Effects of Ramadan Fasting on Health and Athletic Performance

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Chapter: Body Composition, Hematological and Biochemical Modifications during Ramadan Fasting

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Body Composition, Hematological and Biochemical Modifications during Ramadan Fasting

Abstract

During the observance of Ramadan, food and fluid intake is concentrated into the hours between sunset and the following sunrise. Food choices, the sleep/waking cycle, and energy expenditures are among other habits that are often altered throughout this month. Many active individuals who observe Ramadan endeavor to maintain their normal patterns of physical activity during Ramadan, but all of the many consequences of superimposing a daily fast upon a program of vigorous physical activity have yet to be described. Body composition, metabolic markers, electrolytes, hematological parameters, and health-related indices such as blood lipids may all be altered. This chapter summarizes such effects, and explores training tactics that may help to conserve a normal body composition and counter potential changes in hydration status, renal function, immune function and inflammatory markers when active individuals engage in the intermittent fasting of Ramadan.

Introduction

Ramadan lasts between 29 and 30 days. During this month, Muslims abstain from food and fluid intake from dawn (el fajr) to sunset (el moghreb). Ramadan occurs eleven days earlier every year, and thus rotates through each of the four seasons over a 33 year cycle [1]. When it occurs during the summer, the daily fast in some countries can exceed 15 hours, and the hours of darkness may then provide insufficient time for glucose and insulin concentrations to be restored to basal levels [2].

Individuals who are observing Ramadan may change the frequency of their meals [3], the quantity of food eaten [4] and fluid intake [1,5-7]. Not only is the timing of meals altered during Ramadan, but the type of food eaten often differs substantially from that consumed during the rest of the year [8]. One commonly reported trend is an increased preference for fatty foods [1,5,9,10]. Such dietary changes can in turn influence both the utilization and the storage of substrates, and lead to modifications of body composition [5,6,11,12]. There may also be changes in hydration status, renal function, and the behavior of immune and inflammatory systems [5,6,11-14].

Those who are observing Ramadan often try to maintain a normal level of physical activity for recreational and health purposes. Likewise, many athletes seek to continue their normal pattern of training throughout Ramadan, particularly if they are competing at an international level. However, if Ramadan falls during the summer, maintenance of training places a heavy additional stress on mechanisms for the delivery of energy and maintenance of fluid/electrolyte balance [6]. With these issues in mind, recent investigations [1,7] have explored training tactics to maintain and even improve body composition and to prevent dehydration and the impairment of renal function in physically active individuals who are observing Ramadan.

This chapter reviews published research examining the effects of Ramadan fasting on body composition, hematological and biochemical parameters in physically active individuals. It also describes novel approaches to training during Ramadan, examining how far these new tactics influence body composition, lipid profile, and immune and inflammatory markers. The relevant literature was reviewed using PubMed and Google Scholar databases, adopting the search terms of Ramadan fasting, fed versus fasted, hematological, biochemical, renal function, hydration status, immune system, inflammatory markers, lipid profile and sport.

Body Mass and Body Composition

Body mass

Body mass commonly decreases over the course of the day during Ramadan [15,16]. This reflects progressive dehydration, at a rate influenced by environmental conditions, the intensity of physical activity and the resultant rate of sweating. Thus, the body mass of
both soccer players [15] and martial arts practitioners [16] were lower during the afternoon than during the morning during Ramadan. Discrepancies in or lack of information on the time of measurement plainly limit the ability to make comparisons between studies.

Empirical findings among participants in regular physical activity are quite heterogeneous. Many reports note a decrease in total body mass during Ramadan, for instance in subjects practicing general aerobic training [1,6,17-19], soccer players [20,21], various types of elite athletes [22], judokas [12] and rugby players [5,11]. Several factors have been invoked to explain the decrease in body mass, including not only dehydration [1,5,11] but also a negative energy balance [5,6], an increased use of body fat stores both at rest and during exercise [1,2,5,6,11,12], the use of lean tissue in gluconeogenesis or a combination of these factors [1,5,6,11].

