

The physiological effect of intermittent fasting (fasting the month of Ramadan) on anthropometrics and blood variables.

By

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## ABSTRACT

Muslims fast one month each year during the month of Ramadan. Many studies have been conducted on fasting during the month of Ramadan; however, their results were varied. Furthermore, few studies have been conducted on hormones levels during Ramadan and these studies had vastly inconsistent results. It is important to note that none of these studies controlled or even monitored physical activity and food intake. Purpose: The purpose of this study is to examine the effect of fasting during the month of Ramadan on anthropometric and blood variables. This study will determine if intermittent fasting will affect body composition, blood lipid profile, glucose, blood proteins and hormones. Methods: eight healthy athlete males aged ( $21.75 \pm 2.05$  years,  $66.73 \pm 7.51$  kg,  $170.68 \pm 5.21$  cm) participated in this study. The subjects were randomly selected from a first division Saudi Soccer League (Raka Soccer League). Weight, height and body composition of all subjects were recorded at baseline one day before Ramadan (D1), after ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). Blood was collected and then analyzed. Physical activities and food intake were measured. All data was analyzed using 1x3 repeated measures ANOVA ( $p < .05$ ). Results: There was significant decrease in body mass (D1= 66.73 kg, D10= 66.73 kg and D28= 65.53 kg) and Lean body mass (D1= 50.51 kg, D10= 50.46 kg and D28= 49.46 kg) comparing the end of Ramadan with baseline and day 10 of intermittent fasting whereas they were almost identical at the baseline and Day 10 of Ramadan. There was no significant difference in data of Body Fat percentage. Physical activity, Vigorous activity and Moderate activity were significantly decrease at Day 10 and Day 28 of Ramadan. Total cholesterol, Triglycerides, LDL, HDL and VLDL did not show significant differences. However, the ratio of LDL to HDL was significantly increased at Day 10 ( $p = 0.021$ ) and at the end of fasting Ramadan ( $p = 0.004$ ) compare to baseline.

Energy intake showed no significant differences overall across the three times of testing. However, the percentage which recommended dietary allowances of calories from protein showed significant decrease at Day 10 and Day 28 of Ramadan compare to the baseline (D1=17.57 %, D10 =12.50 % and D28 =11.35 %). In addition, the percentage of calories from carbohydrate showed significant increase at Day 10 and Day 28 of Ramadan compare to the baseline (D1 =47.79 %, D10 =59.01 % and D28 =57.89 %). Whereas, there were no significant changes in calories from fat. Fasted Glucose levels were significantly increased at D 10 but not at the end of Ramadan compare to the Pre-Ramadan  $p=0.001$ . Insulin and Cortisol did not change significantly at all measures. However, Glucagon decrease significantly after ten days of intermittent fasting and returned back closer to the Pre-Ramadan at the end of Ramadan. In addition, Albumin levels were significantly lower at Day 10 and Day 28 of Ramadan compare to baseline; however, Albumin levels were still within normal/health range. Conclusion: These results show the level of physical activity and food intake are major contributing factors on the reduction in body weight specifically the lean body mass. Overall, these findings indicate no health risk for fasting during the month of Ramadan.

Key Words: Ramadan, Intermittent fasting, Lipid profiles, Anthropometrics, hormones

## Dedication

Dedicate this important professional achievement to the soul of my wonderful deeply missed Mother. Inexpressible how much I wish she were still with us

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## ABBREVIATIONS

A	Activity
AR	Test was taken after Ramadan
BW	Body Weight
CC%	Percentage of Calories from Carbohydrate
CP%	Percentage of Calories from Protein
CF%	Percentage of Calories from Fat
F	Subjects were female
F,M	Subjects were female and male
HDL	High density lipoprotein
LDL	Low density lipoprotein
LDL/HDL	Ration of LDL to HDL
M	Subjects were male
nW	Subjects were normal
oW	Subjects were overweight
S	Sedentary
TC	Total Cholesterol
TG	Triglycerides
uW	Subjects were underweight
VLDL	Very low density lipoprotein

## CHAPTER I

### INTRODUCTION

Ramadan is the ninth lunar month in the Islamic calendar and Muslims all over the world fast each day of this month from sunset to sunrise. All adults participate with the exception of those who cannot i.e., persons that are traveling, menstruating, pregnant or nursing women, and others with a medical condition that would preclude fasting. During fasting, Muslims abstain from eating, drinking and sexual encounter.

In 2012 was the first time that Muslim athletes competed in the Olympic games during Ramadan; could that cause a major disadvantage for these athletes? Research on the effect of fasting Ramadan on athletic performance will be the subject of major scientific interest in the future.

Several studies have been conducted on the effect of fasting the month of Ramadan on body weight, Glucose levels, and hormone levels. A few studies showed either an increase (Forst and Priani 1987, Nagra et al 1998, Meckel et al 2008) or no changes in body weight during the month of Ramadan (Lamari-Senhadji et al 2009); but most studies show that fasting during Ramadan reduced body weight (Muazzam and Khaleque 1959, Fedail et al 1982, Husain et al 1987, Sweileh et al 1992, Afrasiobi et al 2002, Rahman et al 2004, Dewanti et al 2006, Bouhlel et al 2008, Abdelmalek et al 2011, Trabelsi et al 2012). A study by Leiper and others (2003); believed these body mass losses were mainly due to a

decrease of glycogen-bound water stores, in addition to a loss in body tissue specifically muscle mass.

Studies by Nagra et al (1998), Sulieman et al (1982), Sarraf-Zadegan et al (2000), Halack et al (1988), Aldouni et al (1997), Temizhan et al (2000), Dowod Tahm (2004), and Ziaee V et al (2006) reported that there was a significant decrease in LDL cholesterol while a significant increase in HDL cholesterol were reported by Maslos et al (1993), Aldouni et al (1997), Temizhan et al (2000), Afrasiabi et al (2002), and Rahman et al (2004). High blood cholesterol has long been considered a health factor in cardiovascular disease. These studies show that fasting during Ramadan may help to reduce the risks of CVD.

A few studies have shown the effect of fasting on Ramadan in relationship to blood Glucose levels. Muazzam and Khaleque (1959), Aldouni et al (1997), Larijani et al (2003) Rahman et al 2004), Malhotra et al (1989) , Nomani et al (1989) and Ziaee Vet al (2006) reported that Glucose levels show significant decrease in blood Glucose at the end of the month of Ramadan. While Temizhan et al (2000) reported a significant increase in blood Glucose at the end of the month of Ramadan.

The inconsistency in the results of previous studies might be due to lack of control in the type and amount of food that was consumed by the subjects. The subjects could easily have consumed varying amounts of calories between these two measurements. A reliable study would be one that takes into consideration

not only this factor, but the factor of physical activity in relation to the subjects as well. Thus, there is a need for a study that will investigate the effects of fasting over a period of 14 to 16 hours each day for one month. Furthermore, this study will examine the effects of physical activity during fasting Ramadan.

## 1.1 Statement of the problem

Many studies have been conducted on fasting during the month of Ramadan. However, their results were varied and highly inconsistent. Most of the studies during Ramadan reported a reduction in body weight. Other studies found that body weight increased or was maintained at a Pre-Ramadan level. Furthermore, other studies looked at the effect of fasting during Ramadan on cholesterol and high and low-density lipoproteins levels and have also shown variances. Few studies have been conducted on hormone levels during Ramadan and these studies had vastly inconsistent results. Also, it is important to note that none of these studies controlled food intake with physical activity.

Thus, there is a need for a study, which will consider the amount and type of food intake with physical activity. This study will investigate whether fasting 14 to 16 hours during the day will affect the maintenance of anthropometric measurements, as well as the levels of lipids, proteins, Glucose and hormones. This study may also show if the level of physical activity is major contributing factors to the values in each of these areas during the month of Ramadan.

## 1.2 Hypothesis

Many studies on body weight and blood variables have been conducted relating to fasting during the month of Ramadan. The results have been varied and inconsistent, possibly due to the differences in the procedures and the methods that were used. Most of the studies did not control the food intake and physical activity during fasting, this maybe the major factor affecting previous studies and their results.

The hypotheses of this investigation:

- The first hypothesis of this investigation is that the amount and type of food intake with physical activity levels will affect body weight and body fat significantly during fasting the month of Ramadan.
  
- The second hypothesis of this investigation is that the amount and type of food intake with physical activity levels will affect the lipid profile, Glucose, blood proteins and hormones significantly during fasting the month of Ramadan.

### 1.3 Significant of the study

The purpose of this study is to investigate the physiological and metabolic effects in the human body as related to fasting during the month of Ramadan. Each participating subject will have Glucose, Insulin, Glucagon, Cortisol, Albumin, and serum total protein levels as well as lipid profile values along with Anthropometric measurements evaluated during the month long intermittent fasting. This study may also show if the level of physical activity and food intake are major contributing factors on these variables.

Information collected during this study may help to show that people who fast during the month of Ramadan can fast for an extended period without harmful physiological or metabolic effects. This study will also increase the level of awareness related to fasting and another significant aspect of this study is that it may show a more beneficial way of fasting for religious as well as health reasons.

This study has the potential to have far reaching effects, not only within the scientific community as related to Muslims, but within every aspect of the medical community, such as a decrease in cardiovascular risk and better control for diabetic patients. A study with the documentation of physical activity while fasting could provide valuable information to the Muslims as well as every human being in the world who decides to utilize a fast for reasons of health.

## CHAPTER II

### REVIEW OF LITERATURE

#### 2.1- Body weight and body fat during fasting Ramadan

During the month of Ramadan, Muslims fast from sunrise to sunset, approximately 14 to 16 hours each day. However, they do eat and drink during the remaining hours. The effects of fasting during the month of Ramadan on body weight and body fat have been studied with inconsistent results. The majority of the studies conducted and published from 1959-2012 are related to body weight. Little research and even fewer articles have been written concerning body fat in relationship to the fast of Ramadan. A few studies however, show that fasting during Ramadan significantly reduced body weight and or body fat (Table 1-Body Fat and Table 2-Body Weight). Studies by Maislos et al, 1993 and Beltaifa et al, 2002 reported non-significant changes in body weight. It is important to note that neither of these studies contained to body fat measurement.

Forst and Pirani (1987) showed a significant increase of 3680kcal or a 51.7% in caloric intake and a notable loss from 60.3kg to 58.9kg or a 2.38% decrease in body weight during the month of Ramadan. Reflectively, this weight loss could conceivably be due to increased physical activity. However, no documentation of physical activity was measured in this study. Two other studies examined caloric intake as well. Decreases in caloric intake were noted Khan and

Khattak, 2002 and Angel and Schwartz, 1974, 3.8% and 4.51% found 18.14% and 30.44% with decreases in body weight respectively.

A study conducted on Muslim women found that their body weight and fat mass did not change significantly. Also, they found the daily food intake pre-and post-Ramadan did not change (El Ati et al, 1995). A study on men by Meckel in 2008 showed that while the intensity of the physical activity decreased significantly there was no major difference in either body weight or in caloric intake during Ramadan.

A study of seven male subjects by Angel and Schwartz, 1974 revealed that daily caloric intake significantly decreased during Ramadan. The mean body weight among the seven males decreased significantly from 72.3kg to 69.6kg, a total of 3.32% reduction in body weight. Another study conducted on 12 men and 9 females showed a reduction in body weight along with a decreased food intake in both genders. The females exhibited a 6.41% reduction in body weight, dropping from a mean weight 49.9kg to 46.7kg while the males showed a reduction of 4.04% going from a mean of 62.9kg to 60.3kg. Pre-and post-Ramadan Anthropometric variables also showed no significant changes (Husian 1987).

Two other studies, one conducted on women and the other on men revealed significant correlations between decreased caloric intake and loss in body weight. The study on 12 athletic females during Ramadan revealed

significant decreases in body weight and body mass index (BMI) related to a diminished caloric intake. A mean body weight loss from 56.41kg to 54.78kg, a drop of 2.98% and a loss of 3.02% in BMI were documented (Memari, 2011). The study consisting of nine men showed evidence of body weight loss with a decreased food intake. A mean body weight decrease from 74.00kg to 71.50kg, a 3.50% loss was documented (Abdelmalek et al, 2011).

A study performed by Takruri (1989) examined the various weight categories i.e. normal weight, overweight, and underweight. The researcher found that the female's weight loss was less than the males in all weight categories probably because females have a higher body fat content. Thus, certain types of medical conditions such as obesity could possibly benefit from this type of fasting.

A study of 19 physically active men by Trabelsi et al stated that though the subject's caloric intake did not change the subject demonstrated a significant reduction in body weight and body fat. Interestingly, a significant reduction in water, 4.0L down to 3.3L was noted (Trabelsi et al, 2012). These studies show the influence that caloric intake has on individuals when undertaking an altered diet as well as altered meal schedules. It is important to note that none of these studies showed any correlation between body weight and the level of physical activity during the month of Ramadan. We hypothesize that the inconsistencies in testing results may be due to the type of food eaten as well as the amount of caloric

intake. In addition, the type and the intensity of the PA each subject participates in may be a prime factor.

A study from Hallak and Nomani (1988) found that during the last two weeks of Ramadan fasting (RF), when the subjects increased energy intake by 8 % (from 1696 kcal/day to 1834 kcal/day) while being on a high-fat diet, there was no significant difference in body weights during this time period. Pre-Ramadan each subject consumed 2275 kcal per day. During the first two weeks of the study with reduction in caloric intake there was a significant decrease of 2.9% in body weight.

Biologists Viqul and Chow (2006) investigated patterns in the food intake of 29 subjects for one year in correlation with body mass index (BMI). Their findings showed the mean energy intake was less significant relating to BMI, but had a greater significance related to mean body weight.

Energy intake versus energy expenditure combined with dietary requirements play major roles in body-weight loss and/or control. In order for weight control maintenance to be achieved the energy expenditure must be equal to the energy intake. For weight loss to occur energy intake must be less than energy expenditure to result in body weight loss. Weight loss is also connected to high levels of physical activity, associated with various types of work, especially those that require constant muscle contraction and relaxation. Clearly, these types of physical activities require high-energy intake. Therefore, physical activity has

a major impact on the energy expenditure and energy balance in any 24-hour period (Tappy et al, 2003). An experimental 3-year, study was conducted by Cox with others in 2007, to determine the relationship between weight maintenance, the role of physical activity and the amount of energy intake. Utilizing a program of moderate and vigorous activity each day along with each person's individual diet they concluded the level of physical activity may affect the amount of energy intake required to maintain body weight. Another non-Ramadan study lasting for 12 weeks (Hagan, et al., 1986) compared the amount of weight lost and body fat reduction in obese females and males; through diet with exercise, diet alone, exercise alone and the last group as a sedentary control group. The diet was controlled at 1200 kcal per day and the exercise portion of the study consisted of a 30-minute walk or run 5 times per week. The diet-exercise group with the diet only group had a greater body weight and body fat reduction than either the exercise only or sedentary groups. This study clearly illustrates that the low caloric intake and the level of physical activity affect weight loss.

In conclusion, there have been many studies conducted on the fast of Ramadan related to body weight. The inconsistencies of previous studies appears to have a direct correlation to the fact that the majority of the studies do not control the amount of food intake; nor do they control the level of physical activity between these two measurements. Moreover, additional research needs to be conducted to not only further investigate the fast of Ramadan in relationship to

body weight, but the inclusion and consideration of the level of physical activity along with the amount and type of food intake.

