The Effects of Fluid and Food Restriction on Physical and Mental Performance

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Abstract**—**Eighteen healthy young male subjects (age 20-25) were investigated on two weekly occasions. Control values were obtained from the normal trial in desired. Subjects were required to fill out a questionnaire five times per day – before sunrise (about 08:00h), 12:00 h, 15:00 h, 18:00 h and after sunset (about 19:00) upon retiring. The questionnaire requested information about whether or not subjects had slept, eaten or drunk, and the reasons for these choices. Subjects were also asked to provide how much physical, mental and social activity they had participated in, how tired they felt and how able they felt to perform physical and mental tasks. The analysis compared the mean of the fasting day with the mean of the control day. During fasting conditions, fluid and food intake during daylight hours (between sunrise – sunset) was essentially zero, this was compensated especially after sunset but not so before sunrise. Sleep was altered in this study and which subjects were able to eat, drink and sleep as and when they desired to, fasting values were obtained from the fasting trial in which subjected abstained from eating and drinking during daylight hours but were allowed sleep as and when it was therefore daytime sleepiness was increased. The amounts of physical, mental and social activity performed during the daytime decreased in the fasting day, however perceived ability to perform physical and mental was slightly lower than actual levels performed. To conclude daytime fasting, produced many changes to the aspects of subjects' daily routine, including sleep, food and fluid intake and performance both completed and perceived.

Keywords**—** ***Fasting, Ramadan, Physical Performance, Mental Performance, Sleeping***

I. INTRODUCTION

Each year during the lunar month of Ramadan, healthy Muslims abstain from eating, drinking, smoking and sexual activity in the daytime, as one of the five pillars of Islam, Ramadan is observed by millions of Muslims across the world (Roky et al. 2003; & Roky, Chapotot, Hakkou, Benchekroun & Buguet, 2001). As Ramadan falls within the lunar month of the Islamic calendar, its occurrence changes with time. Therefore each year the Ramadan month occurs 11 days earlier and consequently every 9 years the Ramadan month will fall in a different season (Roky, Houti, Moussamih, Qotbi & Aadil, 2004). As Ramadan requires observing Muslims to abstain from eating food and drink during daylight hours, the fasting is therefore intermittent. This is important as intermittent fasting has no effect on the potential caloric intake of observing Muslims during the Ramadan month. Muslims are therefore allowed to freely eat what and when they please from sunset till dawn. During the holy month the demands of daytime fasting cause Muslims to adapt their normal daily routine changing food, sleep, social and even work patterns. Despite changes to their normal routine Roky et al. (2004) suggested during Ramadan that sedentary individuals usually practice a recreational physical activity in the afternoon, before the breaking of the fast meal, although this was not tested we would suggest that the performance within that chosen activity would decrease as a result of fasting during daylight hours and could occur due to the level of dehydration in the observing individual.

Hakkou, Tazi and Iraki (1994) reported that working hours differed between countries in which Ramadan is observed. Differences included when individuals worked some were reported to work during the day for 6-7h between (09:00-17:00) where food and drink consumption is prohibited, where as other individuals would work split shifts in which they would work 4h during the day and 5h during the night. "These changes in lifestyle during Ramadan suggest changes in the rhythm of normal life, with special concern about sleeping, eating and the rest-activity pattern" (Hakkou, Tazi & Iraki, 1994, p.340). Rhythmicity is a fundamental feature of existence, humans are diurnal creatures therefore are active in the daytime and asleep at night (Reilly, Atkinson & Waterhouse, 1997). Adherents of Ramadan begin to adapt and change their normal circadian rhythm by displacing energy intake and hydration to the hours of darkness, (Reilly & Waterhouse, 2007) this causes hunger, energy levels and subjective fatigue after sunset to be more significantly increased during the holy month, when in a normal rhythm these feelings are suppressed in the late evening but are displayed throughout the day. The normal rhythmicity is controlled by responses to the environment, actions of feedback loops and the internal body clock. Environmental controls consist of the light-dark cycle, environmental temperature, social factors, exercise, food and fluid intake. It is these factors that enable the circadian rhythm to be fixed into approximately 24h (Reilly & Waterhouse, 2007).

The pattern of feeding during the day reflects an exogenous component of a normal circadian (Reilly & Waterhouse, 2007) but with an ultradian component. An ultradian component is a period which can vary from 20h to smaller values in the context of meal times the ultradian is ~3h (Waterhouse, Minors, Atkinson & Benton, 1997). During intermittent fasting food consumption within daylight hours is prohibited therefore after sunset two or three evening meals are eaten (Hakkou et al. 1994). The first intake of solids after sunset is known as 'footor' and is typically in the form of dates taken with water or sometimes soup (Reilly & Waterhouse, 2007). The second meal known as 'ichaa' (Roky et al. 2001) and is taken 3-4h after 'footor' (Hakkou et al. 1994). Finally, a third meal known as 'scoor' is taken before sunrise (Reilly & Waterhouse, 2007). Because all of the meals are consumed at night (during the hours of darkness), they typically affect the amount of sleep fasting Muslims receive, Hakkou et al. (1994) suggested that sleep could be reduced by approximately 3h and broken by the last meal at the end of the night / the beginning of the next day.

Karaagaoglu and Yucecan (2000) reported the nutritional habits of 750 adults (320 males and 430 females) aged from 20-75 years. 95.1% (713.25) of the subjects stated that they consumed two meals per day, the 'ichaa' and the 'scoor'. The same study also reported the types of food consumed at each of the meals. The 'scoor' which was consumed shortly before sunrise consisted of mainly breakfast foods such as cheese, olives, sausage, eggs, jam and/or marmalade and tea. The 'ichaa' which was consumed shortly before retiring to bed consisted of soups, vegetable foods, rice, salads or fresh vegetable, fruit and yoghurt. It was also reported after the 'ichaa' meal that 61.5% (461.25) of the subjects drank tea. Special foods such as 'pide' a form of flat bread only baked during the Ramadan month was also reported to being frequently consumed by the subjects.
In addition to these general effects of Ramadan fasting and its demands on the Muslim population, reported changes in total sleep, sleep latency, food and fluid intake and performance ability both perceived and performed have been focused on by previous research and predominately in this study.

A. Total Sleep

It has been shown that, during Ramadan, nocturnal sleep is reduced (Roky et al. 2003), this was also shown in previous research by Laraqui et al. (as cited in Roky et al. 2004) who reported that the percentage of people who went to sleep after midnight increased during Ramadan in comparison to the month before. The same study by Laraqui et al. (as cited in Roky et al. 2004) found that sleep duration was less than 6h in 68% of 150 workers during Ramadan and only 37% before Ramadan. The same study also reported that bad sleep was more important than thirst and hunger in causing daytime working difficulties. Roky et al. (2004) concluded that daytime functioning was affected by alterations in normal nocturnal sleep during the Ramadan fasting. This was reported as subjective alertness, evaluated by the visual analogue scale (in which subjects scored how alert they felt on a scaled continuum) results showed that perceived alertness decreased at 09:00 and 16:00h and showed an increase at 23:00h. These results suggest that a decrease in perceived alertness during daylight hours could be caused by the reduced energy intake when fasting occurs, the increase in perceived alertness after sunset could be attributed to the increase in caloric intake from the 'breaking of the fast' meals, and potentially the increase in social activity after sunset. This last sentence does not follow from the earlier part, which states that it is mainly the loss of sleep.

Similar results were found by Roky et al. (2001) and Roky et al. (2003) also reported a decrease in total sleep time during the Ramadan month. Finally, Bahammam (2004) in which 8 healthy Muslims tested the effect of Ramadan on sleep architecture, daytime sleepiness and sleep pattern. The results showed that compared to baseline (normal bedtime) that bedtime was delayed in the first and third week of Ramadan with delays of 1h and 18min and 1h and 36min respectively. This was also coupled with a constant wake up time which caused a significant reduction in total sleep time. This reduction in total nocturnal sleep was therefore compensated by napping during the daytime during the Ramadan month. However Bahammam (2004) concluded that sleep architecture remained within normal parameters, and that no significant difference in daytime sleepiness was reported during Ramadan in comparison with baseline sleep measures.