In contrast, several authors have reported no significant change of body mass during Ramadan; the groups studied have included soccer players [23,24], middle-distance runners [25,26], elite power athletes [27] and recreational bodybuilders [7,14]. Activity levels seem to have been as high as in the studies where body mass decreased; possibly, these groups followed a better dietary plan to maximize the intake of food and fluids during Ramadan.

**Body composition**

Several methods have been used to determine changes of body composition during Ramadan. The commonest approach has been to measure skin fold thicknesses and thus to predict the body's fat mass, using a two-compartment model [5-7,11,14,20]. Unfortunately, if body mass decreases due to dehydration, changes in the difference between total body mass and fat mass may give an erroneous impression that lean tissue has been lost. One of the studies cited applied the supposed "gold standard" of hydro densitometry to physically active men during the month of fasting [28]. This method is difficult to implement during Ramadan, since full submersion is required, and no water must pass through the mouth of participants while they are fasting. Moreover, although an accurate estimate of fat mass is obtained, the difference between total and fat mass remains vulnerable to the effects of dehydration, just as with the simpler skinfold methodology. Determinations of bioelectrical impedance have occasionally been used to estimate body fatness [24,29], but this method, like the previous two, can be affected by changes in hydration status [30].

Published data on changes in body fat content during Ramadan have yielded conflicting results, presumably reflecting differences in dietary tactics. The percentage of body fat decreased in judokas [12], and rugby players [5,11], but remained unchanged in physically active men [28], middle-distance runners [25,26], elite power athletes [26], or soccer players [20]. Recently, Trabelsi and co-workers [1] compared a group of physically active men who were practicing aerobic exercise (running, rowing, and cycling at least 3 times/week) before breaking their Ramadan fast (between 4:00 and 6:00 p.m.) with another group who were practicing an equivalent amount of aerobic exercise after breaking their fast (between 9:30 and 10:30 p.m.). The percentage of body fat decreased in the first group, but not in the second [1]. It appears that if aerobic exercise is practiced when fasting, the resulting energy deficit stimulates the use of stored body fat as the substrate for exercise [1].

A parallel study evaluated the effects of a muscle-building program on the body composition of sixteen Tunisian recreational body builders [7]. These again were randomized to two equal groups of subjects training daily either before (between 4:00 and 6:00 p.m.) or after the break of fast (between 9:00 and 10:00 p.m.) during Ramadan for a total of four training sessions/week. The results showed that an equivalent amount of resistance training practiced either before or after the break of fast did not reduce fat or lean tissue mass, possibly because the total energy costs of training were lower.

Table 1 summarizes empirical data on the changes of body fat content in active subjects during Ramadan.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Subjects</th>
<th>Training program</th>
<th>effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trabelsi et al. [14]</td>
<td>9 male recreational bodybuilders</td>
<td>Resistance training program 3 times/week</td>
<td>↓↓</td>
</tr>
<tr>
<td>Trabelsi et al. [14]</td>
<td>12 male recreational rugby sevens players</td>
<td>120 min/day, 4 times/week</td>
<td>↓</td>
</tr>
<tr>
<td>Meckel et al. [23]</td>
<td>10 young male soccer players</td>
<td>90 min/day 3 times/week plus one competition/week</td>
<td>↑</td>
</tr>
<tr>
<td>Trabelsi et al. [1]</td>
<td>10 physically active men</td>
<td>40-60 min/day of aerobic training in fasted state at least 3 times/week</td>
<td>↓</td>
</tr>
<tr>
<td></td>
<td>9 physically active men</td>
<td>40-60 min/day of aerobic training in fed state at least 3 times/week</td>
<td>↓</td>
</tr>
<tr>
<td>Karli et al. [27]</td>
<td>10 elite male power athletes</td>
<td>120 min/day, 6 times/week</td>
<td>↑</td>
</tr>
<tr>
<td>Bouhlel et al. [5]</td>
<td>9 elite male rugby players</td>
<td>120 min/day, 5 times/week</td>
<td>↓</td>
</tr>
<tr>
<td>Choauchi et al. [12]</td>
<td>15 elite male judokas</td>
<td>120 min/day, 6 times/week</td>
<td>↓</td>
</tr>
<tr>
<td>Chennoufi et al. [25]</td>
<td>8 male middle - distance runners</td>
<td>6 to 10 times/week = total of 8 hours/week</td>
<td>↑</td>
</tr>
<tr>
<td>Maughan et al. [20]</td>
<td>59 young male soccer players</td>
<td>60 min/session, 6 to 8 session /week</td>
<td>↑</td>
</tr>
<tr>
<td>Brisswalter et al. [26]</td>
<td>9 well-trained runners</td>
<td>specific training program, 3 times/week</td>
<td>↑</td>
</tr>
<tr>
<td>Ramadan et al. [17]</td>
<td>6 physically active men</td>
<td>jogging or brisk walking exercise with a duration of 30-60 min/day (after dusk), 3 to 5 times/week</td>
<td>↑</td>
</tr>
<tr>
<td>Stannard and Thompson. [28]</td>
<td>8 physically active men</td>
<td>2 to 5 times /week in the weight training gymnasium</td>
<td>↑</td>
</tr>
<tr>
<td>Racinals et al. [29]</td>
<td>11 recreational soccer players</td>
<td>-</td>
<td>↑</td>
</tr>
<tr>
<td>Güvenç [24]</td>
<td>16 amateurs soccer players</td>
<td>120 min/day, 3 times/week</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>8 recreational bodybuilders</td>
<td>Resistance training program in fasted state, 4 times/week</td>
<td>↑</td>
</tr>
<tr>
<td>Trabelsi et al. [7]</td>
<td>8 recreational bodybuilders</td>
<td>Resistance training program in fed state, 4 times/week</td>
<td>↑</td>
</tr>
</tbody>
</table>

