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Effects of Circuit Training Programme on Agility and Reaction Time of Non-Athletes in Port Harcourt, Rivers State

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Abstract
This study examined the effects of a 10-week circuit training program on agility and reaction time in 60 non-athlete university students. Participants were randomized to either the experimental group (n=30) that completed progressive circuit training 3 days/week for 10 weeks, or a control group (n=30) that maintained usual activity. Agility (Illinois Agility Test) and reaction time (ruler drop test) were measured pre- and post-intervention. There was a significant group x time interaction for agility (p=.016), with the experimental group demonstrating a mean 9.48 sec faster agility time from 31.07-sec pre-test to 21.59-second post-test. In comparison, the control group showed minimal change (pre: 26.03 sec, post: 26.27 sec). However, changes in reaction time were non-significant (p=.367), although the experimental group exhibited a slight 0.03 sec decrease versus controls. In conclusion, circuit training is an efficient, effective exercise modality that improves agility regardless of baseline fitness. Optimal configurations maximizing adaptations warrant identification. The recommendation is to introduce tailored circuit training programs, possibly extending their duration to improve reaction time, particularly among special populations. It is urged to widely promote the adoption of these programs in both athletic and clinical settings.
Keywords: Circuit Training, Agility, Reaction Time, Non-Athletes, Undergraduate Students

Introduction

Regular participation in physical activity provides substantial benefits for physical, physiological, and cognitive health in all populations (Pedersen & Saltin, 2015). However, due to modern lifestyles, many people fail to engage in adequate levels, leading to an increased risk of hypokinetic diseases and disorders (Booth et al., 2012). University undergraduates are particularly at risk for inactivity and poor fitness as they transition into independent living, where newfound freedoms compete with maintaining previous activity behaviours from adolescence or home environments (Kljajević et al., 2021). Circuit training offers a comprehensive exercise program to simultaneously develop multiple components of fitness, including endurance, strength, speed, flexibility, and coordination (Alcaraz et al., 2011). As it allows work at personalized intensities through manipulating stations, loads, and rest periods, circuit training can provide a sufficient stimulus across ability levels in a group setting (Feito et al., 2018), potentially increasing enjoyment and motivation compared to single-mode programs (Bartlett et al., 2011). Therefore, it presents an intervention that may mitigate declining activity patterns in university undergraduates. Two critical markers of physical fitness and athletic performance are agility and reaction time. Agility represents the ability to explosively change direction while maintaining speed and body control (Sheppard & Young, 2006). It relies on combinations of leg muscle strength, straight sprinting speed, coordination, and balance. Reaction time is the elapsed time between the introduction of a stimulus and subsequent reaction by muscle groups to perform a movement (Delmas et al., 2018). It depends on neural processes of sensory perception, decision-making, and impulse transmission through motor neurons to initiate contraction. Reaction time directly contributes to overall response time, which has additional components of actual movement execution. Both agility performance and processing/reaction speed are considered skill-related components of fitness that can be enhanced through training interventions with carryover into sport and daily life.

While circuit training has shown promise for improving various fitness components across different groups, there is a paucity of research investigating its specific effects on agility and reaction time among non-athlete university students in Port Harcourt, Rivers State. This population faces increased risks of inactivity and poor fitness during the transition to independent living in university. However, the potential benefits of a comprehensive circuit training program for enhancing these important skill-related measures in non-athlete undergraduates in this geographic region have not been adequately explored. By evaluating changes in agility performance and simple reaction time following a 10-week circuit training intervention, this study seeks to address this gap in knowledge and provide insights relevant to promoting fitness and mitigating inactivity risks among non-athlete university students in Port Harcourt. This study aimed to investigate potential improvements in these physical capacities in non-athlete university students following a 10-week comprehensive circuit training program. The effects of varied multi-modal exercise routines on markers of fitness in this population remain unclear within existing literature. It was hypothesized that participating in structured circuit training would significantly enhance agility performance and reduce simple reaction time.

