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# Effects of a Four-Week Small-Sided Game and Repeated Sprint Ability Training during and after Ramadan on Aerobic and Anaerobic Capacities in Senior Basketball Players

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## ABSTRACT

**Background.** Most studies related to the effect of Ramadan fasting on aerobic and anaerobic performances found in the literature were concerned with individual sports; even studies on team sports were mostly dedicated to football, and none of those studies were involved basketball competitions. **Objectives.** This field investigation examined the effects of a training program in the basics of small-sided games (SSGs) and repeated sprint ability (RSA) during Ramadan observance (R) and a month after Ramadan (AR) (control month) on aerobic and ("anaerobic") performances in fasting basketball players. **Methods.** Sixteen basketball players (age,  $23.4 \pm 2.3$  years; height,  $1.86 \pm .09$  m; body mass,  $78.3 \pm 11.0$  kg; and  $VO_{2max}$ ,  $51.0 \pm 2.7$  ml.min<sup>-1</sup>.kg<sup>-1</sup>) performed two training programs (SSG and RSA) during R and AR, interrupted by fifteen days of total recovery, and were randomly allocated into two groups ( $G_{SSG}$ , n=8 and  $G_{RSA}$ , n=8). RSA parameters, mean heart rate (HR), and aerobic performances were measured on four occasions: before (P1) and after (P2) R and before (P'1) and after (P'2) AR. **Results.** The results have shown that RSA and Ramadan show no significant differences in aerobic and anaerobic performances when compared with SSG and non-Ramadan in senior basketball players. However, there was a significant difference in mean HR ( $p=0.03$ ) between groups when comparing R and AR for  $G_{SSG}$ . **Conclusion.** This study indicated that Ramadan fasting combined with SSG and RSA training has no significant effect on most aerobic and anaerobic performances in male senior basketball players.

**KEY WORDS:** Ramadan, Training, Heart Rates, Basketball, Aerobic, Performance, Fatigue.

## INTRODUCTION

Basketball is an intermittent high-intensity activity that heavily stresses the aerobic and anaerobic metabolism (1). The ability to repeat maximal sprint with short incomplete recovery time (repeated sprint ability [RSA]) was considered a relevant component of basketball performance (2). Furthermore, the aerobic

fitness is more important than previously supposed for the determination of basketball match activities. The implementation of basketball-specific drills in the form of small-sided games (SSGs) was suggested as a viable strategy to functionally improve aerobic fitness (3).

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Moreover, basketball players continue to train and play decisive games at a high level under extreme climatic conditions and with a sporting calendar that is not modified for religious observances (4).

In this context, we can consider the month of Ramadan as among the extreme conditions that influence the performance of Muslim athletes. During this blessed month, Muslim athletes abstain from all food, drink, and other physical needs during the daylight hours. Furthermore, in this holy month, there are chronological, physiological, and hormonal changes that affected the physical performance, making Ramadan a particular model of prolonged intermittent fasting (5, 6, 7, 8, 9, and 10).

Previous investigations have examined the effect of Ramadan fasting and physical activity on aerobic and anaerobic performances. Several studies have investigated the effect of Ramadan fasting on anaerobic performance (11), showing that performances in RSA tests were reduced as result of Ramadan observance. (8) examined the 5-, 10-, and 30-m sprint performance of young national-level judo athletes, reporting no changes in sprint performance during R.

Sprint performance in 10 and 30m sprints showed no changes during the second and fourth weeks of Ramadan in 18-year-old junior soccer players (4). Moreover, in the study by (12), observant subjects showed a slightly greater deceleration in the seven sprints (a deterioration of 9.0% at 2 weeks and 9.3% at 4 weeks, rather than 7.7% before Ramadan). This effect was more marked in morning than afternoon tests.

Concerning the effect of Ramadan observance on aerobic performance, (13) measured maximal oxygen intake directly, using a Bruce treadmill protocol. They observed no difference in peak oxygen transport between before Ramadan and after 2 and 4 weeks of fasting. Moreover, (8) reported no significant changes in Léger test predictions of maximal oxygen intake during R in their study of elite judo athletes. Likewise, other investigators revealed no changes in the performance of submaximal aerobic exercise during R (14). However, (15) noted some decrease in maximal oxygen intake during the first week of Ramadan, but the subject values also had recovered to pre-fast levels by the fourth week of Ramadan.

