The American Journal of Physical Education and Health Science (AJPEHS)

ISSN: 2992-9679 (ONLINE)

VOLUME 3 ISSUE 2 (2025)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Physical Education and Health Science (AJPEHS)

Volume 3 Issue 2, Year 2025
ISSN: 2992-9679 (Online)
DOI: https://doi.org/10.54536/ajpehs.v3i2.5910
https://journals.e-palli.com/home/index.php/ajpehs

Effect of a 10-week Calisthenic-Circuit Training (CCT) on Cardio-pulmonary Parameters of Student Athletes

Karl Eimuhi[1*], Evans Egbon[2], Gideon Etaghene[2]

Article Information

Received: August 10, 2025

Accepted: September 16, 2025

Published: December 26, 2025

Keywords

Blood Pressure, Calisthenic-Circuit Training, Cardio-Pulmonary Parameters, Heartrate, Vital Capacity

ABSTRACT

This study examined the effect of a 10-week Calisthenic-Circuit Training (CCT) program on selected cardio-pulmonary variables of student athletes at the University of Benin, Nigeria. A pretest–posttest experimental design was adopted, involving fifty-four (54) student athletes who participated in the intervention. The CCT protocol, adapted for the study, served as the training instrument. Data was analyzed using repeated measures analysis of variance (ANOVA), with Tukey's LSD post-hoc test applied to identify specific group differences. Statistical significance was set at $p < 0.05$. Findings revealed that participation in the 10-week CCT significantly increased heart rate among the athletes. Changes were also observed in systolic blood pressure, diastolic blood pressure, and vital capacity, though these differences were not statistically significant. The study concluded that CCT can elicit cardiovascular adaptations and recommends regular cardio-pulmonary evaluations for student athletes to enhance performance outcomes. Future research should investigate the effects of varying intensities and durations of CCT on broader physiological and performance parameters.

INTRODUCTION

Within the field of sports and exercise physiology, the use of physiological markers has become an established approach for monitoring how athletes respond to training stimuli. This is largely due to the marked differences in physiological status observed between rest and post-exercise conditions. Such indices provide valuable insights into both the acute and long-term effects of physical activity. Among the most assessed cardio-pulmonary variables in athletes are heart rate, blood pressure, and vital capacity. Compared with sedentary individuals, athletes generally display reduced resting respiratory rates because of enhanced lung function (Hackett, 2020); exhibit more favorable resting and exercise-related blood pressure profiles (Hegde & Solomon, 2015); and show higher heart rate responses under exertion (Ansa *et al.*, 2021). Nonetheless, considerable inter-individual variation exists, influenced by factors such as genetic makeup, training mode, exercise frequency, and intensity of protocols. High training loads can predispose athletes to cardio-respiratory strain, although evidence suggests that sustained aerobic conditioning enhances pulmonary and cardiovascular function while reducing susceptibility to dysfunction (Zhao & Feng Mao, 2002).

Given these concerns, continuous evaluation of athletes' cardiopulmonary function is essential in designing targeted aerobic training regimens. A variety of diagnostic techniques have been developed for this purpose. Aerobic exercise testing, for example, has been shown to influence cardiac and pulmonary function directly (Ansa *et al.*, 2021). Aburub *et al.* (2020) proposed a relational model-based detection method that tracks variations in cardiopulmonary indices during aerobic training, though its limited adaptability restricts universal application. Similarly, Zhang and Zhu (2018) employed a particle swarm optimization technique to approximate cardiopulmonary function with high accuracy, but its lack of comparative reference indices limits practical use in training contexts. More broadly, aerobic exercise is widely recognized for improving cerebral and systemic blood circulation, thereby enhancing oxygen delivery and supporting physiological adaptability. Despite these advances, inconsistencies remain in the literature regarding the most effective exercise modalities and protocols for eliciting improvements in cardiopulmonary parameters.