B. Sleep Latency

In recent years many studies have looked into the affect that intermittent fasting has on sleep latency. Sleep latency is the time taken from bedtime / lights out until the first point of sleep is recorded. Bahammam (2004) tested sleep latency using the multiple sleep latency test in which subjects performed four tests (naps) 2h apart and 2h after waking. After subjects awoke, they were instructed to get out of bed, get dressed into street clothes, and avoid sleeping between naps and avoid any vigorous activity 15min before each nap. At nap times subjects were asked to remove their shoes, loosen their clothing and lie in a bed for 5 min before lights out. If sleep occurred the nap continued for 15min after the first point of sleep (sleep onset), if no sleep occurred the nap was terminated after 20min. Results showed that there was no significant difference in sleep latency of individual naps during the daytime or their mean between baseline, after one week of Ramadan and after three weeks of Ramadan. Subjects were found to be most sleepy at the 12:00

nap but only in the first week of Ramadan, other time of day effects had no effect when comparing baseline, one week of Ramadan and three weeks of Ramadan.

These results conflicted with Roky et al. (2004) who found that sleep latency increased during Ramadan. "Sleep latency, which is inversely proportional to sleepiness, increased during the daytime, particularly at 10:00, 12:00 and 16:00h (Roky et al. 2004). Similar results were found by Roky et al. (2003) who found that sleep latency increased from 27.7 ± 9min before Ramadan to 85.1 ± 29min by the end of Ramadan. Finally eating a large meal before retiring to bed suggests that it will take longer to achieve sleep onset as ingestion of food improves cognitive function. Research suggests that an increase in sleep latency upon retiring to bed for nocturnal sleep during Ramadan is consistent with findings that evening meals improve alertness at bed-time (Smith, Maben and Brockman, 1994). That is, sleep is delayed not only due to more time spent eating but also trying to sleep on a full stomach.

C. Food Intake

Millions of Muslims worldwide partake in Ramadan each year, in which they eschew from food and fluid intake during daylight hours, however this is compensated by increasing the frequency and amount of food intake during darkness (after the sun has set and before the sun rises).Research by Roky et al. (2001) and Hakkou et al. (1994) which reported that Muslims consumed 3 meals ('footor', 'ichaa' and 'scoor') during darkness hours and not 2. Baysal (as cited in Karaagaoglu & Yucecan 2000) suggested that a decrease in the daily number of meals generally increases the proportion of food intake at meals. Karaagaoglu and Yucecan (2000) found that although a reduced food intake due to only eating 2 meals per day during Ramadan did not cause the daily intake to fall below 66.7% of the recommended daily amount, therefore this was not classed as an insufficient amount of energy intake. Although the same study concluded only consuming 2 meals a day due to fasting hampers the provision of sufficient amounts of daily required energy and nutrients (Karagaoglu & Yucecan, 2000). Therefore this study provides contradictory results within its own findings and conclusions and it is unsure if energy requirements and daily nutrients are matched by only consuming 2 meals per day during Ramadan intermittent fasting. Although total energy intake is decreased during Ramadan so is the energy expenditure this is due to changes in the normal circadian. Reilly and Waterhouse (2007) noted that a deficit in energy intake would occur despite the fall in energy expenditure associated with a lower habitual activity profile in the daytime during Ramadan.

D. Fluid Intake

Water is necessary for every system of the body. Proper hydration aids in efficient digestion, elimination of toxins, thermoregulation, joint lubrication and energy production (Felesky-Hunt, 2001). Muslims during the holy month of Ramadan must abstain from drinking during the daylight hours, this reduction will cause individuals to become dehydrated throughout the day. Practicing Muslims are dehydrating at a rate that is determined by (loss of water – amount of metabolic water produced over this period)(Leiper, Molla, Molla, 2003), this can lead to decreases in sportive and physical performance (Roky et al. 2004), hydration is also important for optimal cognitive functioning (Kleiner, 1999). Kleiner (1999) reported that reductions in short term memory and arithmetic ability occurred at a 2% or more body fluid deficit. This was supported by Sharma, Sridharan, Pichan and Panwar (1986) who found that dehydration of 2-3% of body weight resulted in poorer performance on tasks of concentration and psychomotor processing speed. Similar results were also reported by Cian et al. (2000) in which subjects reported a decrement in performance during short term memory, attention and psychomotor processing speed with dehydration of 2% or higher in relation to a decrease of body weight.

Although a decrease in body weight has been reported due to decrease in total water content this is not absolute, Leiper and Prastowo (2000) found that total body content was conserved during Ramadan. The decrease in water turnover is this study appeared due to a reduction in fluid intake, but dehydration was maintained by a reduction in nonrenal (kidney) losses (Leiper & Prastowo, 2000). A potential reason for this is that participants would increase drinking during the night and rise early before sunset to compensate for the daytime restriction in fluid intake (Leiper et al. 2003; Waterhouse, Alkib, Edwards & Reilly, 2008a; Waterhouse, Alkib & Reilly, 2008b). It has also been reported that additional dehydration stress as a cause of Ramadan is not detrimental to the health of fasting Muslims, no detrimental effect on health has yet to been directly attributed to intermittent negative water balance at the levels that may be produced during Ramadan (Leiper et al. 2003). As a result of Ramadan intermittent fasting changes to sleep, food and fluid intakes are likely to impair performance causing a reduction in daytime functioning when performance is usually at its peak

E. Performance

Ramadan causes changes in the normal circadian (Reilly & Waterhouse 2007), in fasting individuals this rhythm is likely to be reduced in amplitude, due to the length of time without food and drink. This causes a reduction in performance capabilities when they should be at their zenith (highest point) this is normally around 16:00h (Reilly & Waterhouse 2007). Bigard (as cited in Leiper et al. 2003) stated that physiologic studies show that Ramadan fasting leads to impairment in muscular performance. Perceived ability to perform physical activity was also measured by Waterhouse et al. (2008a) who stated that there was a significant difference in the time of day effect on perceived physical ability, this was reflected in a peak of ability between 07:00-10:00h and then a fall throughout the rest of the day. This decline in performance ability throughout the day could be due to an impairment caused by nutritional restrictions after sunset (Reilly & Waterhouse, 2007). Bigard (as cited in Waterhouse & Reilly, 2007) measured that maximal voluntary contraction (MVC) decreased over the Ramadan period. They reported decreases in maximum isometric strength of 10-12%, whilst muscular endurance at 35% and 55% caused MVC decreases of 28% and 22% respectively. Research suggests that insulin, blood glucose, low energy levels and mood are potential reasons for these decreases in performance (Reilly & Waterhouse, 2007). Social activity was also found to change during Ramadan, Waterhouse et al. (2008a) reported that social activity was lower in the daytime but became higher post sunset, this however was unlike mental and physical performance ability which showed a decline during daylight hours, social activity showed a plateau effect during the day and then a rise after sunset.

In summary Ramadan causes many demands upon those involved, and is responsible for several aspects of changes in actual and desired behaviour, Changes upon food and fluid intake extend into the hours before and after the fast and relate to dealing with the fasting demands then feelings of hunger and thirst (Waterhouse et al. 2008b). The altered sleep-wake cycle is disrupted by the demands to intake food and fluid in preparation for the fasting day and finally daytime activity is reduced in an effort to conserve energy and maintain levels of euhydration and reduce any effects of intermittent fasting on the health and well-being of the observing individual.

II. Aims and Hypothesis

Previous research has been found to show contradictory results about the effects of intermittent fasting on food and fluid intake, sleep and performance. Most of the current research have concentrated on changes that take place over a prolonged fast such as Ramadan which lasts a duration of 4 weeks; there are fewer studies who have focused and or considered changes on a daily bases as a result of intermittent fasting. In addition to this lack of significant research into daily changes during intermittent fasting, the time of day and how the subjects feel may show insight into what is happening to millions of Muslims each year as they observe the holy month of Ramadan

Previous work in this laboratory has investigated the changes during the daytime during intermittent fasting. Recent research into the diurnal changes in sleep, food and fluid intake and activity during Ramadan was observed by Waterhouse, Alkib, Edwards and Reilly (2008a) and stated that subjects adhered to the requirements of Ramadan by eschewing food and fluid intake during daylight hours. The results from this study showed that increases in food and fluid intake before sunrise and after sunset can be seen as indications that individuals were preparing, or compensating for the fasting period. Results also showed that perceived sleepiness was significantly higher during Ramadan as was the effect time of day on sleepiness. Sleeping in Ramadan was also increased as an attempt to catch up on lost sleep as individuals rise earlier and retire later to allow for eating to occur before sunset and after sunrise. Results also showed that food and fluid intake increased before sunrise during Ramadan, but after sunset results showed unity in that everyone ate and drank at that time and therefore results did not increase during fasting.