To the best of our knowledge, most studies related to the effect of Ramadan fasting on aerobic and anaerobic performances found in the literature were concerned with individual sports (8); even studies on team sports were mostly dedicated to football (11, 12, 16), and none of those studies were involved basketball competitions, which can cross the month of Ramadan, making our study the first to investigate intermittent fasting effects coupled with athletic training program in basketball. So our assumption was that senior basketball players can intercalate RSA and SSG-based training programs during the month of Ramadan without falling into the trap of overtraining.

In this context, our investigation will be conducted according to two main factors, that is training method (SSG vs. RSA) and Ramadan (Ramadan vs. non-Ramadan [control month]). Therefore, the purpose of the present study was to compare the effects of four-week SSG and RSA training during and after Ramadan on aerobic and anaerobic capacities in senior basketball players.

## MATERIALS AND METHODS

**Participants.** Sixteen male basketball players (mean  $\pm$  SD, age, 23.4 $\pm$ 2.3 years; height, 1.86 $\pm$ 0.09 m; body mass, 78.3 $\pm$ 11.0 kg; body mass index [BMI], 22.60 $\pm$ 1.95 kg.m<sup>-2</sup>; and VO<sub>2</sub>max, 51.0 $\pm$ 2.7 ml.min<sup>-1</sup>.kg<sup>-1</sup>) from the second division (4–5 days/week, > 60 min/day, with a training experience of 11.8 $\pm$ 3.9 years) volunteered for this study. The study was conducted 2 weeks after the end of their competitive season. The subjects were randomly assigned to two groups as follows: a SSG group (G<sub>SSG</sub>; n=8) and RSA group (G<sub>RSA</sub>; n=8). The inclusion criteria for study participation were as follows: (i) participation in at least 90% of the training sessions, (ii) Muslims who were fasting during Ramadan (R) and (iii) good health (no pain or injury reported) and not receiving any medication or other drugs. The study was approved by a local research ethics committee, and the protocol was conducted according to the Declaration of Helsinki. All participants provided written informed consent to participate in the study.

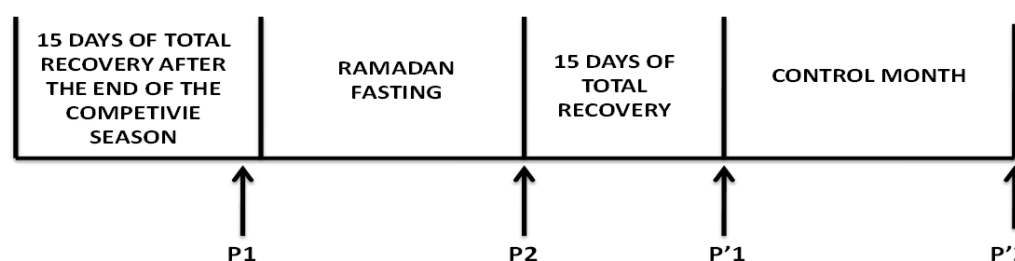
**Design and Procedures.** This study aimed to examine a possible Ramadan observation effect

on players undergoing RSA and SSG intervention. Players were randomly assigned into two training groups, as follows:  $G_{SSG}(n=8)$  and  $G_{RSA}(n=8)$ . The training groups (i.e.,  $G_{SSG}$  and  $G_{RSA}$ ) performed a four-week training program during R and a month after Ramadan (AR), interrupted by 15 days of total recovery, with a frequency of two sessions per week. However, on other days of the week, both groups maintained their normal training routine.

During the Ramadan phase of the study, subjects refrained from eating and drinking from dawn to sunset. Players were informed to

maintain a similar nutrition and hydration routine while consuming the usual Iftar and Sahur meals close to every test.

The Iftar meal contained a salad, soup, spaghetti, chicken thigh, juice, and an apple, whereas the Sahur meal contained a salad, one yogurt, a piece of cake, and a banana. The same meals were served during the control month. The period of fasting in 2016 was from 03:11 to 19:36 h at the beginning of Ramadan to 03:16 to 19:42 h at the end of Ramadan (Figure 1).



**Figure 1.** Representation of the experimental protocol. **P:** Tests (RSA+ yo-yo). **P1:** before Ramadan; **P2:** the end of Ramadan; **P'1:** before control month; **P'2:** the end of control month.