Calisthenic-Circuit Training (CCT), introduced by Eimuhi and Agwubike, has been identified as a promising approach capable of inducing such adaptations. Prior investigations have demonstrated that CCT protocols significantly influence biochemical outcomes, such as serum protein alterations, in university athletes (Eimuhi & Adodo, 2019). CCT involves a structured sequence of bodyweight-based exercises performed across multiple stations, emphasizing high repetitions and short recovery intervals to target different muscle groups. According to Juan (2023), both calisthenics and circuit-style training are effective modalities for physical conditioning, biochemical adaptation, and skill enhancement, ultimately improving human performance. However, the application of CCT to assess cardiopulmonary responses among student athletes has not yet been adequately explored. Consequently, this study was designed to evaluate the impact of a 10-week Calisthenic-Circuit Training program on key cardiopulmonary variables specifically heart rate, blood pressure, and vital capacity among student athletes at the University of Benin.

[1] Medical College of Georgia, Augusta University, Georgia, USA
[2] Department of Human Kinetics and Health Education, Faculty of Education, Ambrose Alli University, Ekpoma, Nigeria
[*] Corresponding author's e-mail: keimuhi@augusta.edu

MATERIALS AND METHODS

Research Design

This study adopted the pretest – posttest experimental design.

Participants

A total of fifty-four (54) student athletes were drawn from a population of 522, representing approximately 10% of the entire cohort. The selection was carried out using a proportionate sampling strategy, ensuring that 10% of athletes from each sport were included. The participants, with a mean age of 23.67 ± 1.85 years, were subsequently distributed into experimental and control groups through a systematic randomization process. To achieve this, the 54 athletes were listed in sequence, after which every alternate individual was allocated to either group, resulting in 27 participants assigned to each condition.

Ethical Clearance

Before the start of this study, an approval was obtained from the Ethics Committee of the University of Benin, Benin City, Nigeria, with approval number EC/UNIBEN/17/20170.

Instrumentation

All research procedures adhered to the World Health Organization (WHO) ethical guidelines for studies involving human participants, and informed written consent was obtained from every athlete prior to enrollment. Baseline (pre-test) measurements were conducted before the commencement of the Calisthenic-Circuit Training (CCT) intervention. The CCT protocol employed in this study had been previously validated, while the physiological assessment instrument was initially verified by a Medical Laboratory Scientist outside Nigeria and subsequently re-examined by two specialists in Exercise Physiology, who confirmed its suitability for data collection. To establish reliability, a pilot trial involving twelve student athletes, six assigned to the experimental group and six to the control group was conducted. The test–retest method was applied, and the resulting correlation coefficient indicated acceptable reliability for the instrument, making it appropriate for the main study.

Training Protocol

An intervention of a Calisthenic-Circuit Training (CCT)

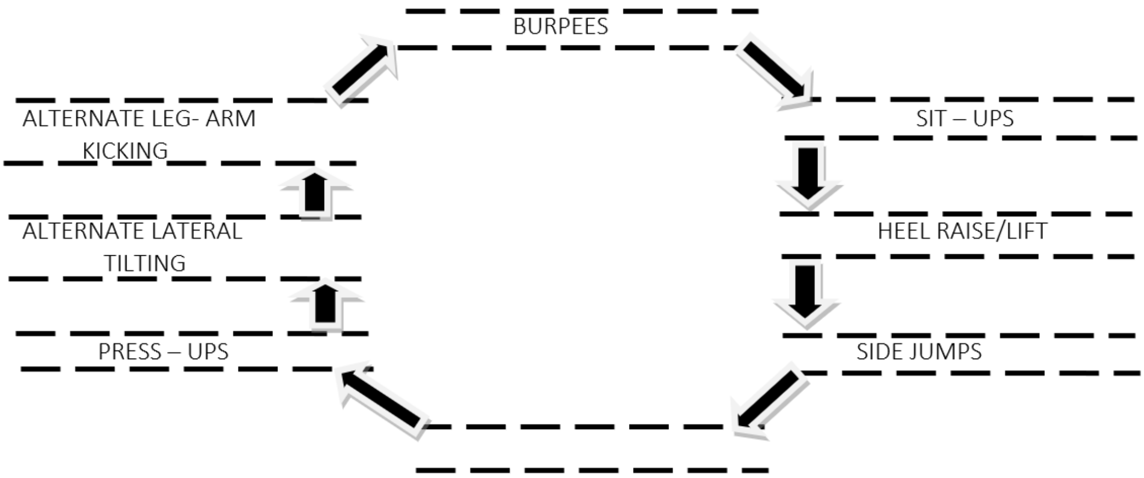

Figure 1: Sequential circuit arrangements of the Calisthenic-Circuit Training (CCT) Exercises

