



Full Length Research Article

TENNIS SERVE PERFORMANCE IN RESTED AND EXHAUSTION CONDITIONS OF COLLEGE-LEVEL PLAYERS

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ABSTRACT

Objectives: The purpose of this study was to evaluate the effects of rested and physical exhaustion conditions on accuracy and speed of tennis serve performance among college-level players.

Design: A repeated measures design with control and experimental groups was used to determine the effects of physical exhaustion on tennis serve performance.

Method: Sixty male tennis players, age=23.58(±1.74) years, were recruited, and randomly assigned into two groups for two serve tests, with the experimental group being given a 1.5-hour simulated competition intervention in between.

Results: Results revealed that the serve performance of the experimental group was significantly deteriorated ($p < .05$) under the physical exhausted condition. There was no significant association among serve parameters between two tests except serve speed ($r > .90$; $p < .05$).

Conclusion: Physical exhaustion following a 1.5-hour simulated competition has a deteriorating effect on serve performance among college-level male tennis players. Further study of skill assessment and /or a prior fitness test is recommended for in-depth investigation.

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INTRODUCTION

Tennis is a popular competitive and recreational sport for people of all ages (Perry, Wang, Feldman, Ruth & Signorile, 2004). There is an increasing number of active tennis players in the world (Gioftsidou *et al.*, 2006). A mixture of anaerobic skills (e.g. speed, agility and power) and aerobic capabilities are needed for competitive tennis athletes (Kovacs, 2007). Tennis may be classified as predominantly an anaerobic activity that requires high levels of aerobic conditioning (Kovacs, 2006). As an intermittent sport, tennis is often performed over a prolonged duration (Hornery, Farrow, Mujika and Young, 2007). Although tennis matches vary substantially in duration in traditional first player to win two sets matches, a time of 1.5 hours has been suggested as a typical average match length (Kovacs & Ellenbecker, 2011). In addition, during the matches, the work-to-rest ratios of competitive tennis athletes range between 1:3 and 1:5, and physical exertion has been shown to greatly reduce the hitting

accuracy (Kovacs, 2007). Physical exhaustion, from a physiological perspective, can be defined as an acute impairment of exercise performance, which ultimately leads to the incapacity to produce maximal force output and /or control motor function (St Clair Gibson *et al.*, 2003). Previous experiments have attempted to quantify the effects of exhaustion on tennis skills, but performance deterioration has not been consistently reported (Davey, Thorpe and Williams, 2002; Kovacs & Ellenbecker, 2011; Martin, Bideau, Nicolas, Delamarche and Kulpa, 2012; Mendes *et al.*, 2012); and as Sam *et al.* (2011) have conducted a study on comparing the tennis serve performance between fatigued and non-fatigued conditions among college players, but since the sample size was minimal and they did not recruit any control group, the effect of outcome was limited. The present study is a follow-up session of the previous study, which enlarges the sample size and includes a control group. The purpose of this study was to evaluate the effect of rested and physical exhaustion conditions on accuracy and speed of the tennis serve. We hypothesized that tennis serve performance will deteriorate after the 1.5-hour simulated competition, with an exhausted condition was assumed at that point in time.

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MATERIALS AND METHODS

Participants

Sixty male college-level tennis players (age=23.58 (\pm 1.74) years; height=170.78 (\pm 4.79) cm; weight=63.08 (\pm 4.11) kg) were recruited for the serve test, with randomly assigned half-half to the groups of experimental and control. Informed consent was obtained from each of the participants and they were told they were free to withdraw from the study at any time without penalty. The study was conducted according to the Declaration of Helsinki and the protocol was fully approved by the Clinical Research Ethics Committee before the date of commencement.

Measures

A radar gun (Sports Radar, Tracer Precision Company; U.S.A) was used to measure the ball velocity (mph). The radar gun was placed inside the serve court, set back 8 inches (20.32cm) from the net, and 18 inches (45.72cm) from the midline stripe, in the opposite serve court so that it was in line with the subject. This allowed for speed to be recorded as the ball came off the racquet, even if the net was hit, or a let occurred.

A paper tag was used to draw a line and marked down the center of each service court, bisecting the service court into right and left halves in order to measure the serve accuracy (Hensley, 1989). The accuracy score was determined according to the target area within the service court in which the ball lands. Serves landing in the designated half (near the side line) of the court were awarded two points; serves landing elsewhere in the service court were awarded one point, and for those landing outside of the service court would receive a zero point. Zero points were also awarded for a double-fault serve (see Figure 1).

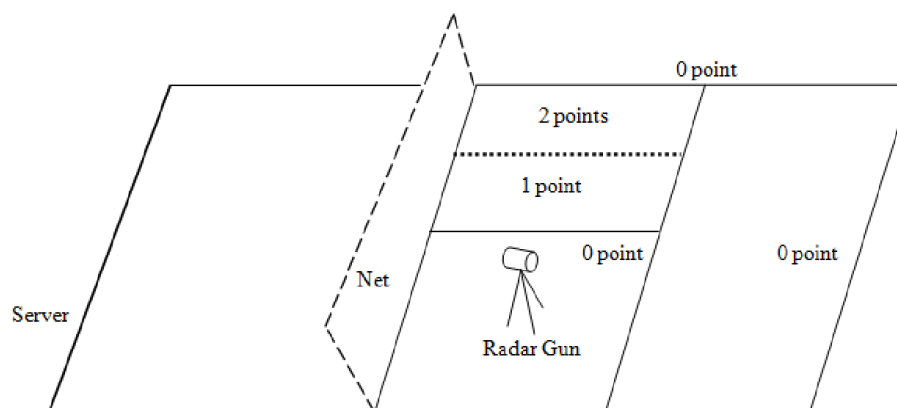


Figure 1. Designated target areas for the service test in rested and physical exhaustion conditions