Table 1: Show the effect of fasting during the month of Ramadan on body fat (BF)

Baseline BF (%)	Ramadan BF (%)	% Changes	Reference
16.70 <sup>F16</sup>	16.20	-2.99	El Ati et al (1995)
23.90 <sup>F46</sup>	22.40	-6.28	Kassab et al (2004)
24.90 <sup>F57</sup>	24.50	-1.61	Al-hourani and Atoum (2007)
16.40 <sup>M9</sup>	16.10	-1.83*	Bouhlel et al (2008)
10.00 <sup>M8</sup>	9.40	-6.00	Chennaoui et al (2009)
19.40 <sup>M18</sup>	18.20	-6.19*	Trabelsi et al (2011)

\* Significant; Baseline would be the point where the subjects were not fasting the month of Ramadan; Ramadan would be the point where the test was performed during the last week of Ramadan; <sup>AR</sup> the test of body weight was taken after Ramadan; BW body weight; <sup>M</sup> the subjects were male; <sup>F</sup> the subjects were female; <sup>F.M</sup> the subjects were female and male; <sup>uW</sup> the subjects were underweight. <sup>oW</sup> the subjects were overweight; <sup>nW</sup> the subjects were normal; <sup>S</sup> Sedentary; <sup>A</sup> Activity

Table 2-1: Show the effect of fasting during the month of Ramadan on body weight.

Baseline BW (kg)	Ramadan BW (kg)	% Changes	Reference
55.4 <sup>F,M13</sup>	54	-2.53	Muazzam and Khaleque (1959)
72.3 <sup>M7</sup>	69.9	-3.32	Angle and Schwartz (1974)
69.5 <sup>F4, M20</sup>	67.7	-2.59*	Fedail et al (1982)
49.9 <sup>F9</sup>	46.7	-6.41*	Husain et al (1987)
62.9 <sup>M12</sup>	60.36	-4.04*	Husain et al (1987)
58.9 <sup>F2,M13</sup>	60.3	2.38*	Forst and priani (1987)
66.2 <sup>M16</sup>	63.8	-3.63*	Hallack et al (1988)
<sup>oW</sup> 76.8 <sup>F25,M50</sup>	72.18	-6.02*	Hamaed Takturi (1989)
<sup>nW</sup> 62.01 <sup>F14,M24</sup>	60.02	-3.21*	Hamaed Takturi (1989)
<sup>uW</sup> 54.17 <sup>F8,M16</sup>	53.53	-1.18*	Hamaed Takturi (1989)
67.61 <sup>F47,M90</sup>	65.51	-3.11*	Hamaed Takturi (1989)
60.5 <sup>M12,F10</sup>	59.8	-1.16*	Mafauzy et al. (1990)
72.1 <sup>F1,M7</sup>	70.18	-2.66*	Sweileh et al (1992)
<sup>4WAR</sup> 68.2 <sup>F8,M16</sup>	68	-0.29	Maislos et al (1993)
59.3 <sup>F16</sup>	58.9	-0.67	El Ati et al (1995)
69.61 <sup>M32</sup>	67.83	-2.56*	Adlouni et al. (1997)
51.9 <sup>F26</sup>	52.6	1.35	Nagra et al (1998)
<sup>S</sup> 77.4 <sup>M7</sup>	76.5	-1.16	Ramadan et al (1999)
<sup>A</sup> 71.5 <sup>M6</sup>	70.5	-1.4	Ramadan et al (1999)
86.7 <sup>M22</sup>	84.4	-2.65*	Afrasiobi et al. (2002)
79.8 <sup>M16</sup>	78.6	-1.5	Afrasiobi et al. (2002)
66.3 <sup>M20</sup>	66.2	-0.15	beltaifa et al (2002)
80.8 <sup>M,F10</sup>	77.7	-3.84*	Khan and Khattak (2002)
56 <sup>M38</sup>	54	-3.57	Dadeya et al. (2002)
64.05 <sup>M 20</sup>	62.07	-3.09*	Rahman et al (2004)
80.8 <sup>F 46</sup>	80.1	-0.87	Kassab et al. (2004)
68.67 <sup>F16,M18</sup>	68.64	-0.04	Yucel et al (2004)

Table 2-2: Show the effect of fasting during the month of Ramadan on body weight.

Baseline BW (kg)	Ramadan BW (kg)	% Changes	Reference
62.4 <sup>F39, M41</sup>	61.2	-1.92*	Ziaee et al. (2006)
55.7 <sup>F39</sup>	54.6	-1.97*	Ziaee et al. (2006)
68.7 <sup>M41</sup>	67.5	-1.75*	Ziaee et al (2006)
64.5 <sup>M37</sup>	63	-2.33*	Dewanti et al (2006)
57.50 <sup>F57</sup>	56.90	-1.04*	Al-Hourani and Atoum (2007)
80.40 <sup>M9</sup>	78.60	-2.24*	Bouhleb et al (2008)
70.50 <sup>F5, M9</sup>	69.10	-1.99	Ibrahim et al (2008)
62.50 <sup>M19</sup>	62.80	0.48	Meckel et al (2008)
80.69 <sup>M62</sup>	78.73	-2.43*	Shariatpanahi et al (2008)
67.10 <sup>M8</sup>	65.60	-2.24	Chennaoui et al (2009)
53.00 <sup>F24</sup>	52.00	-1.89	Lamri-Senhadji et al (2009)
70.00 <sup>M22</sup>	70.00	0.00	Lamri-Senhadji et al (2009)
74.00 <sup>M9</sup>	71.50	-3.38*	Abdelmalek et al (2011)
70.60 <sup>M14BI</sup>	68.50	-2.97*	Kordi et al (2011)
68.00 <sup>M22AI</sup>	66.30	-2.50*	Kordi et al (2011)
56.41 <sup>F12</sup>	54.78	-2.89*	Memari et al (2011)
79.20 <sup>M19</sup>	77.70	-1.89*	Trabelsi et al (2012)

\* Significant; Baseline would be the point where the subjects were not fasting the month of Ramadan; Ramadan would be the point where the test was performed during the last week of Ramadan; <sup>AR</sup> the test of body weight was taken after Ramadan; BW body weight; <sup>M</sup> the subjects were male; <sup>F</sup> the subjects were female; <sup>F,M</sup> the subjects were female and male; <sup>nW</sup> the subjects were underweight. <sup>oW</sup> the subjects were overweight; <sup>nW</sup> the subjects were normal; <sup>S</sup> Sedentary; <sup>A</sup> Activity; <sup>BI</sup> Before Iftar; <sup>AI</sup> After Iafter.

## 2.2- Lipid profile and the fasting of Ramadan

A Lipid Profile (LP) or Lipid Panel is a test that evaluates the levels of Total Cholesterol (TC), High-Density Lipoproteins (HDL), Low-Density Lipoproteins (LDL), and Triglycerides (TG) in serum blood. These levels are vital in the screening and monitoring of multiple medical conditions, i.e., cardiovascular disease (CVD), thyroid disease, liver disease, renal disease, along with various metabolic disorders such as Diabetes Mellitus (DM), (Fischbach, 1998). The levels of a lipid profile frequently evaluate the effectiveness of dietary and medication concerns. Many factors contribute to the deviations found in these levels. These variances have been traced back to metabolic diseases, CVD, pregnancy, thyroid and liver disease, and medication that the person is taking as well as persons who fast for either short or extended periods of time.

During Ramadan fasting the frequency and amount of caloric intake is decreased (Angel and Schwartz, 1974). Because of these dietary changes and the time requirement involved for fasting, the month of Ramadan has been studied multiple times, but with a diversity of results related to each aspect of the Lipid Profile (LP). Many studies showed substantial decreases in total cholesterol levels whereas other investigations documented significant increases in serum blood TC levels during the month of Ramadan.

Asgary et al, 2000 and Aldouni et al, 1997 in studies conducted on both genders showed significant decreases in TC, 7.30% and 7.93%, respectively. While the greatest decrease in TC was 10.04% found by Temizhan et al in 2000.

Several studies conducted on both genders showed noteworthy elevations in TC concentrations. Fedial et al 1982 saw increases of 9.15% in TC levels. Barkia et al in 2011 recorded greater increases in TC levels of 13.64%. Another notable study conducted by Lamri-Senhadji et al in 2009-documented substantial elevations of TC in both genders with an increase in women of 13.83% and in men of 23.60%. Interestingly, the majority of the results obtained from the studies showed no significant changes in TC serum blood levels (Table 3).

In summary, total cholesterol levels on serum blood obtained during Ramadan fasting were widely presented. A few studies showed marked decreases in TC serum levels as great as 10.04% others revealed elevated percentages as high as 23.60%. Although these percentage values were elevated, they remain within the normal/health range. Although, most studies reviewed did not separate decreased or increased percentages per gender those that did revealed diminished as well as elevated finding for both genders. Lamri-Senhadji et al and Barkia et al were in agreement with Aldouni et al, Asgary et al as well as Temizhan et al in their conclusion that the type and amount of caloric intake such as, increasing protein, carbohydrate and fat consumption play a major role in either increasing or decreasing total cholesterol levels. The frequencies of many small meals

instead of having one or two large meals were also considered as a viable contributing factor in lowering total cholesterol levels.

Low-Density Lipoproteins known as “bad cholesterol” is another component of a Lipid Profile. Elevated levels within this are considered negatively from a medical aspect and have been associated with the increased risk of CVD, renal disease and various metabolic disorders. LDL levels have been reported in studies related to Ramadan fasting in a wide range of high and low percentages. Some studies looked at blood values from both genders separately, whereas others recorded a mean percentage covering both genders. In 2004 a study conducted on both genders recorded a mean LDL decrease of 6.49%. While a study comprised of 32 males conducted in 1997 recorded mean LDL decreases of 11.68% (Dowod Tahm, 2004 and Aldouni et al, 1997).

Two other studies, Temezhan et al, 2000 and Lamri-Senhadji et al, 2009 recorded significant changes in both genders but with opposite values per group. Temezhan showed decreases in mean LDL levels for women of 12.40% and men 10.97%, whereas Lamri-Senhadji et al found decrease of 13.29% for women and 32.16 % for men.

Though a number of studies show decreases in LDL levels during Ramadan fast other studies show marked increases in the same blood values. Studies in 2006 and 2011 looked at lab values in each gender. Mean LDL blood value percentages were elevated in both studies, Ziaee et al, 2006 with an increase

of 3.82% and Barkia et al in 2011 with a mean increase of 20.69% (Ziaee et al, 2006 and Barkia et al, 2011).

A study showing one of the highest recorded increases, 24.89% found that the significant elevation of LDL could logically be related to the total caloric intake and the type of dietary fat consumed (Halack et al, 1988), (Table 5). A cholesterol study on non-fasting in 2001 found a strong relationship between the frequency of eating and the levels of TC and LDL. With an increased frequency of meals the serum levels of TC and LDL decrease (Titan et al, 2001).

Interpretation of data varies somewhat per study. However, for the most part a consensus regarding the healthy influence of smaller, frequent meals versus one or two large meals appears to have been established. These smaller meals combined with the specific types of caloric intake such as increased carbohydrate and fat intake may well have a more direct and beneficial outcome in controlling LDL levels than one or two large meals during the Ramadan fast. Additionally, non-fasting study results support the conclusion that concentrations of low-density lipoproteins as well as other components of a lipid profile, high-density lipoproteins, are linked to meal frequency.

High-density lipoproteins are usually considered as “good cholesterol” and contain positive reinforcing factors against various CVD. Increased levels of HDL are considered positive and advantageous from a medical viewpoint. Consequently, decreased levels of HDL can amplify a person’s health risk. A

study, divided into two phases, of sixteen healthy males had significantly decreased levels of HDL by the end of the four-week fast. During phase-one, the first two weeks of Ramadan, each subject consumed 77.1% of carbohydrates and 8.8% of fat. Phase-two followed with caloric intake of 35% carbohydrates and 51% of fat over the last two weeks of fasting. HDL levels at the end of phase one saw a decrease of 8.38%, at the end of phase two HDL levels had decreased to 19.09% (Halack et al, 1988).

Another study that considered energy intake and dietary fat consumption during fasting was Ziaee et al in 2006. He conducted a study on 80 men and women and documented a mean decrease in HDL levels of 9.00%.

Just as energy intake affects decreases in HDL concentrations it also greatly impacts increases in HDL levels. Rahman et al conducted an investigation using twenty healthy males. He reported mean HDL increases of 22.47% with an increased fat intake. Another researcher compared forty-six men and women and obtained mean concentration levels of HDL at a 19.34% increase for the women and a 16.84% increase for the men (Rahman et al, 2004 and Lamri-Senhadji et al, 2009).

Aldouni et al, 1997 and Maislos et al, 1993 both considered “feeding behavior” a vital factor in the increased HDL levels in their Ramadan study groups. Meal frequency and diet composition, increased protein and

carbohydrates with decreased fat intake, were also considered contributing aspects. Mean percentages of HDL levels were 14.30% and 32.01%, respectively.

The greatest HDL concentration percentage increase found was Bouhleb et al, 2008 during a study consisting of 9 well-trained male athletes. A recorded mean HDL of 56.48% was documented.( Table 5)

The findings from these researchers support the concepts and correlations between LDL and HDL concentrations and energy intake. The type and amount of food consumed is also a direct link to serum cholesterol levels.

The last component of a lipid profile is Triglycerides. Persons with high Triglyceride levels have been classified as high-risk individuals for CVD and various Endocrinopathies (Fischbach, 1998).

A study conducted by Ramadan et al in 1999 compared sedentary and active subject groups in relationship to the fast of Ramadan. The sedentary group (S), seven office workers, did not participate in any type of exercise program during fasting. The active group (A), also six office workers, performed a brisk exercise session of jogging or brisk walking for 30 to 60 minutes each day, 3 to 5 times per week. The S group had mean TG reductions of 11.91% while the A group had reductions of 7.33%. (Table 6). Values found during this study showed that group S decreased their caloric intake in order to maintain their body weight. This change in dietary pattern caused a reduction in the serum levels of TG. On

the other hand, group A did not change or decrease their food intake, thus causing an elevation in their serum TG levels (Ramadan et al, 1999).

Aldouni et al reported 30 % decreases in serum TG levels during Ramadan in 1997. His study found a substantial decline in these levels and was most likely related to the dietary pattern changes and the amount and type of fat consumed. The study also related a correlation between increased energy and the amount of carbohydrate intake. The study showing one of the highest recorded decreases in serum TG, 31.20% found that the significant absence of TG was related to but not limited by the replacement of fats to carbohydrates (Halack et al, 1988)

Increases in serum TG were found in several studies. Ziaee et al in 2006 evaluated TG levels in a mixed gender study of 80 subjects. The males showed a slight increase of 10.55% in serum TG levels. Interestingly, the females showed a very slight decrease of 4.39%. A study reviewed with the highest increase was Bouhlel et al in 2008. This study of nine males recorded a mean increase of serum TG level of 28.81%.

In conclusion, the need for improved control over specific biochemical markers is apparent. Heart disease and diabetes are increasing throughout the world. If altering a dietary pattern as seen in these studies can control, elevate and lower these markers without major dietary and pharmacological changes, the medical community will gain vital knowledge (Fischbach, 1998; Venes, 2005). Significant declines in total cholesterol and triglyceride levels are most likely

related to the dietary pattern changes and the amount of fat intake noted during Ramadan. The increase in high-density lipids or “good cholesterol” may also be a by-product of the Ramadan fast.

Multiple studies have found that several small frequent meals have a greater influence on lowering these specific laboratory values than values obtained after the subjects consumed one or two large meals. The physical activity each subject participated in combined with the type of diet consumed also seems to have played a major role in blood chemistry levels found in the studies.

