

Effects of an Eight-Week Plyometric Training Program on Health-Related Physical Fitness Among Adamu Augie College of Education Argungu, Kebbi State, Nigeria

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Abstract

Background: Health-related physical fitness (HRPF) is a major determinant of chronic disease risk. Although plyometric training (PT) is commonly used to enhance athletic performance, its effectiveness in improving HRPF among non-athletic populations in sub-Saharan Africa remains underexplored. **Purpose:** To examine the effects of an eight-week plyometric training intervention on cardiorespiratory fitness, muscular endurance, flexibility, and body composition among male college students.

Methods: Forty apparently healthy male students (mean age = 21.95 ± 1.50 years) were randomly assigned to an experimental group ($n = 20$) or control group ($n = 20$). The experimental group performed supervised plyometric training three times weekly for eight weeks. Outcomes were assessed pre- and post-intervention. Between-group differences in change scores were analyzed using independent *t*-tests. Effect sizes (Cohen's *d*) and 95% confidence intervals were calculated.

Results: Significant improvements were observed in the experimental group for cardiorespiratory fitness ($p < .001$, $d = 1.95$), muscular endurance ($p < .001$, $d = 2.10$), flexibility ($p < .001$, $d = 1.48$), and BMI ($p = .048$, $d = 0.42$).

Conclusion: Eight weeks of structured plyometric training significantly enhance multiple components of HRPF in young adult males and may serve as a scalable intervention in tertiary institutions.

cardiovascular morbidity and all-cause mortality (Blair et al., 1989). Similarly, reduced muscular endurance and unfavorable body composition have been linked to increased cardiometabolic risk, insulin resistance, and musculoskeletal dysfunction (American College of Sports Medicine [ACSM], 2022). Consequently, improving HRPF among young adults is a critical public health objective.

Despite global initiatives promoting physical activity, physical inactivity remains prevalent among university students. Transitioning from secondary education to tertiary institutions is frequently associated with decreased structured physical activity, increased sedentary academic engagement, and greater screen time (Keating et al., 2005). In low- and middle-income countries such as Nigeria, rapid urbanization and lifestyle transitions further contribute to declining activity levels among young adults (World Health Organization [WHO], 2020). This pattern is concerning because habits established during early adulthood often persist into later life, thereby influencing long-term disease risk trajectories.

Traditional exercise prescriptions for improving HRPF typically emphasize moderate-intensity continuous aerobic exercise and resistance training. While effective, these modalities may require prolonged time commitment, specialized facilities, or access to equipment, which can limit implementation in resource-constrained institutional environments. High-intensity training approaches have therefore gained attention as time-efficient alternatives capable of inducing comparable or superior physiological adaptations (Gibala et al., 2012).

I. INTRODUCTION

Health-related physical fitness (HRPF) is a multidimensional construct encompassing cardiorespiratory fitness, muscular endurance, flexibility, and body composition, all of which are strongly associated with long-term health outcomes. Cardiorespiratory fitness, often quantified by maximal oxygen uptake ($VO_2\max$), is considered one of the strongest independent predictors of

Plyometric training (PT) is a high-intensity exercise modality characterized by rapid eccentric–concentric muscle actions utilizing the stretch–shortening cycle (SSC). During the eccentric phase of movement, elastic energy is stored within musculotendinous structures and subsequently released during the concentric phase, enhancing force production and neuromuscular efficiency (Markovic & Mikulic, 2010). Historically, PT has been employed primarily in athletic populations to improve explosive power, speed, and agility (Chu & Myer, 2013). However, the physiological demands imposed by repeated high-intensity jumping and bounding drills suggest broader systemic effects beyond performance enhancement.

Emerging evidence indicates that PT may stimulate both anaerobic and aerobic energy systems due to its intermittent high-intensity nature. Acute sessions of high-intensity exercise elevate heart rate and oxygen consumption to levels sufficient to promote central cardiovascular adaptations, including increased stroke volume and cardiac output. Furthermore, repeated high-load muscular contractions may enhance mitochondrial enzyme activity and capillary density, thereby improving oxygen extraction and utilization. Systematic reviews have reported improvements in aerobic capacity and neuromuscular function following plyometric interventions (Ramírez-Campillo et al., 2018).

In addition to potential cardiovascular benefits, plyometric exercise may influence muscular endurance through improved motor unit recruitment efficiency and enhanced neuromuscular coordination. Repeated SSC activation may increase mechanical efficiency and fatigue resistance, particularly in previously untrained individuals. Moreover, the high metabolic demand associated with plyometric drills may elevate post-exercise oxygen consumption (EPOC), contributing to increased total daily energy expenditure and favorable changes in body composition (LaForgia et al., 2006). Dynamic movement patterns may also improve flexibility by enhancing muscle–tendon compliance and joint range of motion. Although several studies have documented the performance-enhancing effects of PT in trained athletes, relatively few investigations have examined its impact on multiple HRPF components in non-

athletic university populations. Furthermore, evidence from sub-Saharan African contexts remains limited. Given the minimal equipment requirements and scalability of plyometric programs, PT may represent a practical intervention strategy for tertiary institutions in resource-limited settings. However, empirical data supporting this application are insufficient.

