CARDIOVASCULAR REACTIVITY IN MALAY MOSLEMS DURING RAMADAN

R Husain, S H Cheah, M T Duncan

ABSTRACT

The investigation examined the possibility that observance of Ramadan by Moslems in Malaysia is associated with modification of circulatory parameters. Cardiovascular reactivity was investigated employing the cold hand immersion test as the stressor stimulus. Resultant data showed increased blood pressures and vascular resistance during Ramadan in the absence of cold stimulus while the magnitude of the maximal cardiac and vascular response to the applied stressor which served as indicators of reactivity was not affected by the Ramadan situation.

Keywords: *cardiovascular reactivity, Ramadan*

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INTRODUCTION

Current research in risk factors for the development of hypertension include contributions from biobehavioural researchers who introduced the concept of cardiovascular reactivity. The term "reactivity" is used to describe acute cardiovascular changes mediated by the sympathetic nervous system on application of a standardised stressor stimulus[1]. Published findings have reported that hyperreactivity characterised by a greater magnitude of cardiovascular response is associated with increased susceptibility to the development and incidence of circulatory disorders, especially hypertension[2,3].

Methods employed to establish individual cardiovascular reactivity status include application of a laboratory stressor called the cold pressor test. The test consists of hand immersion in cold water (4°C) for a few minutes. The typical cardiovascular responses evoked by afferent pain and cold stimuli would result in a sequence of changes in heart rate, stroke volume and total peripheral resistance mediated by the autonomic nervous system, which can be examined via monitoring of blood pressure, heart rate and cardiac output. The above test was originally designed by Hines and Brown[4] as a possible prognostic tool for development of hypertension. The maximum increase in heart rate and systolic blood pressure from baseline levels during application of the cold stimulus would serve as indicators of cardiac and vascular reactivity respectively. The peak increase in systolic blood pressure in response to the cold pressor test is also known as the pressor response.

The impact of altered feeding and behavioural patterns during Ramadan on various body functions in Malay Moslems have been examined and presented in several reports[5-7]. Information derived from these investigations indicated that the observance of the Ramadan regimen could also affect circulatory parameters such as cardiovascular reactivity.

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The present study was designed to compare the cardiovascular reactivity of a group of healthy young males during normal and Ramadan conditions, employing the cold pressor test as a stressor stimulus. Findings on the effects of Ramadan on the circulatory system would have important applications in view of the relatively large number of Moslems residing in South-East Asia.

METHODS

Eleven healthy young adult male Moslems who have been observing the Ramadan regimen from childhood were accepted for the investigation with their informed consent. The above subjects were normotensive with no known history of circulatory, renal and endocrine disorders. Each subject attended the laboratory once during the second week of the Ramadan month and once two months after the end of Ramadan. Data collection performed during the above occasions represented the Ramadan and normal non-Ramadan period respectively. The experiments were always conducted between 1400-1600 hrs in the same laboratory with an ambient temperature of 24°C. On arrival, the subject sat quietly for 30 minutes before data collection began. Each subject served as his own control. The cold pressor test protocol was as follows: a 20-minute period of rest preceded a 2-minute pre-immersion period when data was collected every 3 seconds and subsequently averaged to represent pre-immersion baseline (BL). This was followed by application of the cold stimulus when the subject's right hand was immersed for 3 minutes in a bucket of crushed ice and water maintained at 4°C during which data collection was performed every 30 seconds. Data representative of the post-immersion recovery period (REC) was collected 1 minute after removal of the hand from cold water.

