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The Leyburn Stairs' Effect on Blood Pressure

Introduction

Sitting is the new smoking. College-aged students across the nation are forced to sit for hours on end each day. One option for students to combat a sedentary lifestyle is to take the stairs. Our study investigates the short-term impact of taking the stairs on blood pressure - a key indicator of cardiovascular health.

Blood pressure (BP), the force exerted by circulating blood against the walls of blood vessels, is tightly regulated to maintain optimal tissue perfusion. The regulation of BP involves interactions between the nervous system, hormonal pathways, and local vascular responses (Figure 1).

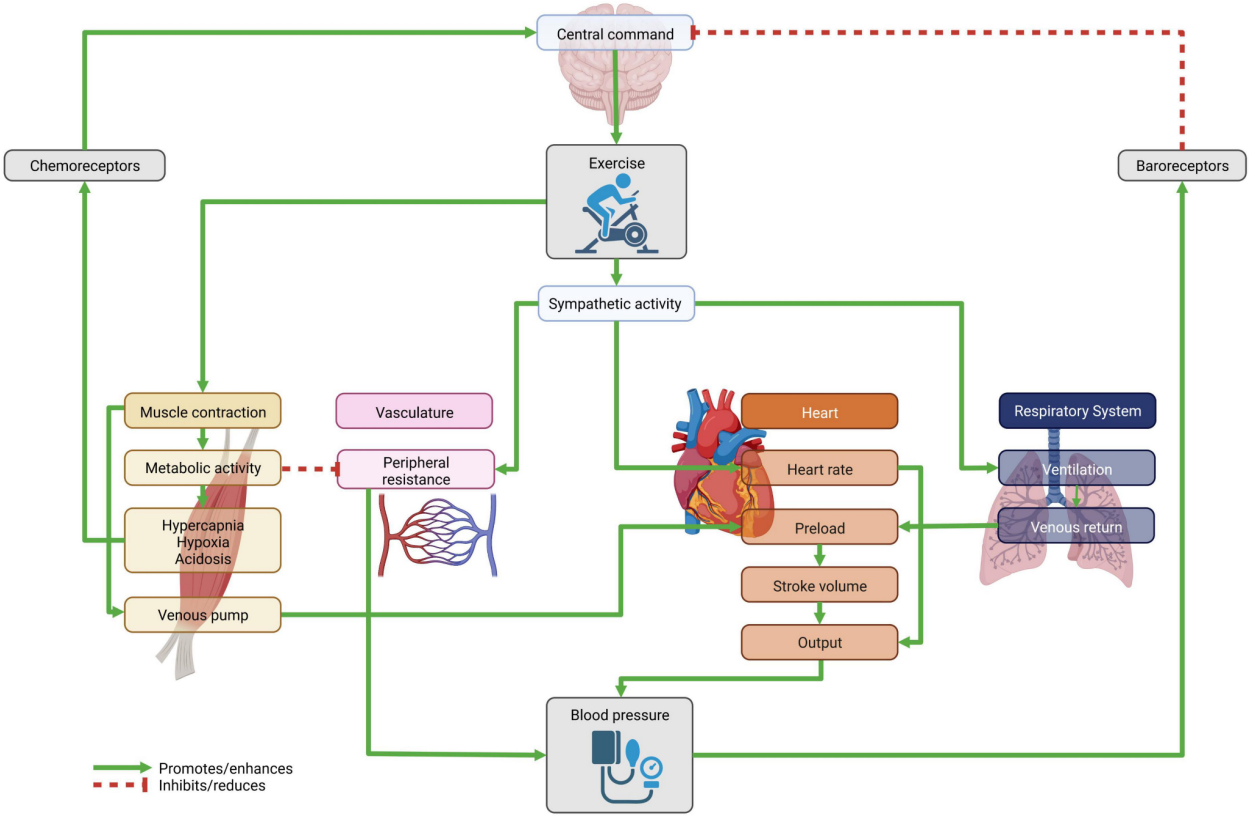


Figure 1: Exercise increases BP. During physical activity, skeletal muscles require more blood to deliver oxygen and remove metabolic waste, necessitating an enhanced cardiac output. Thus, the heart increases its rate and stroke volume, resulting in more blood being pumped per unit of time. Additionally, the sympathetic nervous system is activated, leading to the release of epinephrine and norepinephrine, which play a pivotal role in elevating heart rate, further increasing cardiac activity.

Blood vessels supplying skeletal muscles vasodilate to facilitate increased blood flow. The combined effects of increased cardiac output and vasodilation of blood vessels contribute to an elevation in blood pressure during physical activity. Consistent exercise has been associated with increased arterial compliance, and a reduction in vascular resistance, both of which contribute to lower resting blood pressure over time.

