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Effects of holy month of Ramadan (fasting) on performance of athlete and the recommendation for its modification

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Abstract
Ramadan (/ˌræməˈdɑːn/; Arabic: رمضان Ramaḍān, also transliterated *Ramazan*, is the ninth month of the Islamic calendar, and is observed by Muslims worldwide as a month of fasting to commemorate the first revelation of the Quran to Muhammad (peace be upon Him) according to Islamic belief. This annual observance is regarded as one of the Five Pillars of Islam. The month lasts 29-30 days based on the visual sightings of the crescent moon, according to numerous biographical accounts compiled in the hadiths.
The word Ramadan comes from the Arabic root "ramiḍa or ar-ramaḍ", which means blazing heat or dryness. Fasting is Fardh (obligatory) for adult Muslims, except those who are suffering from an illness, travelling, are elderly, pregnant, breastfeeding, diabetic or going through menstrual bleeding. Fasting the month of Ramadan was made obligatory (wājib) during the month of Sha'aban, in the second year after the Muslims migrated from Mecca to Medina. Fatwa (order) have been issued declaring that Muslims who live in regions with natural phenomenon such as the midnight sun or polar night should follow the timetable of Mecca. While fasting from dawn until sunset, Muslims refrain from consuming food, drinking liquids, smoking, and engaging in sexual relations with one's spouse. Muslims are also instructed to refrain from sinful behavior that may negate the reward of fasting, such as false speech (insulting, backbiting, cursing, lying, etc.) and fighting. Food and drink is served daily, before dawn and after sunset. Fasting for Muslims during Ramadan typically includes the increased offering of salat (prayers) and recitation of the Quran.
Muslim athletes who train and compete during the Holy month of Ramadan face challenges to perform at their optimum level with the restriction of food and fluid from sunrise to sundown, as well as alterations to sleep patterns, as whole mechanism changes abruptly. Some studies reported that the exercise performances of the athletes were adversely affected by Fasting. This review recommends the application of the FITT principles of exercise (i.e., frequency, intensity, time and type). An ideal model twice-a-day training session, which incorporate the different physical and behavioral aspects, are proposed for the athletes in this review in order to minimize the negative impact of Ramadan on their performances. This review will act as a useful guide for coaches and fasting athletes to carefully and strategically plan their training program to generate the most optimal level of competitive and training performance during Ramadan. This model will help them to most of extend to cope-up with harsh conditions of the Holy month of Ramadan.

Keywords: Training, Diet, FITT Principles, Rest & Recovery, Nutrition, Ramadan, Suhar, Iftar

Introduction
Fasting is not only the act of restricting food and fluid alone but it is also an intensely spiritual time, with strict adherence to the fast and an increased devotion to prayers. During Ramadan, Muslims further engage in additional daily mass prayers called *Taraweeh & Nawafil* performed after breaking of the day's fast firstly performed *Magrib Nimaz* and then *Isha Nimaz* that can last between 2-2.5 hours. In Ramadan Muslims perform less physical activity and make themselves much engaged in prayers and in social work, as according to Islam the Holy month of Ramadan is the month in which Allah loves to forgive his sinful followers and in this month the Holy Quran was also descended to the Holy Prophet Peace be upon him. In this month Muslims are only allowed to ingest food and fluid during the day and they primarily consume their meals at two sittings: once before sunrise called the 'Sahur' meal Pre-Dawn meals, before Fajr Azaan), and the other is after sunset, immediately upon the break of the day's fast which is known as 'iftar' meal. In some countries Sporting activities such as football league matches are played afterIftar, and the period between this meal and the competition is generally 2-3 hours. However, in other countries/societies, this is clearly not the case and thus Muslim individuals in these countries will have to adapt and suit their behavior to the majority of society accordingly. International competitions or major sports events scheduling do not take Ramadan into account and many Muslim athletes are compelled to fast despite the expected challenging physical requirements during these events, which will definitely affect their performances in the competitions.
The research paper will briefly identify such strategies and suggest several practical recommendations on how Muslim athletes may try to overcome the challenges of Ramadan fasting while training and competing at the same time. The recommendations provided in this Research paper aim to assist coaches and athletes to plan and organize their preparations for optimal competitive and training performance during Ramadan. This will lead them to enhance their performances.