with duration of ten weeks was used. It was performed three times a week (Tuesdays, Thursdays and Saturdays). Eight basic calisthenic-circuit exercises comprised of alternate leg-arm kicking, burpees, sit-ups, heel raise, side jumps, windmills, press-up and alternate lateral tilting were utilized at separate stations in a circuit by the experimental group while linear training without increment or overload was utilized by the control group for this study. The increment or overload of the exercises for the circuit was by five repetitions per week for each of the stations or 5 seconds per week for lateral tilting. The exercise stations were located at equal distances from one station to another within the eight-station circuit. Each field athlete started exercising from the alternate leg-arm kicking and strictly followed the performance sequence of one station after the other in a clockwise direction. The initial training dosage of each of the eight exercises was adopted in which athletes were subjected to performing to exhaustion/fatigued state and the maximum repetitions divided by two. The outcome constituted the athlete's start-up (initial) training load or pace for the first week. Post-test measurements were conducted again, immediately after the intervention duration has elapsed using the same protocol and procedures.

Statistics Analysis

Data generated were analysed using inferential statistics of repeated measure analysis of variance (ANOVA) to test the hypothesis, while Tukey's LSD post-hoc was used to identify the source of significant differences. Statistical significance was accepted for $p<0.05$. All statistics were performed using Statistical Package for Social Sciences (SPSS) – IBM version 21.

RESULTS AND DISCUSSION

Table 1: Differences between groups and multiple comparisons

	Pre-Experimental[a] (n=27)	Post-Experimental[b] (n=27)	Pre-Control[c] (n=27)	Post-Control[d] (n=27)		
Variables	M±SD	M±SD	M±SD	M±SD	F	p
Heart Rate	65.26±9.64[b]	70.15±7.74[a,c,d]	71.74±11.23	72.19±11.23 [b]	2.683	0.041
Systolic B.P	99.56±12.96	105.74±15.68	95.81±17.13	99.59±15.88	1.851	0.142
Diastolic B.P	54.70±15.45	53.67±15.02	60.26±18.25	56.74±14.92	0.895	0.447
Vital Capacity	2033.33±749.87	2333.33±750.38	22525.93±920.53	2585.19±879.12	2.430	0.069

Different from: a Pre-Experimental; b Post-Experimental; c Pre-Control; d Post-Control; B.P Blood pressure; M Mean; SD Standard Deviation

Table 1 summarizes the differences in heart rate, systolic blood pressure, diastolic blood pressure, and vital capacity measured before and after the 10-week Calisthenic-Circuit Training (CCT) intervention. Analysis using repeated measures ANOVA revealed an upward trend in heart rate, systolic blood pressure, and vital capacity, with a slight reduction in diastolic blood pressure across both experimental and control groups. The F-value for heart rate ($F = 2.683$, $p = 0.041$) was statistically significant, whereas values for systolic blood pressure ($F = 1.851$, $p = 0.142$), diastolic blood pressure ($F = 0.895$, $p = 0.447$), and vital capacity ($F = 2.430$, $p = 0.069$) did not reach significance. Post-hoc analysis using Tukey's LSD further indicated that significant mean differences in heart rate were found between the post-experimental and pre-experimental groups, as well as between the experimental and control groups. Consequently, the null hypothesis regarding heart rate was rejected, while hypotheses concerning systolic blood pressure, diastolic blood pressure, and vital capacity were retained.