**Training program.** Players were part of the same basketball team and performed two training sessions per week with SSG and RSA protocols according to their group allocation ( $G_{SSG}$  and  $G_{RSA}$ ) at least 24 h apart. The session started with a 15-min standardized warm-up (5 min of low-intensity running, 5 min of dynamic stretching, and 5 min of skipping) followed by the experimental training. The remaining training time was dedicated to specific basketball training.

The SSG drill used was in the form of 2v2 on full-length (28 m) and half-width (7.5 m)

court. The 2v2 format was chosen because it was deemed to induce a greater intensity than other SSG drills involving more players (17,18). (Table 1) Drills were played like a competition, with only man-to-man defense, and no free throws or time-outs. Scores were kept to encourage players' motivation and verbal encouragements were provided by the coach. Players were then randomly allocated to pairs (composed of a guard and either a forward or a centre), and new pairs were created for each training session.

**Table 1.** Description of the 4-weeks training program for the small-sided game (SSG) group and the repeated sprint ability group (RSA)

	SSG	RSA
<b>Week 1</b>	2 × (2 × 3 min45)	3 × 6 x 30m (15+15)20s rec
<b>Week 2</b>	2 × (2 × 3 min45)	3 × 6 x 30m (15+15)20s rec
<b>Week 3</b>	2 × (3 × 4 min30)	3 × 8 x 30m (15+15)20s rec
<b>Week 4</b>	2 × (3 × 4 min30)	3 × 8 x 30m (15+15)20s rec

The RSA consisted of three sets of 30-m maximal shuttle running (15m) sprints, after every 20s of passive recovery, repeated 6 and 8

times in the first two and last two weeks of the intervention, respectively (19). The between-set recovery was 4 min (Table 1).

**Session rating of perceived exertion (session-RPE).** The session-RPE method was used to determine the training program load, 30 min after the end of the training session for both groups (Borg's CR-10 scale) (21). Players were largely familiar with this method, which was regularly used during their training program.

**Heart rate (HR) measurements.** The HR during RSA tests was recorded continuously using a cardiofrequency monitor (Polar Electric, Kempen, Germany).

**Anthropometrics measurements.** Weight (kg) was measured by an electronic balance (Pharo 200) and height (m) was measured with a stadiometer (Seca 217). BMI was calculated as follows:  $BMI (kg/m^2) = weight/height^2$ .

**Yo-Yo intermittent recovery test.** The Yo-Yo test was performed according to the procedures suggested by (22). The test consists of 20-m shuttle runs performed at increasing velocities with 10 s of active recovery between runs until exhaustion. Audio cues of the Yo-Yo test were recorded on a CD (Teknosport.com, Ancona, Italy) and broadcasted using a portable calibrated CD player (Philips, Az1030 CD player, Eindhoven, Holland). The test is considered finished when the participant fails to reach the front line in time twice or feels unable to complete another shuttle at the dictated speed. The total distance (TD) covered during the Yo-Yo test level 1 (including the last incomplete shuttle) is calculated and stored for further analyses.

**RSA test.** The RSA test (17) consisted of ten 30-m shuttle sprints (15 m+15 m) each with a single change in direction of 180°, intercepted by 30 s of passive recovery. The participants sprinted linearly from the start line to 15 m, touched a line on the floor with a foot, and then, following a 180° change in direction, returned to the start line as fast as possible. The times of different repetitions are recorded with the aid of the photocells (Brower Timing System, Salt Lake City, UT, USA; accuracy of 0.01s).

**Statistical analysis.** Data analyses were performed using SPSS version 17 for Windows (SPSS Inc., Chicago, IL, USA). Values are presented as mean  $\pm$  SD. The normality of data sets was checked using the Kolmogorov-Smirnov test. Compound symmetry was analyzed using the Mauchlin test. Two-way analysis of variance (ANOVA) with repeated measures was used to

determine the differences between groups (two-condition group,  $G_{SSG}$  or  $G_{RSA} \times$  time of measurement, P1, P2). When a difference was found, a Bonferroni post hoc test was performed. We calculated effect sizes (ES) for each output (23) and 95% confidence interval (ESCI) when significant between-time or between-group differences were found. Paired t-test was applied to compare the aerobic and anaerobic changes observed after 4 weeks of training during R compared to those recorded during AR. Statistical significance was assigned at  $P\text{-value} < 0.05$  for all analyses.