Training Modification
Ramadan fasting is one of the fundamental tenets of being a Muslim, and in some secular societies, Ramadan fasting is not an option or an individual's choice but a mandatory act that reflects the individual's faith to his or her Allah. One of the simplest ways to reduce the adverse impact of Ramadan fasting

is to modify the athlete's training program. One of the training variables that can be manipulated to improve or maintain exercise performance during the month of Ramadan is the time-of-day of training. The available options for coaches and athletes to schedule training sessions are: 2-3 h after Sahur, 1-2 h just before Iftar, and 2-3 h after Iftar.

Training session after Sahur

Earlier to this session, the athlete would have consumed their Sahur meals early in the morning, i.e., between 2-2.3 hours before beginning training. Hence at this stage, he/she would likely to be food & fluid-filled. The training-prompted adaptations of the session are not really ideal since post-exercise food and fluid can only be consumed >5-8 hours. Indeed, there is no effective recovery from training until nutrients are ingested by the athlete. It could also be that training in the morning may lead to a poorer and less than optimal quality of effort situation since the athlete may likely to "pace" himself during the session to conserve energy.

Training session just before Iftar

Training at this time of the day is advantageous since high level of motor coordination and other physical measures such as strength also tend to peak around the late afternoon or early evening period and stimulation levels are closer to the optimum level for exercise performance, at least in the non-fasted state. However, the quality of effort during the session is expected to be compromised due to the acute prolonged absence of food and fluid during the day earlier to exercise. Furthermore, without nutrition as well as chronic daytime sleepiness, the fasted athletes will likely to experience initial onset of fatigue and may face a sensitive risk to injury. Although the quality of training might be compromised, the cellular effects of the mechanical work done, on the other hand, may be advantageous. This view is supported by the findings that the magnitude of training-induced adaptations in the fasted state (i.e., performed in the afternoon) was equivalent to the same training in the non-fasted state. A possible reason for this lack of difference in training-induced adaptations between chronic training in the fasted and non-fasted state was that post-exercise recovery was not compromised because fasting subjects were able to consume food and fluid immediately after their training sessions. Thus, if training is to be conducted during the daytime in Ramadan, it is recommended that the session ends just prior to the breaking of the day's fast to allow ingestion of food and fluid within the ideal window period to optimize cellular training-induced adaptations.

Training session after Iftar

In a recent study, the effects of Ramadan fasting on performance during acute high-intensity exercise sessions were examined at three different times of day: 08:00 h (after Sahur), 18:00 h (beforeIftar) and 21:00 h (afterIftar) in well-trained Muslim athletes. This study found that the most optimal time-of-day to perform high-intensity exercise is 1hour & 30min after the breaking of the day's fast at 21:00 h. Others have also recommended Muslim athletes and coaches to schedule training session to the evening period. A survey conducted has also shown that training in the evenings is one of the self-coping strategies predominantly adopted by elite Muslim athletes in Malaysia. Moreover, there is a tendency for the Ramadan fasted individuals to adopt an "evening-type" behavioral profile and hence the evening session is also within, or close to, the ideal period of the athlete's 24-h clock for performance and psychomotor skill.

Pre-Ramadan training advantages

Plan ahead and introduce change gradually

The most significant unrests that are due to Ramadan fasting have been reported to occur in the first week of Ramadan. Therefore the appropriate managing strategy should be gradually introduced at least three weeks before the start of Ramadan.

Maintain the training stimulus (including both exercise load and/or intensity)

Training loads should be suitable to progress the required fitness and performance levels of the athletes, or should be similar to the training carried out in the lead up to the competition.

Train according to the time of competition

If the time of competition is known, training sessions before a major event should be conducted at the same time of day at which the critical performance is scheduled. However, if the time of competition is not known, training sessions should be programmed in the morning to counteract a possible shift in the sleep wake cycle and its effect on sports performance.

Time training session based on its intensity

Heavy training sessions should be scheduled either in the early evening (after breaking fast) or the late afternoon (close to the time of breaking fast), so that players can replenish their glycogen stores and rehydrate immediately after training. Technical or light training can be carried out at the usual time.