An important distinction to consider when examining the effects of exercise on BP is the known physiological difference between men and women. Studies show that females show lower vascular resistance in general which is reflected during physical activity (Bassareo & Crisafulli, 2020). Women generally have a lower cardiac volume in comparison to males (Figure 2.)

Parameter	Sex-related Differences
Heart Rate	No-difference between sexes
Stroke Volume	Usually higher in men
Stroke Index	Slightly higher in men or similar between sexes
Stroke Volume normalized by lean body mass	No-difference between sexes
Cardiac Output	Usually higher in men
Cardiac Index	Slightly higher in men or similar between sexes
Ejection Fraction	Slightly higher in men or similar between sexes
Arterio-venous oxygen difference	Usually higher in men
Systemic Vascular Resistance	Usually lower in women

Figure 2: Sex differences in BP-related cardiac measures. Even though the underlying mechanism of increased cardiovascular output is identical in males and females, this output varies greatly in magnitude. Gender-related physiological differences result in cardiovascular adaptations to physical activity.

To project the acute effect of physical activity, we used the Leyburn Stair Exercise as a treatment condition for both men and women. This study aims to present how blood pressure changes as a result of physical activity, and differences among men and women respectively. The goal of our study is to examine if the Leyburn Stair Exercise (LSE) leads to a significant increase in BP in both men and women, and if so, how this increase differs between men and women.

Methods

Experimental Design:

Our experiment examined the change in Mean Arterial Blood Pressure (MAP) in college-aged individuals, and we categorized our groups based on gender. Our sample was limited to those enrolled in BIOL-201, a class composed of 3 men and 6 women. This number of subjects was proved to be more than sufficient for producing significant results by our power analysis using a type I error of 1% and a type II error of 20%.

Each subject jogged down 8 flights of stairs to the bottom floor of Leyburn Library and then jogged back up these stairs to the main floor. Each subject's blood pressure was measured before and after the LSE.

Measurements:

The systolic and diastolic blood pressure of each subject was measured using a home blood pressure monitor. These values were converted to Mean Arterial Blood Pressure (MAP). MAP, as seen in previous literature, is used to aggregate the systolic (SBP) and diastolic (DBP) measurements of blood pressure and to look at the change in blood pressure holistically.

$$MAP = \frac{2 * DBP + SBP}{3}$$

CAPTION: Calculation of mean arterial blood pressure using measured diastolic and systolic blood pressure.

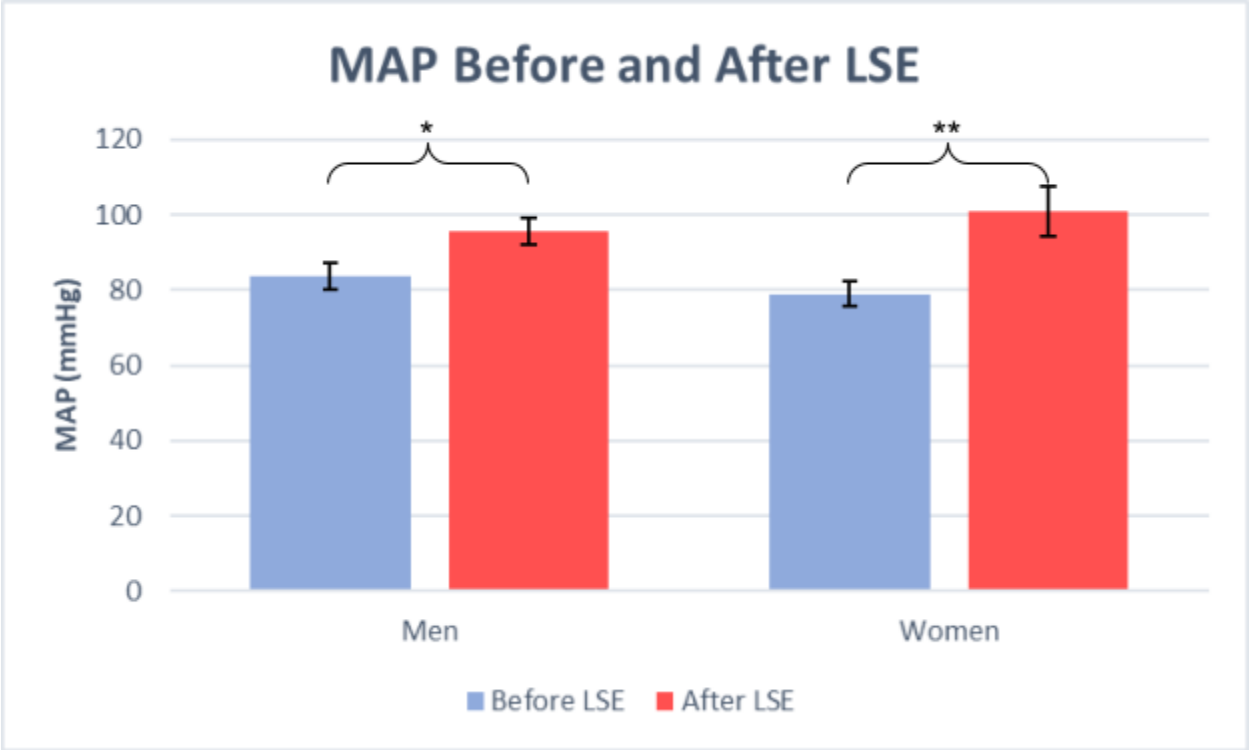
Blood pressure was taken following the user's manual for the Lovia Blood Pressure system. The BP cuff was used on bare skin, with the artery mark about an inch above the elbow pit. The subjects sat up straight without their legs crossed. Subjects were also given a roughly 3-minute resting period before initial blood pressure was taken. According to Brady et. al, 3 minutes is enough time to wait before measuring BP. Subjects were also given directions to read (see Appendix B) and instructed not to talk while BP was being measured.

