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Effects of 8-weeks Circuit Training Programme on Physiological and Performance Characteristics of University Racket Game Players.

Abstract

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Key words: Physiological variables, Performance characteristics, Circuit training programme, Racket games.

The attainment and sustenance of excellent performance in any sporting engagement via the adoptions of specific training method alone may be in doubt without special emphasizes on general fitness training methods. This study was carried out to examine the responses exhibited by University of Ibadan racket game athletes concerning their physiological and performance characteristics following an 8-week circuit training programme.

Multistage sampling technique was used to select 32 participants. The subjects were randomly selected (male and female) from four strata that made-up racket games in the University. These are: Badminton, Table tennis, Tennis and Squash. The subjects underwent training twice a week, for eight consecutive weeks. A single group quasi-experimental design, otherwise known as repeated measure design was used for the study. Data collected were analyzed using descriptive statistics of mean, range and standard deviation for interpretations of research questions, while inferential statistics of paired t-test was adopted to confirm the significance of the stated hypotheses at the 0.05 level of significance.

The results show that there was significant difference in the pretest-posttest responses of physiological variables measured (Resting diastolic and systolic blood pressure RDBP & RSBP, resting heart rate RHR and Body Mass Index BMI). The differences recorded for the performance characteristics of speed and agility was not significant. However, measurements of cardiorespiratory endurance, general muscular endurance, arm muscular strength and flexibility showed statistically significant differences. It was recommended that racket games coaches and players should adopt regimental field training programme and engage in strenuous physical training to achieve better body compositions suitable for competitive engagement in their various sports.

Introduction

Racket sports such as Table tennis, Tennis, Badminton and Squash require a combination of psychological stability, tactical analysis, motor co-ordination as well as strong physical and physiological attributes. These demands make the sports particularly challenging for athletes at different levels (Ogino, Makita, Satomi & Yoshida, 2007). Sports scientists and coaches are often reluctant over the adoptions of seeding method of placement for players in major competitions due to imminent drop in performance, coupled with non-availabilities of profile that contained database reference for periodic measure of performance and physiological

conditioning of athletes (Kawazoe & Yoshinari, 2005).

Cardiovascular system, that combines effective functioning of the heart and blood vessels play a vital role in the maintenance of body homeostasis, which depends on the continuous and controlled movement of blood through the thousands of miles of capillaries that permeate every tissue and reach every cell in the body necessary for all-rounded physiological build-up for the athletes. It was explained that effectiveness of circulatory system rested in the efficiencies of microscopic capillaries that aids blood to perform its ultimate transport function. Nutrients and other essential materials pass from blood capillary into fluids surrounding the cells as waste products are removed (Sanchis, Dorado and Calbet, 2005).

The proceedings of the Second World Congress of Science and Racket Sports held in Germany in 2007 recommended field drilling for athletes in Diaspora. This may help to ensure proper build-up appropriated with compendium of skills peculiar to racket games. Also, the Fifth International Table Tennis Federation Sports Science Congress held in 2007 contain six keynote lectures which provided the latest research on a range of sport science topics as applied to tennis, table tennis, squash and badminton. These made special emphasizes on the needs for profile confirmation of physiological build-up and profile status of every participants in reference to different categories of racket games (Pokholenchuk, Posevin, & Sharara, 2006). This decision was taken due exigent expectations over the periodic ranking and seeding of the players during pre and post stages of the competition (Ogino, Makita, Satomi & Yoshida, 2007). It was further projected that, the availability of appropriate record of physiological status of the respective participants in every organized competition will afford the organizer the opportunity to further proliferate the game in every department (Kawazoe & Yoshinari, 2005).

To develop skill and competitive fitness and conditioning programme for the racket games athletes, special considerations are recommended for their skill and fitness training. This will specify the minimum standard needed to be fulfilled by every participant in terms of physiological requirements that will ensure their eligibility for the competition (Fletcher, 1994).