Systolic (SBP) and diastolic blood pressures (DBP) in torr were measured by the auscultatory Riva-Rocci procedure in the non-immersed arm by the same investigator in all experimental sessions. Mean blood pressure (MBP) was calculated as DBP plus one third pulse pressure. Assessment of cardiac output (Q, l/min), using the impedance cardiograph technique, was performed as described by Kubicek et al[8] and Quail et al[9]. Impedance recordings obtained with the Minnesota Impedance Cardiograph (Model 304B) were used to calculate stroke volume (SV, mL) while EKG recordings were used to monitor heart rate (HR, b/min). Cardiac output was calculated as the product of stroke volume and heart rate; total peripheral resistance (TPR, dynes.sec.cm^{-5}) was calculated according to the equation:

$$\frac{1.333 \times 60 \times MBP}{Q}$$

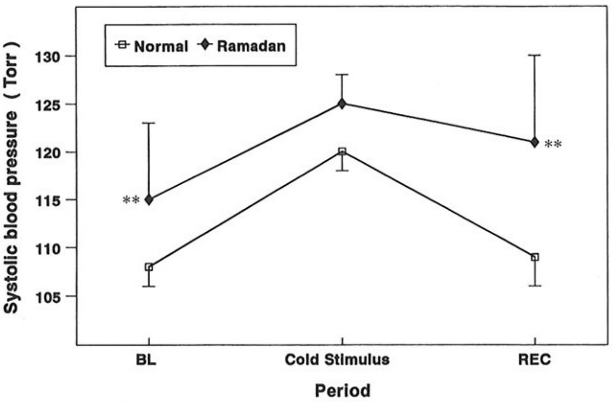
The protocol for data collection followed a set sequence for each epoch.

Table I – Heart rate and blood pressures.

	HR		SBP		DBP		MBP	
	BL	BL to Max	BL	BL to Max	BL	BL to Max	BL	BL to Max
Normal	75 ± 3.6	8.2 ± 1.7 (2-18)	108 ± 2.4	11.0 ± 1.4 (6-17)	70.2 ± 2.2	15.3 ± 2.1	83.0 ± 2.0	14.4 ± 1.7
Ramadan	70 ± 3.2	7.8 ± 1.3 (1-15)	116** ± 2.9	8.8 ± 0.8 (4-12)	72.6 ± 2.1	14.8 ± 1.2	87.2 * ± 2.2	12.3 ± 0.9

Mean ± SE (range in parenthesis). HR (heart rate) in b/min, SBP (systolic blood pressure), DBP (diastolic blood pressure) and MBP (mean blood pressure) in torr. Baseline (BL) and maximal (Max) values.
Significant difference between Normal and Ramadan conditions: **$p < 0.01$ ($n = 11$).

Fig 1 – Systolic blood pressure (SBP) in torr. Baseline (BL), Recovery (REC).



Significant difference between Normal and Ramadan conditions: ** $p < 0.01$.

Fig 3 - Cardiac output in *l*/min. Baseline (BL), recovery (REC).

