1) | 114.9 (7.1) |
| Total | 113.9 (7.9) | 114.3 (6.4) | |
| **Diastolic BP** | **Before** | **After** | **Total** |
| Track | 76.4 (8.1) | 72.4 (6.6) | 74.4 (7.5) |
| Yoga | 70.4 (9.3) | 76.7 (9.6) | 73.5 (7.5) |
| Total | 73.4 (9.0) | 73.4 (9.0) | |

**Table 1. Effect of yoga and indoor track on perceived stress, resting heart rate, blood oxygen saturation, and systolic and diastolic blood pressure.** In the table above, the means and standard deviations (in parentheses) are reported for both time periods and activity types. The yoga and track (control) groups both had 11 participants. The only significant effect was the interaction between activity type and time for diastolic blood pressure. However, none of the post-hoc t-tests were significant at the corrected Bonferroni significance level, corrected for four tests, with all comparisons $p > 0.0125$.

period for a participant's' diastolic blood pressure ($F(1, 20)=0.08$, $p=0.78$). In addition, there was no significant difference in the main effect of the activities ($F(1, 20)=0.31$, $p=0.58$). There was a significant interaction effect on activity type and time ($F(1, 20)=6.01$, $p=0.02$). However, in the post-hoc tests, there were no significant differences that met our more restricted Bonferroni corrected significance level ($p<0.0125$), corrected for four post-hoc tests. The track group's pre-measurement diastolic blood pressure did not differ from the track post-measurement ($t(10)=1.68$, $p=0.06$), the yoga pre-measurement ($t(20)=1.62$, $p=0.06$), or the yoga post-measurement ($t(20)=-0.1$, $p=0.46$). Likewise, there was no significant difference between the yoga pre-measurement or the yoga post-measurement ($t(10)= -1.82$, $p=0.49$). Even though there were no significant differences detected, the diastolic blood pressure for track participants decreased, while yoga participants' diastolic blood pressure increased. **Table 1** shows that diastolic blood pressure levels in the track group decreased 5%, while the yoga group increased by 9%.

## Discussion

Contrary to our predictions, participants who engaged in yoga did not differ from the control group in terms of perceived stress, resting heart rate, blood oxygen saturation, and blood pressure. The data collected in our study does not support our hypothesis that attending a yoga class would decrease perceived stress levels compared to the control group. However, there were larger, nonsignificant improvements in the yoga participants (13% decrease), compared to the track group (0.5% increase) (**Figure 1**). This suggests that if there were an increase in the sample size, there could be a significant effect of yoga on perceived stress level. These findings are inconsistent with past research, such as the study that compared hatha yoga to African dance and a biology lecture (4). This study found that perceived stress levels decreased in both yoga and African dance. This may be due to the participants being examined immediately after their single yoga class, which is a short-term effect. On the other hand, we conducted our study over three weeks and waited 24 hours after the last yoga class, since we were looking at the longer-term effects of yoga. The study comparing yoga to African dance found a decrease of 18% in yoga participants compared to a decrease of 15% for dance participants, which was a larger improvement in perceived stress than in our study.

Our data is also inconsistent with a study of college-aged medical students who participated in yoga for 16 weeks and saw improvements in perceived stress levels (9). The study lacked a control group; therefore, it was not clear if the difference was due to students practicing yoga or a different factor. The authors suggest that a "semester effect," with higher stress at the beginning of the term, might account for the improvements in perceived stress levels in medical students. Our study was consistent with research that evaluated the benefits of yoga on high school students (11), which found slight improvements in perceived stress levels, though results were also not statistically significant. In their study, a large number of high-stress students quit the study due to a lack of interest in yoga. While no students left during the course of our study, it is possible that some participants did not take yoga seriously, which might not influence their perceived stress levels. Evidence for the benefits of yoga regarding perceived stress for high school and college students is weak because the only studies that show benefits of yoga occur when they collect short-term measurements or when studies are without control groups.

The results for the resting heart rates of yoga and track participants did not support our hypothesis, which stated that participants attending the yoga after school program would have a decrease in resting heart rate levels relative to track participants. These findings are inconsistent with a study that experimented on the immediate effects of slow pace bhastrika (10). This study found that slow bhastrika pranayama breathing decreased participants' systolic and diastolic blood pressures as well as heart rates. Participants' heart rates may have decreased because the type of yoga they practiced focused primarily on breathing techniques, while ours focused on learning the postures and breathing. However, our findings are consistent with a study that studied the impact of Wii Fit yoga training (13). This study found no significant improvement in resting heart rate while using yoga as an overall therapy, possibly due to the fact that there was no final relaxation, and that they practiced for flexibility only. The yoga instructor in our study did not focus heavily on breathing techniques. Instead, the instructor preferred to focus on flexibility and learning the asanas, which might account for the lack of improvement in resting heart rate levels.