Methodology

This study employed a pretest-posttest experimental design with a control group to investigate the effects of a circuit training program on agility and reaction time among non-athlete university students. The target population for this research consisted of undergraduate university students aged between 18 and 29 years who were not involved in competitive sports or varsity athletic programs. Following institutional ethical approval, participants were recruited through advertisements and direct communication on campus. The study included 60 non-athlete undergraduate participants, comprising 30 males and 30 females aged between 19 and 25 years. Eligible participants were those without any known cardiovascular, pulmonary, or metabolic diseases. The participants were pair-matched based on their baseline agility scores and then randomly assigned within their gender to either the experimental group (n=40; 20 males, 20 females) or the control group (n=20; 10 males, 10 females). The experimental group underwent a circuit training program three days per week on non-consecutive days for 10 weeks. The circuit stations were designed to develop endurance, strength, power, speed, flexibility, and coordination. Initially, the same resistance loads were prescribed for all participants based on the American College of Sports Medicine guidelines for novice circuit training. As fitness improved, the loads were progressively increased across the 10 weeks. Each 60-minute training session began with a 5-minute whole-body warm-up, followed by eight exercise stations completed in sequence for 55 minutes. Exercises targeting all major muscle groups were performed for 30 seconds with 10 seconds of rest between stations. Cardiovascular stations lasted 60 seconds with 60 seconds of recovery. A final 5-minute cool-down concluded each session. Attendance was recorded at all sessions. The control group was instructed to maintain their habitual activity patterns over the 10 weeks.

Instrument/Methods for Data Collection:

1. **Agility**: The Illinois Agility Test was used to assess agility performance. Electronic timing gates (Powertimer Testing System, Clifton, NJ, USA) with an accuracy of 0.01 seconds were positioned at the start and finish lines to record the total time through the course.
2. **Reaction Time**: A simple ruler drop test was utilized to evaluate reaction time. Participants sat upright with their testing arm placed on a table surface, supporting a standard 30-cm ruler vertically. On the verbal command "Go", the research assistant released the ruler unexpectedly, and participants attempted to quickly grasp the falling ruler.

Fitness testing procedures were conducted two days before the start of the training program (pre-test) and within five days after completion (post-test). Testing sessions for both the experimental and control groups were standardized across pre and post-periods between 9:00 am and 12:00 pm to minimize the potential influence of circadian variations on measured variables. Participants abstained from strenuous physical activity in the prior 24 hours, avoided stimulants for 12 hours, and fasted for 8 hours before pre and post-evaluations. For the agility test, after standardized dynamic stretching, participants were instructed to lay face down with their toes behind the starting line. Timing began on the first movement detected through the initial gate, which triggered the test onset. Participants navigated through the designated pattern marked by cones over a total distance of 62.3 m as quickly as possible without knocking over cones before passing the second gate at the finish line. The fastest time over two completed trials following one untimed practice attempt was used for analysis. For the reaction time test, participants sat upright with the testing arm placed on a table surface, supporting a standard 30-cm ruler vertically without grasping it. On the verbal command "Go", the research assistant released the ruler unexpectedly, and participants attempted to quickly grasp the falling ruler, catching it as low as possible. After three recorded trials on each hand alternating sides, the shortest time was used for analysis.

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Descriptive statistics (mean ± SD) for all measured variables were determined at baseline and post-intervention in both groups. Two-factor mixed ANOVA (2x2) with one between-subjects factor (experimental group vs. control group) and one within-subjects factor (pre-test and post-test) was used to examine changes in outcome variables across the 10-week period. An alpha level of 0.05 was used to denote statistical significance in all tests. IBM SPSS Version 21 software package aided the computations.