Pokholenchuk, Posevin, & Sharara, (2006) submitted that, in other to bridge the gap between table tennis and other racket games, special attention in terms of training should be posed on musculoskeletal and cardiovascular system of the concerned athletes. Musculoskeletal system build-up, as explained by American Association for Health Physical Education, and Recreation (AAHPER, 2006), requires 3 components of physical fitness. These are: muscular strength, muscular endurance and flexibility. These components are found to be inseparable.

Muscular strength (dynamic) is defined as the maximum force a muscle or muscle group can generate at a specific velocity. Every actions associated with rally in racket game requires this component of physical fitness for the survival of the competitive athletes during engagement Sanchis, Dorado and Calbet, (2005). Muscular endurance is the ability of muscle or muscle group to perform repeated contractions against a load for an extended period of time. A times, players may be involved in

prolong match situations that may led to exhaustion, only a very few with better muscular endurance may remain on course for the challenge Mokka, Väättänen, Vällkynen, (2003).

Flexibility has two components: dynamic and static flexibility. Dynamic or static flexibility is the opposition or resistance of a joint to motion, that is, the forces opposing movement rather than the range of movement itself. Static flexibility is the range of motion about a joint, typically measured as the degree of arc at the end of joint movement. These are highly essential for perfect executions of strokes, lob, spin, smash and service in racket games (Pokholenchuk, Posevin, & Sharara, 2006)

Sanchis, Dorado and Calbet, (2005) submitted that if muscular strength, muscular endurance and flexibility are not maintained, musculoskeletal fitness will be compromised. This can significantly impair physical health and well-being of the concerned athletes and may subsequently retard their performances during competition (Ruiz Llamas, & Cabrera Suarez, 2007).

Responses to training stimulus vary from athletes to athletes and confirmed to precede adaptations. Amusa, Igbanugo, & Toriola, (1998) described responses as spontaneous reactions or elicited traits by specified motor units under different conditions. These adaptational processes are importantly necessary to meet the high demands of today's professional tennis players as well as other racket games. The responses cannot be achieved solely by meal-specific and relative training that could be performed on the court, table or pavilion alone. Inadequacy of training programme that could induce total fitness for the athletes was described as militant to remarkable result and achievement for the coaches and concerned players in any competitive situation (Sherman, Creasey, & Batterham, 2006).

Fletcher (1994) pointed out, that there is an additional conditioning programme known to improve both aerobic and anaerobic capacities of performing athletes in every ramification. These may be in different kinds such as sprint interval training and circuit form. These kinds of training are advisable for elite and amateur players in racket games.

The purpose of this study was to examine the responses of physiological and performance characteristics of college racket game players following 8-weeks circuit training programme.

Research Hypotheses

Following research hypotheses were addressed in this study.

1. There will be no significant difference on pretest-posttest physiological variables {resting blood pressure (diastolic & systolic), resting heart rate and body mass index} among the college racket game athletes following 8-weeks circuit training programme.
2. There will be no significant difference in the pretest-posttest motor performance variables (speed, flexibility, agility, leg muscular power & cardiorespiratory endurance) among college racket game athletes following 8-weeks circuit training programme.

Methodology

The pretest-posttest single group quasi-experimental design was used for this study. This design helped to establish differential variation of adaptation among the subjects. The experimental hypotheses were tested by using pretest and posttest measures. This method allowed over-all assessment of the physiological and performance fitness components for 8- Consecutive weeks. Thus, any progression or retrogression could be detected more accurately by comparing the pretest-posttest effects on the dependent variables.

The population for this study comprised all racket game-players from University of Ibadan, Nigeria. Multistage sampling technique was used for this study. Purposive sampling technique was used to select 32 athletes among invitees from different halls of residence of the University. The number was later stratified into four strata of racket games to make a total of 8 athletes in each group. Simple random sampling technique was used to arrive at equal representation of athletes in each stratum based on gender and class of events of the subject (Table tennis, Tennis, Badminton and Squash).

Research Schedule

Eight consecutive weeks was used for the training session in this study. Prior to the commencement of this study, every participant was given an inform consent form to complete. This was followed by necessary briefing for the entire athletes on the nature of the training programme and the testing protocol to be carried out.