Similar work was also carried out in the laboratory by Waterhouse, Alkib and Reilly (2008b) upon the effects of Ramadan and food and fluid intake, fatigue, physical, mental and social activities. Results showed that increases in physical, mental and social activities occurred during Ramadan after sunset as did increases in perceived mental and physical ability, these activities were recorded as lower during the day during Ramadan and then increased after sunset becoming greater than on a control day. Results also suggested that fluid intake increased before sunrise and after sunset for preparation for the fast and recovery from the fast, more water was reported to be consumed pre-sunrise and ‘thirsty’ and ‘health’ were stated as reasons for drinking during the Ramadan fasting. After sunset all types of drinks were imbibed in greater amounts and an increased frequency during Ramadan in comparison to control days. There was also an increased food intake in Ramadan after sunset, frequency of eating, the size of the meal and food scores all increased in comparison to control days. Finally results showed that more naps were taken in Ramadan with majority taken within the first part of the daytime to recover from sleep lost by rising early to eat in preparation for the fast, naps were reduced in the hours close to sunset with social, physical and mental activities likely implicating potential time to nap.

A third study in the laboratory by Waterhouse, Alabed, Edwards and Reilly (in press) into changes in sleep, mood, subjective and objective responses to physical performance during the daytime in Ramadan was completed and results showed that participants went to bed and rose later during Ramadan, results also stated that subjects felt they got to sleep later during Ramadan (increase in sleep latency) and that food and fluid intake was greater just before retiring to bed during Ramadan in comparison to control days. This increase food and fluid intake just before retiring was suggested to aid individuals and promote sleep. However, results showed that naps were taken too infrequently and could not be analysed, this was not the case for reasons for NOT napping in which ‘too busy’ was stated as the most common reason this was predominately high during both control and Ramadan but higher in fasting conditions. Results into the amount of food and drink consumed showed that individuals did not rise earlier and eat before sunrise during Ramadan. This contradicts both previous studies in the laboratory by Waterhouse et al. (2008), results did however confirm that all subjects ate and drank after sunset.

Fluid intake scores were reported as higher during Ramadan in comparison to control days, but both scores reached towards the maximum drinks score. During Ramadan the frequency of drinking water was significantly increased and drinking fizzy drinks was significantly decreased. As with drinking all subjects were found to eat after sunset, 'hunger' was recorded as the main reason for eating during both the control days and Ramadan but 'recovery from fasting' significantly increased during the Ramadan trial. Finally results showed that activities during the day decreased and activities in the evening increased during Ramadan.

Using a laboratory-based study is beneficial to research into the effects of Ramadan fasting on sleep, food and fluid intake and performance as it allows the researcher to control and analyses the data within a safe hygienic facility. Working within the laboratory will allow for accurate results to be produced using gold standard equipment to analyses the data, Working within the laboratory also helped control the subjects day so that results can be obtained, as this study looked at a time of day effect and the effects of intermittent fasting, working within the laboratory enabled subjects not be able to sleep through all daylight hours as a method of reducing the effect of hunger and thirst. If this study was taken out of the laboratory and into the 'field' it would be more difficult to receive data at each time point throughout the day as subjects would not have to attend the laboratory at a specific times and present data to the researchers at these times. Due to previous research within the laboratory and the findings reported this provides a rationale for this study to follow up daytimes' changes in food and fluid consumption, sleepiness and performance outcomes and abilities.

In this present study we used a series of questionnaires (see appendices 1,2 &3) to analyses the amount of sleep undertaken, food and drink consumed and their feelings towards physical and mental activities of 20 university students, throughout a day of intermittent fasting (similar to those in Ramadan in which food and drink is abstained throughout the daylight hours) and a control day (in which subjects could eat and drink freely). The aims of the study were to test if changes between the fasting and control day would affect the subject's performance ability and performance outcome throughout the day? To show how the effect (if any) of a reduced sleep-wake cycle would affect daytime sleepiness and consequently 'napping'? Finally to examine if subjects would rise earlier therefore decreasing their sleep-wake cycle in order to prepare for the fasting condition by eating and drinking larger amounts before sunrise? and to see if they would eat and drink more after sunset and subsequently delay their normal retiring time in order to compensate for the restriction of food and fluid throughout daylight hours? We have compared the sleeping, eating and drinking habits, and performance abilities of individuals in two conditions control and fasting.

III. Methods

1) Subjects and General Protocol

20 male subjects from the Tripoli University student body (aged 21.8 ± 1.87years, body mass 77.4 ± 8.77kg, and height 1.77 ± 0.04m) participated in the study. After having the general protocol and any questions answered subjects gave informed consent to participate in the study. All experiments were completed between 20/05/2018 and 20/05/2018. The Human Ethics Committee of the University approved the procedures.

2) Procedures

a) Familiarisation session

Each subject was then asked to attend a familiarisation session held on 26/06/2018 in which further explanation of the testing days were explained, including the two experimental conditions (fasting and non-fasting), the various tests that will be performed will be described and subjects will be allowed to practice them and the subjects were told when to attend for the first trail all dates for testing were between 20/05/2018 and 20/05/2018. Total body mass (kg) and height (cm) were determined by stadiometer and a calibrated scale mass (Seca 702, Seca GmbH & Co.KG, Hamburg, Germany) on each visit to the laboratory, these were recorded to the nearest 0.1 kg and 0.1 cm, respectively. Upon informed consent by the subjects we coded them using the subject code provided by TU ethics committee by random selection. Any questions were then answered by the researchers and subjects left the laboratory. 24 hours later subjects' surnames were lined up alphabetically and the first experimental condition they will complete was selected in a counterbalance fashion remove any order effect. Subjects were then sent an email stating which trail they would complete first either fasting or non-fasting.

b) . Experimental sessions

Experimental conditions consisted of 2 different trials 1 being normal (non-fasting day) in which subjects were free to choose when to sleep, and what and when to eat and drink. The other trial was a fasting day in which subjects were free to choose when to sleep, and what and when to eat before 07:00h and 18:00h. Between 07:00h and 18:00h subjects were free to sleep if they choose to but food and fluid intake is prohibited. Each experimental day consisted of 4 testing sessions: 09:00h, 12:00h, 15:00h and 18:00 h. Upon each experimental session participants completed a series of tests and gave a urine sample before the testing started. The tests completed at each session were: questionnaires (concerning the amount of sleep, food and drink consumption and activities and feelings); Urine sample; Stroop test; accuracy at throwing darts (20 times); hand grip strength (dominant hand only, 3 times); vertical jumps (3 times); The tests were selected in an order which allowed for the most physically demanding test to be last so that fatiguing effects would be reduced. The experimental conditions were separated by 7 days to allow subjects to recover, with the subject undertaking the opposite experimental condition after this 'recovery' period.

2.3 Detailed protocol and measurements made

09:00, 12:00, 15:00 and 18:00h

1. On departing from the familiarisation session subjects were given a questionnaire (Waterhouse, Alkib, Edwards, & Reilly, 2008) for them to complete on the morning of the first experimental day prior to attending the laboratory asking questions related to the amount of sleep received the night before the experimental day, drink and food the subject had consumed and how the subject was feeling at this time. These questionnaires were compiled based on previous work by, Waterhouse, Alkib, Edwards, Reilly (2008). Subjects received the first questionnaire during the familiarisation day and were instructed to complete the questionnaire on the morning of the testing day regardless of which experimental condition they were completing.

2. Subjects were also given a sterilised urine pot (70ml, Startedt, Leicester, England) in which they were asked to fill with urine from the morning of the experimental day prior to attending the laboratory. Urine samples were taken and then sealed in sterilised containers and handed to the researcher.

3. Upon arrival to the laboratory in which samples were securely stored within the laboratory subjects were instructed to perform a Stroop test, the Stroop test is a word recognition test as it measures working memory in which the name of a colour is displayed in another colour different from the name of that colour. Subjects were instructed to say the colour of the word as it is written on the card in front of them, the subjects complete 20 individual cards and the time taken is recorded on a stopwatch (Fastime, Leicestershire, England).