Rahman found that HDL concentrations increased while his subjects’ were consuming a high fat diet, these findings are in conflict with previous studies and nutrition’s acknowledged role in lipid profile concentrations. This investigation may explain that the type and amount of food intake combined with the level of physical activity may directly impact blood chemistry levels such as those related to a Lipid Profile.

Table 3-1: show the effect of fasting during the month of Ramadan on total cholesterol

Baseline TC (mg/dl)	Ramadan TC (mg/dl)	% Changes	Reference
227 <sup>M7</sup>	229	0.88	Angel and Schwartz (1974)
164.69 <sup>F4,M20</sup>	179.77	9.15*	Fedail et al. (1982)
186.30 <sup>M16</sup>	189.9	1.93	Halack et al. (1988)
216.11 <sup>F10,M12</sup>	224.61	3.94	Mafauzy et al. (1990)
150 <sup>F8,M32</sup>	156	4.00	Maislos et al. (1993)
178.61 <sup>F16</sup>	194.07	8.66	El Ati et al. (1995)
165.85 <sup>M32</sup>	152.71	-7.93*	Aldouni et al. (1997)
<sup>S</sup> 178.22 <sup>M7</sup>	189.43	6.29	Ramadan et al. (1999)
<sup>A</sup> 207.60 <sup>M6</sup>	204.12	-1.68	Ramadan et al. (1999)
228.09 <sup>F,M50</sup>	214.18	-6.1	Sarraf-Zadegan et al. (2000)
226.09 <sup>F,M50</sup>	209.59	-7.30*	Asgary et al. (2000)
198.7 <sup>M25</sup>	183.5	-7.65*	Temizhan et al. (2000)
193.3 <sup>F27</sup>	173.9	-10.04*	Temizhan et al. (2000)
247.10 <sup>M22</sup>	245.6	-0.2	Afrasiabi et al. (2002)
202.10 <sup>M16</sup>	202.8	0.35	Afrasiabi et al. (2002)
204.90 <sup>F,M10</sup>	203.35	-0.75	Khan and Khattak (2002)
168.40 <sup>M20</sup>	165.15	-1.93	Rahman et al (2004)
181.32 <sup>F,M60</sup>	176.29	-2.77	Dowod Tahm (2004)
170.49 <sup>F46</sup>	177.06	3.85	Kassab et al. (2004)

\* Significant; Baseline would be the point where the subjects were not fasting the month of Ramadan; Ramadan would be the point where the test was performed during the last week of Ramadan; <sup>AR</sup> the test of body weight was taken after Ramadan; BW body weight; <sup>M</sup> the subjects were male; <sup>F</sup> the subjects were female; <sup>F,M</sup> the subjects were female and male; <sup>uW</sup> the subjects were underweight. <sup>oW</sup> the subjects were overweight; <sup>nW</sup> the subjects were normal; <sup>S</sup> Sedentary; <sup>A</sup> Activity

Table 3-2: show the effect of fasting during the month of Ramadan on total cholesterol

Baseline TC (mg/dl)	Ramadan TC (mg/dl)	% Changes	Reference
166.1 <sup>M41</sup>	168.7	1.57	Ziaee V et al. (2006)
170.7 <sup>F39</sup>	171.5	0.47	Ziaee V et al. (2006)
168.3 <sup>F,M81</sup>	170	1.01	Ziaee V et al. (2006)
150.77 <sup>M9</sup>	169.72	12.57	Bouhleb et al (2008)
199.60 <sup>F5,M9</sup>	188.10	-5.76	Ibrahim et al (2008)
204.12 <sup>F24</sup>	232.35	13.83*	Lamri-Senhadji et al (2009)
206.44 <sup>M22</sup>	255.16	23.60*	Lamri-Senhadji et al (2009)
170.10 <sup>F6,M19</sup>	193.30	13.64*	Barkia et al (2011)
150.77 <sup>M10</sup>	158.51	5.13	Trabelsi et al (2011)
151.56 <sup>M19</sup>	157.73	4.07	Trabelsi et al (2012)

\* Significant; Baseline would be the point where the subjects were not fasting the month of Ramadan; Ramadan would be the point where the test was performed during the last week of Ramadan; <sup>AR</sup> the test of body weight was taken after Ramadan; BW body weight; <sup>M</sup> the subjects were male; <sup>F</sup> the subjects were female; <sup>F,M</sup> the subjects were female and male; <sup>uW</sup> the subjects were underweight. <sup>oW</sup> the subjects were overweight; <sup>nW</sup> the subjects were normal; <sup>S</sup> Sedentary; <sup>A</sup> Activity

Table 4: show the effect of fasting the month of Ramadan on low-density lipoprotein (LDL).

Baseline LDL (mg/dl)	Ramadan LDL (mg/dl)	% Changes	Reference
94.40 <sup>M16</sup>	117.9	24.89*	Halack et al. (1988)
99.50 <sup>F8,M16</sup>	97.5	-2.01	Maslos et al. (1993)
112.50 <sup>M32</sup>	99.36	-11.68*	Aldouni et al. (1997)
114.90 <sup>M25</sup>	102.3	-10.97*	Temizhan et al. (2000)
121.00 <sup>F27</sup>	106	-12.40*	Temizhan et al. (2000)
<sup>8W</sup> AR <sup>138.40</sup> <sup>F,M50</sup>	140.72	1.68	Sarraaf-Zadegan et al. (2000)
148.00 <sup>M22</sup>	144.2	-2.57	Afrasiabi et al. (2002)
111.00 <sup>M16</sup>	122.4	10.27	Afrasiabi et al. (2002)
80.03 <sup>F,M10</sup>	78.48	-1.93	Khan and Khattak (2002)
119.07 <sup>F,M60</sup>	111.34	-6.49*	Dowod Tahm (2004)
114.90 <sup>M41</sup>	119.6	4.09	Ziaee V et al. (2006)
115.40 <sup>F39</sup>	120.1	4.07	Ziaee V et al. (2006)
115.20 <sup>F,M80</sup>	119.6	3.82*	Ziaee V et al. (2006)
98.97 <sup>F24</sup>	85.82	-13.29*	Lamri-Senhadji et al (2009)
110.56 <sup>M22</sup>	75.00	-32.16*	Lamri-Senhadji et al (2009)
112.11 <sup>F6,M19</sup>	135.31	20.69*	Barkia et al (2011)
95.10 <sup>M19</sup>	89.30	-6.10	Trabelsi et al (2012)

\* Significant; Baseline would be the point where the subjects were not fasting the month of Ramadan; Ramadan would be the point where the test was performed during the last week of Ramadan; <sup>AR</sup> the test of body weight was taken after Ramadan; BW body weight; <sup>M</sup> the subjects were male; <sup>F</sup> the subjects were female; <sup>F,M</sup> the subjects were female and male; <sup>uW</sup> the subjects were underweight <sup>oW</sup> the subjects were overweight; <sup>nW</sup> the subjects were normal; <sup>S</sup> Sedentary; <sup>A</sup> Activity

Table 5: shows the effect of fasting during the month of Ramadan on high-density lipoprotein (HDL).

Baseline HDL (mg/dl)	Ramadan HDL (mg/dl)	% Changes	Reference
72.80 <sup>M16</sup>	58.9	-19.09*	Halack et al. (1988)
72.80 <sup>M16</sup>	66.70	8.38	Halack et al. (1988)
27.80 <sup>F8,M16</sup>	36.7	32.01*	Maslos et al. (1993)
35.18 <sup>M32</sup>	40.21	14.30*	Aldouni et al. (1997)
8 <sup>WAR</sup> 42.14 <sup>F,M50</sup>	41.75	-0.93	Sarraf-Zadegan et al. (2000)
53.30 <sup>M25</sup>	54.7	2.63*	Temizhan et al. (2000)
53.70 <sup>F27</sup>	54.8	2.05*	Temizhan et al. (2000)
42.90 <sup>M22</sup>	48	11.89*	Afrasiabi et al. (2002)
43.20 <sup>M16</sup>	45	4.17	Afrasiabi et al. (2002)
71.91 <sup>F,M10</sup>	71.13	-1.08	Khan and Khattak (2002)
38.14 <sup>M20</sup>	46.71	22.47*	Rahman et al (2004)
36.10 <sup>M41</sup>	32.4	-10.25*	Ziaee V et al. (2006)
44.10 <sup>F39</sup>	40.8	-7.48	Ziaee V et al. (2006)
40.00 <sup>F,M80</sup>	36.4	-9.00*	Ziaee V et al. (2006)
41.75 <sup>M9</sup>	65.33	56.48*	Bouhleh et al (2008)
93.94 <sup>F24</sup>	112.11	19.34*	Lamri-Senhadji et al (2009)
75.77 <sup>M22</sup>	88.53	16.84*	Lamri-Senhadji et al (2009)
38.66 <sup>F6,M19</sup>	38.66	0.00	Barkia et al (2011)
42.53 <sup>M10</sup>	54.12	27.25*	Trabelsi et al (2011)
42.91 <sup>M19</sup>	53.35	24.33*	Trabelsi et al (2012)

\* Significant; Baseline would be the point where the subjects were not fasting the month of Ramadan; Ramadan would be the point where the test was performed during the last week of Ramadan; <sup>AR</sup> the test of body weight was taken after Ramadan; BW body weight; <sup>M</sup> the subjects were male; <sup>F</sup> the subjects were female; <sup>F,M</sup> the subjects were female and male; <sup>uW</sup> the subjects were underweight. <sup>oW</sup> the subjects were overweight; <sup>nW</sup> the subjects were normal; <sup>S</sup> Sedentary; <sup>A</sup> Activity

Table 6: show the effect of fasting during the month of Ramadan on Triglycerides

Baseline TG (mg/dl)	Ramadan TG (mg/dl)	% Changes	Reference
115.79 <sup>F4,M20</sup>	111.4	-3.79	Fedail et al. (1982)
95.2 <sup>M16</sup>	65.5	-31.20*	Halack et al. (1988)
113.15 <sup>F8,M16</sup>	96.5	-14.71	Maslos et al. (1993)
87.72 <sup>M32</sup>	61.4	-30.00*	Aldouni et al. (1997)
80.5 <sup>F,M26</sup>	92.5	14.91	Nagra et al (1998)
169.29 <sup>S M7</sup>	149.12	-11.91	Ramadan et al. (1999)
131.57 <sup>A M6</sup>	121.93	-7.33	Ramadan et al. (1999)
209 <sup>F,M50</sup>	193	-7.66*	Asgary et al. (2000)
150.6 <sup>M25</sup>	121.8	-19.12*	Temizhan et al. (2000)
92.8 <sup>F25</sup>	66.2	-28.66*	Temizhan et al. (2000)
260.4 <sup>M22</sup>	226.6	-12.98*	Afrasiabi et al. (2002)
235.7 <sup>M16</sup>	171.1	-27.41*	Afrasiabi et al. (2002)
119.29 <sup>F,M10</sup>	118.42	-0.73	Khan and Khattak (2002)
146.66 <sup>M20</sup>	131.04	-10.65	Rahman et al (2004)
116.66 <sup>F,M60</sup>	127.19	9.03	Dowod Tahm (2004)
77.7 <sup>M41</sup>	85.9	10.55*	Ziaee V et al. (2006)
54.7 <sup>F39</sup>	52.3	-4.39	Ziaee V et al. (2006)
66.6 <sup>F,M80</sup>	69.7	4.65	Ziaee V et al. (2006)
51.75 <sup>M9</sup>	66.66	28.81*	Bouhleb et al (2008)
116.90 <sup>F5,M9</sup>	87.50	-25.15*	Ibrahim et al (2008)
58.77 <sup>F,M50</sup>	81.58	38.81*	Lamri-Senhadji et al (2009)
63.16 <sup>F,M50</sup>	60.52	-4.18*	Lamri-Senhadji et al (2009)
96.49 <sup>F6,M19</sup>	96.49	0.00	Barkia et al (2011)
61.40 <sup>M10</sup>	70.17	14.28	Trabelsi et al (2011)
60.52 <sup>M19</sup>	67.54	11.60	Trabelsi et al (2012)

### 2.3 Glucose, Creatinine and hormones levels during fasting Ramadan

Due to the amount of time required for fasting, the multiple components relating to Ramadan fast has been extensively studied in diverse combinations with varied and vast results (i.e. weight loss, BMI, caloric intake, dehydration, lipid, Glucose and creatinine levels, etc). A Reliable data on the exploration of the effects of fasting on hormone levels, specifically, Insulin, Glucagon, and cortisol levels are scarcer or non-existent.

Most metabolic and physiological functions in the human body derive its' energy from Glucose. This makes the maintenance of blood Glucose levels one of the body's highest priorities. The absorptive phase refers to the first couple of hours after a meal when Glucose is the principal source of energy for tissues. During time between meals, the post-absorptive phase, fatty acids become the main source of energy for the body (Smith, 2005). When blood Glucose levels are high, large amounts of Glucose are taken up and stored by the liver and muscle as glycogen; excluding periods of constrained dietary intake when carbohydrate intake is severely restricted.

The main source of fuel for the brain is Glucose. The brain and central nervous system (CNS) uses approximately 150grams of carbohydrates per day. Any decrease in serum Glucose levels, which would include the state of fasting, initiates multiple body maintenance systems in order to increase serum concentrations of Glucose (Nelson and Cox, 2004).

A number of studies revealed nearly negligible percentage changes in Glucose levels in correlation to fasting of Ramadan. Asgary et al, 2000 and Nagra et al, 1998 conducted studies on both genders during Ramadan. Results showed only minimal percent changes in serum Glucose concentrations during fasting. Combined mean value changes were 92.57mg/dL dropping to 90.22mg/dL, a 2.54% change and 84.10mg/dL dropping to 82.3mg/dL equaling a 2.14% change in serum blood Glucose levels, Asgary et al 2000 and Nagra et al 1998 respectively (Table 7).

A Ramadan study in 2002 focused on the effects of fasting on Glucose levels in ten healthy men. Food and fluid intake were recorded before and during the first and fourth week of fasting. Blood samples were obtained prior to, and repeated in the second and fourth week of fasting. Mean Glucose levels decreased from 82.15mg/dL to 79.63mg/dL, showing a minimal drop of 3.07%. (Khan and Khattak, 2002).

Minimal Glucose decreases continue with Adlouni et al's study in 1997. They conducted a study on thirty-two healthy male subjects. Utilizing four serum blood samples taken at days 8, 15, 22 and 29 (last day of Ramadan); each subject provided his own baseline. Glycemic changes were significant with a decrease of 14.1% (mean levels were 91.88mg/dL with a decrease to 78.91mg/dL) by day 29 of Ramadan.

Several studies documented significant decreases in serum Glucose levels in connection to Ramadan fasting. A study from the Endocrinology & Metabolism Research Center in 2003 relating to both genders on fasting serum Glucose concentrations in healthy adults showed considerable percentage decreases in serum Glucose levels. While dietary intake was not controlled, it was recorded through the use of a food frequency questionnaire on the first and fifteenth days of Ramadan. After establishing a baseline for both genders, levels were examined on the fourteenth and twenty-eighth day of Ramadan. Following 14 days of fasting, female Glucose levels decreased from a mean of 89.7mg/dL (baseline) to a mean of 67.5mg/dL; this level further dropped to a mean serum level of 65.7mg/dL at 28 days of fasting constituting a substantial decrease of 26.76%. Males during this same period of time showed mean levels as follows: 87.5mg/dL decreased to 81.1mg/dL followed by a substantial drop to 60.8mg/dL a 30.51% decrease in serum Glucose levels. It is important to note, the caloric intake decreased for all participants and sleep patterns were altered during Ramadan (Larijani et al, 2003).