## RESULTS

Data in Table 2 present the effects of Ramadan fasting combined with two training programs (SSG and RSA) and AR on RSA and aerobic performances in basketball players.

The results showed that there was no significant effect after four weeks of Ramadan intermittent fasting on most RSA parameters, HR, and aerobic performance for both groups.

Data in Table 3 show the delta variation of RSA parameters and TD performance measured in subjects during R and AR.

The delta variation of the best time (TPIC) indicates a significant difference by comparing Ramadan with the control month for both  $G_{SSG}$  (R [0.07] vs. AR [0.02], 0.02 [S]) and  $G_{RSA}$  (R [0.07] vs. AR [0.01], 0.05 [S]).

Concerning the delta variation of mean HR measured during the RSA test, there were significant differences in the  $G_{SSG}$  by comparing Ramadan with the control month (R [-1.54] vs. AR [0.3], 0.0393[S]); however, there were no significant differences in the  $G_{RSA}$  (R vs. AR, 0.1038 [NS]).

Statistical analysis revealed that there were no significant differences concerning RPE scores when comparing Ramadan with the control month (AR) for both groups.

## DISCUSSION

According to the two main factors in our investigation, which are the training method (SSG vs. RSA) and Ramadan (Ramadan vs. non-Ramadan [control month]), the findings have shown that RSA and Ramadan have no significant differences in aerobic and anaerobic performances when compared with the SSG and non-Ramadan in senior basketball players.

Table 2. Data expressed as mean ± SD of RSA parameters, heart rate mean and TD performance measured in subjects during Ramadan and month after Ramadan.

		The Fasting month of Ramadan			The Month after Ramadan		
		P1	P2	ES	P'1	P'2	ES
TT(s)	G <sub>SSG</sub>	59,78 ±0,68	58,42 ± 2,44	0,80	59,84 ±0,62	59,58 ± 0,70	0,04
	G <sub>RSA</sub>	59,72 ±1,14	59,22 ±1,32	0,11	59,81 ±1,11	59,65 ±1,08	0,02
TPIC(s)	G <sub>SSG</sub>	5,90 ± 0,11	5,83 ± 0,14	0,02	5,91 ±0,09	5,89 ±0,10	0,007
	G <sub>RSA</sub>	5,88 ±0,13	5,81 ±0,17	0,02	5,90 ±0,12	5,89 ±0,11	0,008
FI%	G <sub>SSG</sub>	1,32 ± 0,75	0,17 ± 3,45	1,17	1,30 ± 0,55	1,12 ± 0,53	0,10
	G <sub>RSA</sub>	1,61 ± 0,57	1,96 ±1,02	0,32	1,40 ±0,45	1,34 ±0,36	0,12
HRmean (beat/min)	G <sub>SSG</sub>	183,83 ± 4,77	185,36 ±4,50	0,26	186,83 ±4,46	186,53 ± 2,75	0,80
	G <sub>RSA</sub>	186,90 ± 5,75	188,55 ±4,17	0,73	189,03 ±2,95	189,33 ± 2,74	0,30
TD(m)	G <sub>SSG</sub>	1792,50± 208,65	2065,00 ±331,19	0,70	1837,50 ± 181,88	2022,50 ± 291,68	0,55
	G <sub>RSA</sub>	1627,50 ±412,79	1805,00 ±529,66	0,52	1667,50 ±441,68	1852,50 ± 499,48	0,45

Data are expressed as mean ± SD; G<sub>SSG</sub>: small-sided games group; G<sub>RSA</sub>: repeated sprint ability; TT: total time; TPIC: best time group; FI: fatigue index; HR: heart rate; TD: total distance covered in YOYO test; P1: before Ramadan; P2: during the 4<sup>th</sup> week of Ramadan; P'1: before AR ; P'2: during the 4<sup>th</sup> week of AR; ES: effect size; \*: p < 0.05; \*\*: p < 0.005.

Table 3. Data expressed as mean ± SD expressing delta variation of RSA parameters and TD performance measured in subjects during Ramadan and month after Ramadan.