Remember to drink enough

Acute hypohydration (dehydration) will occur during daylight hours especially during bouts of strenuous physical activity in the heat. Fluid intake should be monitored daily. Pre-training urine concentration and body mass should be checked in order to ascertain that individual athletes are not significantly dehydrated before training. It is suggested that individuals who are hypohydrated by 3% or more of usual body mass should not undertake strenuous, prolonged (about 60 min) exercise, especially in hot environments. Sensible dietary strategies that ensure adequate fluid intake especially just before dawn, coupled with behavioural adaptations that minimize daytime fluid losses before training will help preserve hydration status and physical performance. Athletes should be allowed cool water to rinse out their mouth, whenever they require, which will alleviate their thirst without breaking their daytime fast. Where possible, sweat loss should be minimized by reducing non-training activity, staying in the shade or air conditioned areas.

Fitness levels

The rapid onset of fatigue among Ramadan fasted athletes can reduce quality of performance and/or increase the risk to injury. Thus, another strategy to reduce early fatigue is to make the Muslim fasted athletes as fit as possible when approaching Ramadan. This strategy is often ignored by the coaches but was clearly evident in a classic study where investigator examined the effects of Ramadan fasting on high intensity endurance performance. The investigator demonstrated that exercise performance of fitter fasted Muslims were less likely to be

negatively affected by Ramadan fasting. Seemingly, the physically fitter Muslims are more able to cope better with unrests of Ramadan fasting. This was indirectly supported by previous study showing that active fasted Muslims are able to conserve more body water as compared to less active ones. Performance of well-trained athletes may be less affected by hypo-hydration than that of untrained individuals. Trained individual is able to store more glycogen within the working muscles.

Trained individuals are characterized with high levels of tolerance to fatigue, positive attitude and greater mental strength than untrained individuals. In short, by making the athletes fitter, the fasted Muslim athletes will face the physical challenges of training and competing while fasting with greater self-confidence.

"Acclimatization" to Ramadan Fasting

In a recent study, subjects were made to exercise in a hypo-hydrated state on several junctures. While performance in the hypo-hydrated state was much lower compared to performance in the hypo-hydrated state, the declined in performance in the later hypo-hydrated trials were progressively attenuated. The investigator argued that in the later trials, subjects seemed to be "habituated" or have somewhat adapted to the physical and mental stress of exercising in the hypo-hydrated state and hence performance was less adversely affected. In the same manner, it can be reasoned that fasting individual can also habituate himself to cope with exercises in the less than optimal Ramadan fasted state. For example, the Muslim athlete could practice the fast during the year out of the period of Ramadan, especially during the month before fasting, which could habituate the individual to Ramadan observation later on.

Training intensity/Load

It is worthwhile to assess the athlete's training intensity and/or load during Ramadan fasting to ensure that the fasted athletes are provided with sufficient training stimuli. This is to ensure that they do not to suffer from detraining and at the same time, to not overly stress them until they have over-reached or over-trained. In this regard, measuring the athlete's subjective perceived ratings of the session using the categorical Borg's RPE 1-10 scale is a simple and practical tool to track the physical load that the fasted individuals are experiencing over all the training sessions performed during the Ramadan month. When these values are compared with the non-fasted players, the difference or similarity observed may allow the coaching staff to determine the overall physical and mental stress that the fasted athletes are experiencing.

Enthusiasm/Willingness to train

While the session-RPE helps to provide inputs on what the athlete is experiencing during training, the coaches can also do a simple evaluation of the athlete's willingness and desire to train as well as fatigue levels prior to training. Previous study has used a simple visual analogue scale, with word descriptors anchored at both ends of the 100 mm line that expressed the two most extreme ratings of the variable. The athlete simply mark his perceived physical and mental conditions (i.e., defined as the athlete's readiness to train) along this line, just prior to the commencement of exercise. A consistently low or poor response over several consecutive training sessions would flag something has gone amiss with the fasted athlete. The coaching staff could then conduct a more detailed follow-up investigation on the athlete e.g., clinical assessments to determine the cause of the poor pre-exercise attitude.

