Impact of circuit training on total distance covered and VO2 max in national-level women cricket players of Bangladesh

Impacto del entrenamiento en circuito en la distancia total recorrida y el VO2 máximo en jugadoras de críquet a nivel nacional de Bangladesh

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Abstract

Background and Study Aim: The study investigates the effect of circuit training on the cardiorespiratory fitness of national-level female cricket players in Bangladesh. Thirty players were randomly selected from different playing positions (batters, bowlers, and all-rounders) and underwent a pre-and post-test design with no control group.
Material and Methods: The primary measure of cardiorespiratory fitness was assessed using the Yo-Yo Intermittent Recovery Test Level-1 (YYIRT1), where the total distance covered and VO2 max were recorded. The players participated in a circuit training program thrice weekly for four weeks. Significant improvements were observed in total distance covered and VO2Max across all player categories (batters, bowlers, and all-rounders).
Results: After the four-week circuit training program, significant within-group improvements were found in total distance covered and VO_2 max across all groups. Batters, bowlers, and all-rounders increased their total distance by 48.92%, 53.36%, and 30.51%, respectively (all $p < 0.001$). VO_2 max improved by 8.68%, 9.11%, and 5.00%, respectively (all $p < 0.001$). Significant time effects were observed for both total distance covered and VO_2 max ($p < 0.001$), with time × group interactions also significant ($p \leq 0.05$). No significant group effects were found.
Conclusions: The study concludes that circuit training can effectively enhance the cardiorespiratory fitness of female cricket players, contributing to optimal performance in national-level competition. The findings support the integration of circuit training into regular fitness programs for female athletes, helping them meet the physical demands of cricket.

Keywords

Circuit training; Cardiorespiratory fitness; Female cricket players; VO_2Max; Yo-Yo Intermittent Recovery Test.

Resumen

Antecedentes y objetivo del estudio: El estudio investiga el efecto del entrenamiento en circuito sobre la aptitud cardiorrespiratoria de jugadoras de críquet a nivel nacional en Bangladesh. Se seleccionaron al azar treinta jugadores de diferentes posiciones de juego (bateadores, lanzadores y jugadores polivalentes) y se sometieron a un diseño de prueba previa y posterior sin grupo de control.
Material y métodos: La medida principal de la aptitud cardiorrespiratoria se evaluó mediante la prueba de recuperación intermitente Yo-Yo Nivel-1 (YYIRT1), donde se registraron la distancia total recorrida y el VO2 máximo. Los jugadores participaron en un programa de entrenamiento en circuito tres veces por semana durante cuatro semanas. Se observaron mejoras significativas en la distancia total recorrida y el VO2Max en todas las categorías de jugadores (bateadores, lanzadores y todoterreno).
Resultados: Después del programa de entrenamiento en circuito de cuatro semanas, se encontraron mejoras significativas dentro del grupo en la distancia total recorrida y el VO_2 máximo en todos los grupos. Los bateadores, lanzadores y polivalentes aumentaron su distancia total en un 48,92%, 53,36% y 30,51%, respectivamente (todos $p < 0{,}001$). El VO_2 máx mejoró en un 8,68 %, 9,11 % y 5,00 %, respectivamente (todos $p < 0{,}001$). Se observaron efectos significativos del tiempo tanto para la distancia total recorrida como para el VO_2 máx. ($p < 0{,}001$), y las interacciones tiempo × grupo también fueron significativas ($p \leq 0{,}05$). No se encontraron efectos grupales significativos.
Conclusiones: El estudio concluye que el entrenamiento en circuito puede mejorar eficazmente la aptitud cardiorrespiratoria de las jugadoras de críquet, contribuyendo a un rendimiento óptimo en competiciones a nivel nacional. Los hallazgos respaldan la integración del entrenamiento en circuito en los programas regulares de acondicionamiento físico para las atletas, ayudándolas a satisfacer las demandas físicas del cricket.

Palabras clave

Entrenamiento en circuito; aptitud cardiorrespiratoria; Jugadoras de críquet; VO2máx; Prueba de recuperación intermitente Yo-Yo.