Another investigation with noteworthy findings was conducted on thirteen healthy adults. This study extended the number of blood samples for investigation to five; at one week prior to Ramadan (baseline), repeated on day 1, 10, and day 28 of fasting. The final blood sample was obtained four weeks after completion of Ramadan. The mean levels were 84.00mg/dL with a drop to

74.00mg/dL, an 11.90% decline in serum blood Glucose levels. (Muazzam and Khaleque, 1959)

Increases in serum Glucose have also been included. It is important to note that the increases of Glucose we found were negligible in comparison to the decreases in Glucose during Ramadan fast.

Studies showing insignificant increases were from Dowad (2004) with an increase of 0.54% (mean levels of 100.53mg/dL to 101.07mg/dL), the other study was by Mafauzy et al (1990) showing an elevation in Glucose levels of 1.87% (mean levels of 192.77mg/dL elevated to 196.37mg/dL). The interesting aspect regarding this study is that it was conducted on twenty-two diabetic patients on oral hypoglycemic agents. Blood was drawn for serum Glucose levels just prior to the start of Ramadan and at the end of the fasting month.

Studies in 1993 and 1975 showed slight increases in serum Glucose levels. Maislos conducted a study consisting of twenty-four healthy subjects. Blood value testing was performed at day 26 and 27 of Ramadan and at one month after Ramadan. Mean serum blood Glucose concentrations slightly increased from 79.00mg/dL to 83.00mg/dL, an elevation of 4.82% (Maislos et al, 1993). The 1975 study included seven males and took a different approach to Glucose testing while fasting. They were required to maintain daily dietary records ending one-week post-Ramadan. Oral Glucose tolerance testing was performed at the conclusion of Ramadan and again 12 weeks later. Documented mean Glucose

levels were 85.00mg/dL elevating to 89.00mg/dL or a 4.71% increase in serum Glucose levels. Also noteworthy, were their findings of a correlation between “increased ability to dispose of Glucose and enhanced Insulin secretion in response to an oral Glucose challenge” (Angel and Schwartz, 1975).

Slightly higher increases in Glucose levels were reported from a study by El Ati et al conducted using sixteen women as subjects. Four laboratory-testing dates were utilized: 2 days before fasting, the 2<sup>nd</sup> and the 28<sup>th</sup> days of Ramadan and, finally, one month after Ramadan. An increase in serum blood Glucose levels of 7.2% were noted; with mean levels rising from 87.56 to 93.86 (El Ati et al, 1995).

When caloric intake is restricted for extended periods of time a state known as fasting occurs. Whether fasting for medical, personal or religious reasons Glucose may not always be readily accessible as a fuel source, the body is then forced to manufacture it from other nutrients, such as from fatty acids found in adipose tissue or proteins found in muscle tissue. The use of fatty acids for fuel usually begins when the post-absorptive phase exceeds 14-16 hours. It is the breakdown and utilization of proteins for energy over extended periods, which can become a life-threatening occurrence due to the wasting of proteins causing organ failure (Spriet et al, 2004; Wardlaw; Kessel, 2002 and Smith, 2005).

A few studies examined both Glucose and Insulin concentration levels during fasting. In 2004, a group of medical physicians examined female

participates during Ramadan. They focused on Glucose and Insulin levels while fasting. Serum levels were run on the 14th and 28th day of Ramadan; baseline was established prior to beginning of fast. A mean Glucose of 97.47mg/dL (baseline) decreased to a mean of 94.94mg/dL on the 28<sup>th</sup> day, a drop of 2.59%. Insulin concentration levels showed a negligible increase from a mean of 7.3 $\mu$ U/mL (baseline) to a mean of 8.83 $\mu$ U/mL (Kassab et al, 2004). A study of eight mid-distance athletes revealed mean Insulin levels of 20.0 U.1<sup>-1</sup> (baseline) to 26.1 U. 1<sup>-1</sup> one week after Ramadan (Chennaoui et al, 2009). Other studies revealed no substantial changes in Insulin concentration levels (Fedail et al, 1982; Bouhlel et al, 2008).

As previously stated; as blood sugar levels decrease Insulin production and secretion is inhibited; as this occurs the release of Glucagon is stimulated. Glucagon is a peptide hormone released by the alpha cells of the pancreas when blood Glucose levels fall. When Glucagon is secreted it acts on the hepatocytes to activate the enzymes that are necessary for the breakdown and return of glycogen into Glucose. Knowing that Glucagon's major function is to increase blood Glucose levels, it makes sense that Glucagon is secreted in response to hypoglycemia or low blood concentrations of Glucose (Spriet et al, 2004 and smith et al, 2005).

Cortisol is a major glucocorticoid and the third hormone of interest to this investigation in relation to fasting the month of Ramadan. It is produced in the

adrenal cortex and released in response to fasting and high stress situations. Cortisol is a counterregulatory hormone for Insulin. Like Glucagon cortisol reacts to occurrences of hypoglycemia, whether from excess stress, fasting or low blood sugars related to high levels of serum Insulin, glycogenolysis. Some of the pathways for Glucose synthesis from amino acids (gluconeogenesis) are induced by cortisol as well as by Glucagon (Smith et al, 2005).

Cortisol levels are included in Ramadan studies in order to explore alterations in biological rhythm-circadian cycles, as well as the effects of fasting on biochemical processes. A study by Maughan et al in 2008 divided 78 male athletes into two fasting and two non-fasting groups. Samples were obtained at 3-week pre-Ramadan (baseline) and after 2-week and 4-week; the results were 93  $\mu\text{g.l}^{-1}$ , 108  $\mu\text{g.l}^{-1}$ , and 111  $\mu\text{g.l}^{-1}$ , for fasting group, respectively. When comparing the baseline with the second week result there was an elevation of 16.13%, that elevation was increased to 19.35% at week four of Ramadan. For non-fasting group the baseline was 149 that value remained a constant for 2 weeks and increased to 7.38% at the end of Ramadan.

Another study on cortisol during Ramadan was conducted by Al-Hadramy in 1987, participants was 7 men and 3 women. Samples were obtained at 1-day pre-Ramadan (baseline) and day 24 of fasting, results was 348 nmol/l and 542 nmol/l, respectively. Comparing the baseline with day 24 resulted in an elevation of 55.75%. These two studies are in conflict with the results of Chaouachi et al in

2007. Fifteen athletes were examined on cortisol levels during Fasting Ramadan. The samples were obtained 4 day pre Ramadan, 7, 16, and day 29 of fasting Ramadan, the results were  $13.4 \text{ mg.l}^{-1}$ ,  $9.0 \text{ mg.l}^{-1}$ ,  $9.3 \text{ mg.l}^{-1}$ , and  $10.3 \text{ mg.l}^{-1}$ , respectively. When comparing the baseline with day 7, 16, 29, results were decreased 32.48%, 30.6%, 32.13%, respectively.

The physiological relationship between cortisol and creatinine in the human body is understood and acknowledged. In times of stress or extreme muscle trauma whether damage is from excessive over-use or traumatic accident cortisol a glucocorticoid can be released in response to several different biochemical requirements. When muscles are stressed or extensively damaged enough to warrant increased muscle metabolism cortisol is able to stimulate amino acid mobilization from muscle protein. The waste product of this metabolism is creatinine. A muscle like every other structure in the body requires fuel. When Glucose levels are low cortisol acting as a counter regulatory hormone may be released in the body stimulating gluconeogenesis, thus, providing muscles with fuel for muscle protein metabolism which in turn produces creatinine (Smith et al, 2005).

Creatinine is produced as a waste by product generated from muscle metabolism. It is produced from creatine, a molecule of major importance for energy manufacture in muscles. Approximately 2% of the body's creatine is converted to creatinine daily. Creatinine is transported through the bloodstream

and filtered by the kidneys. Creatinine levels are a key indicator of several metabolic occurrences' as well as acute and chronic medical conditions. Decreased muscle mass related to eating disorders, inadequate intake of dietary protein or malnutrition as well as degenerative muscle diseases can cause decreased levels of creatinine. Serum levels can also increase with muscle damage such as immediately following Myocardial Infarction or muscle damage from extreme over use. Abnormally, elevated concentrations in urine could indicate renal dysfunction (Venes, 2005; Fischbach, 1998; Smith, 2005).

As previously stated elevated creatinine levels can be an indicator of muscle damage in the human body. Studies have explored the effects of fasting Ramadan on creatinine levels in humans. While both Maislos et al and Ramadan et al reported no vital changes in creatinine levels in the their data of fasting studies, Ramadan et al did explore a bit further by dividing his group into active and sedentary subjects and looked at pre-and post-Ramadan creatinine levels. The results of active group presented with mean values of 99.3mg/dl (baseline) with an elevation to 104.30mg/dl, a change of 5.04% (Table 8). While the sedentary group data had a mean value of 95.14mg/dl (baseline) to 95.29mg/dl, a change of 0.16% (Ramadan et al, 1999).

However, another study documented decreases in creatinine levels. Lab values showed a mean of 71mg/dl (baseline) with a decrease to 63mg/dl, a drop of 11.27 were noted (Beltaifa et al, 2002). Nineteen male subjects were divided into

two groups, one tested after feeding and the other tested after fasting. The fasting group is the focus of this study. Creatinine values went from a mean of 87.80mg/dl (baseline) to 94.42mg/dl, a change of 7.52% (Trabelsi et al, 2012). Another study that demonstrated marked changes was Bouhlel et al in 2008. They evaluated the participants before and after exercise at one week before Ramadan, 10 days and the last day of Ramadan. Pre-exercise values had a mean of 71.9mg/dl (baseline) and 78.1mg/dl, an increased change of 8.62%, while post-exercise values were a mean of 83.1mg/dl (baseline) to 72.1mg/dl, a decreased change of 13.24% (Bouhlel et al, 2008).

In summary, fasting influences many physiological functions. It can induce positive as well as potentially harmful metabolic responses within the body. Multiple actions as well as biochemical responses come into play when the human body detects hypo or hyperglycemic states. The pancreas produces increased levels of Insulin in response to hyperglycemic episodes just as Insulin levels are decreased for periods of hypoglycemia. The liver also rapidly responds to hyper and hypoglycemic occurrences by aiding in the adjustment of Glucagon and the storage of glycogen. Gluconeogenesis, the manufacture of Glucose from amino acids and fats instead of from carbohydrates, occurs when a person's caloric intake changes such as in the state of fasting. Clearly, fasting has a more positive than negative effect on lipid serum levels. Studies produce visible proof,

via blood serum values, that metabolic marker's such as total cholesterol, high-density lipids and triglyceride levels can positively be affected by fasting.

Fasting during Ramadan frequently alters the body's natural rhythm cycles. Our patterns of eating, sleeping, and socialization can all be affected. Cortisol levels play a significant role in adjusting and supporting these physiological rhythms. Gluconeogenesis and glycogenolysis are affected by fasting and can both be stimulated by cortisol release in response to hypoglycemic as well as decreased protein levels in the body.

A positive aspect in research related to fasting during Ramadan is an increase in the number of studies exploring and evaluating exercise versus non-exercise groups along with different types of exercise during the month of Ramadan (Ramadan et al, 1999, Bouhlel et al, 2008).

The collection of data related to creatinine levels, muscle damage and long term fasting could provide valuable insight to our scientific communities. Without a doubt, data collected through research of the month of Ramadan and fasting could be increasingly advantageous to many health aspects, education, and exercise professionals.

Table 7-1: show the effect of fasting during the month of Ramadan on Glucose

Baseline Glucose (mg/dl)	Ramadan Glucose (mg/dl)	% Changes	Reference
84.00 F3,M10	74.00	-11.90*	Muazzam and Khaleque (1959)
85.00M7	89.00	4.71	Angel and Schwartz (1974)
192.77F10,M12	196.37	1.87	Mafauzy et al. (1990)
79.00 F8,M16	83.00	4.82	Maislos et al (1993)
87.56F16	93.86	7.20	El Ati et al. (1995)
91.88M32	78.91	-14.12*	Adlouni et al. (1997)
84.10F,M26	82.30	-2.14	Nagra et al (1998)
92.57F,M50	90.22	-2.54	Asgary et al. (2000)
75.80F27	92.60	22.16*	Temizhan et al. (2000)
77.70M25	91.90	18.28*	Temizhan et al. (2000)
82.15M,F10	79.63	-3.07	Khan and Khattak (2002)
89.70F48	65.70	-26.76*	Larijani et al. (2003)
87.50M67	60.80	-30.51*	Larijani et al. (2003)

\* Significant; Baseline would be the point where the subjects were not fasting the month of Ramadan; Ramadan would be the point where the test was performed during the last week of Ramadan; <sup>AR</sup> the test of body weight was taken after Ramadan; BW body weight; <sup>M</sup> the subjects were male; <sup>F</sup> the subjects were female; <sup>F,M</sup> the subjects were female and male; <sup>uW</sup> the subjects were underweight. <sup>oW</sup> the subjects were overweight; <sup>nW</sup> the subjects were normal; <sup>S</sup> Sedentary; <sup>A</sup> Activity

Table 7-2: show the effect of fasting during the month of Ramadan on Glucose

Baseline Glucose (mg/dl)	Ramadan Glucose (mg/dl)	% Changes	Reference
100.53 <sup>F,M60</sup>	101.07	0.54	Dowod (2004)
95.30 <sup>M20</sup>	85.60	-10.18*	Rahman et al (2004)
97.47 <sup>F46</sup>	94.94	-2.59	Kassab et al. (2004)
78.20 <sup>F39</sup>	69.70	-10.87*	Ziaee Vetal (2006)
75.00 <sup>M41</sup>	68.80	-8.27*	Ziaee Vetal (2006)
79.60 <sup>F,M80</sup>	69.20	-13.07*	Ziaee Vetal (2006)
181.70 <sup>M9</sup>	185.57	2.13	Bouhlel et al (2008)
109.30 <sup>F5,M9</sup>	96.40	-11.80*	Ibrahim et al (2008)
189.43 <sup>M10</sup>	185.57	-2.04	Trabelsi et al (2011)
189.05 <sup>M19</sup>	185.95	-1.64	Trabelsi et al (2012)

\* Significant; Baseline would be the point where the subjects were not fasting the month of Ramadan; Ramadan would be the point where the test was performed during the last week of Ramadan; <sup>AR</sup> the test of body weight was taken after Ramadan; BW body weight; <sup>M</sup> the subjects were male; <sup>F</sup> the subjects were female; <sup>F,M</sup> the subjects were female and male; <sup>uW</sup> the subjects were underweight <sup>oW</sup> the subjects were overweight; <sup>nW</sup> the subjects were normal; <sup>S</sup> Sedentary; <sup>A</sup> Activity

Table 8: show the effect of fasting during the month of Ramadan on Creatinine

Baseline Creatinine ( $\mu\text{mol/l}$ )	Ramadan Creatinine ( $\mu\text{mol/l}$ )	% Changes	Reference
73.8 <sup>F16</sup>	79.1	7.18	El Ati et al (1995)
71.00 <sup>F8,M14</sup>	71.00	0.00	Maislos et al (1998)
99.30 <sup>M6 A</sup>	104.30	5.04	Ramadan et al (1999)
95.14 <sup>M7 S</sup>	95.29	0.16	Ramadan et al (1999)
71.00 <sup>F,M20</sup>	63.00	-11.27*	Beltaifa et al (2002)
86.90 <sup>M16</sup>	88.20	1.50	Ramadan (2002)
71.90 <sup>M9</sup>	78.10	8.62	Bouhleb et al (2008)
83.10	72.10	-13.24	Bouhleb et al (2008)
87.80 <sup>M19</sup>	94.40	7.52*	Trabelsi et al (2012)

\* Significant; Baseline would be the point where the subjects were not fasting the month of Ramadan; Ramadan would be the point where the test was performed during the last week of Ramadan; <sup>AR</sup> the test of body weight was taken after Ramadan; BW body weight; <sup>M</sup> the subjects were male; <sup>F</sup> the subjects were female; <sup>F,M</sup> the subjects were female and male; <sup>uW</sup> the subjects were underweight <sup>oW</sup> the subjects were overweight; <sup>nW</sup> the subjects were normal; <sup>S</sup> Sedentary; <sup>A</sup> Activity

## 2.5 The physical performance of Muslim athletes during Ramadan

The Muslim athletes in the London Olympic Games of 2012 were facing an immense challenge as they compete during the fast of Ramadan. There is a similarity between fasting and a single bout of endurance exercise on metabolic stress. Each type of stress causes a depletion of energy resources within the human body (Stannrd, 2011).