Procedure for Data Collection

Venue: The physiology laboratory of the Department of Human Kinetics and Health Education, University of Ibadan, Nigeria, and the University Gymnasium was used for the measurement of physical and physiological characteristics and the circuit training, which was the intervention programme (Appendix 1) The rubberized 400m track in the main bowl of University stadium was used for the 12-minute run test.

Measurement of Physical Characteristics:

Age: The participants' age was recorded in years to the nearest birthday.

Height: The height of the subject was measured with height-meter. The participant stood erect on the flat base of the height-meter, feet together with heels, buttocks and rear of the head in contact with the height-meter while looking straight ahead. The height was measured to the nearest 0.5cm.

Weight: The Hana portable weighing scale was used. This was calibrated in kilogrammes ranging from zero to 120 kilogrammes. Participants' weight was taken with only sports pants on and with no shoes. Weight was read to the nearest kilogramme.

Measurement of Physiological Characteristics:

Heart rate: The participants' heart rate was measured using the auscultation procedure as described by American College of Sports Medicine, (2000) and demonstrated by Baumgartner and Jackson, (1999). The bell of the stethoscope was put directly on the heart region. Resting heart rate was measured two minutes after standing while the recovery heart rate was measured immediately after the 12-minute run test. Heart rate was recorded in beats per minute (bpm).

Blood pressure: Blood pressure was monitored indirectly (Wingate, 1978) using a mercury sphygmomanometer and stethoscope. Resting orthostatic blood pressure was measured two minutes after standing as directed by Amusa, Igbunugo & Toriola, (1998).

The inflatable cuff of a sphygmomanometer was wrapped carefully round the upper arm with the bag over the brachial artery and is connected with the mercury manometer. The bell of the stethoscope was applied over the brachial artery in the cubital fossa and the cuff was inflated to a level well above

that which will abolish the korotkov sound. The pressure in the cuff was then allowed to fall slowly and the return of the sound will be taken as the systolic pressure. The point at which the sound became muffled was taken as representing the diastolic pressure.

Maximum Oxygen Consumption (Max VO₂): Subjects were instructed to run for 12 minutes in the fastest possible time. Alternation of walking with running was allowed, but the objective is to cover some numbers of laps within the stipulated 12 minutes time. The numbers of laps covered were recorded for each subject. Max VO₂ was estimated from the results of the 12-minute run test, using Cooper's Nomogram (Cooper, 1990).

Measurements of Performance Characteristics:

Speed: The 40meters Dash test was used to evaluate the sprinting capacity of the subject. This test was intended to measure the ability to run 40meters within the shortest possible time. The subject's score was the time measured to the nearest tenth of a second that elapsed between the starting signal and the time he/she crosses of the finishing line. The manual electronic timer was used and the best time of three trials was recorded.

Flexibility: A modified sit and reach box was used to measure hip flexibility. The subjects were asked to remove their shoes and assume the sitting position with the knees fully extended feet touching the apparatus. The arms were extended forward with one hand on the top of the other. The subject used the tip of the middle finger to push forward the movable wood on top of the box along the calibrated scale. The subject stretch forward slowly while bending the knees. The score was the maximum distance reached, and the sum of three trials was recorded. A test-retest reliability of 0.93 was recorded for the instrument (Bowers & Fox 1992).

Muscular endurance: The pull-up (for male) and flex arm hangs (for female) were used to measure the endurance of the muscle group of the forearms. The subject were instructed to grasp the horizontal bar with both palms facing forward, arms fully extended, with feet off the ground. The body is raised until the chin is above the top of the bar. The body was then lowered until the arms were fully extended. The numbers of repetition made appropriately were counted within the stipulated time.

General Body Endurance: The burpee (squat thrust) test was used to measure general body endurance. From a standing position, the subject bent forward at the knees, placed their hands on the floor in front of his feet and simultaneously thrust the legs backwards and returned to standing positions. The number of repetition made within the stipulated time was recorded. American College of Sports Medicine. (2000) reported a reliability of 0.92 for burpee.