4. Subjects are then instructed to throw a dart (Unicorn Precision darts, 24 g, Unicorn Products Ltd, England) at a 20cm target 20 times collecting the dart after each throw, the target was 2.37m as measured from the 'bullseye' (center) of the target. This distance of 2.37m is the same as the (marker from where you throw) in a professional game. After each dart thrown the subject will collect the dart and prepare for the next throw, after each throw a score will be given and recorded by the researcher. One dart is used and collected and used again for each score registered to remove learning affect of throwing the dart. (Edwards et al., 2000).

5. Dominant hand grip strengths were then recorded using as hand grip machine (Takei Kiki Kogyo, Tokyo, Japan), grip strength is reliable, objective and valid only when exerting maximal voluntary effort (Mathiowetz, Weber, Volland, & Kashman, 1984), subjects were instructed to hold the hand grip in their dominant hand and complete one maximal effort by gripping the bar and holding for a few seconds. The hand grip machine records the maximum force reached during the grip and displays this score and stores it until the machine is reset. The subject will then be asked to rest for 10 seconds before repeating the same maximal effort, the subject completed 3 maximal efforts with all efforts being recorded and the highest score achieved being highlighted by the researcher this high score was determined by having a result that was greater than other values, this had to include a decline in performance after the highest score was achieved, this meant that if no decline had taken place after 3 hand grip tests further test were performed until a decline was recorded and the highest score was determined.

6. Subjects then performed 3 vertical jumps. Subjects were instructed to stand with their backs against a wall with their right arm raised straight above their head, the researcher then measured the subjects maximum standing reach, the subjects then placed chalk on the right hand and prepared for their jump. Subjects were instructed to jump as far vertically as they could from a stationary position reaching above their head and marking the highest perceived point of the jump with their chalked hand. The researcher then took the maximum score, the maximum score was determined by having a value that higher than the other jumps but there had to be a decline in performance to show that a maximum had score occurred. This meant that if the after jumps n decline in jump height had occurred further jumps were performed until the jump height value declined.

After the vertical jump tests were completed subjects were free to leave the laboratory and continue their day as normal but under the condition, they have been testing either normal (non-fasting) or fasting.

Subjects were given the daytime questionnaire and another urine pot (70ml, Started, Leicester, England) and instructed to complete the questionnaire and provide another urine sample and return to the laboratory 3 hours later in which they would repeat all tests and procedures. Upon the final testing session at approximately 18:00h subjects completed all tests and procedures and were given the evening questionnaire to complete and had back to the researcher the next morning, after exiting the laboratory after the final testing session the experimental condition was over, thus meant that subjects were then allowed to eat and drink as they please despite if they were the fasting or non-fasting condition, subjects were instructed to complete the evening questionnaire before retiring to bed and completing all sections including what they ate and drank after the experimental condition was complete.

Subjects were then finally instructed to return to the laboratory 1 week later to test the remaining condition, this was simply the opposite condition in which the subjects completed in the first trail, all tests and procedures were kept constant and so were the testing times for reliability and validity.

B. Analyses and treatment of results

The urinary sample was tested using a pocket urine osmolarity refractometer. (Pocket Pal-Osmocheck, Vitech Scientific LTD, Japan) The urine was tested after each testing session at approximately 09:00, 12:00, 15:00 and 18:00 h in both conditions (fasting and non-fasting). Any health and safety regulations were completed and risk assessment was confirmed, before being able to analyse urine the OSMOCHECK needed to be calibrated this was done by zeroing the equipment using distilled water. A small sample of water approximately 0.3ml was placed onto the sample stage and the machine was run as normal, the water was then wiped away and the lens cleaned using a tissue and then it is ready to test Urine. A 3ml sample of urine was then tested in the same way by placing the urine onto the lens and pressing start on the machine on the OSMOCHECK machine measures the density of the sample and provides a score(mOsmol/kgH20) omitted on the machine through the LCD screen. The urine is then wiped away from the lens and the process of zeroing the machine was repeated, the urine sample was tested 3 times and the average score taken. Urine samples were also randomly selected and tested against the gold standard machine for testing osmolarity. Advanced Micro-Osmometer (Model 3300, Vitech-Scientific Ltd, West Sussex, England) results showed that the there was no significant difference between the gold standard machine and the OSMOCHECK handheld machine.

C. Treatment of Data

Preliminary analysis indicated that the means of the variables did not differ significantly between the fasting and the control day. Mean values for each variable were calculated for each subject and time interval for the control and fasting day. Values could be directly obtained from the questionnaires for Q.2 and Q's. 14-19. Scores for total or interval fluid (Q5-6) or food intake (Q10-11) were calculated as follows. For fluid intake, score of 0 represented no intake; 1 indicated a sip; 2 indicated less than one cup / glassful; 3 indicated one cup / glassful; and 4 indicated more than one cup / glassful. For food intake, score of 0 represented no intake; 1 indicated a snack; 2 indicated a small meal; 3 indicated a medium-sized meal; and 4 indicated a large meal. For the remaining variables, such as whether or not a nap was taken, whether or not fluid was consumed, whether or not food was consumed and the reasons for making such choices were calculated using the 'fraction of occasions'. In which the number of times a reason was cited was divided by the total number of subjects who participated in the activity (drinking, eating and sleeping or not drinking, not eating and not sleeping).

D. Statistical Analysis

The data were analysed by means of the Statistical Package for Social Sciences (SPSS) for windows, using a two-way ANOVA with repeated measures. To test the normality of the data the Shapiro Wilk test was used, however not all the data was normally distributed but the repeated measures ANOVA is known as being quite robust. To correct for violations of sphericity, the degrees of freedom were corrected in the normal way, using the Huynh-Feldt ($\beta>0.75$) or Greenhouse-Geisser ($\beta<0.75$) values for e, as appropriate (Field 2000). The main factors were Day (2 levels, controls versus Fasting) and Time of Day (5 levels, pre 09:00, 12:00, 15:00, 18:00 and post 18:00). Sphericity and Post Hoc analysis were run on the data. Significance was set as $P < 0.05$. As there is no test for equal variance in a two-way repeated measures design ANOVA, we assume that the data is of an equal variance. To test if subjects chose to eat or drink before sunrise the McNemar's test were used, this tests differences between two related groups (Field, 2005, p. 538) in this study the McNemar's test was used to determine if subjects ate or drank before sunrise.

IV. . RESULTS

From the original twenty subjects recruited, eighteen subjects completed all of the testing sessions therefore results show data from the eighteen who completed the testing protocol.

1) . Fluid and food intake

Since fluid and food consumption are prohibited between sunrise and sunset in Ramadan, comparisons at 09:00-12:00h (t2), 12:00-15:00h (t3) and 15:00-18:00h (t4) between intakes on control days and in Ramadan would be meaningless. However, it was thought that comparisons at both pre sunrise (before 08:00h, t1) and post sunset (after 18:00h, t5) would be useful, since they would indicate preparations for and the recovery from daytime fasting. To test if subjects chose to eat or drink before sunrise the McNemar's test were used, this tests differences between two related groups (Field, 2005, p. 538) in this study the McNemar's test was used to determine if subjects ate or drank before sunrise. There was no significant difference between the condition (control and fasting) and the number of subjects that reported food consumption (n=18, $p > 0.05$). The reasons for eating before sunset during the control day (figure 1.1.) were 'hungry', however during fasting 'hungry' was cited less and 'preparation' and 'health reasons' cited more as the reasons for eating before sunrise.

Fig1.1. Fraction of occasions during control and fasting days for reasons for eating before sunrise.

Reasons for NOT eating (figure 1.2) were 'not hungry', 'busy' and 'never do'. 'Not hungry' and 'busy' and were cited frequently on both the control and the fasting day. However there was a significant difference between the condition (control and fasting) and the number of subjects that reported drink consumption before sunrise (n=18, $p < 0.05$).