↑↑: no-significant; ↓↓: significant decrease; ↑: significant increase.

**Hematological parameters**

Measurements of hematocrit and blood hemoglobin concentration are commonly used to evaluate hydration status [31,32]. The reported effects of Ramadan fasting on these two parameters in physically active individuals have not been consistent. One issue has been the timing of blood sampling, since dehydration is more likely in the late afternoon than early in the morning. Increases of hematocrit and hemoglobin have been noted in rugby union [5], sevens players [11] and physically active men [6]. Dehydration was attributed to a decrease in the 24-hour water intake during Ramadan [5,6,11].
Lipid profile can increase insulin sensitivity and improve glucose tolerance in both humans and animals [2]. Nevertheless, some improvement of regulation might be anticipated, since intermittent starvation similar to that experienced in Ramadan during the hours of daylight. One useful tactic for such individuals might be to consume foods with a low glycemic index at the by the falling blood glucose concentration during the afternoon. Unfortunately, athletes sometimes cannot avoid training during the fall. Such observations suggest that an athlete's ability to complete an intensive physical training session or perform at his or her maximum may be compromised lower glucose concentrations in the afternoon (04:00 p.m.) that in the morning (09:00 a.m.) during Ramadan [16]. Such observations including runners [19,43,44] and participants in team sports (soccer and basketball) [18].

Biochemical parameters

Plasma and serum electrolytes: Serum sodium concentration is another potential indicator of hydration status [31,34]. Values increase in sedentary men during Ramadan, but interestingly such a change is not duplicated in physically active men [17] or soccer players [20]. Possibly, athletes, pay greater attention to maximizing their fluid intake during the hours of darkness. However, if Ramadan falls during a hot and humid month, the daily fluid losses may be such that an increase in serum sodium and chloride concentrations is difficult to avoid. Increased sodium concentrations have been reported in rugby sevens players [13] and in rugby union players [5].

During Ramadan, dehydration develops progressively over the day [35]. Amateur soccer players thus show higher plasma sodium and potassium concentrations in the afternoon (05:00 p.m.) than in the morning (07:00 a.m.) during Ramadan [15].

During Ramadan, some physically active men opt to train at night, few hours after the Iftar, in order to minimize their fluids losses. This strategy appears to be effective from the viewpoint of fluid balance; thus, Tabelsi and co-workers [1] noted that serum electrolytes concentrations (sodium, potassium and chloride) did not change during Ramadan if aerobic training was undertaken after breaking the fast, whereas sodium and chloride concentrations increased if aerobic training was performed before breaking the fast.