Memari with others in 2011 established that the time-span of an individual's agility performance test was significantly affected by fasting during Ramadan. Interestingly, the vertical board jump and the balance performance did not show any statistical changes. Conversely, a study by Kordi in 2011, revealed no noteworthy changes in any times related to agility performance or vertical jumping.

A study conducted by Meckel with others tested different variables of performance such as a: vertical jump, 40m run, 4 x10m shuttle run, sum 6 x 40m run, and a 3000m run. They found that the aerobic endurance was significantly decreased based on the increased time of a 3000m run lasting from 812.8 seconds to 819.9 seconds at the end of Ramadan fast. In addition, they found the ability of jumping was decreased significantly from 44.8 cm to 44.0 cm. In their study, which consisted of nineteen healthy young male soccer players, a significant decrease in athletic performance capacities was confirmed.

Nine subjects in a study that was conducted by Abdedlmalek et al in 2011 performed Wingate test. Subjects participated in a three-part exercise plan consisting of the first and fourth week of Ramadan, followed up with a last session at three weeks after Ramadan. The conclusions of that study noted that there was no significant difference during the occasions of testing.

Chennaoui with others in 2009 conducted a study on eight middle distance athletes. Their results showed that the maximal aerobic velocity test was influenced negatively by fasting during Ramadan which was statistically significant by comparing days 7 and 21 of Ramadan with 5 days prior to start of Ramadan. Also, they looked at fatigue, which was significantly increased at the end of Ramadan from 5.0 to 7.3.

A comparison study was conducted of sedentary and active males in response to physical exercise training sessions during Ramadan. The subjects were thirteen healthy men who were tested using the sub-maximal test on a bicycle ergometer for maximal oxygen consumption, ventilation, carbon dioxide output, the respiratory exchange ratio and the heart rate. They found the maximal aerobic capacity was considerably higher in the active group in comparison to the sedentary group and the respiratory exchange ratio was decreased significantly in both groups at the end of RF and only for the A group the heart rate was notably decreased while there were no prominent differences in the other variables (Ramadan et al, 1999). In a subsequent study in 2002 Ramadan confirmed his

earlier findings of diminished heart rate and ventilation at the end of Ramadan in correlation to performance testing (Ramadan, 2002).

In summary, the athletes performance were influenced by fasting the month of Ramadan on endurance ability. However, the results on the strength and power performance were inconsistent in the studies conducted during Ramadan fasting. It is important to consider that the length of a sport event is the major factor that may influence the performance of athletes during fasting Ramadan.

## CHAPTER III

### METHODS & PROCEDURES

#### 3.1 Participants

Ten healthy athletic male subjects without any known disease or taking any medication that influenced lipid profile, Glucose, hormone levels were randomly selected from a first division Saudi soccer league (Raka Soccer League).

#### 3.2 Study Design

Subjects were asked to come to the Prince Faisal Bin Fahad Sports Medicine Hospital four times. Table 3.1 shows the timeline of the testing and procedures. Two times before the month of Ramadan, while the other two during the month of Ramadan. The first visit was one week before the month of Ramadan and health history and physical activity were obtained while the second visit was at one day before the month of Ramadan. The third visit was on the 10th of Ramadan while the fourth visit was on the 28th of Ramadan. During each visit, physical activity, height and weight were determined. During the last three visits the body composition was measured using a Dual Energy X-ray Absorptiometry (DEXA) measurement, venous blood was collected using standard venipuncture technique. The subjects were asked to recall their diet for the three days prior to the second, third and fourth visit. In addition, the subjects were asked to eat the same amount and type of food one day before each visit.

Visit 1	Visit 2	Visit 3	Visit 4
1 week prior to Ramadan	1 day prior to Ramadan	10th day of Ramadan	28th day of Ramadan
Questionnaires	Physical Activity	Physical Activity	Physical Activity
Health History	Questionnaire	Questionnaire	Questionnaire
Physical Activity	3 day diet recall	3 day diet recall	3 day diet recall
	DEXA scan	DEXA scan	DEXA scan
	Fasting blood draw	Fasting blood draw	Fasting blood draw

Table 3-1 timeline of testing procedures

### 3.2.1 Anthropometric

Each individual had have his height measured and his weight was recorded. We used a standard height measurement chart and the obtained measurement was rounded to the nearest centimeter (cm). Each subject's weight was obtained utilizing a standard digital weight scale and rounded to the nearest 0.1 kilogram (kg). Body fat and lean body mass was obtained through the use of Dual-Energy X-ray Absorptiometry (DEXA). During this test, subjects were asked to lay face up, on a padded table, motionless for 7-15 minutes while the scanner arm of the DEXA machine passes over their entire body to examine body composition (relative amounts of fat mass and lean body mass).

### 3.2.2 Blood Analysis

Blood samples were analyzed for lipid profile, Glucose, Insulin, Cortisol, Glucagon, Albumin and Total protein venous blood was collected from the antecubital fossa using standard venipuncture technique. A sterile 20G, 11/2 inch needle attached to a sterile 10ml syringe (Becton Dickinson & Co., Franklin Lakes, NJ) with leur-lock adaptor was used for all test subjects at each blood draw. Prior to each blood draw, the subject was requested to sit for 30 minutes to minimize risk of hemoconcentration of blood sample. All blood sampling was performed at 1800 hours on the day of testing; in the fasting state.

After obtaining the sample, 10 ml of venous blood was transferred to two Vacutainer tubes containing no additives (Becton Dickinson Vacutainer Systems, Franklin Lakes, NJ). Blood was allowed to clot for 30minutes at 25°C. Blood was centrifuged for 15 minutes at 4°C. Serum sample was stored at -80°C and remain stable for at least one month. The following day all samples for each subject was run in duplication in the same assay.

### 3.2.4 Dietary Recall and Physical Activity

All subjects were asked to record food and drink consumption (including portion sizes) for three days (two weekdays and one weekend day) prior to their 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> visit. The Arab Food Analysis Program was used to analysis the food intake. In addition, the subjects filled physical activity questioners for seven consecutive days prior 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> visit. The Global Physical Activity Questionnaire (QPAG) Analysis Guide was used to analysis the physical activity.

### 3.2.5 Statistic

We used SPSS package to analyze the data for all variables (Body Weight, Fat Body Mass, Lean Body Mass, Ratio of Andriod to Gynoid, Glucose, Insulin, Glucagon, Cortisol, Albumin, Total Protien, TC, TG, LDL, VLDL, Ratio LDL to HDL, Physical Activity, Vigorous Activity, Moderate Activity, Walking Activity, Energy Intake, Protein Intake, Fat Intake and Carbohydrate Intake). Data was expressed as means  $\pm$  SD and were analyzed using analysis variance repeated measures a 1x3 ANOVA.  $P < 0.05$  was accepted as statistically significant.

## RESULTS

### 4.1 Description of the subjects

The subject characteristics are presented as mean and standard deviation ( $M \pm SD$ ) in table 4.1. The data was obtained from eight subjects who were athletic soccer players from a first division Saudi soccer league (Raka Soccer League) with an average age of  $21.75 \pm 2.05$ , average height of  $170.68 \pm 5.21$  cm and average body weight of  $66.73 \pm 7.51$  kg. The sample size was too small to evaluate whether assumptions of multivariate normality were satisfied. The Mauchly test was performed to assess possible violation of the sphericity assumption

### 4.2 Body composition

The data of body weight kg (BW), Lean body mass, Body Fat percentage (BF%) and Android to Gynoid Ratio (A/G) are presented in Table 4.2 as means and standard deviations. To evaluate whether intermittent fasting effect BW, Lean, BF% and A/G levels on athletic soccer players, one-way repeated measures ANOVA were performed. Eight participants were tested under three measurement conditions: baseline one day before Ramadan (D1), after ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). The Mauchly test was performed to assess possible violation of the sphericity assumption; this was not significant for BW, Lean, BF% and A/G as presented in table 4.3, which

suggests that the sample size is too small and therefore this test may not have sufficient power to detect violations of sphericity. The Greenhouse-Geisser  $\epsilon$  value of 0.964, 0.903, 0.666, and 0.748 for BW, Lean, BF% and A/G, respectively suggested that the sample variance/covariance matrix did not depart substantially from sphericity. Because the Greenhouse-Geisser  $\epsilon$  value was close to 1, no correction needs to be made to the degrees of freedom used to evaluate the significance of the F ratio.

The overall F of differences in mean BW and Lean across the three measurement conditions was statistically significant:  $F(2, 14) = 7.200, p = .007$  and  $F(2, 14) = 8.648, p = .004$ , respectively; the corresponding effect size was a partial  $\pi^2$  of .507, and .553 for BW and Lean, respectively. In other words, after stable individual differences in BW and Lean are taken into account, approximately 50%, and 55% of the variances were related to intermittent fasting. Note that even if the  $\epsilon$  correction factor is applied to the degrees of freedom for F, the obtained value of F for differences in mean BW and Lean among the three times of testing remains statistically significant.

Planned contrasts were obtained to compare the three times of measuring the levels of BW and Lean.

BW levels during baseline ( $M_{D1} = 66.73$ ) were similar to the mean of BW during the D10 ( $M_{D10} = 66.73$ ). There was no significant difference between the two means:  $t(7) = .000, p = .1.000$ . However, the mean difference between

BW during D10 ( $M_{D10} = 66.73$ ) and D28 ( $M_{D28} = 65.53$ ) was statistically significant:  $t(7) = 3.136$ ,  $p = .016$ . In addition, BW during the baseline ( $M_{D1} = 66.73$ ) was also higher than the mean of BW during D28 ( $M_{D28} = 65.53$ ). The mean difference between D1 and D28 was statistically significant:  $t(7) = 3.140$ ,  $p = .016$ . A graph of Body Weight means change appears in figure 4.1. Thus, of the three measure interventions in this study, only the comparison between the baseline with D10 and D28 had significant changes.

Lean body mass levels during baseline ( $M_{D1} = 50.519$ ) were almost identical to the mean of Lean body mass during the D10 ( $M_{D10} = 50.469$ ). There were no significant difference between the two means:  $t(7) = .189$ ,  $p = .856$ . However, the mean difference between Lean during D10 ( $M_{D10} = 50.469$ ) and D28 ( $M_{D28} = 49.462$ ) was statistically significant:  $t(7) = 3.049$ ,  $p = .019$ . In addition, Lean during the baseline ( $M_{D1} = 50.519$ ) was also higher than the mean of Lean during D28 ( $M_{D28} = 49.462$ ). The mean difference between D1 and D28 was statistically significant:  $t(7) = 4.115$ ,  $p = .004$ . A graph of Body Weight means change appears in figure 4.2. Thus, of the three measure interventions in this study, only the comparison between the baseline with D10 and D28 had significant changes.

BF% and A/G showed no significant differences between all the measurements. The overall F of differences in mean BF% and A/G across the three measurement conditions was also not statistically significant:  $F(2, 14)$

=.033,  $p = .968$  and  $F(2, 14) = 1.334$ ,  $p = .295$ , respectively; the corresponding effect size was a partial  $\pi^2$  of 0.005 and 0.160. In other words, after stable individual differences in BF% and A/G are taken into account, 0.5% and 16% of the variance in BF% and A/G respectively were related to intermittent fasting. Note that even if the  $\epsilon$  correction factor is applied to the degrees of freedom for F, the obtained value of F for differences in mean BF% and A/G among the three times of testing remains not statistically significant. A graph of BF% and A/G means change appears in figure 4.3 and 4.4.

### 4.3 Glucose, Blood Proteins and Hormones

The data of Glucose, blood proteins and hormones are presented in table 4.4 as means and standard deviations. To evaluate whether intermittent fasting effect Glucose, Insulin, Glucagon, Cortisol, Albumin and Total Protein levels on athletic soccer players, one-way repeated measures ANOVA was performed. The Mauchly test was performed to assess possible violation of the sphericity assumption; this was not significant for Glucose, Insulin, Glucagon, Cortisol Albumin and Total protein as presented in table 4.5. It suggested that the sample size is too small; this test may not have sufficient power to detect violations of sphericity. The Greenhouse-Geisser  $\epsilon$  value of 0.628, 0.623, 0.640, 0.943, 0.657, 0.992 for Glucose, Insulin, Glucagon, cortisol, albumin and total protein, respectively suggested that the sample variance/covariance matrix did not depart substantially from sphericity. Because the Greenhouse-Geisser  $\epsilon$  value was sufficient, no correction needs to be made to the degrees of freedom used to evaluate the significance of the F ratio.

The overall F of differences in mean Glucose, Glucagon and Albumin across the three measurement conditions was statistically significant:  $F(2, 14) = 4.025, p=.042$ ;  $F(2, 14) = 6.16, p=.012$ ;  $F(2, 14) = 23.47, p=.001$  respectively; the corresponding effect size was a partial  $\pi^2$  of .365, .468 and .770 for Glucose Glucagon and Albumin, respectively. In other words, after stable individual differences in Glucose, Glucagon and Albumin are taken into account, about 36%,

46% and 77% of the variance in Glucose, Glucagon and Albumin, respectively were related to intermittent fasting. Note that even if the  $\epsilon$  correction factor is applied to the degrees of freedom for F, the obtained value of F for differences in mean Glucose, Glucagon and Albumin among the three times of testing remains statistically significant.

Planned contrasts were obtained to compare between the three times of measuring the levels of Glucose, Glucagon and Albumin.

Glucose levels during baseline ( $M_{D1} = 81.87$ ) were found lower than the mean of Glucose during the D10 ( $M_{D10} = 90.75$ ). The difference between the two means was not statistically significant:  $t(7) = -2.095$ ,  $p = .074$ . In addition, the mean difference between Glucose during D10 ( $M_{D10} = 90.75$ ) and D28 ( $M_{D28} = 91.00$ ) was not statistically significant:  $t(7) = -0.057$ ,  $p = .956$ . However, Glucose during the baseline ( $M_{D1} = 81.87$ ) was lower than the mean of Glucose during D28 ( $M_{D28} = 91.00$ ). The mean difference between D1 and D28 was statistically significant:  $t(7) = -5.164$ ,  $p = .001$ . A graph of Glucose means change appears in figure 4.5. Thus, of the three measure interventions in this study, only the comparison between D1 and D28 had significant changes.