Introduction

Physical fitness refers to a player's ability to engage in sports without fatigue, jump high, run fast, change direction quickly, and extend their joints to their full potential (Jacobs et al., 2024). Physical fitness includes health-related and skill-related components such as body composition, muscular endurance, cardiovascular endurance, flexibility, and muscular strength, all of which are associated with a person's health (Koley, 2011).

Cricket performance is heavily reliant on physical fitness. Physically fit cricket players have been shown to perform better, be more reliable and less injury-prone (Marín-Pagán et al., 2020). On the other hand, cricket is a game that tests mental and physical strength as well as playing ability. The importance of fitness will vary depending on the game and the player's role in the team. For example, one-day cricket matches require athletes to be in better shape than Test matches, and a fast bowler may have stricter fitness standards than an opening batter (Ahamad et al., 2015).

Cardiorespiratory fitness is essential for cricket players, as it allows them to sustain prolonged physical exertion and maintain peak performance for extended periods in various aspects of the game, such as running between the wickets, fielding and bowling or batting (Marín-Pagán et al., 2020). In this context, circuit training has emerged as an effective method for increasing cardiorespiratory fitness by combining different exercises that target different muscle groups and energy systems, thereby promoting overall physical conditioning according to the specific demands of the sport (Ahamad et al., 2015).

Circuit training is one form of conditioning that is an efficient way for coaches to train many athletes in limited time and space with limited equipment. This training combines resistance and aerobic exercise, allowing the body to use the maximum amount of oxygen during exercise (Taşkin, 2009). This is very important for athletes in sports like cricket, where endurance and strength are essential to perform well. This training promotes coordination, flexibility, anaerobic and aerobic endurance, and strength. Several studies have been conducted on the effect of circuit training on various physical fitness qualities of cricket players and other athletes. The researcher was thus motivated to conduct this study in order to fill the following gap: Most of the abovementioned studies were focused on the effect of circuit training on male players (Stuelcken et al., 2007). Since no study on this issue has been done on Bangladeshi National female cricket players to date, this study might help to fill this gap. Therefore, this study aimed to determine the effect of circuit training on the cardiorespiratory fitness qualities of National-level female cricketers in Bangladesh. In light of these considerations, this research aims to provide empirical insights into the effectiveness of circuit training regimes on the cardiorespiratory fitness levels of national-level Bangladeshi women cricket players (Mola & Bayisa, 2020). This knowledge can contribute to the existing body of literature and inform future training and conditioning strategies in the sport, ultimately equipping female cricketers with the physical attributes necessary to meet the competitive demands of national-level competition (Marín-Pagán et al., 2020).

This study not only seeks to validate the benefits of circuit training but also highlights the importance of incorporating evidence-based, gender-specific training methodologies in the preparation of female athletes, ensuring they can reach their full potential and succeed at the highest levels of the sport. Moreover, addressing the intricacies involved in the training methodologies for female cricketers will help bridge the knowledge gap in current sports science literature, particularly related to the practical applications of these findings in cricket-specific training contexts. Ultimately, by focusing on the impact of circuit training on this demographic, the research endeavors to offer actionable recommendations that coaches can implement in training programs, thereby enhancing the overall standard of performance within women's cricket in Bangladesh and contributing to the growth of the sport on a global scale.

Method

Participants

The study involved thirty (N=30) national-level women cricket players from Bangladesh. Participants were randomly selected based on their performance in the domestic cricket league, with specific selection criteria including key performance indicators such as batting averages, bowling economy rates, and all-rounder statistics from the past season. Players must have played at least ten competitive matches in the domestic league to qualify for selection. The selected players were invited to the national coaching camp, where they were divided into three equal-sized groups based on their roles: batters (n=10), bowlers (n=10), and all-rounders (n=10), ensuring a balanced representation across playing positions.

Research Design

This study employed a pre-test and post-test single-group experimental design to evaluate the effects of circuit training on the aerobic capacity of national-level female cricket players. Although the inclusion of a control group is ideal in experimental research to establish stronger causal inferences, it was not feasible in this context due to logistical constraints. All selected participants were part of a centralized national coaching camp where training protocols were uniformly administered by national staff. Isolating a subset of athletes from the training regimen for the purpose of serving as a control group would not only disrupt the structured training schedule but also raise ethical concerns regarding equitable access to performance-enhancing programs.