Surprisingly, bodybuilders experience some increase in some serum electrolytes towards the end of Ramadan, whether they train at night or during the day [7]. These results seem in conflict with the findings during aerobic training. However, the total water intake of the bodybuilders decreased during Ramadan, even if they trained at night, whereas the men who were practicing aerobic exercise at night succeeded in maintaining their water intake. Possibly, athletes who engage in resistance training receive less guidance on the maintenance of fluid balance than those who are involved in aerobic activities.

Regardless of the time of day when training is undertaken, subjects should drink some 600 mL/h of fluid (the normal gastric emptying rate) from the breaking of fast until bedtime, and an additional 1L at the Sahour meal in order to minimize chronic dehydration [36].

Renal function markers

Creatinine clearance, and the plasma/serum concentrations of creatinine, urea and uric acid are all potential measures of renal function [37-39], although an increased breakdown of tissue protein could compromise the use of these indices during Ramadan. Increases of serum urea and creatinine have been observed in sedentary men during Ramadan [17]. However, possibly because of adaptations of renal function, the serum uric acid concentration is lower in physically active than in sedentary men [17]. Likewise, creatinine clearance values for elite rugby union players did not change during Ramadan [40].

In contrast, serum in urea, creatinine and uric acid concentrations were all increased in one recent study of rugby sevens players when Ramadan occurred in a hot and humid summer month [13]. Moreover, an increase in serum creatinine concentration and a decrease in creatinine clearance were seen in subjects who performed aerobic exercise during Ramadan, whether they trained before or after breaking their fast [1]. Likewise, resistance training performed either before or after breaking the fast increased the serum creatinine levels of bodybuilders who continued training during Ramadan [7].

Glycemia

The daily fast of Ramadan can induce a progressive drop in blood glucose concentration over the course of the day, even in healthy sedentary subjects [41,42]. A greater capacity for gluconeogenesis may prevent the drop in blood glucose levels in athletes, even if their energy intake is decreased during Ramadan [5,13]. However, in most studies where this has been measured, there has been no significant decrease of lean tissue mass over the month of intermittent fasting, and thus not much gluconeogenesis from the breakdown of tissue protein. Other studies of physically active men [1,6] and recreational bodybuilders [7,14] also found no significant change of blood glucose during Ramadan. However, decreased blood glucose levels have been seen in those performing more sustained aerobic activities, including runners [19,43,44] and participants in team sports (soccer and basketball) [18].

Glucose levels are certainly affected by the time of day when blood samples are taken [45]; for instance, martial arts practitioners show lower glucose concentrations in the afternoon (04:00 p.m.) that in the morning (09:00 a.m.) during Ramadan [16]. Such observations suggest that an athlete’s ability to complete an intensive physical training session or perform at his or her maximum may be compromised by the falling blood glucose concentration during the afternoon. Unfortunately, athletes sometimes cannot avoid training during the hours of daylight. One useful tactic for such individuals might be to consume foods with a low glycemic index at the Sahour meal, in order to prolong the release of sugars into the blood stream [46].

Little is known regarding possible changes in the action of insulin and other mechanisms of glycemic control during Ramadan. Nevertheless, some improvement of regulation might be anticipated, since intermittent starvation similar to that experienced in Ramadan can increase insulin sensitivity and improve glucose tolerance in both humans and animals [2].

Lipid profile

The lipid profile is an important indicator of cardiovascular health, and it is instructive to examine the changes in this profile that...
develop during the observance of Ramadan. Empirical data are conflicting, perhaps because findings are influenced not only by the timing of blood samples and any changes of diet, but also by the initial body fat content, and possible changes in physical activity during Ramadan.

The serum concentration of total cholesterol increased in judokas [12], but not in middle-distance runners [25], rugby union players [40], physically active men [6,11] or bodybuilders [7,14]. An increase serum high density lipoprotein cholesterol concentration (HDL-C) seen in judokas [12] and rugby union players [40] have been attributed to a mobilization of body fat stores during Ramadan. Supporting this view is an increase of HDL-C in subjects practicing aerobic exercise before breaking their fast [1], and in those undertaking resistance training in either a fed or a fasted state [7].