Glucagon levels during baseline ( $M_{D1} = 42.87$ ) were found greater than the mean of Glucagon during the D10 ( $M_{D10} = 29.12$ ). The difference between the two means was statistically significant:  $t(7) = 3.346$ ,  $p = .012$ . In addition, the Glucagon Levels during the baseline ( $M_{D1} = 42.87$ ) were also greater than the

Glucagon mean during D28 ( $M_{D28} = 34.00$ ). However, the mean difference between Glucagon D1 and D28 was not statistically significant:  $t(7) = 1.761$ ,  $p = .122$ . Also, the mean difference between Glucagon during D10 ( $M_{D10} = 29.12$ ) and D28 ( $M_{D28} = 34.00$ ) was not statistically significant:  $t(7) = -2.177$ ,  $p = .066$ . A graph of Glucagon means change appears in figure 4.6. Thus, of the three times interventions in this study, only D10 had significantly lower mean Glucagon than D1 baseline.

Albumin levels during baseline ( $M_{D1} = 46.75$ ) were found greater than the mean of Albumin levels during the D10 ( $M_{D10} = 42.50$ ). The difference between the two means was statistically significant:  $t(7) = 5.19$ ,  $p = .001$ . In addition, Albumin during the baseline ( $M_{D1} = 46.75$ ) was also greater than the mean of Albumin during D28 ( $M_{D28} = 41.25$ ). The mean difference between Albumin D1 and Albumin D28 was statistically significant as well:  $t(7) = 10.29$ ,  $p = .001$ . However, the mean difference between Albumin during D10 ( $M_{D10} = 42.50$ ) and Albumin D28 ( $M_{D28} = 41.25$ ) was not statistically significant:  $t(7) = 1.15$ ,  $p = .29$ . A graph of Albumin means change appears in figure 4.7. Thus, of the three measure interventions in this study, only D10 and D28 had significantly lower mean than baseline.

Insulin, Cortisol and Total Protein showed no significant differences between all the measurements. The overall F of differences in mean Insulin, Cortisol and Total Protein across the three measurement conditions was not

statistically significant:  $F(2, 14) = .539, p = .595$ ;  $F(2, 14) = 1.637, p = .230$  and  $F(2, 14) = 1.135, p = .349$ , respectively; the corresponding effect size was a partial  $\pi^2$  of 0.071, 0.19, and 0.14. In other words, after stable individual differences in Insulin are taken into account, about 7%, 19% and 14% of the variance in Insulin, Cortisol and Total Protein respectively were related to intermittent fasting. Note that even if the  $\epsilon$  correction factor is applied to the degrees of freedom for F, the obtained value of F for differences in mean Insulin, Cortisol and Total Protein among the three times of testing remains not statistically significant. A graph of Insulin, Cortisol and Total Protein means change appears in figure 4.8, 4.9 and 4.10, respectively.

#### 4.4 Lipid Profiles

The data of total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL), high-density lipoprotein (HDL), very low-density lipoprotein (VLDL) and the ratio of low-density lipoprotein to high-density lipoprotein (LDL/HDL) are presented in Table 4.6 as means and standard deviations. To evaluate whether Ramadan fasting effect TC, TG, LDL, HDL, VLDL and LDL/HDL levels on athletic soccer players, a one-way repeated measures ANOVA was performed. The Mauchly test was performed to assess possible violation of the sphericity assumption; this was not significant for TC, TG, LDL, HDL, VLDL and LDL/HDL as presented in table 4.7. It suggested that the sample size is too small; this test may not have sufficient power to detect violations of sphericity. The Greenhouse-Geisser  $\epsilon$  value of 0.593, 0.631, 0.575, 0.858, 0.631, 0.894 for TC, TG, LDL, HDL, VLDL and LDL/HDL, respectively suggested that the sample variance/covariance matrix did not depart substantially from sphericity. Because the Greenhouse-Geisser  $\epsilon$  value was sufficient, no correction needs to be made to the degrees of freedom used to evaluate the significance of the F ratio.

The overall F of differences in mean LDL/HDL across the three measurement conditions were statistically significant:  $F(2, 14) = 11.301, p = .001$ ; the corresponding effect size was a partial  $\pi^2$  of .618. In other words, after stable individual differences in LDL/HDL are taken into account, about 62% of the

variance in LDL/HDL was related to fasting Ramadan. Note that even if the  $\epsilon$  correction factor is applied to the degrees of freedom for F, the obtained value of F for differences in mean LDL/HDL among the three times of testing remains statistically significant.

Planned contrasts was obtained to compare between the three times of measuring the levels of LDL/HDL.

LDL/HDL levels during baseline ( $M_{D1} = 1.76$ ) were found lower than the mean of LDL/HDL during the D10 ( $M_{D10} = 2.01$ ). The difference between the two means was statistically significant:  $t(7) = -2.975$ ,  $p = .021$ . Also, LDL/HDL during the baseline ( $M_{D1} = 1.76$ ) was lower than the mean of LDL/HDL during D28 ( $M_{D28} = 2.00$ ). The mean difference between D1 and D28 was statistically significant:  $t(7) = -4.136$ ,  $p = .004$ . However, the mean difference between LDL/HDL during D10 ( $M_{D10} = 2.01$ ) and D28 ( $M_{D28} = 2.22$ ) was not statistically significant:  $t(7) = -2.266$ ,  $p = .058$ . A graph of LDL/HDL means change appears in figure 4.11. Thus, of the three measure interventions in this study, only the comparison between D1 with D10 and D28 had significant changes.

TC, TG, LDL, HDL and VLDL showed no significant differences between all the measurements. The overall F of differences in mean TC, TG, LDL, HDL and VLDL across the three measurement conditions was not statistically significant:  $F(2, 14) = .297$ ,  $p = .748$ ;  $F(2, 14) = 1.803$ ,  $p = .201$ ;  $F(2, 14) = 2.391$ ,  $p = .128$ ;  $F(2, 14) = 2.88$ ,  $p = .089$ ; and  $F(2, 14) = 1.803$ ,  $p = .201$ ,

respectively; the corresponding effect size was a partial  $\pi^2$  of 0.041, 0.205, 0.255, 0.292, and 0.205, respectively. In other words, after stable individual differences in TC, TG, LDL, HDL and VLDL are taken into account, about 4%, 20%, 25%, 29% and 20% of the variance in TC, TG, LDL, HDL and VLDL respectively were related to intermittent fasting. Note that even if the  $\xi$  correction factor is applied to the degrees of freedom for F, the obtained value of F for differences in mean TC, TG, LDL, HDL and VLDL among the three times of testing remains not statistically significant. Graphs of TC, TG, LDL, HDL and VLDL means change appears in figure 4.12, 4.13, 4.14, 4.15 and 4.16, respectively.

#### 4.5 Physical activities

The data of physical activities MET-minutes/week (PA), vigorous (V), moderate (M) and walking (W) are presented in Table 4.8 as means and standard deviations. To evaluate whether intermittent fasting effect PA, V, M, and W levels on athletic soccer players, one-way repeated measures ANOVA were performed. Eight participants were tested under three measurement conditions: baseline one day before Ramadan (D1), after ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). The Mauchly test was performed to assess possible violation of the sphericity assumption; this was not significant for PA, V, M and W as presented in table 4.9, which suggests that the sample size is too small and therefore this test may not have sufficient power to detect violations of sphericity. The Greenhouse-Geisser  $\epsilon$  value of 0.704, 0.900, 0.802, and 0.598 for PA, V, M and W, respectively suggested that the sample variance/covariance matrix did not depart substantially from sphericity. Because the Greenhouse-Geisser  $\epsilon$  value was sufficient, no correction needs to be made to the degrees of freedom used to evaluate the significance of the F ratio.

The overall F of differences in mean PA, V and M and W across the three measurement conditions was statistically significant:  $F(2, 14) = 29.363, p = .001$ ,  $F(2, 14) = 23.355, p = .001$  and  $F(2, 14) = 8.888, p = .003$ , respectively; the corresponding effect size was a partial  $\eta^2$  of .807, .769 and .559 for PA, V and M, respectively. In other words, after stable individual differences in PA, V and M

are taken into account, approximately 80%, 76% and 55% of the variances were related to intermittent fasting. Note that even if the  $\epsilon$  correction factor is applied to the degrees of freedom for F, the obtained value of F for differences in mean PA, V and M among the three times of testing remains statistically significant.

Planned contrasts were obtained to compare the three times of measuring the levels Physical Activities, Vigorous activities and Moderate activities.

physical activity levels during baseline ( $M_{D1} = 4036$ ) were higher than the mean of PA during the D10 ( $M_{D10} = 3715$ ). There was no significant difference between the two means:  $t(7) = 2.257$ ,  $p = .059$ . However, the mean difference between PA during D10 ( $M_{D10} = 3715$ ) and D28 ( $M_{D28} = 2309$ ) was statistically significant:  $t(7) = 5.028$ ,  $p = .002$ . In addition, PA during the baseline ( $M_{D1} = 4036$ ) was also higher than the mean of PA during D28 ( $M_{D28} = 2309$ ). The mean difference between D1 and D28 was statistically significant:  $t(7) = 6.351$ ,  $p = .001$ . A graph of PA means change appears in figure 4.17. Thus, of the three measure interventions in this study, only the comparison between the baseline and D10 with D28 had significant changes.

Vigorous physical activity levels during baseline ( $M_{D1} = 1500$ ) were higher than the mean of V during the D10 ( $M_{D10} = 1075$ ). There were no significant difference between the two means:  $t(7) = 1.831$ ,  $p = .110$ . However, the mean difference between V during D10 ( $M_{D10} = 1075$ ) and D28 ( $M_{D28} = 45$ ) was statistically significant:  $t(7) = 5.749$ ,  $p = .001$ . In addition, PA during the

baseline ( $M_{D1} = 1500$ ) was also higher than the mean of PA during D28 ( $M_{D28} = 45$ ). The mean difference between D1 and D28 was statistically significant:  $t(7) = 6.051, p = .001$ . A graph of Vigorous physical activity means change appears in figure 4.18. Thus, of the three measure interventions in this study, only the comparison between the baseline and D10 with D28 had significant changes.

Moderate physical activity levels during baseline ( $M_{D1} = 1305$ ) was lower than the mean of M during the D10 ( $M_{D10} = 1485$ ). There were no significant difference between the two means:  $t(7) = -.606, p = .564$ . However, the mean difference between M during D10 ( $M_{D10} = 1485$ ) and D28 ( $M_{D28} = 517$ ) was statistically significant:  $t(7) = 4.244, p = .004$ . In addition, M during the baseline ( $M_{D1} = 1305$ ) was also higher than the mean of M during D28 ( $M_{D28} = 517$ ). The mean difference between D1 and D28 was statistically significant:  $t(7) = 4.009, p = .005$ . A graph of Moderate physical activity means change appears in figure 4.19. Thus, of the three measure interventions in this study, only the comparison between the baseline and D10 with D28 had significant changes.

Walking activities showed no significant differences between all the measurements. The overall F of differences in mean W across the three measurement conditions was also not statistically significant:  $F(2, 14) = 3.238, p = .070$ ; the corresponding effect size was a partial  $\pi^2$  of .316. In other words, after stable individual differences in W are taken into account, 31% of the variance in walking was related to intermittent fasting. Note that even if the  $\epsilon$  correction

factor is applied to the degrees of freedom for F, the obtained value of F for differences in mean Walking among the three times of testing remains not statistically significant. A graph of Walking and means change appears in figure 4.20.

#### 4.6 Food Intakes

The data of Energy Intake (EI), Percentage of Calories from Protein (CP%), Percentage of Calories from Fat (CF%) and Percentage of Calories from Carbohydrate (CC%) are presented in Table 4.8 as means and standard deviations. To evaluate whether intermittent fasting effect EI, CP%, CF%, and CC% levels on athletic soccer players, one-way repeated measures ANOVA were performed. The Mauchly test was performed to assess possible violation of the sphericity assumption; this was not significant for EI, CP%, CF%, and CC% as presented in table 4.9, which suggests that the sample size is too small and therefore this test may not have sufficient power to detect violations of sphericity. The Greenhouse-Geisser  $\epsilon$  value of 0.798, 0.969, 0.777, and 0.651 for EI, CP%, CF%, and CC%, respectively suggested that the sample variance/covariance matrix did not depart substantially from sphericity. Because the Greenhouse-Geisser  $\epsilon$  value was sufficient, no correction needs to be made to the degrees of freedom used to evaluate the significance of the F ratio.

The overall F of differences in mean CP%, and CC% across the three measurement conditions was statistically significant:  $F(2, 14) = 10.475, p = .002$  and  $F(2, 14) = 7.321, p = .007$ , respectively; the corresponding effect size was a partial  $\pi^2$  of .599 and .511 for CP%, and CC%, respectively. In other words, after stable individual differences in CP%, and CC% are taken into account, approximately 59% and 51% of the variances were related to the month of

Ramadan. Note that even if the  $\epsilon$  correction factor is applied to the degrees of freedom for F, the obtained value of F for differences in mean CP%, and CC% among the three times of testing remains statistically significant.

Planned contrasts were obtained to compare the three times of measuring the levels Percentage of Calories from Protein and Percentage of Calories from Carbohydrate intake.

Percentage of Calories from Protein during baseline ( $M_{D1} = 17.57$ ) were higher than the mean of CP% during the D10 ( $M_{D10} = 12.50$ ). There was significant difference between the two means:  $t(7) = 3.754, p = .007$ . In addition, CP% during the baseline ( $M_{D1} = 17.57$ ) was also higher than the mean of CP% during D28 ( $M_{D28} = 11.35$ ). The mean difference between D1 and D28 was statistically significant:  $t(7) = 3.971, p = .005$ . However, the mean difference between CP% during D10 ( $M_{D10} = 12.50$ ) and D28 ( $M_{D28} = 11.35$ ) was statistically not significant:  $t(7) = .817, p = .441$ . A graph of CP% means change appears in figure 4.17. Thus, of the three measure interventions in this study, only the comparison between the baseline with D10 and D28 had significant changes.

Percentage of Calories from Carbohydrate (CC%) during baseline ( $M_{D1} = 47.79$ ) were lower than the mean of CC% during the D10 ( $M_{D10} = 59.01$ ). There was significant difference between the two means:  $t(7) = -2.663, p = .032$ . In addition, CP% during the baseline ( $M_{D1} = 47.79$ ) was also lower than the mean of CC% during D28 ( $M_{D28} = 57.89$ ). The mean difference between D1 and

D28 was statistically significant:  $t(7) = -3.431, p=.011$ . However, the mean difference between CC% during D10 ( $M_{D10} = 59.01$ ) and D28 ( $M_{D28} = 57.89$ ) was statistically not significant:  $t(7) = .504, p=.629$ . A graph of CP% means change appears in figure 4.17. Thus, of the three measure interventions in this study, only the comparison between the baseline with D10 and D28 had significant changes.

Energy Intake (EI) and Percentage of Calories from Fat (CF%) showed no significant differences between all the measurements. The overall F of differences in mean EI and CF% across the three measurement conditions was not statistically significant:  $F(2, 14) = 2.069, p = .163$  and  $F(2, 14) = 4.323, p = .035$  the corresponding effect size was a partial  $\pi^2$  of .228 and .382. In other words, after stable individual differences in EI and CF% are taken into account, 22% and 38% of the variance in EI and CF% respectively was related to the month of Ramadan. Note that even if the  $\epsilon$  correction factor is applied to the degrees of freedom for F, the obtained value of F for differences in mean EI and CF% among the three times of testing remains not statistically significant. A graph of EI and CF% means change appears in figure 4.20.

Table 4.1. Subject characteristics.

Characteristics	Minimum	Maximum	Mean $\pm$ SD
Age (yrs)	19.00	24.00	21.75 $\pm$ 2.05
Height (cm)	161.50	177.00	170.68 $\pm$ 5.21
Body Weight (kg)	54.70	76.90	66.73 $\pm$ 7.51

Subjects participated in the study (n=8).