Despite the absence of a control group, several methodological strategies were implemented to mitigate potential biases. Each participant served as her own control through the use of pre- and post-intervention testing, which allows for the assessment of within-subject changes over time. Standardized testing protocols were maintained across all sessions, ensuring consistency in measurement conditions.

Participants were further categorized based on playing roles into three subgroups—batters, bowlers, and all-rounders—to examine whether responses to the training intervention varied across positions. The circuit training program was conducted three times per week over a period of four weeks (28 days), with all sessions held in the afternoon. The primary outcome variables, total distance covered and VO_2 max, were measured using the Yo-Yo Intermittent Recovery Test Level-1 (YYIRT1), a validated tool for assessing aerobic fitness in intermittent sports.

Table 1. The study design layout

Treatment	Circuit exercise training method program
Frequency	3 days per week
Total duration	28days (4 weeks)
Exercise days	Saturday, Monday and Wednesday
Time of training	Afternoon (for all exercise days)

Criterion Measures

Table 2. Criterion Measures for Cardiorespiratory Fitness

Criterion measure	Description	Calculation/Formula
Total distance covered	Cumulative distance run by each participant during the YYIRT1, reflecting endurance and aerobic capacity.	
Vo_2max	Maximum rate of oxygen consumption indicating aerobic fitness, calculated from the distance covered in YYIRT1.	VO2 Max (mL*kg-1*min-1) = IR1 distance (m) × 0.0084 + 36.4

Data Collection Procedure

The data collection process occurred in two distinct phases: the pre-test phase and the post-test phase. Baseline data were collected during the pre-test phase before initiating the circuit training program. All participants completed a YYIRT1 to assess aerobic fitness, with total distance covered and VO2 max documented as performance metrics. The post-test was administered immediately after completing the four-week circuit training program, adhering to the same procedure as the pre-test to maintain consistency and reliability.

The Declaration of Helsinki's ethical guidelines were followed in this study (WMA - The World Medical Association-WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Participants, 2024). We obtained ethical clearance for our study (ERC/FBST/JUST/2023-161) from the Faculty of Biological Science and Technology at Jashore University of Science and Technology, Bangladesh. Before data collection commenced, all participants received comprehensive information regarding the study's objectives, methodologies, and their entitlement to withdraw at any point without repercussions. Before taking part in the study, each subject gave their informed consent. Personal information and data were anonymized to maintain confidentiality, with results reported solely in aggregate form.

Conducting the YYIRT1

The YYIRT1 was carried out on a 20-meter track marked by cones. Individuals had to travel between these cones at increasingly quicker speeds, as indicated by aural cues, for the examination (Figure 1). A 5-meter recuperation zone was established at one end of the circuit, allowing runners to rest or jog between runs. The test instructions were administered similarly to all participants, emphasizing the significance of running as far as possible while remaining in rhythm with the auditory signals. After each 20-meter run, athletes had 10 seconds to jog around the recovery marker before starting the next run. The examination stopped when the individual could not keep up with the audio cues. The overall distance completed by each participant and their corresponding VO2 max values were the major parameters used to evaluate test performance. The total distance covered was calculated by multiplying the number of shuttles completed by 40 meters (2 x 20 meters). VO2Max was calculated using the formula: VO2Max (mL·kg-1·min-1) = IR1 distance (m) × 0.0084 + 36.4.

Circuit Training Program

The circuit training program was conducted three times a week for four weeks. Each session began with a 15-20-minute warm-up, followed by exercises designed to improve aerobic and anaerobic capacity. The exercises and recovery times were progressively adjusted each week to challenge the participants and enhance their fitness levels. The training sessions targeted specific energy systems, ensuring the players developed endurance and strength throughout the program.