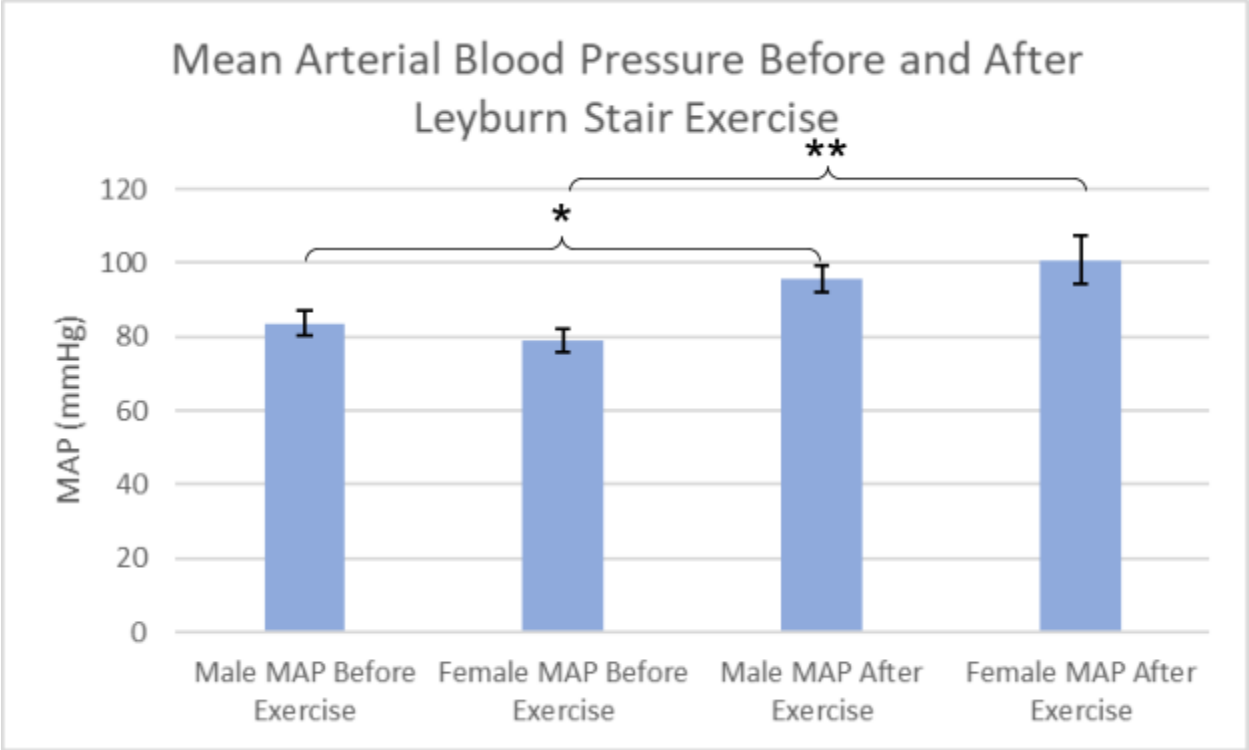
The Leyburn Stairwell consists of 8 flights of 12, 7-inch tall, stairs each (96 steps in total). After completing the LSE, the subjects' blood pressure was measured again according to the same regulations but without a resting period.

Results

Differences in MAP before and after the Leyburn Stair Exercise were compared via a student t-test and a confidence interval for both males and females (see technical report).

MAP increased after LSE in both men ($p = 0.0126$) and women ($p = 0.0012$). Thus, in our t-test, we can reject our null hypothesis that there was no change in BP after the LSE.





CAPTION: Mean Arterial Blood Pressure in men (n=3) and women (n=6) before and after the Leyburn Stair Exercise.