Amendments to Nutrition

The absence of nutrients for a prolonged period of time can result in hypoglycemia and lowers the amount of endogenous glycogen concentration. Thus, the most fundamental issue with nutrition is that the athlete will need to take into account the type, amount and time of day of food ingestion in order to optimize the endogenous substrates storage for future use during exercise. Therefore, the same FITT principle used in training will be applied to the modifications of dietary intake during Ramadan.

The FITT Principle

The FITT principle is a formulae or methodology used for prescribing exercising. Regardless of the type of program you are writing you need to apply the FITT principle. The FITT principle stands for frequency, intensity, time and type and a brief description is given in the table below.

FITT Principle Training before Ramadan

F	Frequency	● This refers to how many times you complete a training session each week. ● It is usually expressed as x / week e.g. 2-3 x/week.
I	Intensity	● This refers to the amount of effort that is put into a specific exercise, or how hard you train. ● Intensity is expressed as % MHR, RPE or <RM, RM, >RM.
T	Time	● This refers to two things, firstly, how long the total training session goes for and secondly, the time of each interval, set, specific exercise within the training session.
T	Type	This refers to the type of activity that will be performed and refers to a number of aspects of the training session: ● The type of training i.e. cardiovascular, resistance or flexibility. ● The type of resistance, cardiovascular or flexibility training i.e. strength, power, static, LSD etc. ● The types of exercises to be conducted i.e. bench press, crunches, road running, etc.
Guidelines For Prescribing A Warm Up		
F	Frequency	Prior to every training / sporting / physical activity session
I	Intensity	The intensity of a warm up needs to be lower than the main training phase. Intensity can be measured in a number of ways. **Cardiovascular Exercise** When referring to cardiovascular exercise it can be prescribed as a % of MHR or as a Rating of Perceived Exertion (RPE). Generally, cardiovascular warm ups need to be: • 50-65% MHR, or • 5-6 /10 RPE

		Resistance Exercise When referring to resistance exercise it can be prescribed as a Rating of Perceived Exertion (PE) / % of absolute intensity / <RM, RM, >RM. Generally, cardiovascular warm ups need to be: • < RM • 5-6 /10 RPE Generally the intensity of a warm up will start low and gradually increase in preparation for the training phase Note: The warm up should not induce fatigue.
T	Time	As a rule the warm up should go for 15-20% of the duration of the whole session. For example, a 30 minute workout will have a 5-7 minute warm up and a 60 minute workout will have a 10-12 minute warm up.
T	Type	The warm up can be broken down into two phases. Systemic /general warm up – focusing on increasing internal body temperature and blood flow e.g. rowing machine, jogging etc. Specific warm up – focusing on the muscles, joints and movement patterns that will be used in the training phase e.g. bodyweight movements, dynamic stretching. The bulk of the exercises included in a warm up need to be specific to the training phase. For example: • If the session is a cycle session, the warm up needs to be on the bike at a lower intensity. • If the session is weights the warm up needs to be movement patterns that replicate the exercises in the training session i.e. push ups, ball throws, body weight squats etc.

Guidelines for Prescribing Cooling Down

F	Frequency	At the completion of every training / sporting / physical activity session
I	Intensity	The intensity of a cool down needs to be low. Remember intensity can be measured in a number of ways. **Cardiovascular Exercise** When referring to cardiovascular exercise it can be prescribed as a % of MHR or as a rating of Perceived Exertion (PE). Generally, cardiovascular cool downs need to be: • 30-40% MHR, or • 3-4 /10 RPE **Resistance Exercise** When referring to resistance exercise it can be prescribed as a rating of Perceived Exertion (PE) / % of absolute intensity / <RM, RM, >RM. Generally, cardiovascular warm ups need to be: • < RM • 3-4 /10 RPE
T	Time	As a rule the cool down should go for 15-20% of the duration of the whole session. For example, a 30 minute workout will have a 5-7 minute cool down and a 60 minute workout will have a 10-12 minute cool down.
T	Type	The cool down can be broken down into two phases. Systemic /general cool down– focusing on increasing internal body temperature and blood flow e.g. walking Stretch – focusing on the muscles and joints that were used in the training phase e.g. static stretching.