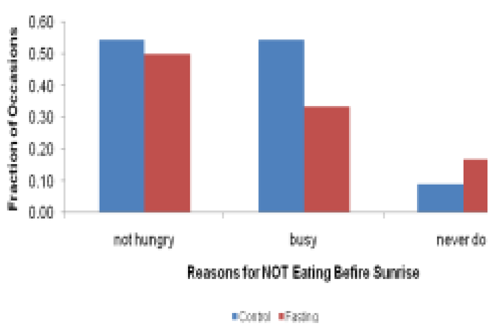

Fig1.2. Fraction of occasions during control and fasting days for reasons for not eating before sunrise

Statistical analysis showed that there was no significant difference between control and fasting days and the food score, $F_{1, 17} = 2.96$, $P > 0.05$. However, there was a significant difference between the time of day and the food score, $F_{1, 17} = 279.57$, $P < 0.05$. Figure 1.3 showed that there was no significant interaction between the condition (control or fasting) and the time of day on the food score, $F_{1, 17} = 0.97$, $P > 0.05$. A lack of interaction means that changes in food score with time are essentially the same in both the control and fasting day.

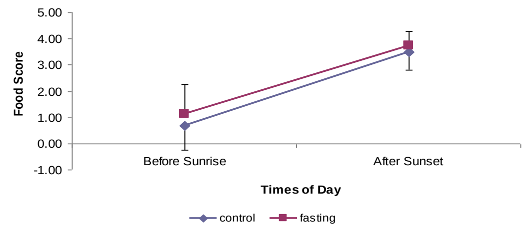

Fig1.3. The effects of control and fasting days in food scores before sunrise and after sunset.

Reasons for drinking before sunrise (figure 1.4) during the control day were 'thirsty' and 'health reasons', 'thirsty' were cited frequently in both the control and fasting day. During the fasting day 'preparation' was also frequently cited

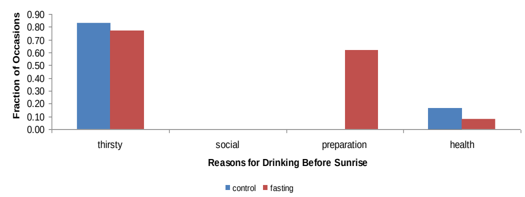

Fig1.4. Fraction of occasions during control and fasting days for reasons for drinking before sunrise.

Reasons for NOT drinking before sunrise (figure 1.5) during the control day were 'not thirsty', 'too busy', and 'never do' and were cited frequently on both the control and the fasting day

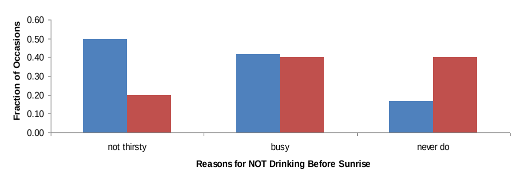

Fig1.5. Fraction of occasions during control and fasting days for reasons for not drinking before sunrise.

Figure 1.6 shows that 'water', 'tea / coffee' and 'fruit juice' were cited as the drinks consumed before sunrise. During the control day subjects only reported 'water' as the drink they consumed but the amount of subjects who drank was significantly less $p = 0.02$. During the fasting day subjects consumed 'water', 'tea / coffee' and 'fruit juice'

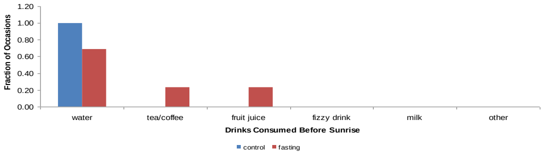

Fig1.6. Fraction of occasions during control and fasting days for types of drinks consumed before sunrise.

Statistical analysis showed that there was a significant difference between control and fasting days on the drink scores F1, 17 = 12.33, P < 0.05. There was also significant difference between the time of day and the drink score, F1, 17 = 60.45, P < 0.05. Figure 1.7. showed that there was a significant interaction between the condition (control or fasting) and the time of day on the drink score, F1, 17 = 5.91, P < 0.05. A significant interaction means that changes on drink score with time are different during the control and fasting day. Figure 1.7. Shows an increase in drink consumed on the fasting day in comparison to the control day.

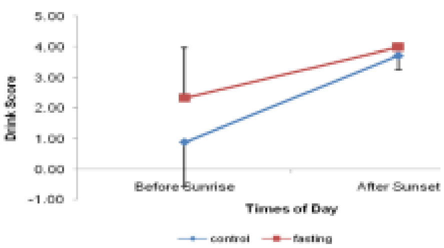

Fig1.7. The effects of control and fasting days in drink scores before sunrise and after sunset.

Figure 1.7. The effects of control and fasting days in drink scores before sunrise and after sunset.
All participants ate in the evening, with mean food scores of 3.50 ± 0.71 and 3.72 ± 0.57 on control and fasting days respectively, as all participants ate after sunset there was no need to run the McNemar's test as all participants reported yes for eating. Reasons for eating were 'hungry', 'recover from fasting' and 'health' for both control and fasting days. During the fasting trail 'recover from fasting' substantially increased as 'hungry' slightly decreased (figure 1.8).

Fig1.8. Fraction of occasions during control and fasting days for reasons for eating after sunset.

All participants drank in the evening, with mean drink scores of 3.72 ± 0.46 and 4.00 ± 0 on control and fasting days respectively. Statistical Analysis showed that there was a significant difference between conditions (control and fasting days) and drink scores recorded after sunset t17 = -2.56, p <0.05. This is shown in figure 1.7. Reasons for eating were 'hungry', 'social reasons', 'recovery from fasting' and 'health reasons' for both the control and fasting days. Figure 1.9 shows that on the fasting day 'recovery from fasting dramatically increased, whilst 'thirst' and 'health' slightly increased and 'social' reasons slightly decreased.

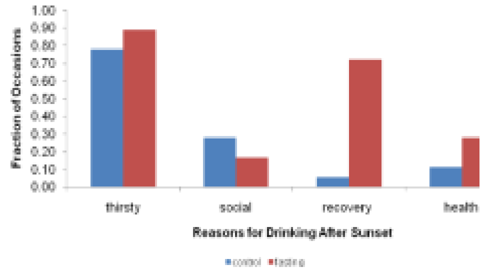

Fig1.9. Fraction of occasions during control and fasting days for reasons for drinking after sunset.

During the fasting day more drinks were consumed (figure 1.10), 'water' was cited frequently in both the fasting and control day, 'fruit juice' showed a large increase during the fasting day as 'tea / coffee', 'fizzy drink', 'milk' and 'other' remained fairly constant within the two conditions (control and fasting).

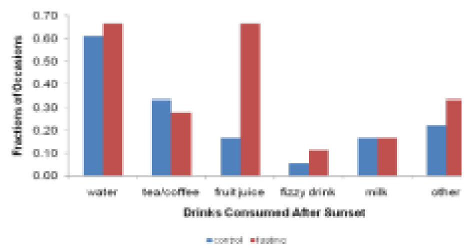

Fig1.10. Fraction of occasions during control and fasting days for types of drinks consumed after sunset.

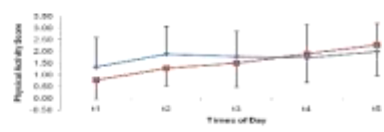

Fig1.11. The effects of time of day and condition (control or fasting) upon physical activity score

2). *Sleeping / Naps*

During the daytime (t2, t3 and t4) were taken too infrequently to be analysed statistically, however reasons for NOT sleeping / napping can be shown (figure 2.1, 2.2 and 2.3). All reasons 'Not tired', 'Too busy' and 'Never do' remained fairly constant between both conditions (control and fasting) and throughout the day.

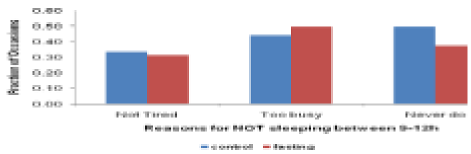

Fig2.1. Fraction of occasions during control and fasting days for reasons for not sleeping between 09:00-12:00h.

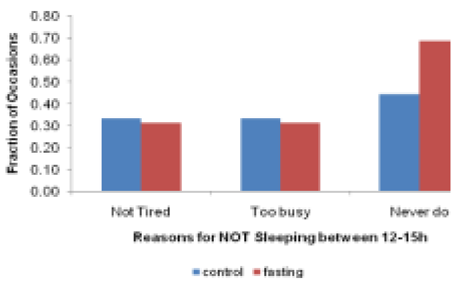

Fig2.2. Fraction of occasions during control and fasting days for reasons for not sleeping between 12:00-15:00h.