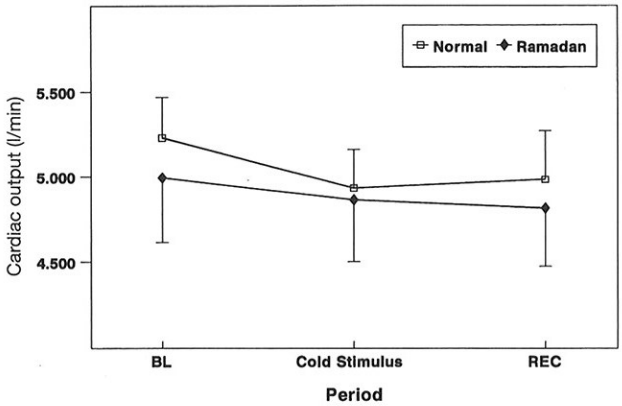
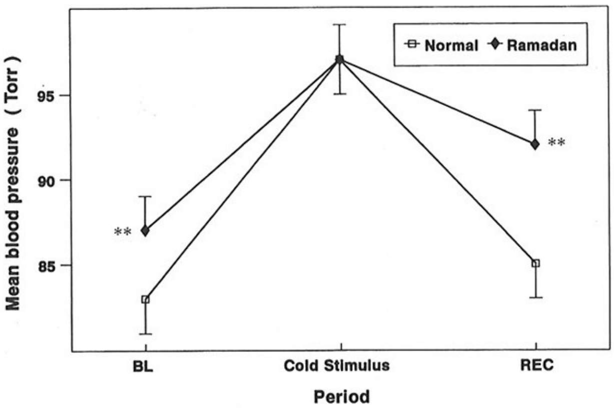
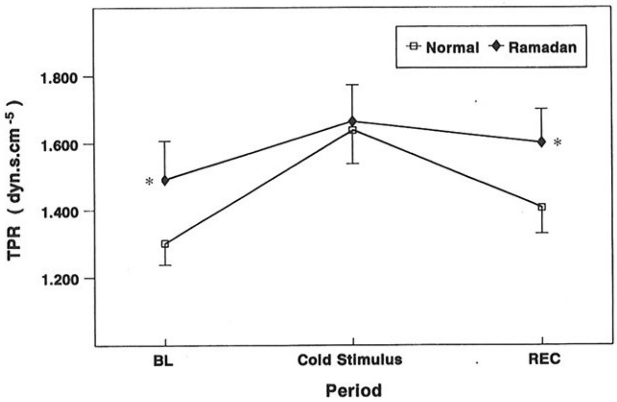


Fig 2 - Mean blood pressure (MBP) in torr. Baseline (BL), Recovery (REC).



Significant difference between Normal and Ramadan conditions: ** $p < 0.01$.

Fig 4 - Total peripheral resistance (TPR) in dyn.s.cm^{-5}. Baseline (BL), Recovery (REC).



Significant difference between Normal and Ramadan conditions: * p 0.05.

The paired t-test was used to compare relevant data between normal and Ramadan conditions, with rejection of the null hypothesis when $p < 0.05$.

RESULTS

The physical characteristics of the 11 young male subjects were: height 167 ± 2 cm, weight 57.9 ± 2 kg (normal) and 56.8 ± 2 kg (Ramadan), mean ± SE. Their ages ranged between 22-30 years and they were university employees belonging to the Malay ethnic group.

Cardiovascular data presented in Table I contain pre-immersion baseline values and the maximal increase from baseline during the 3-minute cold immersion. The magnitude of the pressor response (BL to max for SBP) was characterised by large individual variation with no significant difference between normal and Ramadan conditions. The maximal increase in heart rate (BL to max) showed similar characteristics. There was no significant correlation between the magnitude of the peak heart rate increase and the peak SBP increase among the individuals tested.

The pattern of changes in systolic blood pressure (SBP) during the pre-immersion (BL) and post-immersion (REC) period together with the maximal SBP attained during cold stimulation is displayed in Fig 1. Estimations of mean blood pressure for the periods corresponding to the above periods for SBP are shown in Fig 2. Values obtained for cardiac output (Q) and total peripheral resistance (TPR) during baseline and recovery periods and that which corresponded with attainment of the maximal

SBP are presented in Fig 3 and 4 respectively. Cardiac output remained relatively stable throughout the entire experimental period with a slight declining tendency during cold immersion when SBP peaked. Average values for cardiac output were slightly lower during Ramadan but the difference was not significant. Stroke volumes during normal conditions averaged 76 ± 5 mL (BL), 72 ± 4 mL (cold stimulus) and 75 ± 5 mL (REC); during Ramadan they were 75 ± 6 mL (BL), 71 ± 5 mL (cold stimulus) and 77 ± 6 mL (REC).

The small decline in cardiac output during cold stimulation was caused by stroke volume changes since corresponding heart rates were at baseline levels. Analysis of vascular and cardiac data obtained showed that the pressor response was predominantly a vascular event since it was not accompanied by elevations in cardiac output.