Low density lipoprotein (LDL) cholesterol concentrations also increase in judokas during Ramadan [12], perhaps due to an increased consumption of saturated fatty acids [47] associated with altered food choices.

Chaouachi and co-workers [12] noted that although the serum triglyceride values of judokas were increased sixteen days after the beginning of Ramadan, values had returned to pre-Ramadan levels towards the end of the month. In contrast, in a group of rugby players, Bouhlel and colleagues [40] found increased triglyceride values at the end of Ramadan. Others have reported no significant change of triglycerides concentrations during Ramadan [1,7,48].

The altered feeding behavior seen during Ramadan may increase apolipoprotein A1 levels, with a resulting increase in protection of the cardiovascular system [12,49]. On the other hand, the apolipoprotein B levels in judokas remained unchanged during Ramadan [12].

Immune markers

There is as yet only limited information on changes of immune function during Ramadan. If a negative energy balance develops, this might depress immune function, but as yet no evidence has been seen of such a change. The total leucocyte count of soccer players during Ramadan was increased when blood samples were collected in the morning (09:00 a.m.), but was unchanged for subjects whose blood samples were collected the afternoon (01:30 p.m.) [20]. No change in either the total or the differential leucocyte count was seen in judokas during Ramadan [50]; however, one problem in interpreting data from these subjects is that any tissue trauma sustained during training is likely to induce an inflammatory response, with consequent slight increases in immunoglobulin A and immunoglobulin G [50]; this makes it difficult to discern the effects of Ramadan alone. Likewise, no changes of total leucocytes or leucocyte subsets were seen in Muslims bodybuilders practicing resistance training, whether before or after breaking their fast [7]. It is worth emphasizing that in the several studies completed to date, all values for immune markers have remained well within normal clinical limits. Thus, there is no evidence that the combination of physical activity and Ramadan fasting has affected immune function. Nevertheless, further tests are needed in long distance events such as marathon and ultra-marathon runs, the type of situation where impairment of immune function is most commonly observed even in the absence of Ramadan fasting.

Inflammatory markers

Findings regarding the effect of training and Ramadan observance upon inflammatory markers are inconsistent. C-reactive protein concentrations increased in judokas [50], decreased in a sample of soccer players who were tested in the morning [20], and did not change in either middle-distance runners [24] or recreational bodybuilders training either before or after breaking their fast [7]. Serum transferrin concentrations increased in soccer players [20], but did not change in judokas during Ramadan [50]. The prealbumin, albumin, haptaglobin and homocysteine concentrations of judokas also remained unchanged during Ramadan [50], and ferritin concentrations remained unchanged in soccer players [20]. Although some observers have reported statistically significant changes in inflammatory markers values, it must again be emphasized that values have remained within the normal laboratory reference range.

Conclusions

Athletes who maintain predominantly aerobic-based training during Ramadan may expect to see some decrease in their body fat stores. In addition, if training is conducted during daylight under hot and humid conditions, changes in hematological and biochemical parameters reflect a progressive dehydration and possibly some impairment of renal function. However, information obtained to date does not suggest that the immune and inflammatory systems are adversely affected by Ramadan. Moreover, changes in hematological and biochemical parameters are usually relatively small, with values remaining within the normal reference range. The implication seems that intensive physical training can be maintained with safety during Ramadan.

Recent studies have helped in defining optimal tactics to maintain homeostasis and conserve or enhance body composition while continuing rigorous training during Ramadan. If aerobic training is practiced before the night-time break in fasting, it may stimulate lipid mobilization, thus reducing body fat stores and improving the lipid profile. However, cumulative dehydration may develop over four weeks of aerobic training in a fasted state, so that care must be taken if this training plan is adopted. In contrast, it seems that resistance-based training can be performed safely either before or after breaking the fast. Lean body mass seems well maintained, and the immune and inflammatory systems do not appear to be adversely affected by Ramadan. Mild dehydration and an improvement of lipid profile are likely with resistance training, whether the exercise is performed in a fed or a fasted state.

References


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