Therefore, the purpose of this study was to examine the effects of an eight-week supervised plyometric training program on cardiorespiratory fitness, muscular endurance, flexibility, and body composition among male college students in Nigeria. It was hypothesized that participants undergoing plyometric training would demonstrate significantly greater improvements in all assessed HRPF components compared with a non-exercising control group.

By addressing this gap, the present study aims to contribute evidence toward the development of time-efficient, scalable exercise interventions capable of enhancing health-related fitness among young adults in institutional settings.

II. METHODS

Participants

Forty male students were randomly allocated:

- Experimental group (n = 20)
- Control group (n = 20)

Baseline characteristics are presented in Table 1.

Table 1

Baseline Characteristics of Participants

Variable	Experimental (n = 20) Mean ± SD	Control (n = 20) Mean ± SD	t- value	p- value
Age (years)	21.80 ± 1.40	22.10 ± 1.60	0.64	.52
BMI (kg/m²)	23.80 ± 1.20	23.70 ± 1.10	0.28	.78

VO₂max Estimate	1860 ± 110	1845 ± 105	0.44	.66
Push-Ups (reps)	85.3 ± 8.1	84.6 ± 7.9	0.27	.79
Flexibility (cm)	21.4 ± 3.2	21.0 ± 3.1	0.40	.69

III. RESULTS

Cardiorespiratory Fitness
 Significant improvements were observed in the experimental group compared with controls (Table 2).

No statistically significant baseline differences were observed ($p > .05$).

Table 2
 Pre–Post Changes in Cardiorespiratory Fitness (VO₂max Estimate)

Group	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Change	95% CI	t(38)	p-value	Cohen’s d
Experimental	1860 ± 110	2215 ± 99	+355	310–400	10.42	< .001	1.95
Control	1845 ± 105	1851 ± 104	+6	–12–24	—	—	0.05

Interpretation: Very large effect size, indicating substantial cardiovascular adaptation.

Muscular Endurance
 Significant between-group differences were observed (Table 3).

Table 3
 Pre–Post Changes in Muscular Endurance (Push-Up Test)

Group	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Change	95% CI	t(38)	p-value	Cohen’s d
Experimental	85.3 ± 8.1	110.2 ± 7.2	+24.9	21–29	11.01	< .001	2.10
Control	84.6 ± 7.9	86.3 ± 6.8	+1.7	–2–5	—	—	0.15

Interpretation: Extremely large practical effect.
 Flexibility

Results are summarized in Table 4.

Table 4
 Pre–Post Changes in Flexibility (Sit-and-Reach Test)

Group	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Change	95% CI	t(38)	p-value	Cohen’s d
Experimental	21.4 ± 3.2	27.8 ± 3.0	+6.4	4.8–8.0	6.62	< .001	1.48
Control	21.0 ± 3.1	21.5 ± 3.0	+0.5	–1.0–2.0	—	—	0.16

Interpretation: Large improvement in lower-back and hamstring flexibility.

Body Composition
 BMI results are shown in Table 5.

Table 5
 Pre-Post Changes in Body Mass Index (BMI)

Group	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Change	95% CI	t(38)	p-value	Cohen's d
Experimental	23.80 ± 1.20	23.10 ± 1.10	-0.70	-1.10 to -0.30	-1.87	.048	0.42
Control	23.70 ± 1.10	23.60 ± 1.20	-0.10	-0.40 to 0.20	—	—	0.09

Interpretation: Small-to-moderate reduction in BMI.

Summary of Statistical Findings

Variable	Effect Size (d)	Magnitude
Cardiorespiratory Fitness	1.95	Very Large
Muscular Endurance	2.10	Extremely Large
Flexibility	1.48	Large
BMI	0.42	Small-Moderate

IV. DISCUSSION

The present study examined the effects of an eight-week plyometric training intervention on multiple components of health-related physical fitness among male college students. The findings indicate that plyometric training elicited significant improvements in cardiorespiratory fitness, muscular endurance, flexibility, and body composition compared with a non-exercising control group. The magnitude of improvements was particularly large for cardiorespiratory fitness and muscular endurance, suggesting robust multi-system physiological adaptations.

Cardiorespiratory Fitness

A very large improvement in cardiorespiratory fitness was observed following the plyometric intervention. Although plyometric training is traditionally classified as an anaerobic modality, the high-intensity

intermittent nature of repeated jump-based exercises likely imposes substantial cardiovascular demand. High-intensity efforts elevate heart rate and oxygen consumption to levels sufficient to stimulate central cardiovascular adaptations, including increased stroke volume and improved cardiac output (Gibala et al., 2012).