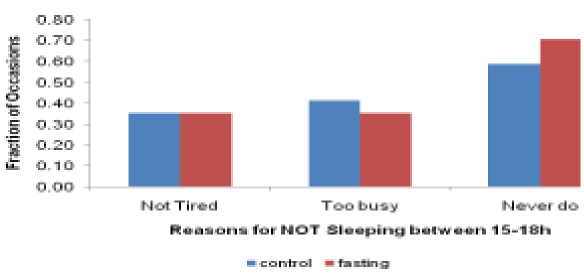

Fig2.3. Fraction of occasions during control and fasting days for reasons for not sleeping between 15:00-18:00h

B. . Performance

1) Physical Activity

Statistical analysis showed that there was no significant difference between control and fasting days on the amount of physical activity completed $F_{1, 17} = 2.01$, $P > 0.05$. However, there was a significant difference between the time of day and the amount of physical activity completed, $F_{4, 68} = 8.29$, $P < 0.05$. Figure 3.1 showed that there was no significant interaction between the condition (control or fasting) and the time of day on the amount of physical activity completed, $F_{4, 68} = 1.52$, $P > 0.05$. A lack of interaction means that changes on physical performance throughout the day were essentially the same during the control and fasting day

2) Mental Ability

Statistical analysis showed that there was no significant difference between control and fasting days on the amount of mental activity completed $F_{1, 17} = 5.37$, $P > 0.05$. However, there was a significant difference between the time of day and the amount of mental activity completed, $F_{2.95, 50.15} = 8.57$, $P < 0.05$. Figure 3.2 showed that there was no significant interaction between the condition (control or fasting) and the time of day on the amount of physical activity completed, $F_{4, 68} = 1.39$, $P > 0.05$. A lack of interaction means that changes in mental performance throughout the day are essentially the same during the control and the fasting day.

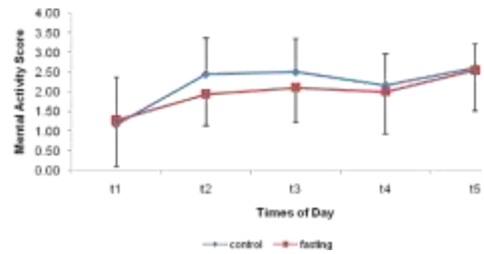

Fig3.2. The effects of time of day and condition (control or fasting) upon mental activity score.

3) Social Activity

Statistical analysis showed that there was no significant difference between control and fasting days on the amount of social activity completed $F_{1, 17} = 0.07$, $P > 0.05$. However, there was a significant difference between the time of day and the amount of mental activity completed, $F_{2.37, 40.23} = 14.67$, $P < 0.05$. Figure 3.3 showed that there was no significant interaction between the condition (control or fasting) and the time of day on the amount of social activity completed, $F_{3.90, 66.35} = 0.54$, $P > 0.05$. A lack of interaction means that changes in social activity throughout the day are essentially the same during the control and fasting day.

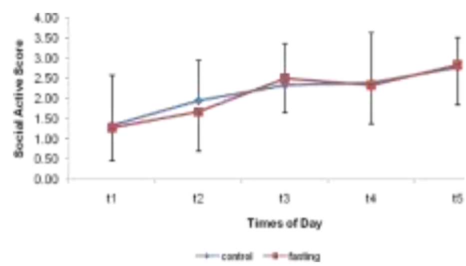

Fig3.3. The effects of time of day and condition (control or fasting) upon social activity score.

C. Perceived Sleepiness

Statistical analysis showed that there was no significant difference between control and fasting days on the amount of perceived sleepiness $F_{1, 17} = 1.74$, $P > 0.05$. However, there was a significant difference between the time of day and the amount of perceived sleepiness, $F_{2.69, 45.74} = 4.45$, $P < 0.05$. Figure 3.4 showed that there was no significant interaction between the condition (control or fasting) and the time of day on the amount of perceived sleepiness, $F_{2.50, 42.43} = 1.53$, $P > 0.05$. A lack of interaction means that changes in perceived sleepiness throughout the day are essentially the same during the control and the fasting day.

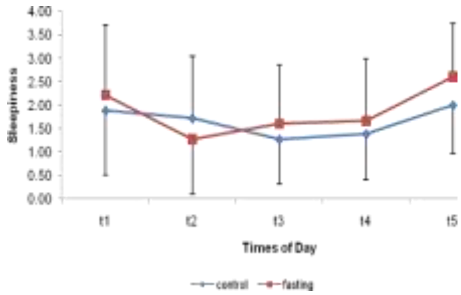

Fig3.4. The effects of time of day and condition (control or fasting) upon perceived sleepiness.

1) Perceived Physical Ability

Statistical analysis showed that there was a significant difference between control and fasting days on the amount of perceived physical ability $F_{1, 17} = 5.51$, $P < 0.05$. Statistical analysis also showed a significant difference between the time of day and the amount of perceived physical ability, $F_{3.79, 64.46} = 5.07$, $P < 0.05$. Figure 3.5 showed that there was no significant interaction between the condition (control or fasting) and the time of day on the amount of perceived physical ability, $F_{3.90, 66.33} = 0.76$, $P > 0.05$. A lack of interaction means that changes in perceived physical ability throughout the day are essentially the same during the control and fasting day

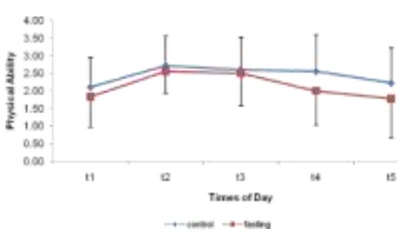

Fig3.5 The effects of time of day and condition (control or fasting) upon perceived physical ability.

D. Perceived Mental Ability

Statistical analysis showed that there was a significant difference between control and fasting days on the amount of perceived mental ability $F_{1, 17} = 5.37$, $P < 0.05$. Statistical analysis also showed a significant difference between the time of day and the amount of perceived mental ability, $F_{2.95, 50.15} = 8.57$, $P < 0.05$. Figure 3.6 showed that there was no significant interaction between the condition (control or fasting) and the time of day on the amount of perceived mental ability, $F_{4, 68} = 1.39$, $P > 0.05$. A lack of interaction means that changes in perceived mental ability throughout the day are essentially the same during the control and fasting day.

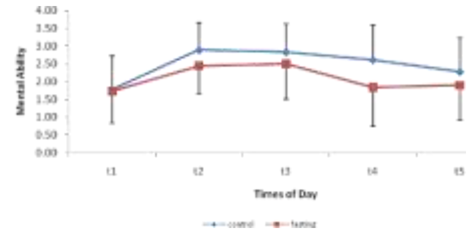

Fig3.6. The effects of time of day and condition (control or fasting) upon perceived mental ability

V.. Discussion

A. General Findings

The results of this study confirm that Ramadan is associated with changes to an individual's lifestyle. Reasons for eating, drinking, sleeping and activities performed are all affected by the daily requirements of Ramadan intermittent fasting. The results obtained from the questionnaires (appendix 1, 2 & 3) in this study show the amount of food, drink and sleep consumed and the amount of performance (physical, mental and social) completed within a control and fasting day. The aims of this study was to determine changes, if any, between control and fasting days on subject's: i) performance ability and performance outcome throughout the day; ii) the amount of 'naps' taken throughout the day to compensate for rising earlier to prepare for daylight fasting; iii) to determine if subjects would rise earlier and consume more food and drink in preparation for fasting and; iv) to determine if subjects would delay normal retiring time and consume more food and drink in order to compensate for daytime fasting.