We also created 1-tailed, 95% confidence intervals for the increase in MAP for before and after the LSE in both men and women. For men, we can say the average increase will be between (8.80, 14.97). For women, we can say the average increase will be on the interval (14.89, 28.67)

We calculated the percent increase in MAP for all subjects to account for differences in male and female physiology, and we ran a student t-test to determine whether the increase was different between the two genders. A two-tailed t-test returned a p-value of 0.075, which is not significant ($\alpha = .05$). Therefore, we are unable to reject our null hypothesis that there is a statistically different increase in MAP between men and women.

Discussion

The significant p-values revealed by our t-tests exhibit the certainty that blood pressure will increase in a college-aged individual after completing the LSE. Our upper and lower limits of both the men's and women's 95% confidence intervals being in the positive confirm this finding.

Our power analysis determined that our n is sufficient, we can take our sample (BIOL-201 students) to be a decent representation of the college-aged student population. As we mentioned in the introduction, short-term BP spikes due to exercise are extremely beneficial for the cardiovascular system. Therefore, we recommend college-aged people should take the stairs when they have the chance - it's an easy way to be healthier!

One source of error in our experiments may be the monitor itself. The monitor we used is a home health tool from Amazon, not a piece of medical-grade equipment, which affects the precision and accuracy of our data. Additionally, the observations were recorded by students of the BIOL-201 class, not medical professionals, which may result in errors such as improper tightening of the cuff, incorrect placement on the arm, or many other variables.

Students often take the stairs between classes. The resulting BP spike may linger for the first few minutes of instruction. This study raises further questions about the effects of a short-term BP spike on cognitive performance, and focus in class.

Alternatively, the short-term increase in MAP after taking the stairs, if repeated on a daily basis, may lead to a decrease in resting blood pressure, which is associated with improved cardiovascular health and higher cognitive functioning (Giuseppe et al., 2019).

Conclusion.

Ultimately, we found that BP universally increased across genders after completing the Leyburn Stair Exercise, most noticeably in systolic blood pressure, and slightly more for women than for men.

Appendix.

A.

		Initial			After Exercise						
Subject	Sex	Systolic	Diastolic	MAP	Systolic	Diastolic	MAP	Change in Systolic	Change in Diastolic	Change in MAP	% MAP Increase
1 -	M	126	75	92	164	72	102.6666667	38	-3	10.66666667	11.5942029
2 -	M	112	65	80.666667	131	79	96.33333333	19	14	15.66666667	19.42148761
3 -	M	119	58	78.333333	147	58	87.66666667	28	0	9.333333333	11.91489362
4 -	F	108	66	80	135	86	102.3333333	27	20	22.33333333	27.91666666
5 -	F	98	69	78.666667	131	74	93	33	5	14.33333333	18.22033898
6 -	F	114	76	88.666667	181	95	123.6666667	67	19	35	39.47368421
7 -	F	116	66	82.666667	148	85	106	32	19	23.33333333	28.22580645
8 -	F	95	46	62.333333	112	50	70.66666667	17	4	8.333333333	13.36898396
9 -	F	115	65	81.666667	155	86	109	40	21	27.33333333	33.46938775

B.

Instructions for subject to read before completing the Leyburn Stair Exercise:

> "Today, we will be doing a simple test to measure your blood pressure before and after exercise.
>
> We will first measure your blood pressure now. Take a minute to relax, and breathe normally.
>
> Once your initial blood pressure has been measured, you will walk all the way to the bottom of the Leyburn stairwell, and back up to our classroom (M47.)
>
> Then, we will measure your blood pressure again."

C. AmazonBasics Lovia Digital Blood Pressure Monitor model #502

Citations & Takeaways:

Forte, Giuseppe et al. "Effects of Blood Pressure on Cognitive Performance: A Systematic Review." Journal of clinical medicine vol. 9,1 34. 22 Dec. 2019, doi:10.3390/jcm9010034

-> lower blood pressure increases cognitive functioning in the long run, diastolic blood pressure linked to blood supply in brain

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Sharman, J. E., et al. "The Effect of Exercise on Large Artery Haemodynamics in Healthy Young Men." European Journal of Clinical Investigation, Received 6 July 2005; Accepted 11 October 2005, vol. 35, no. 12, 2005, pp. 738–44, https://doi.org/10.1111/j.1365-2362.2005.01578.x.

Amazon Lovia Blood Pressure System User's Manual: https://images-na.ssl-images-amazon.com/images/I/911kKv3naKL.pdf

Brady, T. M., Charleston, J., Ishigami, J., Miller, E. R., Matsushita, K., & Appel, L. J. (2021). Effects of different rest period durations prior to blood pressure measurement: The best rest trial. Hypertension, 78(5), 1511–1519. https://doi.org/10.1161/hypertensionaha.121.17496