		The Fasting month of Ramadan	The Month after Ramadan
		ΔP2-P1	ΔP'2-P'1
TT(s)	G <sub>SSG</sub>	-1,36 ± 2,24	-0,25 ± 0,10
	G <sub>RSA</sub>	-0,50 ± 0,32	-0,16 ± 0,06*
TPIC(s)	G <sub>SSG</sub>	-0,07 ±0,06	-0,01 ±0,02
	G <sub>RSA</sub>	-0,07 ±0,06	-0,01 ±0,02
FI%	G <sub>SSG</sub>	-1,15 ± 3,30	-0,17 ± 0,28
	G <sub>RSA</sub>	0,34 ± 0,92	-0,06 ± 0,33
HR mean(beat/min)	G <sub>SSG</sub>	1,54 ± 0,73	-0,3 ± 2,23*
	G <sub>RSA</sub>	1,65 ± 2,08	0,30 ±0,84
TD(m)	G <sub>SSG</sub>	272,5 ±196,81	185 ± 155,56
	G <sub>RSA</sub>	177,5 ±147,53	185± 128,62

Data are expressed as mean ± SD; G<sub>SSG</sub>: small-sided games group; G<sub>RSA</sub>: repeated sprint ability; TT: total time; TPIC: best time group; FI: fatigue index; HR: heart rate; TD: total distance covered in YOYO test; P1: before Ramadan; P2: during the 4<sup>th</sup> week of Ramadan; P'1: before AR ; P'2: during the 4<sup>th</sup> week of AR; ES: effect size; \*: p < 0.05; \*\*: p < 0.005.

Regarding aerobic performances, the TD covered during the Yo-Yo intermittent recovery test did not differ between the two sessions of measurement and between groups by comparing R and AR, which is in the same line with the study conducted by (8) that showed that estimated values for maximal aerobic velocity and VO2max during the multistage fitness test were relatively unchanged during R in elite judo athletes.

However, (24) reported that fasting resulted in a significant reduction in aerobic capacity in the 3000-m run. (12) and (11) recently found a significant reduction in the performance in the Yo-Yo intermittent recovery test during R in young football players, and this significant reduction of performances during R can be explained when fasting is associated with

catecholamine inhibition and reduced venous return, causing a decrease in the sympathetic tone, which leads to a decrease in blood pressure, HR, and cardiac output (25,26).

Concerning anaerobic performances, the present study showed that the total time (TT), TPIC, and fatigue index (FI) during the RSA test did not differ significantly at the end of Ramadan. Furthermore, there were no significant differences between both groups.

Besides, our study disagrees with that of (22), which showed a decrease in speed endurance measured by 4×10-m run time (i.e., an increased sum of the six sprint times and performance decrement during the RSA test). These authors showed a significant mean performance decrement of 9.5% at the end of Ramadan

compared to 9.0% before Ramadan. In addition, (22) showed that the sum of the six sprint times increased from 46.36 s before the beginning of the Ramadan to 46.73 s at the end of the month. Moreover, in agreement with previous findings, (11) showed a significant decrease in the highest power output during a 5×6-s RSA test during R. These changes may reflect a decreased glycolytic capacity and slower replenishment of muscle creatine phosphate stores during the short recovery period between the sprints during R.

Otherwise, the mean HR measured during the RSA test did not differ significantly by comparing P1 and P2 between groups. In fact, our study is the first to examine the HR variation in the RSA test during R, so there are no other studies to compare with; however, it seems that several previous studies (14, 27, and 16) revealed a significant decrement in HR during R after endurance exercises, as explained by changes in blood pressure and cardiac output.

The present study has some limitations. First, the intervention program was of short duration. Second, the relatively small number of participants may have underpowered the study. Also, we did not include the factor of the competitive season (season vs. recovery) what will be the goal of our future research in relation to this investigation. Finally, we did not use a

control group, which was substituted by a control month.

## CONCLUSION

This study indicated that Ramadan observance combined with RSA and SSG has no significant effect on the aerobic and anaerobic performances of both groups. However, the mean HR was higher for GSSG during R than in the control month (AR).

## APPLICABLE REMARKS

- Basketball players can keep their basic training during Ramadan.
- Coaches and fitness trainers can use this modeling training program (RSA and SSG) during Ramadan without fear of decreased aerobic and anaerobic performances.

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