Agility test: Dodge Run was used to measures the ability of the athlete in running and changing direction. The athlete starts behind the starting line. On the command "Go", the athlete ran to the left of the first chair and right of the second chair, left of the third and right of the fourth chair, and then waves back around the chairs in that same movement to the starting line. Three attempts were allowed and the average score recorded (Armstrong, 2003).

Results, Analysis and Discussions of Findings

The results showed that there weresignificant differences in the pretest-posttest responses on physiological variables tested in the study.

Table 1: Descriptive Statistics of the Demographic Variables

Variable	Measures	Mean	N	Range	SD
Height	Pretest	1.58	32	0.17	0.42
	Posttest	1.58	32	0.17	0.42
Weight	Pretest	62.40	32	56-69.0kg	3.34
	Posttest	60.41	32	55-67.1kg	3.28

Body Weght: There was a difference in the pretest-posttest body weight of racket game athletes following 8-weeks circuit training programme. The t-value was 9.604 was statistically significant. The results was in line with the observation of Bowers and Fox (1992) who submitted that persistence in any rigorous activities would led to an immediate drop in body weight of the athletes, especially during progressive resistant training.

Table 2: Descriptive Statistics of the Physiological Characteristics:

Variable	Measures	Mean	N	Range	SD
RDBP	Pretest	78.22	32	66-86Hg.mm	4.58
	Posttest	73.97	32	62-82Hg.mm	4.58
RSBP	Pretest	161.72	32	128-176Hg.mm	12.79
	Posttest	153.22	32	122-173Hg.mm	14.86
RHR	Pretest	75.19	32	62-88bpm	5.92
	Posttest	68.81	32	58-82bpm	6.87
BMI	Pretest	25.06	32	23.2-27.6	1.04
	Posttest	24.27	32	22.4-27.08	1.01

Discussions on the Physiological Characteristics

Resting Diastolic Blood Pressure (RDBP): There was a difference in the pretest-posttest RDBP of racket game athletes following 8-weeks circuit training programme. However, the calculated t-value of 11.078 did not yield a statistically significant difference. This was because there was just a slight drop in the pretest-posttest measurements of the RDBP (78.2mmHg to 73.9mmHg) following the intervention. The result was in line with Astrand & Rodahl, (1986) who postulated that performance has little or no effect on the resting diastolic blood pressure compared to frequent or sharp increment in systolic blood pressure.

Resting Systolic Blood Pressure (RSBP): There was significant difference in the pretest-posttest RSBP of racket game athletes following 8-weeks circuit training programme. The intervention yielded a t-value of 6.567. The finding was in agreed with the submission of Astrand & Rodahl (1986) who contended that performance has symbolic influence on the sharp increment or drop of systolic blood pressure of highly conditioned athletes following rigorous training.

Resting Heart Rate (RHR): The 8 weeks circuit training programme gave a difference in the pretest-posttest RHR of racket game athletes but this recorded only a slightly drop from 68.81bpm to 6.90bpm. The calculated t-value was 6.980 was not statistically significant. The researcher advocates for a prolong period of time for conditioning exercises to have significant effects on posttest RHR.

Body Mass Index (BMI): The result shows that there was a significant difference in the pretest-posttest BMI of racket game athletes following 8-weeks circuit training programme. The drop in BMI could be attributed to the positive effect training on body composition. Mokka, Vääänen & Väikkynen, (2003) postulated that the level of competitiveness may heighten the exigencies of code switch and code mixed from one energy system to another during normal game situations in racket games.

Table -3 Descriptive Statistics of the Performance Characteristic.

VARIABLE	N	X	SD	df	t-cal	p-value
SPEED	32	.9497	.40833	31	13.157	.000
CARDIO-RESPIRATORY ENDURANCE	32	1.3028	.44373	31	-16.609	.000
AGILITY	32	.6788	1.19662	31	3.209	.003
ARM STRENGTH	32	4.4188	2.27882	31	-10.969	.000
HIP-FLEXIBILITY	32	3.0453	.96474	31	-17.857	.000
GENERAL MUSCULAR ENDURANCE	32	3.7675	1.66892	31	-12.770	.000

P<0.05-N S and P>0.05-S (df=31 at 2.039 for critical table value).