Procedure

All subjects were permitted a warm-up of approximately 10 minutes. For serves, subjects were asked to stand at either side of the center baseline and serve each ball as fast and as accurately as possible. A box of balls was placed several feet behind the center mark on the end of the court where the server was located. Each subject was given a second attempt if the first serve was fault, and if both serves were fault, zero points were awarded for that serve. If a serve hit the net and

landed in the service court, also known as a let, subjects were given a re-serve which did not count against the two attempts given for each one serve.

Research design

A repeated measures design was used to determine the effects of physical exhaustion on tennis serve performance. Participants in experimental group were asked to serve on both rested and fatigued conditions, totally two sessions, following the above procedures. Simulated match-play environment for leading to exhausted condition was a general single tennis competition which last for 1.5 hours. The competition was followed the latest (2014-2015) international tennis rules and regulations. Ten new balls (same type) were provided in each match-play and players were played each game in the same tennis court; each subject completed 10 serves per session (in rested and fatigue conditions). Participants in control group were asked to do light warm-up (light jog and skill specific drills practice) exercise for 1.5 hours instead of simulated competition. Both accuracy and speed were measured during all serve testing sessions. Speed (mph) of each serve was multiplied by the accuracy point value to create an overall serve performance score for each serve. Overall serve performance scores for all 10 attempts each session were accumulated to create one score for further analysis.

Statistical analysis

Paired sample t test was conducted to compare the tennis serve performance (accuracy, speed, accuracy *speed) before and after 1.5-hour simulated competition (experimental) or light warm-up exercise (control). Pearson product moment correlation coefficient was used to reveal the relationship between pre-test and post-test of those scores. The level of significance was set *apriori* to $p=0.05$.

RESULTS

There were a significant deteriorate on serve speed ($p<.05$) and serve score ($p<.05$) under the physical exhausted condition in experimental group; a significant deterioration on the serve speed ($p<.05$) was also observed after a 1.5-hour light intensity exercise in control group (see Table 1). The correlation between pre-test and post-test in speed was significantly high (experimental: $r=.98$, $p<.001$; control: $r=.96$, $p<.001$) but none

Table 1. Comparison of the pre-test and post-test scores

Variable		Group					
		Experimental			Control		
		M(SD)	t(df)	p-value	M(SD)	t(df)	p-value
Accuracy	Pre-test	1.10(.66)	1.96(29)	0.059	1.00(.78)	-.21(29)	.831
	Post-test	.80(.61)			1.03(.55)		
Speed	Pre-test	89.47(10.11)	4.40(29)	.0000	98.70(8.68)	7.36(29)	.000
	Post-test	87.93(10.79)			95.57(8.91)		
Serve Score	Pre-test	98.23(59.86)	2.13(29)	0.041	96.03(75.15)	-.12(29)	.901
	Post-test	70.30(54.94)			98.00(51.45)		

Table 2. Association between pre-test and post-test scores

		Correlation
Experimental (n=30)	Accuracy	.13
	Speed	.98***
	Serve Score	.22
Control (n=30)	Accuracy	.23
	Speed	.96***
	Serve Score	.11

***p<.001

in accuracy ($r=.23$, $p>.05$) and serve score ($r=.22$, $p>.05$) (see Table 2).

DISCUSSION

The present study was to explore whether physical exhaustion condition following a 1.5-hour simulated competition protocol would affect serve performance (accuracy, speed, accuracy *speed) or not. The results are quite conclusive; almost all the scores among 3 serve parameters at post-test in the experimental group showed a declining trend, which means the physical exhaustion condition did affect our athletes' serve performance, and those effects are quite significant; however, in the control group, a significant decrease in the serve speed was observed, it might imply that the speed parameter may be easily varied either on rested (with tiny warm-up) or physical exhausted conditions, but the level of changes was minimum, since the correlation between pre-test and post-test was particularly high ($r>.9$), whereas accuracy and serve score were not. In addition, although the serve accuracy in the experimental group did not reach the adequate significant level, its p-value ($p=.059$) still very close to the critical cut-point ($<.05$), as an exploratory issue, the difference may become obvious if more subjects involved. The current results generally support our hypothesis that the serve performance would deteriorate after a 1.5-hour simulated competition, based on the assumption this amount of exercise would adequately fulfill the requirement of exhaustion. However, the exhaustion requirement is extremely sensitive to the individual physical fitness and skill levels of the participants. Although all the participants were recommended by their coach as being in the same category of skill level, future studies in this area may require an initial skill assessment as well as a prior fitness test to remove those latent threats, and ensure the quality of the study.

Conclusion

The present results demonstrated that a 1.5-hour simulated competition intervention has a certain effect deterioration of tennis serve performance among college-level male players, especially on the overall serve score (accuracy *speed),

whereas the speed parameter alone seems difficult to differentiate between the effects of physical exhaustion other possible factor(s) influencing it. Further study is thus recommended to delineate the mechanism underneath.

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