International Journal of Physical Education, Fitness and Sports-IJPEFS Vol.2. No.1.March 2013, ISSN 2277-5447

DIURNAL RHYTHMS IN SELECTED PHYSICAL VARIABLES BEFORE AND DURING RAMADAN FASTING

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DOI: 10.26524/1315.

Abstract

The purpose of the present study was to assess diurnal variations in selected physical variables before and during Ramadan fasting. The physical variables (speed, speed endurance, agility and power) were documented around the clock at five 4-hourly intervals before Ramadan began and on the twenty-third day of Ramadan (daytime fasting). Ten healthy non-smoking male handball players volunteers were included in the study after routine clinical and laboratory examinations. These subjects were selected from Department of Physical Education and Sports Sciences, Annamalai University. Their ages averaged 27 ± 1.9 years. Time series were analysed with repeated measures ANOVA which revealed that there was a statistically significant changes as a result of Ramadan fasting among experimental days and times on speed, speed endurance, agility and power. Experimental day and time interaction showed that during Ramadan, compared with control period, time related variations of speed, speed endurance, agility and power changed significantly. To evaluate rhythmicity, the single cosinor method was used. Cosinor analysis clearly shows the shift in acrophase obtained from the subjects before to the 23rd day of Ramadan fasting. Ramadan induces day time changes in speed, speed endurance, agility and power.

Keywords: *Ramadan, fasting, speed, speed endurance, agility and power.*

Introduction

Rhythmicity is a fundamental feature of existence and circadian rhythms have been observed in the vast majority of human physiological variables [1]. One of the more fundamental rhythms is that of the sleep–wakefulness cycle which is harmonised with the natural alternation of daylight and darkness in the environment. Patterns of food and fluid ingestion also fit a diurnal rhythm, in time with arrangements for sleeping and being active. The ingestion of food and liquid is highly influenced not only by immediate biological needs but also by external factors such as social circumstances, habit and individual and family choices.

Normal patterns of fluid and food intake are broken when the sleep–wake cycle is disrupted. Different types of disturbance are attributable to time-zone transitions, working on rotating shift systems and sleep deprivation. Sleep–wake cycles are also affected by ageing and so is the autonomic drive to imbibe fluid [2]. This study is on Ramadan, a holy month for Muslims.

During Ramadan one of the most important rules of Islam is that any healthy adult Muslim must refrain from eating, drinking, smoking, and sexual relations from sunrise to sunset during the month of Ramadan, the ninth month of the Muslim calendar. Since this is a lunar calendar, the timing of this month of fast changes each year and the duration of restricted food and beverage intake can vary from between twelve to sixteen hours. Intake is restricted to the night hours within a short span of time, which thus delays sleep and reduces its duration. Environmental factors such as the timing of the rest-activity cycle [3] and meals [4] play a part in the synchronization of individuals to the 24-h day (and are accordingly known as synchronisers). They modulate or modify one or several of the parameters characterising the circadian rhythm of a biologic variable [5-7]. We have previously shown that changes in the circadian rhythms of nutrition-related biological variables [8-10] occur during Ramadan. The purpose of the present study was to assess diurnal variations in selected physical variables before and during Ramadan fasting.

Methods

Subjects

Volunteers meeting the inclusion criteria participated in this study after giving their informed written consent. The study design was in accordance with the guidelines issued by the ethics committee Annamalai University. The investigation

conforms to the principles outlined in the declaration of India. Ten healthy non-smoking male handball players volunteers were included in the study after routine clinical and laboratory examinations. These subjects were selected from Department of Physical Education and Sports Sciences, Annamalai University. Their ages ranged from 25 to 29 years (mean ± SD = 27 ± 1.9 yr.). None took any medication either before or during the study; none had any chronic or acute somatic or psychiatric disorder; and none had taken a transmeridian flight within two months of the study.

Protocol

The volunteers were studied twice over a 12-h span: one week before Ramadan (control: end of December) and on the twenty-third day of Ramadan (Ramadan: end of January). On both test days, speed, speed endurance, agility and power were measured at the following clock hours: 0600 h, 0900 h, 1200 h, 1500 h and 1800 h.