The observed elevation in heart rate following the CCT protocol aligns with previous findings by Kumar and Kaur (2020) and Islegen and Daglioglu (2020), both of whom reported significant increases in heart rate after structured aerobic training. Regular conditioning enhances myocardial efficiency, enabling the heart to pump more blood per beat, thereby reducing cardiac strain during rest. Well-trained athletes often demonstrate resting heart rates below 60 bpm, with elite endurance performers sometimes recording values in the 40s. Nevertheless, the present findings contrast with D'Souza *et al.* (2014), who showed that exercise training could reduce resting heart rate through downregulation of hyperpolarization-activated cyclic nucleotide-gated potassium channels. This discrepancy may also relate to parasympathetic adaptations, as aerobic training strengthens vagal activity, increasing stroke volume and lowering resting heart rate, which in turn reduces cardiovascular disease risk. During exercise, vasodilation in active muscle groups alongside compensatory vasoconstriction in less active regions elevates cardiac output to meet metabolic demand, often driving up heart rate. Prolonged adaptations, however, may eventually lower resting heart rate by increasing stroke volume and vascular shear stress. Additionally, training-related sex differences exist; women often present higher exercise heart rates than men at equivalent workloads due to smaller stroke volumes linked to reduced heart size and blood volume (Bassareo & Crisafulli, 2020).

Regarding blood pressure, no significant changes were detected in either systolic or diastolic measures. These outcomes corroborate with Wielemborek *et al.* (2016), who reported that during dynamic exercise systolic pressure typically rises in proportion to intensity while diastolic pressure remains relatively stable. Mean arterial pressure increases largely because cardiac output outweighs reductions in peripheral resistance. Reductions in systolic pressure after training may result from diminished cardiac output regulated by central command and the exercise pressor reflex (Shokri *et al.*, 2022). Moreover, consistent aerobic training is known to attenuate sympathetic activity, lowering systemic vascular resistance and blood pressure (Cavalcante *et al.*, 2007). Variability in outcomes across studies is likely related to differences in exercise type, intensity, and duration.

For vital capacity, no statistically significant improvement was observed, although trends suggested higher values in the experimental group. This agrees with findings by Doherty and Dimitrio (2007), who reported greater vital capacity and forced vital capacity among athletes compared with sedentary individuals. Similarly, Durmic *et al.* (2017) found that regular training enhances pulmonary function compared to non-active populations. Typically, about 80% of individuals present vital capacity values within predicted norms for their age, sex, stature, and body mass, though athletes often exceed these thresholds. Pulmonary function is influenced by respiratory muscle strength, lung expansion capacity, and airway flexibility, all of which may benefit incrementally from sustained physical training.

CONCLUSION

Ten weeks of Calisthenic-Circuit Training (CCT) significantly increased the heart rate of student athletes in the University of Benin. However, no significant difference was observed in systolic blood pressure, diastolic blood pressure and vital capacity of student athletes of the University of Benin following a 10-week CCT protocol. Regular cardio-pulmonary and physiological assessments should be conducted among students athletes for optimal sport performance. Further intervention studies assessing exercise performance and physiological parameters in relation to varying training intensities of CCT protocol should be conducted.

REFERENCES

Aburub, A., Ledger, S. J., & Hunter, S. M. (2020). Cardiopulmonary function and aerobic exercise in Parkinson's: a systematic review of the literature. *Movement Disorders Clinical Practice, 7*, 6. https://doi:10.1002/mdc3.13011

Ansa, O. E. O., Mprah, K. W., Moses, M. O., Owusu, I., & Acheampong, E. (2021). Effect of community-based functional aerobic training on motor performance and quality of life of children with spastic cerebral palsy. *Ethiopian Journal of Health Sciences, 31*(2), 381–392. https://doi:10.4314/ejhs.v31i2.21

Bassareo, P. P., & Crisafulli, A. (2020). Gender Differences in Hemodynamic Regulation and Cardiovascular Adaptations to Dynamic Exercise. *Current Cardiology Reviews, 16*(1), 65–72. http://doi:10.2174/1573403X15666190321141856

Cavalcante, M. A., Bombig, M. T., Luna, F. B., Carvalho, A. C., Paola, A. A., & Póvoa, R. (2007). Quality of life of hypertensive patients treated at an outpatient clinic. *Arquivos Brasileiros de Cardiologia, 89*, 245-250. http://doi:10.1590/s0066-782x2007001600006