Figure 1. During data collection

Statistical Analysis

Data normality was assessed using the Shapiro-Wilk test. Results are presented as means and standard deviations. A mixed-design ANOVA (2 x 3) was conducted to assess the effects over time (pre- and post-test) across three groups (batters, bowlers, and all-rounders). Additionally, ANCOVA was performed with pre-test scores as covariates to compare post-test differences between groups, followed by Bonferroni-adjusted independent t-tests for post-hoc analysis. Paired t-tests were conducted to assess within-group changes from pre- to post-test. Additionally, percentage change scores for each variable within each group were calculated in Microsoft Excel using the formula: (meanpost−meanpre)/meanpre×100. Effect sizes (ES) were reported as partial eta squared (η^2p) based on ANOVA results. Hedge's g, derived from paired t-tests, evaluated group-specific changes from pre- to post-measurements. Hedge's g, obtained from paired t-test results, was used to evaluate specific changes within each group from pre- to post-measurements. Effect size interpretation for partial eta squared (η^2p) was categorized as small (<0.06), moderate (0.06–0.13), and large (≥0.14). Hedge's g was interpreted with the following thresholds: trivial (<0.2), small (0.2–0.6), moderate (>0.6–1.2), large (>1.2–2.0), very large (>2.0–4.0), and extremely large (>4.0). Statistical significance was determined at p≤0.05.

Results

Below table-4 of normality showed that Data were normally distributed and passed homogeneities too. So researcher opted parametric statistical tool to draw inferences from the collected data.

Table 3 presents the demographic characteristics of participants across the groups, showing no significant differences in baseline scores. No significant baseline differences were found for any dependent variable (one-way ANOVA, p = 0.466–0.774). As shown in Table.5, A four-week circuit training program resulted in significant within-group percentage changes from pre- to post-test across all groups. As shown in Fig.2, Total Distance Covered: batters showed a 48.92% (t=6.459, p =< .001, d=2.04); bowlers showed a 53.36% (t=8.171, p =< .001, d=2.58); and all-rounders showed a 30.51% (t=4.723, p =0.001, d=1.49). As shown in Fig.3, VO2 Max: batters showed a 8.68% (t=6.458, p =< .001, d=2.04); bowlers showed a 9.11% (t=8.186, p =< .001, d=2.58); and all-rounders showed a 5.00% (t=4.688, p =0.001, d=1.48). Significant time effects were observed for total distance covered (F2,27=124.53, p =< .001) and VO2 Max (F2,27=124.53, p =< .001). However, no significant group effects of total distance were covered (F2,27=1.88, p =0.352) and VO2 Max (F2,27=1.08, p =0.353). A significant time × group interaction was observed when comparing the groups at post-test, with baseline scores as covariates. Notable differences were found in the total distance covered p≤0.05 and VO_2 max p≤0.05.

Table 3. Participants' demographics characteristic

	Batters (n = 10)	Bowlers (n = 10)	All-rounders (n = 10)	*P* value*
Age (yrs)	26.70 ± 3.16	22.50 ± 5.52	28.40 ± 4.14	0.016
Height (cm)	156.2 ± 0.03	160.4 ± 0.06	156.7 ± 0.03	0.111
Weight (kg)	54.60 ± 3.50	53.40 ± 3.62	53.50 ± 4.55	0.752
BMI (kg/m²)	22.42 ± 2.01	20.81 ± 1.90	21.78 ± 1.78	0.182

*Significant at p < 0.05

Table 4. Tests of Normality (Shapiro-Wilk)

	Group	Vo_2Max			Distance		
		Statistic	df	Sig.	Statistic	df	Sig.
Pre-Test	Batter	.948	10	.646	.948	10	.642
	Bowler	.965	10	.838	.965	10	.838
	All-rounder	.828	10	.052	.823	10	.058
Post-Test	Batter	.954	10	.720	.954	10	.719
	Bowler	.948	10	.643	.948	10	.642
	All-rounder	.805	10	.057	.805	10	.057

Table 5. Statistical comparisons within and between groups for all the dependent variables

Variables	Batters (n = 10)		Bowlers (n = 10)		Allrounders (n = 10)		ANOVA P Value (η^2_p)		
	Pre-test	Post -Test	Pre-test	Post -Test	Pre-test	Post -Test	Time effect	Group effect	Time × Group Interaction
Total Distance Covered	932 ± 199.60	1388 ± 349.75[a]	892.00 ± 307.56	1368 ± 449.31[a]	852.00 ± 214.20	1112 ± 233.08[a]	< .001 (0.822)	0.352 (0.074)	0.037 (0.217)
VO_2 Max	44.22 ± 1.67	48.06 ± 2.93[a]	43.89 ± 2.58	47.89 ± 3.77[a]	43.56 ± 1.79	45.74 ± 1.95[a]	< .001 (0.821)	0.353 (0.074)	0.036 (0.219)

*Note: significant difference between pre-and post-test

Figure 2. Depicts the total distance covered mean changes from pre- to post-intervention across the three groups: batters, bowlers, and all-rounders.