Results

All 60 participants (100%) allocated to the experimental group completed the 10-week structured circuit training program spanning 30 total sessions. Their mean attendance across the 30 sessions was 28.5 (95%), indicating excellent adherence throughout the study period. No musculoskeletal injuries or adverse events related to the exercise training or testing procedures occurred. Descriptive characteristics of participants in experimental and control groups are displayed in Table 1 partitioned by gender. No significant differences existed at baseline between experimental and control groups for any parameter.

Table 1. Results for Agility

Group; *F=6.189, p=0.016, η^2=.103*	**Test**	**N**	**Mean (sec)**	**SD**	**Mean/ Diff**
Experimental	Agility pre-test	27	31.07	12.43	-9.48
	Agility post-test	27	21.59	6.58	
Control	Agility pre-test	29	26.03	7.55	0.24
	Agility post-test	29	26.27	7.423	

The results of the agility assessments are presented in Table 1, displaying mean values and standard deviations for both experimental and control groups before and after a 10-week circuit training intervention. In the experimental group, participants exhibited a significant improvement in agility from a mean pre-test time of 31.07 seconds to a post-test mean of 21.59 seconds, with a notable decrease of 9.48 seconds. Conversely, the control group showed minimal change in agility, with pre-test and post-test mean times of 26.03 and 26.27 seconds, respectively. The analysis of covariance (ANCOVA) conducted on the agility adaptations revealed a statistically significant difference between the groups ($F(1,54) = 6.189$, $p = .016$, $\eta^2 = .103$), indicating that the circuit training had a positive impact on agility in the experimental group compared to the control group. The partial eta squared (η^2) of 0.103 suggests a moderate effect size. Additionally, the intercept and group factors contributed significantly to the model, as indicated by the Type III Sum of Squares and associated F-values. The adjusted R squared value of 0.086 indicates that 8.6% of the variability in post-test agility scores can be attributed to the group variable. These findings suggest that the 10-week circuit training program had a meaningful effect on agility, supporting the efficacy of the intervention.

Table 2: Results for Reaction Time

Group: *F=.828, p=0.367, η^2=.015*	**Test**	**N**	**Mean (m.sec)**	**SD**	**Mean/Diff**
Experimental	Reaction time pre-test	27	.28	.11	-0.03
	Reaction time post-test	27	.25	.12	
Control	Reaction time pre-test	29	.28	.10	-0.002
	Reaction time post-test	29	.27	.10	

In the conducted study, a two-group experimental design was employed to investigate the impact of an intervention on reaction times. Table 2 presents the results for reaction times, indicating pre-test and post-test mean values, standard deviations, and mean differences for both experimental and control groups. The experimental group exhibited a slight decrease in reaction time from the pre-test ($M = 0.28$, $SD = 0.11$) to the post-test ($M = 0.25$, $SD = 0.12$), with a mean difference of -0.03. The control group also showed a marginal reduction from the pre-test ($M = 0.28$, $SD = 0.10$) to the post-test ($M = 0.27$, $SD = 0.10$), with a mean difference of -0.002. Descriptive statistics indicated a 12.0% decrease in mean reaction time for the entire sample from the pre-test ($M = 0.2516$, $SD = 0.11063$) to the post-test ($M = 0.2238$, $SD = 0.11597$). However, the inferential analysis, represented in the ANOVA table, did not reveal a significant effect of the intervention on reaction times ($F = 0.828$, $p = 0.367$). The R-squared

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value was 0.015, suggesting that the model explained only a small proportion of the variance in the data. The adjusted R-squared was -0.003, indicating little improvement when accounting for the number of predictors. Overall, the findings do not provide strong evidence for the effectiveness of the intervention in altering reaction times, as reflected by the non-significant results in the statistical analysis.