B. Fluid and Food Intake

The results for food intake suggest that preparations for fasting before sunrise were not significantly made ($P > 0.05$) although mean food scores of 0.67 ± 0.91 and 1.11 ± 1.13 were observed in the control day and fasting day, respectively. Thus, showing an overall increase in total food consumed before sunrise on the fasting day this was an insufficient to be classed as preparing for the fasting period. Food scores after sunset also showed an increase, as results showed increases close to the maximum score significant increases are difficult to obtain between the control and fasting day of 3.50 ± 0.71 and 3.72 ± 0.57, respectively. Again, showing that there was no significant difference ($P > 0.05$) between the amount of food consumed after sunset in the control and fasting day (see figure 1.3). These results, which show that food consumption was not significantly increased in the fasting day in both preparation and compensation are contradictory of previous work by Karaagaoglu and Yucecan (2000), Waterhouse et al. (2008a), and Waterhouse et al. (2008b), which report that food scores significantly increases during fasting (Ramadan). However, reasons for eating were frequently observed as 'hungry' and in 'preparation' for fasting (see figure1.1) or 'recovery' from fasting (see figure 1.8). These findings were in agreement with previous research by Hakkou et al. (1994), Waterhouse et al. (2008) and Waterhouse, Alabed, Edwards and Reilly (in press).

We suggest that the reasons food scores are not significantly different, in preparation for the fasting period, and compensation after the fasting period are due to the nature of the participants and the protocol of the study and also due to food almost reaching maximum levels in the evening during both the control and fasting day. As this study only requires subjects to fast during daylight hours for one day, skipping breakfast and consequently having a reduced total food intake will not raise any health issues, in comparison to other research which compared food intake during Ramadan which is a total of 28 days in duration. If subjects continuously reduced food intake over a 28-day period we would expect health issues to occur such as decreases in weight and potentially malnutrition. Secondly as the subjects used in this study were not from a Muslim background, they had little experience in intermittent fasting so they did not prepare and compensate substantially after the fasting period.

The results for fluid intake suggest that preparations of fasting were significantly different between the control and fasting day ($P < 0.05$). Mean drink scores observed were 0.89 ± 1.45 and 2.33 ± 1.64 in the control and fasting day respectively (see figure 1.7). Reasons for drinking before sunrise were 'thirsty' in both conditions but 'preparation' showed a large increase in the fasting trial only (see figure 1.4). These findings were in agreement with previous work by Waterhouse et al. (2008b). Reasons for not drinking before sunrise showed 'too busy' as highly cited in both conditions. However, these findings contradict with the Waterhouse et al. (2008b) paper who found that 'not thirsty' was cited most frequently as the main reason for not drinking. We suggest that due to the subjects not being Muslim that they would not rise early enough to drink before sunrise and therefore stated 'too busy' as the reason for not drinking as they woke at a normal time and did not drink before sunrise. If the subjects were from Muslim population, we would expect almost all subjects to rise early and drink large amounts of fluid. The results also showed that during the fasting although more fluid was consumed that the fraction of occasion of drinking water was reduced, as tea / coffee and fruit juice rose on that day (see figure 1.6). For the control day 'water' was observed as the only drink consumed before sunset, these results contradict previous work by Waterhouse et al. (2008a) and Waterhouse et al. (2008b) who reported that water was reported more frequently on fasting days, previous work suggests that high levels of water consumption could be due to a cultural factor as well as a 'thirst'.

After sunset, all subjects drank large amounts of fluid as a compensatory response to fasting and in the control day, therefore the percentage of subjects who drank was 100% and drink scores rose to almost the maximum score in the control day and the maximum score in the fasting day. Mean drink score of 3.72 ± 0.46 and 4.00 ± 0 in the control and fasting day respectively (see figure1.7). The main reason for drinking was due to being 'thirsty' in both the control and fasting day, also 'recovery' was frequently cited after fasting had occurred (see figure 1.9). In comparison to before sunrise, all drinks were imbibed (see figure 1.10) after sunset and although the fraction of occasion decreased during water consumption a substantial increase in the amount of fluid consumed will compensate for this slight reduction allowing participants to regain a normal level of hydration. These results show strong correlations and therefore closely agree with previous research by Karaagaoglu and Yucecan (2000) and Waterhouse et al. (2008b). These results indicate that subjects drank large amounts of fluid after sunset on both the control and fasting day, this suggests that regardless of culture subjects drink more in the evening in both control and after fasting situations. In the control situation subjects drank high amounts of fluid because they were 'thirsty', this reason was also present after fasting but a greater emphasis on 'recovery' was expressed by subjects.

C. Sleeping / Naps

Results for daytime sleeping and perceived sleepiness showed that although subjects reported feeling tired, sleeps / naps were not frequently taken throughout the day. There was a significant difference ($P < 0.05$) in the time of day and the amount of perceived sleepiness recorded by participants (see figure 3.4), and showed that sleepiness increased throughout the day and into the night. Although subjects felt tired sleeps were not taken with 'too busy' and 'never do' frequently cited as the reasons for not sleeping (see figures 2.1, 2.2 & 2.3). These findings contradict previous work by Margolis and Reed (2004) and Waterhouse et al. (2008a; 2008b) but agree with Waterhouse et al. (in press). We suggest that as subjects were from a university background, that time spent awake in the day was spent in university doing work, therefore providing little opportunity to sleep during the day.

D. Performance

Results into the amount of physical, mental and social activity showed that no significant differences ($P > 0.05$) occurred between the control and fasting days, this study that activity fluctuated around the same score without too much alteration throughout the day but eventually rose in the evening (see figures 3.1, 3.2 & 3.3). Although changes were minimal between the control and fasting day in regards to the amount of physical, mental and social activity performed by subjects, results have shown that activities were lower during the daytime in Ramadan and then showed an increase towards the evening, this increase became greater than the control day in physical and social activity (see figures 3.1 & 3.3) but not in mental activity (see figure 3.2). These results were similar to previous research by Waterhouse et al. 2008b) and Roky, Iraki, HajKhlifa, Ghazal and Hakkou (2000). We suggest that performance was reduced during the day as subjects were potentially in the laboratory or in university therefore unable to carry out high levels of physical, mental and social activity. We suggest this would be the same on both days, as the problem might be that much of the work was "set work", and only "optional work" would decrease.

Finally, research into perceived physical and mental ability revealed during the fasting day perceived ability was significantly lower ($P < 0.05$) than in the control day (see figures 3.5 & 3.6). A reduced willingness to perform physical and mental tasks (work) was also found by Karaagaoglu and Yucecan (2000) and Waterhouse et al. (2008a), suggesting that increases in sleepiness coupled with a lack of food (to provide energy) cause perceived physical and mental ability to be reduced and consequently reduce the amount of physical and mental work performed by the subjects. Contradictorily this study showed that although perceived physical and mental ability decreased throughout the day and into the evening but actual physical and mental activities rose towards the late afternoon and early evening. We suggest that this could be due to the nature of the protocol, as fasting only took place for one day and would therefore not be sufficient to change the amount of physical and mental activity completed by the subjects, also as subjects are in university mental performance is maintained throughout the day and into the night especially if the subject is doing work.

VI. Conclusion

To conclude it is clear that Ramadan makes many demands on those involved, and is responsible for changes in food and drink consumption, daytime sleepiness and behaviour. Behavioural changes include both actual and perceived physical, mental and social abilities. Despite reductions in food and drink consumption during the daylight hours the opportunity to prepare before sunrise or recuperate after sunset is available, but when testing non-Muslim populations it is unclear if individuals utilise this time to potentially reduce the effects of intermittent fasting and consequently minimise forced behavioural changes.

VII. Further Recommendations

If this study or a similar study were to be replicated recommendations would be: i) Increase the protocol from one day of control and one day of fasting to allow for changes in behaviour, food, drink and sleep patterns to adapt over time, similar to Ramadan; ii) Use both Muslim and non-Muslim participants to compare differences in culture and intermittent fasting; iii) Perform testing completely within the lab this could include housing participants and therefore being able to monitor actual levels of sleep, actual amounts and types of food and drink consumed, the amount of physical performance completed by subjects (more freedom to do / not to do as they wish) .

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IX. . APPENDICES

6.1. Morning (9am) questionnaire

Questionnaire to be answered at 09:00 h

Name…………………………………..; Fasting or normal day?..................................

A. SLEEP:

1. What time did you go to sleep?.......................

2. How much did this differ from your normal nights sleep?

-5 hours ----------------------------0 hours-----------------+5 hours
(earlier) (normal) (later)

3. How well did you sleep, compared with normal?

-5-------------------------------------0-----------------------+5
(more waking episodes) (normal) (fewer waking episodes)

4. What time did you wake?......................

5. How much did this differ from your normal nights sleep?

-5 hours ------------------0 hours--------------------+5 hours
(earlier) (normal) (later)

6. How alert did you feel 30 min after rising in comparison to a normal nights sleep?

-5 ---------------------------------- 0----------------------- +5
(less alert) (normal) (more alert)

B. DRINK:

7. Did you drink anything BEFORE 08:00h? (please ring answer)

Yes No

If you answered "Yes", go to question 8; if you answered "No", go to question 11.