Recommendations for training program & rest in the Month of Holy Ramadan Fasting for athletes

Am		**Noon**		**Pm**	**Pm**	**Pm/Am**	
3-3:45	**5-7**	**8-11**	**11-12:00**	**1-7:30**	**7:458:30**	**8:30-10**	**11-3:00**
Eat and drink (Sahur meal)	Sleep	Training	Day sleep	Rest	Eat & drink Iftar meal	Train high-intensity and Eat & drink	Sleep

The table below further elaborate the nutritional strategies to optimize the achievement of sports nutrition goals during Ramadan fasting.

Issue	Details	Special explanations
Where possible, move the schedule of exercise to a time of the day that best provides the appropriate nutrition support	Sessions undertaken in the morning after sunrise Pros: benefit from eating and drinking strategies undertaken during the previous evening and before dawn Cons: Little opportunity to refuel, rehydrate, and recover after these sessions Sessions scheduled to finish just before Iftar (breaking fast) Pros: benefit from ability to eat for recovery at Iftar and during evening Cons: undertaken with minimal pre-exercise support Sessions undertaken 2-3 h after the break of the fast Pros: best opportunities to fuel and hydrate before, during, and after Cons: must be balanced against the importance of sleep	Major changes in the daily timetable of training/ competition, as well as sleep, may be possible in countries that are predominantly Islamic

Make the most of important eating times	Breaking of the fast: Adapt or supplement meals in quantity/quality to meet specific needs for fluid, carbohydrate, and protein, especially for recovery after recent exercise session The last meal (Sahur): Eat as close as possible to sunrise and choose foods that contribute to sports nutrition needs for the day Food/fluid consumed during or after exercise undertaken in the evening: Support needs for performance and recovery Remember that this food/fluid contributes to total day's nutrient needs Make use of special sports foods to reduce gastrointestinal discomfort from pro-active eating strategies	By delaying training/competition to the evening, Iftar can be used as the pre-exercise meal, and the main evening meal can be delayed until after the exercise Players who must train during the day when fasting should maximize refuelling and hydration during the night and at Sahur, rest after training, and begin replenishing with Iftar
Consider important nutrients	Carbohydrate Consume at break of fast and meal before dawn, and other meals during the evening, especially where these meals represent post-, pre- or in-exercise intake Set targets according to fuel cost of exercise Consume small amounts during exercise undertaken after the fast is broken, even if there is little need for additional fuel. Mouth contact with carbohydrate may promote a ''happier'' brain for better performance Eat immediately after exercise if possible, to enhance refuelling rate Consume low glycaemic carbohydrate choices at meal consumed before dawn to allow slow release of glucose Protein Consume 20 g ''fast'' high-quality protein soon after exercise where possible, but note that enhanced protein synthesis from exercise persists for 16-24 h In absence of information on best protein spread over the day, consume protein at each meal opportunity (avoid eating only carbohydrate-rich food choices) Consume ''slow'' proteins at meal consumed before dawn to help with protein balance over day Add protein to carbohydrate-rich snacks to enhance muscle glycogen storage when carbohydrate targets can't be met	Many common foods associated with Iftar are rich in carbohydrate (e.g. figs/dates) and high quality protein (milk and laban yoghurt). The substantial meal after prayers typically features savoury dishes with carbohydrate-rich components (rice) and protein (meat or fish) Other combinations of carbohydrate and protein include Thareed (bread containing), starch pudding (milk), and rice porridge Care should be taken with Ramadan treats, since many are very high in fat. Some recipes can be adapted to promote carbohydrate content and reduce fat (e.g. replace puff pastry in Um Ali with bread) Ma'amoul, dried fruits and nuts are suitable snacks When eating opportunities are limited, drinks with high energy/nutrient density can be useful to meet high-energy requirements. Sahur meals that are high in carbohydrate include rice with egg, cheese, and milk.