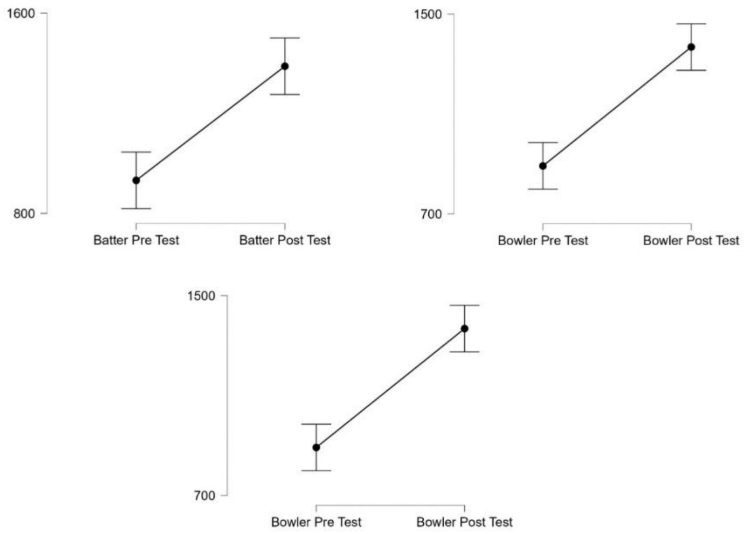
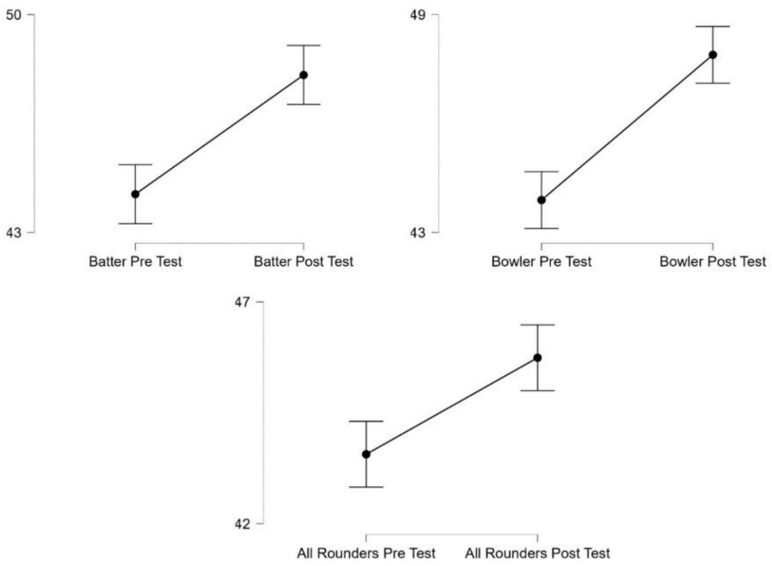


Figure 3. Depicts the VO2 Max mean changes from pre- to post-intervention across the three groups: batters, bowlers, and all-rounders.



Discussion

The findings of this study demonstrate that circuit training significantly enhances cardiorespiratory fitness in national-level female cricket players in Bangladesh. The marked improvements observed across different player categories—batters, bowlers, and all-rounders—emphasize the adaptability of this training methodology to meet the aerobic and anaerobic demands of cricket (Kumar et al., 2023). These findings are supported by previous research in that structured training interventions such as circuit training are capable of producing significant enhancement in endurance, recovery capital, and oxygen utilization in physically demanding sports athletes (Christie et al., 2008). This improvement is critical for cricket players who need high fitness levels to excel in long matches, maintain focus during crucial moments, and perform consistently throughout their competitive seasons (Nilesh AF., 2023; Fitrian et al., 2023).