Table 4.2.Changes in Body Composition

Measurements	Before Ramadan	10 <sup>th</sup> of Ramadan	28 <sup>th</sup> of Ramadan
Body Weight(kg)	66.73±7.51	66.73±8.05	65.53±7.63* ^
Lean (kg)	50.51±5.33	50.46±5.79	49.46±5.18* ^
Fat %	17.88±2.75	17.81±2.46	17.86±3.00
A/G Ratio	1.21±0.13	1.19±0.17	1.15±0.15

Data presented as mean ± standard deviation. \*=significantly different vs. baseline (p<0.05). ^ =significantly different vs. D10.

Table 4.3. Present data of Mauchly's Test of Sphericity

Within subjects effect	Mauchly's W	Approx. Chi-Square	df	Sig	Greenhouse-Geisser
BW	.962	.230	2	.892	.964
Lean	.893	681	2	.711	.903
Fat %	.499	4.173	2	.124	.666
A/G	.662	2.473	2	.290	.748
Test of with-Subjects Effects					
Source	df(...)	F	Sig	Partial Eta Squared	%
BW	(2,14)	7.200	.007	.507	50
Lean	(2,14)	8.648	.004	.553	55
Fat %	(2,14)	.033	.968	.005	0.5
A/G	(2,14)	1.334	.295	.160	16

Table 4.4.Changes in Blood variables

Measurements	Before Ramadan	10 <sup>th</sup> of Ramadan	28 <sup>th</sup> of Ramadan
Glucose	81.87±04.01	90.75±11.90	91.00±03.25*
Insulin	07.60±02.63	06.45±03.90	06.18±03.73
Glucagon	42.87±16.69 ^	29.12±08.80	34.00±09.97
Cortisol	13.57±05.67	12.53±05.71	09.27±05.43
Albumin	46.75±01.58 ^	42.50±01.85	41.25±02.54*
Total Protein	77.00±03.11	74.87±05.48	74.62±04.37

Data presented as mean ± standard deviation. \*=significantly different vs. baseline (p<0.05). ^ =significantly different vs. D10.

Table 4.5. Present data of Mauchly's Test of Sphericity

Within subjects effect	Mauchly's W	Approx. Chi-Square	df	Sig	Greenhouse-Geisser
Glucose	.408	5.376	2	.068	.628
Insulin	.394	5.584	2	.061	.623
Glucagon	.438	4.959	2	.084	.640
Cortisol	.939	.376	2	.828	.943
Albumin	.478	4.430	2	.109	.657
Total Protein	.992	.049	2	.976	.992
Test of with-Subjects Effects					
Source	df(...)	F	Sig	Partial Eta Squared	%
Glucose	(2,14)	4.025	.042	.365	36
Insulin	(2,14)	.539	.595	.071	7
Glucagon	(2,14)	6.164	.012	.468	46
Cortisol	(2,14)	1.637	.230	.190	19
Albumin	(2,14)	23.47	.001	.770	77
Total Protein	(2,14)	1.135	.349	.140	14

Table 4.6.Changes in Lipid profiles

Measurements	Before Ramadan	10 <sup>th</sup> of Ramadan	28 <sup>th</sup> of Ramadan
TC	158.02±26.89	158.98±17.58	162.85±24.31
TG	96.20±60.59	65.20±14.70	73.51±21.64
LDL	88.62±26.21	96.93±15.82	102.01±19.92
HDL	50.25±05.06	48.80±6.51	46.39±05.46
VLDL	19.24±12.11	13.04±02.94	14.70±04.32
LDL/HDL ratio	01.76±00.52 ^	02.01±00.41	02.22±00.50*

Data presented as mean ± standard deviation. \*=significantly different vs. baseline (p<0.05). ^ =significantly different vs. D10.

Table 4.7. Present data of Mauchly's Test of Sphericity

Within subjects effect	Mauchly's W	Approx. Chi-Square	df	Sig	Greenhouse-Geisser
TC	.314	6.945	2	.031	.593
TG	.415	5.276	2	.072	.631
LDL	.261	8.070	2	.018	.575
HDL	.834	1.090	2	.580	.858
VLDL	.415	5.276	2	.072	.631
LDL/HDL	.882	.757	2	.685	.894
Test of with-Subjects Effects					
Source	df(...)	F	Sig	Partial Eta Squared	%
TC	(2,14)	.297	.748	.041	4
TG	(2,14)	1.803	.201	.205	20
LDL	(2,14)	2.391	.128	.255	25
HDL	(2,14)	2.882	.089	.292	29
VLDL	(2,14)	1.803	.201	.205	20
LDL/HDL	(2,14)	11.301	.001	.618	61

Table 4.8.Changes in Physical Activity Levels

Measurements	Before Ramadan	10 <sup>th</sup> of Ramadan	28 <sup>th</sup> of Ramadan
Physical Activity	4036±830	3715±829	2309±1101* ^
Vigorous	1500±584	1075±465	45±127* ^
Moderate	1305±509	1485±492	517±321* ^
Walking	1231±985	1155±738	1746±1066

Data presented as mean ± standard deviation. \*=significantly different vs. baseline (p<0.05). ^ =significantly different vs. D10.

Table 4.9. Present data of Mauchly's Test of Sphericity

Within subjects effect	Mauchly's W	Approx. Chi-Square	df	Sig	Greenhouse-Geisser
PA	.579	3.275	2	.194	.704
V	.889	.709	2	.702	.900
M	.753	1.704	2	.427	.802
W	.327	6.707	2	.035	.598
Test of with-Subjects Effects					
Source	df(...)	F	Sig	Partial Eta Squared	%
PA	(2,14)	29.363	.000	.807	80.
V	(2,14)	23.355	.000	.769	76
M	(2,14)	8.888	.003	.559	55
W	(2,14)	3.238	.070	.316	31

Table 4.10.Changes in Food Intake

Measurements	Before Ramadan	10 <sup>th</sup> of Ramadan	28 <sup>th</sup> of Ramadan
Energy Intake(Kcal)	3121±489	3080±419	2986±479
Protein (%)	17.57±5.33	12.50±5.79	11.35±5.18* ^
Fat (%)	38.65±5.96	29.23±7.35	31.77±3.86
Carbohydrate (%)	47.79±9.36	59.01±6.22	57.89±4.36

Data presented as mean ± standard deviation. \*=significantly different vs. baseline (p<0.05). ^ =significantly different vs. D10.

Table 4.11. Present data of Mauchly's Test of Sphericity

Within subjects effect	Mauchly's W	Approx. Chi-Square	df	Sig	Greenhouse-Geisser
Energy Intake (Kcal)	.747	.1754	2	.416	.798
Protein (%)	.967	.198	2	.906	.969
Fat (%)	.712	2.034	2	.362	.777
Carbohydrate (%)	.465	4.599	2	.100	.651
Test of with-Subjects Effects					
Source	df(...)	F	Sig	Partial Eta Squared	%
Energy Intake (Kcal)	(2,14)	2.069	.163	.228	22
Protein (%)	(2,14)	10.475	.002	.599	59
Fat (%)	(2,14)	4.323	.035	.382	38
Carbohydrate (%)	(2,14)	7.321	.007	.511	51

Figure 4.1. Results of Body weight data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28)  
\*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.

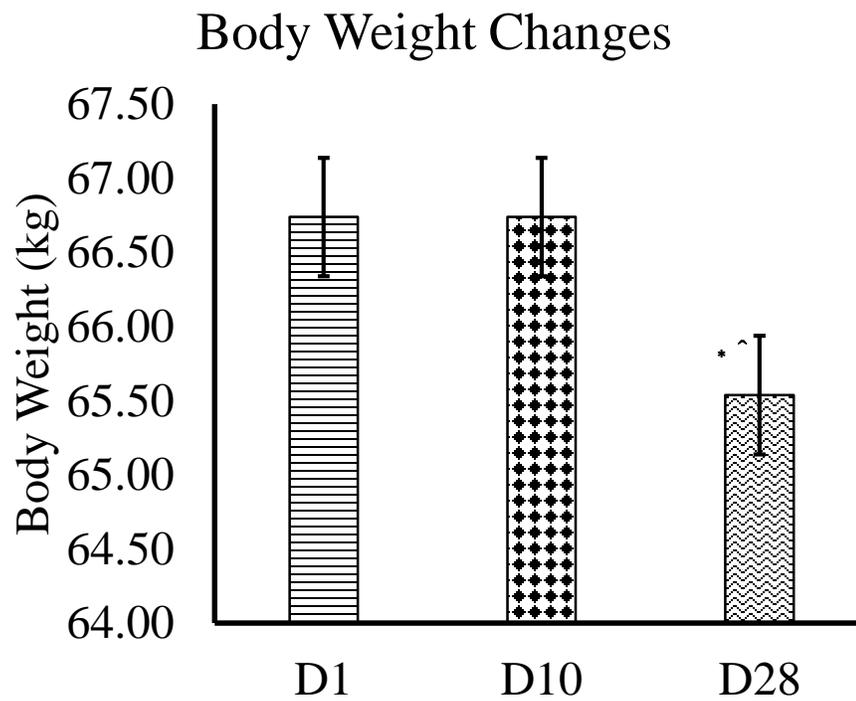


Figure 4.2. Results of lean (kg) data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28) \*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.

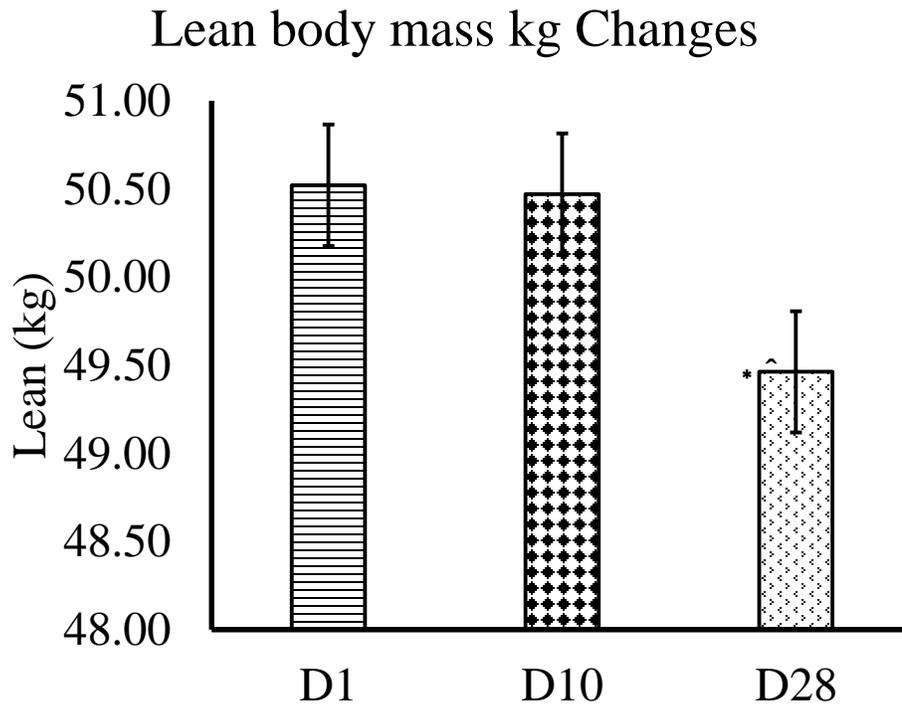


Figure 4.3. Results Body Fat Percentage data for data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28)  
\*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.

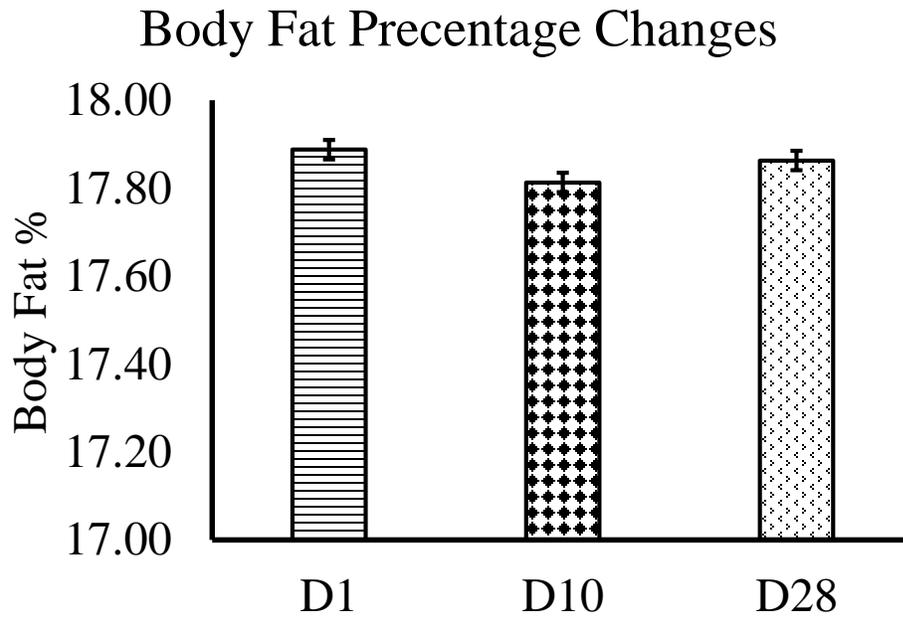


Figure 4.4. Results of Android to Gynoid Ratio data for data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28)  
\*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.

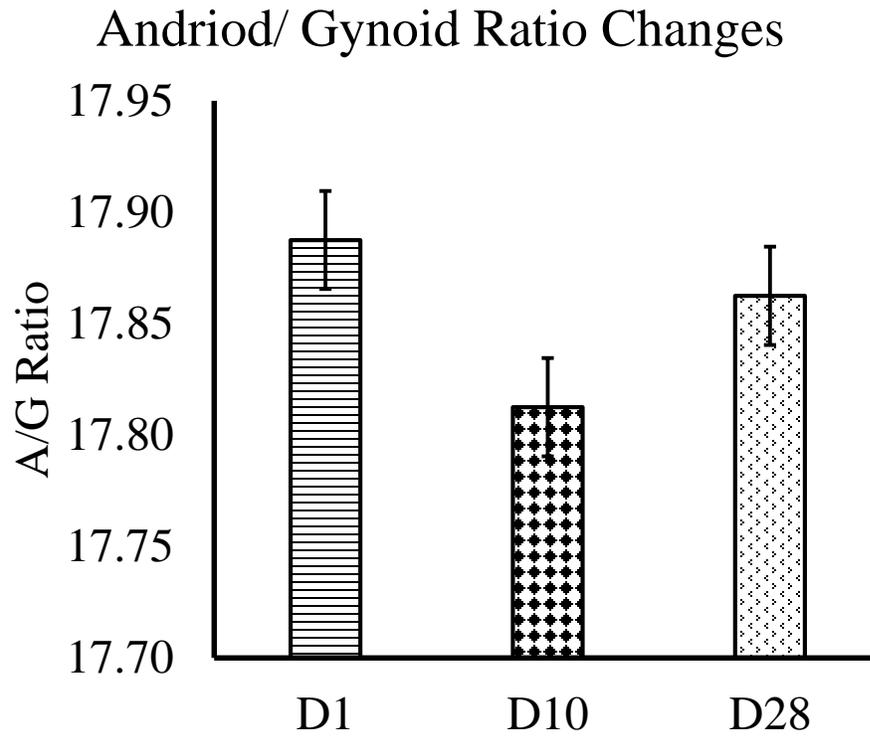


Figure 4.5. Results Glucose data for data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28)  
\*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.

