

Tennis: A Physiological Profile During Matchplay

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This research was funded by a USTA Sports Science and Medicine Research Grant (1990).

INTRODUCTION

- The physiological demands of a tennis match are not well understood because little research has been conducted on this topic.
- Although some studies have investigated pre-and post-play metabolic responses, there has been little documentation of measurements other than heart rate during actual play.
- Tennis matches are unique in nature as they include intermittent exercise of varying intensity with numerous recovery periods over a long duration, which make duplication of the demands difficult to recreate in a laboratory setting.
- Therefore, field testing through on-court match play is necessary to develop scientifically-based training programs to improve consistency of training methods for tennis.

PURPOSE

- The goals of this study were to measure the following variables of skilled tennis players *during* near match play conditions:
 - heart rate
 - hemocrit
 - hemoglobin
 - plasma concentrations of:
 - glucose
 - lactate
 - cortisol
 - testosterone
- The addition of testosterone measurements allowed for speculation of the overall anabolic/catabolic state during play.
- The testing scheme was designed to offer a "real-time" window of the physiological response to playing a competitive singles match.

SAMPLE

The participants for this study included 10 healthy Division University males of approximately equal playing ability.

- Mean Age: (20.3 years)
- Mean Height: (176.9cm)
- Mean Weight: (72.8kg)
- Mean Percent Body Fat: (10.6%)
- Mean Aerobic Power (VO_{2max}): ($58.5 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$)

- Players refrained from eating for two hours prior to each test and ingested only water during testing.
- The primary year-round conditioning activity for all the players was tennis in addition to resistance training and moderate running

METHOD

- All subjects completed a laboratory treadmill test as well as an on-court test on separate days.
- Heart rate was monitored by portable monitor during both sessions and blood samples were taken at consistent intervals for measurement of physiological variables.
- The treadmill test was used to determine VO_{2max} , max heart rate, plasma substrate and hormonal responses.
- The on-court tests were conducted on an indoor hard court with a temperature of 17°C and consisted of a 10 minute warm-up period followed by 85 minutes (6, 15 minute periods) of continuous singles play. Recovery time between points was limited to 30 seconds and changeovers were limited to 90 seconds, except when a blood sample was taken. Those changeovers were 135 seconds long.
- Players were asked to maintain the same effort and intensity as they would in a tournament match and to use an all-court style of play.



RESULTS

Results of the Treadmill Test

- VO_{2max} and MHR were $58.5 \pm 9.4 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ and 195.6 ± 6.3 beats per minute, respectively
- Plasma lactate, glucose, and testosterone increased significantly ($p < 0.05$) above pre-exercise concentrations immediately and 5 minutes after exercise.
- Plasma cortisol concentration and ratio of testosterone to cortisol did not change in response to maximal exercise.

- The plasma volume changes of $-15.4 \pm 4.7\%$ immediately post-exercise and $-12.3 \pm 4.6\%$ at 5 minutes post exercise indicate significant hemoconcentration occurred.

Results of the On-court Test

- The heart rate increased during the warm-up period ($p < 0.05$) from a pre-exercise value of 75.6 ± 7.7 beats-min⁻¹ to 126.2 ± 7.7 beats-min⁻¹.
- During the 85 minutes of match play, the mean HR was 144.6 ± 13.2 beats-min⁻¹ and remained significantly elevated at 5 minutes into recovery
- The percentage of MHR (maximal heart rate reserve determined with Karvonen formula) averaged during the warm-up and play was 47.5% and 61.4% respectively.
- Measures of plasma lactate and glucose concentrations did not change ($p > 0.05$) over the duration of the match play condition and recovery when compared to pre-exercise measures. An insignificant decrease in plasma glucose that was observed after the warm-up period was followed by a 23% increase ($p < 0.05$) above the warm-up concentration, after the second 15 minute segment of play. The plasma glucose concentration remained steady just above the pre-exercise value from then on.

- A slight ($p < 0.05$) increase in plasma cortisol corresponded with the decrease in glucose following the warm-up period and plasma cortisol levels progressively decreased during matchplay. The measures obtained at the conclusion of play and into the recovery were significantly lower than pre-exercise concentrations.
- Plasma testosterone levels increased progressively throughout the warm-up and match play session including a significant increase during the 5 minute recovery period.
- In addition, the testosterone to cortisol ratio also progressively increased to significantly greater than pre-exercise values by the end of matchplay and through recovery.
- Plasma volumes changed by the following measures: $-0.7 \pm 5.3\%$ post-warm-up, $2.3 \pm 4.1\%$ at the completion of play and 5.1 ± 8.3 after the 5 minute recovery period.

RECOMMENDATIONS

- The mean heart rate during the 85 minutes of play was adequate to satisfy the MHR intensity demands for sustaining and increasing cardiorespiratory fitness in healthy adults even when considering intermittent characteristics of tennis.
- Although the blood glucose concentrations remained relatively consistent, the downward trend in this study as well as in past research strongly supports the ingestion of suitable carbohydrates during prolonged play to sustain glucose levels.
- This study found non significant increases in plasma lactate due to the moderate and intermittent demands of tennis and the relatively high level of endurance of the test subjects. This result points out the importance of endurance training for tennis players and how it is vital in assisting them to reduce lactate levels during play.
- Actual competition may result in higher levels of cortisol because psychological factors can increase plasma cortisol independently of that induced by exercise.
- Although tennis matchplay is composed of intervals of high-intensity exercise, the overall response is similar to that of prolonged moderate exercise.

CONCLUSION

- The demands of singles tennis matchplay was not intense enough to cause an increase in plasma cortisol but did cause an increase in plasma testosterone.
- Based on the plasma lactate response in this study, conditioning programs for tennis should focus on exercises near, but not beyond, the anaerobic threshold.



YEAR PERFORMED 1990