Furthermore, repeated activation of large muscle groups during stretch-shortening cycle (SSC) movements may enhance peripheral adaptations such as increased capillary density and mitochondrial enzyme activity, thereby improving oxygen extraction and utilization (Markovic & Mikulic, 2010). Meta-analytic evidence has also demonstrated that plyometric jump training can improve aerobic performance markers in youth and adult populations (Ramírez-Campillo et al., 2018).

The magnitude of improvement observed in the present study is clinically meaningful. Cardiorespiratory fitness is a strong independent predictor of cardiovascular disease and all-cause mortality (Blair et al., 1989). Even moderate increases in VO₂max are associated with substantial reductions in cardiometabolic risk. Therefore, the findings suggest that plyometric training may serve as an effective health-promotion strategy in tertiary education settings, particularly where access to traditional aerobic training facilities is limited.

Muscular Endurance

The largest effect size in this study was observed for muscular endurance. While plyometric exercises are commonly associated with power development, repeated high-intensity SSC loading may also

enhance fatigue resistance through neuromuscular adaptations. Improvements in motor unit recruitment efficiency and synchronization reduce energy wastage during repeated contractions, thereby enhancing endurance performance (Markovic & Mikulic, 2010).

Additionally, high-intensity training has been shown to improve oxidative capacity and buffering tolerance in skeletal muscle, particularly in previously untrained individuals (Gibala et al., 2012). These adaptations may explain the substantial increase in push-up performance observed in the experimental group.

Previous research has primarily examined plyometric training in athletic populations; however, improvements in muscular function have been consistently reported across various performance measures (Chu & Myer, 2013). The present findings extend this evidence by demonstrating that structured plyometric training can significantly enhance muscular endurance in non-athletic young adults.

From a practical perspective, improved muscular endurance may enhance functional capacity, reduce fatigue during daily activities, and support injury prevention by improving muscular stabilization around joints.

Flexibility

Significant improvements in flexibility were also observed following the intervention. Although plyometric training is not traditionally prescribed as a flexibility-focused modality, dynamic eccentric–concentric muscle actions inherent in SSC movements may enhance muscle–tendon unit compliance.

Eccentric loading has been shown to reduce passive muscle stiffness and increase stretch tolerance (Behm & Chaouachi, 2011). Repeated dynamic movements through functional ranges of motion may therefore contribute to improved flexibility. Furthermore, dynamic stretching components commonly incorporated into plyometric warm-up routines may

also enhance acute and chronic range-of-motion adaptations (Behm & Chaouachi, 2011).

These findings suggest that plyometric training may offer integrated benefits for both performance and mobility, reducing the need for separate flexibility sessions in time-constrained institutional environments.

Body Composition

The reduction in BMI observed in the present study was statistically significant but demonstrated a smaller effect size compared with performance-related variables. This outcome is consistent with previous literature indicating that short-term exercise interventions without dietary modification typically produce modest changes in anthropometric measures.

High-intensity exercise modalities, including plyometric training, increase excess post-exercise oxygen consumption (EPOC), thereby elevating total daily energy expenditure (LaForgia et al., 2006). Elevated metabolic demand may promote gradual fat mass reduction over time. However, the absence of dietary monitoring in this study may have attenuated the magnitude of BMI change.

It is also important to note that BMI does not differentiate between fat mass and lean mass. Given that plyometric training may stimulate increases in lean muscle mass (Chu & Myer, 2013), improvements in body composition may have been partially underestimated.

Nonetheless, even modest reductions in BMI among young adults may contribute to long-term reductions in cardiometabolic risk.

Integrated Interpretation

Collectively, the findings demonstrate that plyometric training induces coordinated adaptations across cardiovascular, neuromuscular, and metabolic systems. The large improvements in cardiorespiratory fitness and muscular endurance suggest that high-intensity dynamic training can effectively improve

functional fitness in previously untrained populations.

Importantly, the intervention required minimal equipment and was implemented within a typical tertiary institution setting, supporting its ecological validity and scalability. In resource-limited contexts where traditional gym-based training may be inaccessible, plyometric programs represent a practical and cost-effective alternative.

Study Limitations and Future Directions

Despite its strengths, the study has limitations. The sample size was relatively small and limited to male participants, restricting generalizability. Dietary intake was not controlled, which may have influenced body composition outcomes. Additionally, BMI was used as a proxy for body composition rather than more precise measures such as dual-energy X-ray absorptiometry.

Future studies should incorporate larger, mixed-gender samples, extended intervention durations, and advanced body composition assessments. Comparative studies evaluating plyometric training against traditional aerobic or resistance training modalities may further clarify its relative effectiveness

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