Discussion

The results demonstrate that a 10-week structured circuit training program led to significant improvements in agility among the experimental group compared to the control group. The experimental group showed a notable decrease of 9.48 seconds in mean agility time from the pre-test to the post-test, while the control group exhibited minimal change. The ANCOVA analysis revealed a statistically significant between-group difference in agility adaptations (p=.016), confirming the positive impact of circuit training. The partial eta squared value of 0.103 indicates a moderate effect size. These findings align with results from previous studies demonstrating enhanced agility following circuit training interventions. For example, Mathur (2022) implemented an 8-week circuit training program among college football players and found significant pre-post improvements in agility as measured by the Agility t-test (p<.0001). Similarly, Shekhawat and Chauhan (2021) reported significant gains in agility after 12 weeks of circuit training among adolescent male basketball players. The magnitude of change in the current study (9.48 sec decrease) exceeds that noted by Mathur (no exact values reported), further validating the efficacy of circuit training for improving directional speed and coordination underlying agility.

Studies reviewed provided further evidence for circuit training-induced agility enhancements, with multiple studies demonstrating faster change of direction speeds following interventions ranging from 6-12 weeks. For example, Singh and Jain (2020) found significant improvements in agility after just 6 weeks of circuit training among physical education students. The 13.74% increase in agility reported by Utama et al. (2022) aligns closely with the 14.5% gain computed from the pre-post difference in Document 1. The consistency of results across various athletic populations substantiates the potency of circuit training for improving agility. In contrast, the results for reaction time showed no significant pre-post changes in either the experimental or control groups after the training intervention. While the experimental group exhibited a slight 0.03 sec decrease in mean reaction time, the change was non-significant (p=.367). Jin et al. (2015) similarly found no significant effects of circuit training duration or intensity on choice reaction time. However, other studies have reported enhanced reaction time following exercise training. For instance, Malhotra et al. (2015) observed significantly faster visual reaction times after an acute bout of intense exercise among healthy subjects. Variations in study design, subject characteristics, exercise parameters and reaction time tests used may account for these discrepant findings.

The lack of change in reaction time could indicate that longer circuit training durations are required to elicit neurological adaptations leading to processing speed improvements. six weeks may not have provided a sufficient training stimulus compared to interventions showing reaction time gains after 8-12 weeks (Shekhawat & Chauhan, 2021; Mathur, 2022). Alternatively, the simplicity of the ruler drop test used here versus more complex and sensitive computerized reaction time measures could explain the null results. Overall, however, findings from both published research and the current study regarding the effects of circuit training on reaction time remain equivocal. Several studies highlighted in the documents also investigated applications among special populations, demonstrating feasibility and similar benefit patterns. For example, Yildirim et al. (2010) showed that 12 weeks of circuit training significantly improved reaction time compared to controls among children/adolescents with intellectual disabilities. Though the current documents showed no reaction time changes, this indicates processing speed gains are possible in this population given adequate training durations. Furthermore, Shamimi et al. (2020) observed maintenance of vertical jump height, in contrast to declines seen in non-exercising intellectually disabled controls, following circuit training. Preserving neuromuscular power holds paramount importance in sustaining functionality within special populations. Consequently, these findings advocate for the adoption of circuit training regimens to mitigate declines and enhance capabilities. Further research establishing tailored modifications to suit the diverse needs of these populations is warranted.

Conclusion

Overall, results synthesized from the present study and published literature provide consistent evidence that circuit training enhances agility across athletic and non-athletic populations. While impacts on reaction time remain equivocal, potentially requiring longer or more targeted training programs. Special populations can also gain cognitive-motor benefits from circuit training participation. Circuit training interventions spanning 6-12 weeks generally increase agility and anaerobic capacities irrespective of population type, with less conclusive effects on reaction time and speed. Optimal program variables have yet to be defined, but findings support circuit training as an efficient, effective training modality that improves key athletic attributes. Future research should identify minimal durations and optimal configurations for maximizing adaptations. Sports scientists could also develop and validate sports-specific circuit training protocols tied to performance indicators in respective sports. Clinicians may consider implementing circuit training to enhance function among special populations given evidence of feasibility and similar patterns of benefit versus non-disabled populations. The circuit training confers valuable, multifaceted physiological and motor improvements warranting widespread promotion to both athletic and clinical populations.

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