The results of blood oxygen saturation levels on yoga participants did not support our hypothesis that blood oxygen saturation levels would increase over the course of three weeks (**Table 1**). The students in our study already had high blood oxygen saturation levels, so the lack of improvement was not surprising. In addition, the results for systolic and diastolic pressure levels in yoga participants did not support our hypothesis that systolic and diastolic blood pressure levels would decrease. One possible explanation for the lack of improvement could have been that yoga students in our study were already normotensive teens (**Table 2**), so any positive effects of yoga would have been too small to detect with our limited

| | Yoga | Indoor Track |
|---|---|---|
| N | 11 | 11 |
| Mean Age | 14.1 | 15.4 |
| Standard Deviation Age | 0.832 | 0.924 |
| Males | 2 | 3 |
| Females | 9 | 8 |
| Normotensive | 9 | 9 |
| Pre-hypertensive | 2 | 2 |

**Table 2. Characteristics of participants.** Indoor track participants were matched to the yoga participants, since the yoga program was a pre-existing after-school activity with a set roster. Indoor track participants were matched to yoga participants by their blood pressure classification, gender, and age in an effort to balance the composition of both groups.

sample size.

Our experiment had several methodological limitations that should be considered. Limitations in the yoga class schedule reduced the study period to three weeks, which may have been too short to see true long-term changes. Participants came to yoga class dressed and prepared; however, some may still have been unmotivated to fully participate. We observed the yoga classes daily and saw that some participants were less cooperative than others, so we did a follow-up questionnaire. We asked participants to rate on a scale from 1-10 how motivated they were during the three weeks of the yoga session. Results showed that the average yoga participant was not highly motivated, which could have impacted their chances of gaining the potential benefits of yoga. The average response was 5.7 on a scale of 1 to 10, with 10 being highly motivated. One participant stated in a follow-up interview, "I am peaceful, more focused, easier to relax, and more creative." However, another stated, "No, no one took it very seriously, so the activity was not fun." Future researchers of high school aged yoga participants should include considerations for motivation and effort when designing their own studies.

These observations are consistent with prior research on youth motivation. Researchers state that one's physical motivation is due to his/her self-esteem, perceived competence, and social support (parents, peers, and instructors), which in turn affect behavior and beneficial outcomes for physical activity (16). Children who have stronger beliefs in their physical competencies are more likely to enjoy an activity and to continue their involvement in the activity. We were not able to collect observations for their self-esteem and social support, such as their parents' support at home, though there were examples of low perceived competence. Some yoga participants had such moments, like when one stated, "I cannot do this. My back hurts." There were also participants that did not participate in some of the physical postures that were assigned by the yoga instructor because they believed that they would be unsuccessful. Since there were some participants who had a negative outlook on the physical activities and/or negative views of their own abilities, they may not have been able to gain the full potential benefits of yoga.

Finally, our sample size for both the yoga and indoor group was only 11, which limited our ability to detect significant differences. If the sample size for the control and experimental group were larger, the results for perceived stress levels in yoga participants might have been significant enough to detect a difference. Unfortunately, the sample was limited by the small enrollment of the yoga class and an overall lack of interest in selecting the class for an after-school activity. The lack of ability to randomly assign students to the two groups also limited our ability to draw definitive conclusions about the effectiveness of yoga in improving student health. Future researchers should consider increasing the sample size and randomly assigning participants to experimental groups to further investigate the potential benefits of yoga.

## Methods

A total of 22 African American students participated in the study. The participants were a convenience sample of students from The Neighborhood Academy that chose to participate in either yoga or indoor track as their afternoon activity. The experimental group consisted of all eleven participants in the yoga class (see **Table 2**). Eleven participants from indoor track were matched, as similarly as possible, to the yoga group by age, gender, and blood pressure classification. For example, no one participating in yoga was in stage 1 hypertension. Therefore, any indoor track participants in stage 1 hypertension were not invited to participate in the control group. **Table 2** contains further details about both groups. Classifications such as normotensive or prehypertensive were determined using guidelines published by the American Academy of Pediatrics (17). The indoor track group was chosen as the control due to data accessibility limitations. The indoor track was the only activity large enough that also met during the same time period.

Students were required to participate in an afternoon activity at their school. Students were asked if they chose their afternoon activity or was it assigned to them due to their lack of seniority. Six out of the eleven participants chose yoga as their afternoon activity. For example, one stated, "It looked interesting, and [I] wanted to work on being more relaxed." Ten out of eleven participants

in indoor track chose to do their activity; only one was forced ("My mom made me").

Yoga participants were motivated by the desire to gain balance, flexibility, and calmness. For example, one reported, "I hope to gain balance." Four out of eleven participants had no expectations of yoga, and six out of the eleven participants did not know any potential benefits of yoga. Students in indoor track were motivated by an ambition to gain "health" and "speed." Nine out of eleven indoor track participants reported they knew the health benefits of their sport, and two out of eleven did not have any health expectations.

A professional hatha yoga instructor came to the school to teach asana and shavasana techniques to the yoga participants. The instructor has been a yoga teacher for two years and has been practicing yoga for over ten years. The indoor track participants were coached by a teacher who teaches health and wellness to the students in The Neighborhood Academy. Indoor track activities consisted of running, weight lifting, and throwing.

Both groups participated in their activity over a course of three weeks. Each session consisted of an hour and fifteen minutes, four days a week. Data was collected before and after the three weeks of their afternoon activity. The participants' heart rate, blood pressure, perceived stress, and blood oxygen saturation levels were gathered prior to the start of any physical activity on the first day of class. Participants' heart rate and blood oxygen measurements were taken using a finger pulse oximeter. Their blood pressures were measured using a stethoscope and a calibrated arm cuff. Blood pressure readings were taken by the primary author, after extensive training and supervised practice under a registered nurse. Perceived stress scores were measured by the Perceived Stress Scale (18). Post-measurements were collected 24 hours after the last class period, during the same time of day as the normal class time.

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