Before Ramadan started, the subjects were synchronised to nocturnal rest from 2000 h ± 0115 h to 0600 h ± 0130 h and to diurnal activity. On test days they were awakened at 0500 h, to have their physical variables. Physical activity did not differ qualitatively or quantitatively during Ramadan, compared with the control day (they had the same tasks and working hours before and during Ramadan). One week before Ramadan the sunrise was at 06:27 hours, sunset was at 17:54 hours and length of the day was 11 hours 26 minutes and 19 seconds during the study. On the twenty-third day of Ramadan the sunrise was at 06:36 hours, sunset was at 18:13 hours and length of the day was 11 hours 37 minutes and 18 seconds during the study. The difference between these two days on length of the day was 29 seconds. During and before Ramadan the subjects slept uninterruptedly from 2130 h to 0530 h. All meals were quantitatively and qualitatively standardised by a nutritionist and were eaten at fixed hours that fit the subjects usual schedules and Ramadan customs.

Meal timing and composition before Ramadan was:
0800 h: idly or dosa or pongal, coffee and milk (< 400 kcal)
1200 h: meat, vegetables, rice and fruit (< 1500 kcal)
2000 h: soup, chapatti, chicken (< 1100 kcal).
Meal timing and composition during Ramadan was:
1900 h: milk, dates, soup, meat, vegetables, rice, fruit, coffee and pastry (< 2200 kcal)
0001 h: semolina, milk, fruit and pastry (< 800 kcal).

Statistical analysis

Time series were analysed with a repeated measures analysis of variance (ANOVA; 2 within, 0 between) with SPSS software (11.5 version) to test the time-related variations (effect of time in both experimental conditions), the influence of Ramadan upon the 12-h mean concentrations (Ramadan vs. control) and the possible interaction of Ramadan upon the time-related variations (experimental day and time interaction).

To evaluate rhythmicity, the single cosinor method [11, 12] was used. The single cosinor method identifies and evaluates the cosine mathematical function best fitting the data as a function of time. The function, $f(t) = M + A \cos(\omega t + \phi)$, defines three parameters characteristic of each statistically significant rhythm: MESOR; amplitude; acrophase. MESOR (midline estimating statistic of rhythm) approximates the arithmetical mean of the data for a 24-hour period, and amplitude is the measure of one half the extent of HR rhythmic variation in a cycle.

Results

ANOVA (Table 1) shows statistically significant time related variations (time effect) and during Ramadan (Ramadan vs. control) for speed, speed endurance, agility and power. Experimental day and time interaction showed that during Ramadan, compared with control period, time related variations of speed, speed endurance, agility and power changed significantly.

The mean cosinor were calculated for speed, speed endurance, agility and power before and 23rd day of Ramadan with day time fasting. Table 2 shows the parameters that characterize the diurnal variation of the subjects were monitored in two different experimental conditions. A different situation appears for the Achrophase, the speed peaks at 13:57 (before Ramadan) to 14:59 (23rd day of Ramadan fasting). It means a delay of at least 1:02 hours. The speed endurance peaks at 12:52 (before Ramadan) to 16:54 (23rd day of Ramadan fasting). It means a delay of at least 4:02 hours. The agility peaks at 13:17 (before Ramadan) to 14:32 (23rd day of Ramadan fasting). It means a delay of at least 1:05 hours. The power peaks at 16:33 (before Ramadan) to 14:52 (23rd day of Ramadan fasting). It means an advance of at least 1:42 hours. This analysis clearly shows the shift in acrophase obtained from the subjects before to the 23rd day of Ramadan fasting.

Discussion

Ramadan is the month during which Muslims must refrain from eating and drinking from sunrise until sunset while maintaining their usual social and occupational activities. These long-lasting modifications—daytime fasting accompanied by a delay and shortening of night-time sleep and changes in behaviour and social habits—have been shown to result in a phase delay of many biological rhythms.

There is fairly comprehensive evidence of circadian rhythms in many aspects of human performance. In fasting individuals, this rhythm is likely to be reduced in amplitude, due to the length of time without food at the time of day that performance capabilities should be at their zenith. There are also likely to be peripheral (local muscular) as well as central (cerebral) influences on the variations in muscle performance over the solar day, both of which are likely to be impaired by food deprivation. All these expected changes in performance with time of day are likely to be due not only to the body clock [10] but also to exogenous influences including lifestyle and nutrition.