One notable finding was the significant increases in VO_2 max and total distance covered, as measured by the Yo-Yo Intermittent Recovery Test Level-1. These enhancements reflect improved aerobic capacity and recovery, vital for sustaining performance during continuous play and repeated high-intensity efforts, such as sprinting between wickets or executing quick bowling spells (Pote et al., 2020). This is particularly relevant to cricket, where physical and mental endurance is tested over extended periods, and minor gains in fitness can translate into considerable performance advantages (Khattak et al., 2020). The consistency of these improvements across all player categories highlights the universal benefits of circuit training, irrespective of specific roles, further validating its broad applicability for conditioning athletes in cricket and other team sports (Anitha et al., 2018).

Interestingly, while the intergroup comparisons did not yield significant differences, the within-group improvements were substantial. This suggests that batters, bowlers, and all-rounders responded positively to the training intervention, each benefitting in ways aligned with their specific positional demands (Noakes & Durandt, 2000; Sunarto et al., 2023). However, this uniformity in outcomes may not necessarily imply identical adaptations; rather, it raises the possibility that variations in training response are more influenced by individual characteristics than by role-specific demands. Factors such as baseline fitness, recovery ability, genetic predisposition, and previous training history can all contribute to how an athlete responds to a given intervention. This highlights the importance of considering individualized training approaches, which may further enhance outcomes by tailoring programs to each athlete's unique profile. For instance, batters rely on power, explosiveness, and sustained focus, supported by improved aerobic and anaerobic capacity (Vickery et al., 2014). Bowlers, who often face repetitive stress and high-intensity demands, showed enhancements that could aid in recovery and reduce the risk of fatigue-related injuries. The dual demands of batting and bowling, all-rounders displayed gains that likely reflect their need for well-rounded fitness, including endurance and strength (M. Kumar, 2016).

The effectiveness of circuit training also lies in its ability to incorporate a wide variety of exercises targeting multiple physiological systems. Combining aerobic and resistance components allows athletes to optimize oxygen consumption, build muscular endurance, and improve overall functional fitness (Weldon et al., 2021). Given their sport's dynamic and multifaceted nature, such comprehensive conditioning is crucial for female cricketers, which requires quick adaptations to diverse physical challenges (Constable et al., 2021). Moreover, the observed improvements in VO_2 max suggest that circuit training can enhance energy utilization efficiency, enabling athletes to perform at higher intensities for longer durations without fatigue (Wang et al., 2023).

From a practical perspective, the findings emphasize the importance of integrating circuit training into routine fitness programs for female cricketers (Heinrich et al., 2012). Coaches and trainers use this approach to design sessions having endurance, agility and recovery to make the players more prepare physically to meet the physical demands during training and competition (Bandyopadhyay, 2020). Furthermore, the study highlights the value of tailored training methodologies that account for gender-specific physiological and performance considerations, helping female athletes bridge gaps in conditioning practices and achieve parity in fitness standards (Orchard et al., 2005; Saini & Singh, 2023).

The need for a control group in this study is limited, as it restricts the ability to establish causal relationships definitively. Despite this, the pre-and post-test designs yield helpful insight into the benefits circuit training interventions. As in any research, future work will be required to strengthen these findings and could include randomized controlled trials or comparative work with other training methods, as well as the interaction of training intensity and duration with various player positions. However, longitudinal studies can also be employed to determine the long-term effects of circuit training on the maintenance of female cricketer's fitness, their prevention of injury, and their overall performance.

Conclusions

This study reinforces the efficacy of circuit training as a conditioning tool for enhancing cardiorespiratory fitness in national-level female cricket players. The observed gains in VO_2 max and total distance covered prove its application in sports-specific training programs. Circuit training in context with the regular fitness regimens can help coaches to prepare athletes to be physically and competitively prepared for cricket, as well as improving health and injury resilience. These findings add to literature on gender specific athletic training and offer actionable recommendations for improving the physical conditioning of female cricketers at national and international levels.

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