Regularity

There is enough need to take good caloric food intake, as many calories will burn during the day. Thus, the typical three main meals (Suhar, Iftar, & Night Snacks) during the normal non-Ramadan period to Ramadan meals consume will help in ensuring that the athletes will likely to consume sufficient amount of calories over the 24 hours period during Holy month of Ramadan. So it is very important for the athlete to make a balanced diet schedule so that he/she can store energy for coming month of energy.

Intensity (or amount)

An athlete should make himself ensure that his total energy intake is able to support the energy requirement for performance and recovery as well as satisfy the overall requirement for the day. The sufficient amount of important nutrients including carbohydrate and protein should be consumed in a great quantity. The food intake should be according to the type of activity. The activity demands the type of food and nutrient intake. The athlete should also take sufficient amount of water as Sahur is the last time that a Muslim Athlete can ingest anything. So coaches should also have the knowledge of nutrition.

Timing

Athletes should be reminded to consume their Sahur meal as close as possible to sunrise just before the commencement of the day's fast while Iftar to be taken immediately at sunset once allowable to break from fasting. This strategy will ensure that the body is in the 'fasted state' for the shortest period possible. It is well established that the best time to consume food and fluid for recovery is the period immediately after exercise, especially after heavy training. There is a 'window of opportunity' for higher rates of glycogen storage during first 2-4 h post-exercise. Thus, this supports the argument that if heavy training is to be conducted during the daytime in Ramadan, the session should be timed such that it ends just prior to the breaking of the day's fast to allow unrestricted ingestion of food and fluid for enhanced post-exercise recovery.

Type

There are three main types of nutrients that the body needs on daily basis: carbohydrates, proteins and fats. A recent review, however, suggested that during Ramadan, there was a greater tendency for Muslims to consume a greater amount of fats and at the same time reduce their carbohydrate intake. A possible reason for this is that Muslims tended to choose dense-nutrient food to compensate for the less meals sittings over the 24 hours period. However, food taken by athletes for Iftar and Sahur should contain predominantly nutrients of carbohydrate and protein. So, that they can consume these nutrients during the day of fasting and can continue with their training schedule.

Rest and Recovery

During Ramadan, there is loss of sleep and rest as Muslims usually wake up early at pre-dawn and with the added social and religious activities that take place after sunset, can lead to 2-3 hours of sleep lost per day. When this acute sleep debt occurs over consecutive days, the accumulation of sleep loss will ultimately lead to chronic sleep deficiency, which in turn could affect physical and mental performance directly or indirectly via mood swings or feelings of lethargy. Hence, rest and recovery gain greater importance in the athlete's overall training program during Ramadan. So an athlete needs day sleep to compensate with the night sleep so that he will feel himself/herself in better condition and physically & mentally fit. Below are additional steps or behavioral patterns that

athletes can adopt to enhance their overall rest and recovery situation during Ramadan.

Minimizing useless physical activity during daytime

Ramadan fasted athletes should minimize any kind of unnecessary physical activity during the daytime period to limit the use of precious available endogenous resources such as muscle and liver glycogen, and blood glucose. This is also to prevent the occurrence of accumulative physical fatigue, which could hamper exercise during the later part of the day. So an athlete should take maximum rest during the day time.

Planned sleeps

Ramadan fasted athletes are recommended to take afternoon or planned naps at appropriate time during the daytime because of the reduced sleeping hours at night. Planned naps for 30-40 min can significantly improve alertness. However, it is advised to best avoid prolonged (>60 min) daytime naps and/or naps close to bedtime as this will tend to disturb night-time sleep and make it more difficult for the individuals to adjust to the changing biological clock. So an athlete should take as much sleep which will compensate his night sleep.

Conclusion

Ramadan fasting can have a negative impact on athlete's exercise performance, which can influence training and competitions results. Ramadan observance involves the shortage of several aspects of one's primary needs, and this review suggests that there is no single approach but rather, an agreement of several strategies to try to avoid or reduce the adverse instabilities of Ramadan fasting. This includes implementing or applying different aspects of frequency, intensity (amount or volume), timing and types of training, nutrition, sleep, rest, and even personal lifestyle and social behavioral strategies. These changes in life style and training program can overcome the difficulties which will hinder during the Holy month of Ramadan.

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