A factor that is obviously relevant to the fasting athlete during the period of Ramadan is the timing of training. Normally, high intensity exercise is best tolerated at the time that resting core temperature is at its high-point [13]. Dehydration and lack of food intake are likely to mean that the quality of the training stimulus will be impaired if training is conducted in the middle or towards the end of a diurnal fast. There is some suggestion of habituating to training at a particular time of day, Edwards et al. [14] reporting that competitive performance in cycle time-trials is influenced positively by training at that time in the days before racing. Whilst exercising in the daytime during Ramadan may lead to such a habituation effect, performance is still likely to be impaired by nutritional restrictions after sunrise.

The decreases in muscle performance were corroborated for psychomotor measures [15]. There is also evidence of increased incidence of traffic accidents occurring in the month of Ramadan. Whether these events are related to changes in insulin, blood glucose, low energy levels or mood changes, or a combination of these factors, are unclear. Irritability has been found to increase during Ramadan, peaking at the end of the month [16, 17].

Kirkendall, Zerguini, Dembri, Junge, Dvorak (2006) focused on two professional teams in Algiers in their investigation of the impact of Ramadan on biochemical and performance indices of soccer players [18]. By the end of the period of fasting, the players displayed decreases in sprinting speed, agility, speed of dribbling and 12-min run performance. These changes were accompanied by reductions in blood cholesterol, low-density lipoproteins, triglycerides and glucose. Most players felt they had poorer quality of sleep, training and match performance during the period of fasting. These negative states would in turn have an adverse effect on motivation for exercise. When players were re-examined 2 weeks after the end of Ramadan, many of the blood variables had recovered to normal but performance measures were still below initial baseline values.

In conclusion, the studies completed so far are of limited value in helping to understand how performance is affected by the intermittent fasting practised during Ramadan. A fall in performance may be caused by alterations in circadian rhythms, fatigue due to disturbances of the sleep–wake cycle or a reduction in energy reserves—or, more likely, by an interaction of all these factors. The time of day at which testing has been conducted, the fitness levels of subjects and the measurements made may be critical. In certain circumstances, athletes may be exempt from the fast and so may not experience the same dietary discomfort as strict religious adherents. Dispensations apply when athletes are ill or are travelling. For those reasons it is not clear how practicing Muslims might best maintain their training programmes in harmony with altered circadian rhythms during Ramadan. The temporal programming of physical activity is a tool capable of modifying the temporal structure of physical, physiological and biochemical variables. This approach can be of great interest for coaches who plan training programs and it may benefit athletes when time zone adjustment is an issue, such as transferring to a different continent for a competitive event.

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Table 1 ANOVA for repeated measures for physical variables documented before (control) and on the twenty third day (Ramadan) of daytime fasting during the month of Ramadan.

Variables	Effects	df	F – Value	P - Value
Speed	Ramadan vs. Control	1	18.95	0.001
	Time	4	29.42	0.0001
	Experimental day and time interaction	4	27.53	0.0001
Speed endurance	Ramadan vs. Control	1	21.62	0.001
	Time	4	36..41	0.0001
	Experimental day and time interaction	4	30.62	0.0001
Agility	Ramadan vs. Control	1	42.60	0.0001
	Time	4	18.12	0.0001
	Experimental day and time interaction	4	20.64	0.01
Power	Ramadan vs. Control	1	30.12	0.01
	Time	4	48.21	0.001
	Experimental day and time interaction	4	39.65	0.0001

Table 2 Rhythmometric analysis (mean cosinor) of Diurnal variation on the selected physical variables before and 23rd day of Ramadan fasting.

Variables	Speed		Speed endurance		Agility		Power	
	Before	After	Before	After	Before	After	Before	After
MESOR	5.9	6.3	45.7	50.8	10.2	11.6	44.4	38.9
Amplitude	0.1	0.1	0.9	1.6	0.4	0.8	2.4	7.8
Acrophase	13:57	14:59	12:52	16:54	13:17	14:32	16:33	14:52