Doherty, M., & Dimitriou, L. (2007). Comparison of lung volume in Greek swimmers, land-based athletes, and sedentary controls using allometric calling. *British Journal of Sports Medicine, 31*(4), 337-41. http://doi:10.1136/bjsm.31.4.337

Durmic, T., Popovic, B. L., Svenda, M. Z., Djelic, M., Zugic, V., Gavrilovic, T., Mihailovic, Z., Zdravkovic, M., & Leischik, R. (2017). The training type influence on male elite athletes' ventilatory function. *BMJ Open Sport Exercise Medicine, 3*(1), e000240. http://doi:10.1136/bmjsem-2017-000240

D'Souza, A., Bucchi, A., Johnsen, A. B., Logantha, S. J. R. J., Monfredi, O., Yanni, J., Prehar, S., Hart, G., Cartwright, E., Wisloff, U., Dobryznski, H., DiFrancesco, D., Morris, G.M., & Boyett, M.R. (2014). Exercise training reduces resting heart rate via downregulation of the funny channel HCN4. *Nature Communication, 13*(5), 3775. http://doi:10.1038/ncomms4775

Eimuhi, K. E., & Adodo, S. M. (2019). Serum Protein adjustments following a 10-Week Calisthenic-Circuit Training programme among University of Benin student athletes. *Journal of Research and Contemporary Issues in Human Kinetics and Health Education, 4*(1), 20-26. https://hkhejournal.com/wp-content/uploads/2019/07/5-1.pdf

Hackett, D. A. (2020). Lung Function and Respiratory Muscle Adaptations of Endurance-and Strength-Trained Males. *Sports (Basel), 8*(12),160. http://doi:10.3390/sports8129160

Hegde, S. M., & Solomon, S. D. (2015). Influence of Physical Activity on Hypertension and Cardiac Structure and Function. *Current Hypertension Reports, 17*(10), 77. http://doi:10.1007/s11906-015-0588-3

Islegen, G., & Daglioglu, O. (2020). The Effect of Aerobic Exercise on Pulmonary Function and Aerobic Capacity in Sedentary Men. *International Journal of Sport, Exercise & Training Sciences. 6*(3), 80–87. http://doi:10.18826/useeabd.784339

Juan, C. S. (2023). *Calisthenics and Human Performance. 7,*1. Retrieved from http://www.livestrong.com/article/439209-what-is-calisthenic-training/.

Kumar, S., & Kaur, A. (2020). Effect of Uphill Running Training and Staircase Training on Lean Body Mass, Fat Mass, Vital Capacity and Resting Heart Rate of Male Sportsmen. *Journal of Emerging Technologies and Innovative Research. 5,* 11 https://www.jetir.org/papers/JETIRDS06163.pdf

Qi, M., Zhu, Y., Zhang, L., Ting, Wu., & Wang, J. (2018). The effect of aerobic dance intervention on brain spontaneous activity in older adults with mild cognitive impairment: A resting-state functional MRI study. *Experimental and Therapeutic Medicine,* https://doi:10.3892/etm.2018.7006

Shokri, I. S. M. S., Suhaimi, N. S. M. D., Illias, N. F., Adnan, R., & Ismail, H. (2022). The effect of cardiovascular responses on aerobic exercise and relationship between pulmonary function and body composition among sedentary students. *Journal of Physical Education and Sport, 22*(256), 2012 – 2017. http://doi:10.7752/jpes.2022.09256

Wielemborek-Musial, K., Szmigielska, K., Leszczynska, J., & Jegier, A. (2016). Blood Pressure Response to Submaximal Exercise Test in Adults. *Biomed Research International*, 5607507. http://doi:10.1155/2016/5607507

Zhao, Q., & Feng, M. F. (2002). Effects of Aerobic Training on Cardiopulmonary Function Based on Multiple Linear Regression Analysis. *Journal of Healthcare Engineering, 7399119,* 6. https://doi.org/10.1155/2022/7399119