Vascular resistance as represented by estimations of total peripheral resistance exhibited a significant increase during Ramadan in the absence of cold stimulation (Fig 4). TPR rose to similar levels during immersion regardless of differences in initial (BL) and recovery (REC) levels assessed during normal and Ramadan conditions.

DISCUSSION

Major differences in Ramadan conditions when compared with normal conditions which may affect body systems are concerned with the pattern of feeding, drinking and sleeping imposed by the fasting schedule, as well as the psychology related to the religious aspects of Ramadan. Previous studies have explored the possibility that a month of hunger, thirst and sleeplessness constituted a stressful situation. Reported findings pertinent to the circulatory system include a decline in heart rate and metabolic rate[5] and activation of renal water and sodium conserving mechanisms[7]. The above adaptations were found to be most significant during the second week of Ramadan which provided the rationale for testing the subjects during the second week of Ramadan. The present study was designed to examine if cardiovascular reactivity is altered during Ramadan.

The cold pressor test is a simple physical stressor which can be used to examine cardiovascular reactivity status. The standardised pain and cold stimuli elicit the typical response of cardiac acceleration mediated by sympathetic beta-adrenergic discharge and vasoconstriction via sympathetic alpha-adrenergic discharge with minimal vagal activation. The maximal increase in heart rate and systolic blood pressure are used as indices of cardiac and vascular reactivity which can be affected by altered sympathetic activity[10,11]. The cardiovascular responses monitored in the present study were driven by pain and cold sensations and had the advantage of relative freedom from psychological and emotional effects when compared with other laboratory stressor techniques which had been employed to test cardiovascular reactivity such as mental arithmetic and reaction time tasks[12].

A state of stress is typically accompanied by increased sympathetic relative to vagal discharge to the heart and increased sympathetic discharge to peripheral vasculature. Our study showed that when the subjects were resting quietly both before and after cold immersion, cardiac functions in terms of heart rate and stroke volume do not appear to be driven by increased sympathetic discharge during Ramadan. Cardiac reactivity as tested by application of the cold stimulus also remained unchanged during Ramadan. Systolic blood pressure, mean blood pressure and total peripheral resistance data indicate that vascular resistance is significantly elevated during Ramadan when the subjects were resting quietly without cold exposure. The similarity of the increase in vascular resistance provoked by the cold pressor test indicated that vascular reactivity was not affected by Ramadan.

Major findings in the present investigation lead us to hypothesise that during Ramadan, the degree of dehydration experienced in the afternoon hours caused activation of the renin-angiotensin system resulting in increased plasma levels of Angiotensin II, which is known to act as a powerful vasoconstrictor with minimal effects on the heart. One of our earlier studies which showed reduced renal salt excretion during Ramadan lends further support to the above postulate[7].

Individual autonomic balance, the major determinant of cardiovascular reactivity, was not significantly altered during Ramadan. The reason for this could be that the devotees were initiated into the Ramadan ritual from childhood. After many years of conditioning, the deprivation of food, drink and sleep is accepted in a spirit of religious calm. Consequently, if our subjects did not perceive Ramadan as a stressful situation, stressor activated augmentation of sympathetic activity would not occur. Efforts to increase the number of experimental subjects were curtailed by a cold injury incident. One of the subjects developed severe pain and oedema in the immersed hand which resulted in hospitalisation[13].

Nevertheless, our observations are sufficient to show that in healthy, normotensive individuals, the magnitude of elevation of arterial pressures during Ramadan is not excessive and should not pose a cause for concern. Since drinking is permitted at the end of the daylight fast, the brief period of dehydration should be tolerable and its effects on the circulatory system should not constitute a health hazard. Cardiovascular reactivity status is also not altered during Ramadan. Little is known about clinical implications associated with observance of the Ramadan fast in the management of patients with systemic disease[14]. How hypertensive individuals on various therapeutic indications including angiotensin-converting enzyme inhibitors would respond to the postulated rise in blood pressure resulting from elevated angiotensin levels Ramadan awaits further investigation.

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