Discussions on the Performance Characteristics

The result showed that there was significant difference in the pretest-posttest measures of performance variables of: speed, agility, flexibility, leg muscular power and cardiorespiratory endurance following 8-weeks circuit training (Table.3). Juila, Chris & Hughes, (2005) advocated for field speed work for squash players to strengthen their reaction time during normal game situation. Also, Zhang Ying Qiu, (2004) recommended more robust speed drilled for tennis player during the pre seasons conditioning.

The results on flexibility were agreement with the findings of Torres, Cabello & Carrasco, (2005) who recorded improved hip flexibility following 8 weeks aerobic training of University male tennis and badminton players. Mokka, Vääänen & Väikkynen, (2003) and Ogino, Makita, Satomi & Yoshida, (2007) submitted that there is a mutual interdependence between muscular strength and endurance as the necessity for achieving greater height in any competitive engagement following fitness training. Finally, this outcome of this research which showed

that agility improved with training corroborates with the finding of Pokholenchuk, Posevin & Sharara (2006) on high class racket game athletes following 10-weeks progressive aerobic exercises.

Table 4: Paired Sample Statistics

	Mean	N	SD	Std. Error Mean
1.Pair HGT 1	1.5756 ^a	32	0.04165	0.00736
	1.5756 ^a	32	0.04165	0.00736
HGT 2				
2.Pair WGT 1	62.4000	32	3.33737	0.58997
	60.4134	32	3.27996	0.57982
WGT 2				
3.Pair BMI 1	25.0637	32	1.04354	0.18447
	24.2694	32	1.01115	0.17875
BMI 2				
4.Pair RHR 1	75.1875	32	5.91574	1.04576
	68.8125	32	6.87416	1.21519
RHR 2				
5.Pair RSBP 1	161.7188	32	12.78919	2.26083
	153.2188	32	14.86007	2.62691
RSBP 2				
6.Pair RDBP 1	78.2188	32	4.57718	0.80914
	73.9688	32	4.57542	0.80883
RDBP 2				
7.Pair Zscore (WGT1) (WGT2)	0.000000	32	1.000000	0.17677670
	0.000000	32	1.000000	0.17677670

The correlation and t cannot be computed because the standard error of the difference is 0.

Table 5: Paired Samples Correlations

	N	Correlation	Sig.
Pair 2 WGT1 & WGT2	32	0.938	0.000
Pair 3 BMI 1 & BMI 2	32	0.886	0.000
Pair 4 RHR1 & RHR2	32	0.683	0.000
Pair 5 RSBP1&RSBP2	32	0.870	0.000
Pair 6 RDBP1 & RDBP2	32	0.888	0.000
Pair 7 Zscore (WGT1) & Zscore (WGT2)	32	0.938	0.000

Conclusion and Recommendations.

Most of the physiological and motor performance variables studied in this research showed significant differences when their pretest and posttest values were compared. It is therefore recommended that racket games coaches should be proactive and embrace the adoption regimental field training programme as recommended during 2006 World Congress of Science and Racket Sports for all their affiliated member world-over. Also, racket games players should engage in strenuous physical training to achieve better body compositions suitable for competitive engagement in their various sports.

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Appendix 1

Main Intervention Programme

Before the commencement of every training session all the participants underwent the preliminary routine of warming up activities comprising stretching exercises prior to the main programme.

Week One to Week Four

General body conditioning circuit training

Station one: 5 minutes continuous jogging with alternate walking as relief.

Station two: 2x10 repetitions of burpee.

Station three: 3x20 meters sprint (work back time as relief ratio).

Station four: 10 repetitions of pull-up (male) and flex arm hang (female)

Station five: 2x30 meters agility bounding exercise. (5 minutes for each station, 25minutes).

Week Five to Week Eight

Station one: 10 minutes continuous jogging without alternate walking as relief.

Station two: 2x20 repetitions of burpee

Station three: 4x40 meters sprint (work back time as relief ratio).

Station four: 20 repetitions of pull-up (male) and flex arm hang (female)

Station five: 4x30 meters agility bounding exercise. (10 minutes for each station, 50minutes).

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Appendix: At the end of the paper

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