8. How much did you drink? (please ring one answer)

a. One sip or mouthful
b. Less than one glass or cupful
c. One glass or cupful
d. More than one glass or cupful

9. WHAT DID YOU DRINK? (PLEASE RING AS MANY ANSWERS AS APPLY)

a. Water
b. Tea or coffee
c. Fruit juice
d. A fizzy drink
e. Milk
f. Other

10. Why did you drink? (please ring as many answers as apply)

a. I felt thirsty
b. I was with a friend and being sociable
c. For health reasons
d. In preparation for the day (not be able to drink throughout the day so drink now)

Go to Section C, FOOD

11. Why did you NOT drink? (please ring as many answers as apply)

a. I did not feel thirsty
b. I never drink at this time
c. I was too busy
d. I am not allowed to drink during this time

C. FOOD:

12. Did you eat anything BEFORE 08:00 h? (please ring answer)

Yes No

If you answered "Yes", go to question 13; if you answered "No", go to question 15.

13. How much did you eat? (please ring one answer)

a. A snack
b. A small meal
c. A medium sized meal
d. A large meal

14. Why did you eat? (please ring as many answers that apply)

a. I felt hungry
b. I was being sociable
c. In preparation for the day (not be able to eat throughout the day so eat now)
d. For health reasons

Continue onto Section D, ACTIVITES AND FEELINGS

15. Why did you NOT eat? (please ring as many answers as apply)

a. I did not feel hungry
b. I never eat at this time
c. I was too busy
d. I am not allowed to eat during this time

D. ACTIVITIES AND FEELINGS

The answers required for questions 16-21 are a number from 0 to 4, in which:
0 means "not at all"
1 means "slightly"
2 means "moderately"
3 means "quite a lot"
and 4 means "very much"

16. How physically active have you been? (ANSWER 0-4)…….

17. How mentally active have you been? (ANSWER 0-4)…….

18. How socially active have you been? (ANSWER 0-4)…….

19. How sleepy do you now feel? (ANSWER 0-4)…….

20. How able to perform physical tasks do you now feel? (ANSWER 0-4)…….

21. How able to perform mental tasks do you now feel? (ANSWER 0-4)…….

End of questionnaire
Thank you for your time.

6.2.Daytime (12, 15, 18) questionnaire

Questionnaire to be answered at 12:00 h, 15:00 h and 18:00 h

Name……………………..; Fasting or normal day?..................................
Time of answering questionnaire……………….

A. SLEEP:
1. Have you slept in the last 3 h? (please ring answer)

Yes No

If you answered “Yes”, go to question 2; if you answered “No”, go to question 4

2. How long did you sleep?..................

3. Why did you sleep? (please ring as many answers as apply):
a. tired
b. bored
c. felt unwell

Go to section B, DRINK

4. Why did you NOT sleep? (please ring as many answers as apply):
a. not tired
b. too busy
c. never do at this time

E. DRINK:
5. Have you drunk anything in the last 3 h? (please ring answer)

Yes No

If you answered “Yes”, go to question 6; if you answered “No”, go to question 9.

X. 6. How much did you drink? (please ring one answer)

e. One sip or mouthful
f. Less than one glass or cupful
g. One glass or cupful
h. More than one glass or cupful

7. WHAT DID YOU DRINK? (PLEASE RING AS MANY ANSWERS AS APPLY)
g. Water
h. Tea or coffee
i. Fruit juice
j. A fizzy drink
k. Milk
l. Other

8. Why did you drink? (please ring as many answers as apply)

e. I felt thirsty
f. I was with a friend and being sociable
g. For health reasons
h. In preparation for the day (not be able to drink throughout the day so drink now)

Go to Section C, FOOD

9. Why did you NOT drink? (please ring as many answers as apply)

e. I did not feel thirsty
f. I never drink at this time
g. I was too busy
h. I am not allowed to drink during this time

F. FOOD:
10. Have you eaten anything in the last 3 h? (please ring answer)

Yes No

If you answered “Yes”, go to question 11; if you answered “No”, go to question 13.

11. How much did you eat? (please ring one answer)

e. A snack
f. A small meal
g. A medium sized meal
h. A large meal

12. Why did you eat? (please ring as many answers that apply)

e. I felt hungry
f. I was being sociable
g. In preparation for the day (not be able to eat throughout the day so eat now)
h. For health reasons

Continue onto Section D, ACTIVITES AND FEELINGS

13. Why did you NOT eat? (please ring as many answers as apply)

e. I did not feel hungry
f. I never eat at this time
g. I was too busy
h. I am not allowed to eat during this time

G. ACTIVITIES AND FEELINGS

The answers required for questions 14-19 are a number from 0 to 4, in which:
0 means “not at all”
1 means “slightly”
2 means “moderately”
3 means “quite a lot”
and 4 means “very much”

14. How physically active have you been? (ANSWER 0-4)……...

15. How mentally active have you been? (ANSWER 0-4)………

16. How socially active have you been? (ANSWER 0-4)………

17. How sleepy do you now feel? (ANSWER 0-4)………

18. How able to perform physical tasks do you now feel? (ANSWER 0-4)………

19. How able to perform mental tasks do you now feel? (ANSWER 0-4)………

End of questionnaire
Thank you for your time.

3. Retiring questionnaire

Questionnaire to be answered on retiring at the end of an experimental day

Name…………………………………..; Fasting or normal day?..................................

A. SLEEP:
1. What time will you go to sleep?.......................

2. How much will this differ from a normal night?

-5 hours ---------------------------0 hours---------------+5 hours
(earlier) (normal) (later)

3. How tired do you feel, compared with normal?

-5------------------------------------0----------------------+5
(less tired) (normal) (more tired)

H. DRINK:
4. Did you drink anything AFTER 18:00h? (please ring answer)

Yes No

If you answered "Yes", go to question 5; if you answered "No", go to question 8.

5. How much did you drink? (please ring one answer)

i. One sip or mouthful
j. Less than one glass or cupful
k. One glass or cupful
l. More than one glass or cupful

6. WHAT DID YOU DRINK? (PLEASE RING AS MANY ANSWERS AS APPLY)
m. Water
n. Tea or coffee
o. Fruit juice
p. A fizzy drink
q. Milk
r. Other

XI. 7. Why did you drink? (please ring as many answers as apply)
i. I felt thirsty
j. I was with a friend and being sociable
k. For health reasons
l. To recover from the daytime (not be able to drink throughout the day)

Go to Section C, FOOD

8. Why did you NOT drink? (please ring as many answers as apply)
i. I did not feel thirsty
j. I never drink at this time
k. I was too busy

I. FOOD:
9. Did you eat anything AFTER 18:00 h? (please ring answer)

Yes No

If you answered "Yes", go to question 10; if you answered "No", go to question 12.

10. How much did you eat? (please ring one answer)
i. A snack
j. A small meal
k. A medium sized meal
l. A large meal

11. Why did you eat? (please ring as many answers that apply)
i. I felt hungry
j. I was being sociable
k. To recover from the daytime (not be able to eat throughout the day)
l. For health reasons

Continue onto Section D, ACTIVITES AND FEELINGS

12. Why did you NOT eat? (please ring as many answers as apply)
4. I did not feel hungry
5. I never eat at this time
6. I was too busy

J. ACTIVITIES AND FEELINGS
The answers required for questions 13-18 are a number from 0 to 4, in which:
0 means "not at all"
1 means "slightly"
2 means "moderately"
3 means "quite a lot"
and 4 means "very much"

13. How physically active have you been? (ANSWER 0-4)……...

14. How mentally active have you been? (ANSWER 0-4)………

15. How socially active have you been? (ANSWER 0-4)………

16. How sleepy do you now feel? (ANSWER 0-4)………

17. How able to perform physical tasks do you now feel? (ANSWER 0-4)………

18. How able to perform mental tasks do you now feel? (ANSWER - 4)………