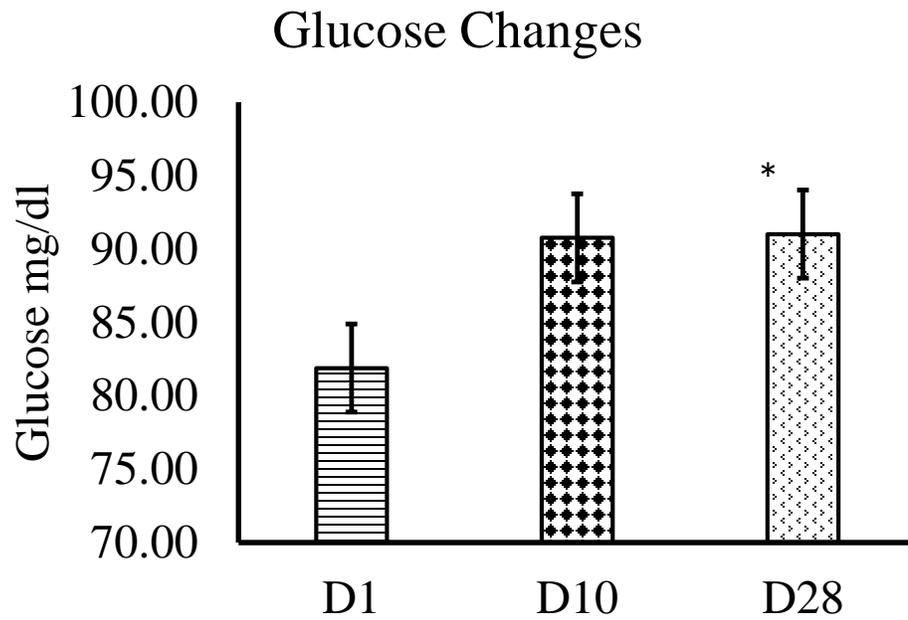


Figure 4.6. Results of Glucagon data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \*=significantly different vs. baseline ( $p < 0.05$ ). ^=significantly different vs. D10.

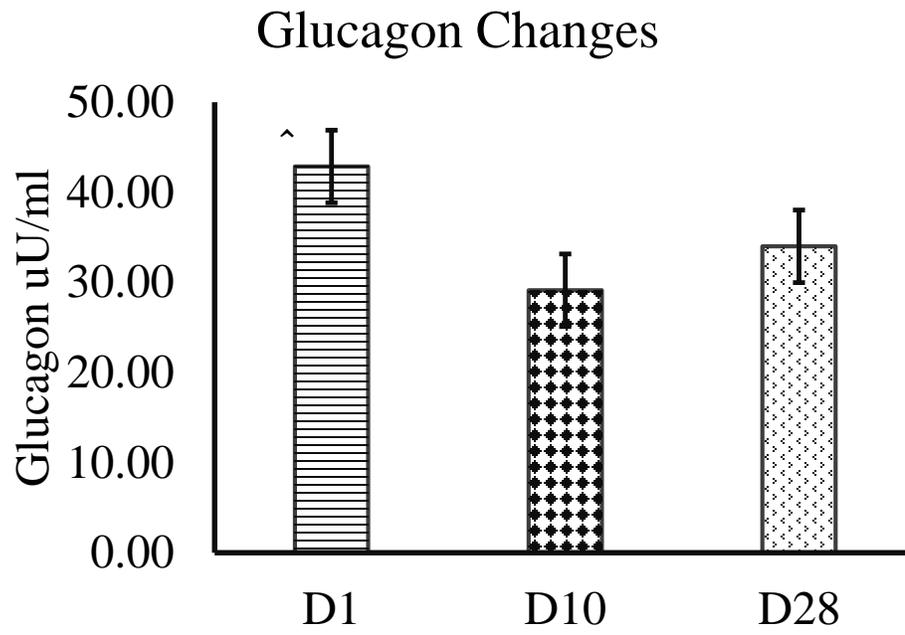


Figure 4.7. Results of Albumin data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.

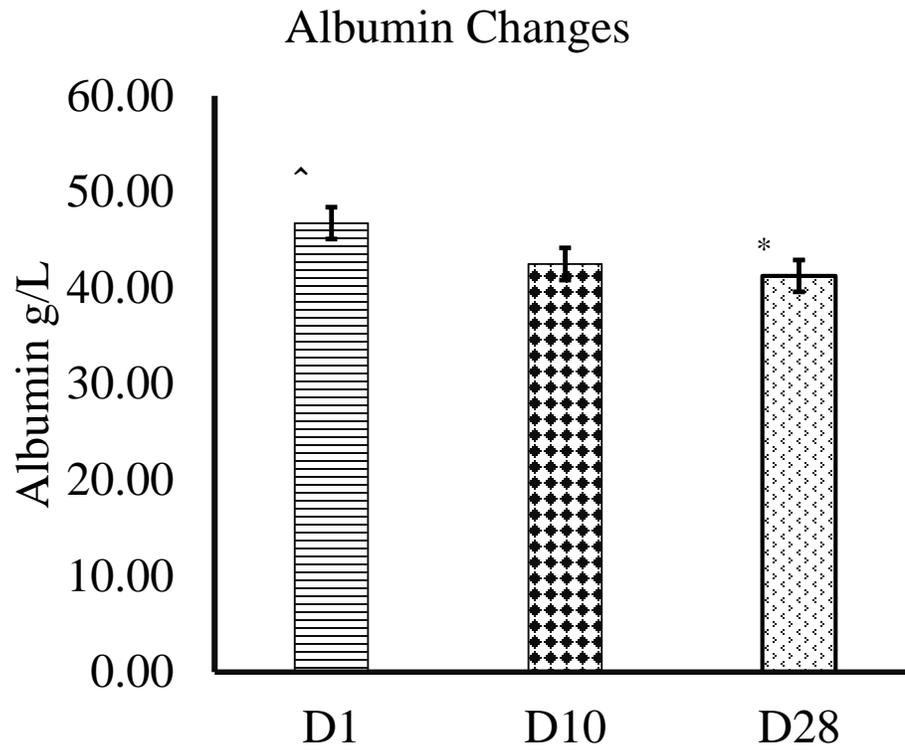


Figure 4.8. Results of Insulin data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \* = significantly different vs. baseline ( $p < 0.05$ ). ^ = significantly different vs. D10.

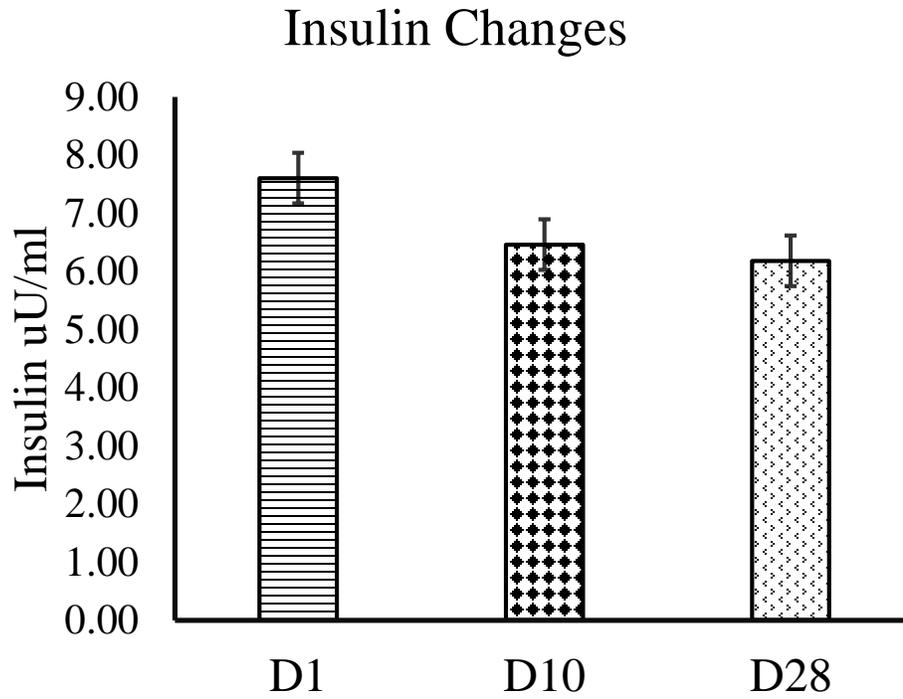


Figure 4.9. Results of Cortisol data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \*=significantly different vs. baseline ( $p < 0.05$ ). ^=significantly different vs. D10.

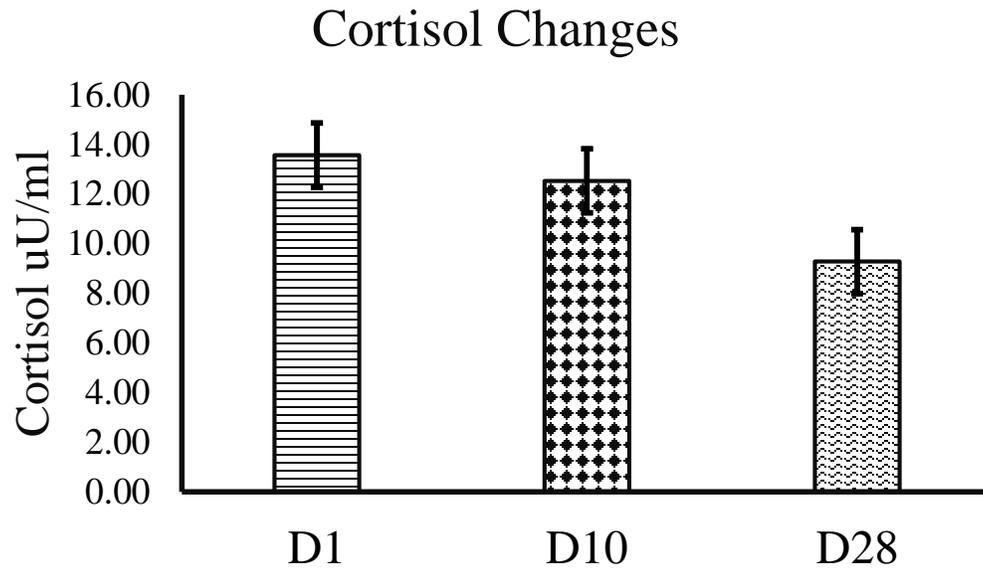


Figure 4.10. Results of Total Protein data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.

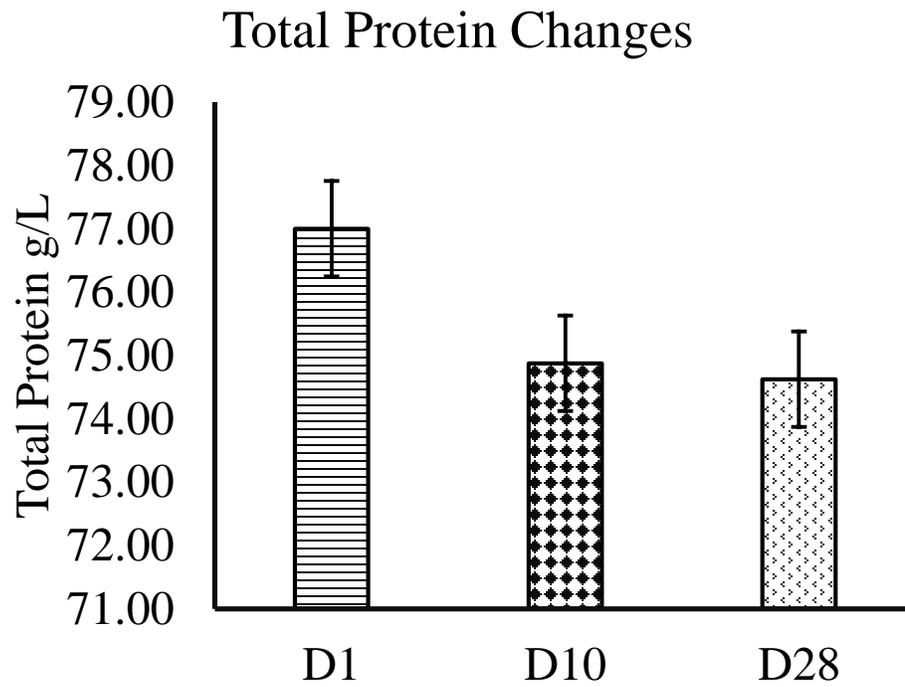


Figure 4.11. Results of LDL/HDL Ratio data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \*=significantly different vs. baseline (p<0.05). ^=significantly different vs. D10.

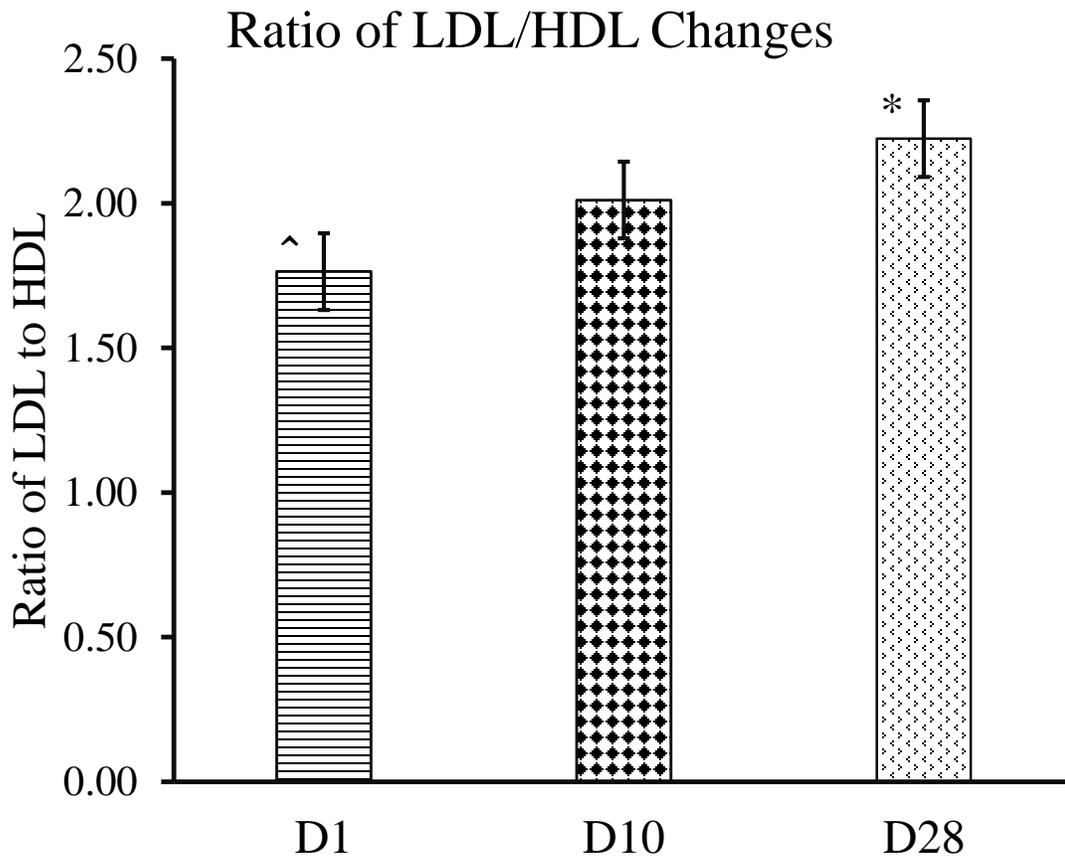


Figure 4.12. Results of Total Cholesterol data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \* = significantly different vs. baseline ( $p < 0.05$ ). ^ = significantly different vs. D10.

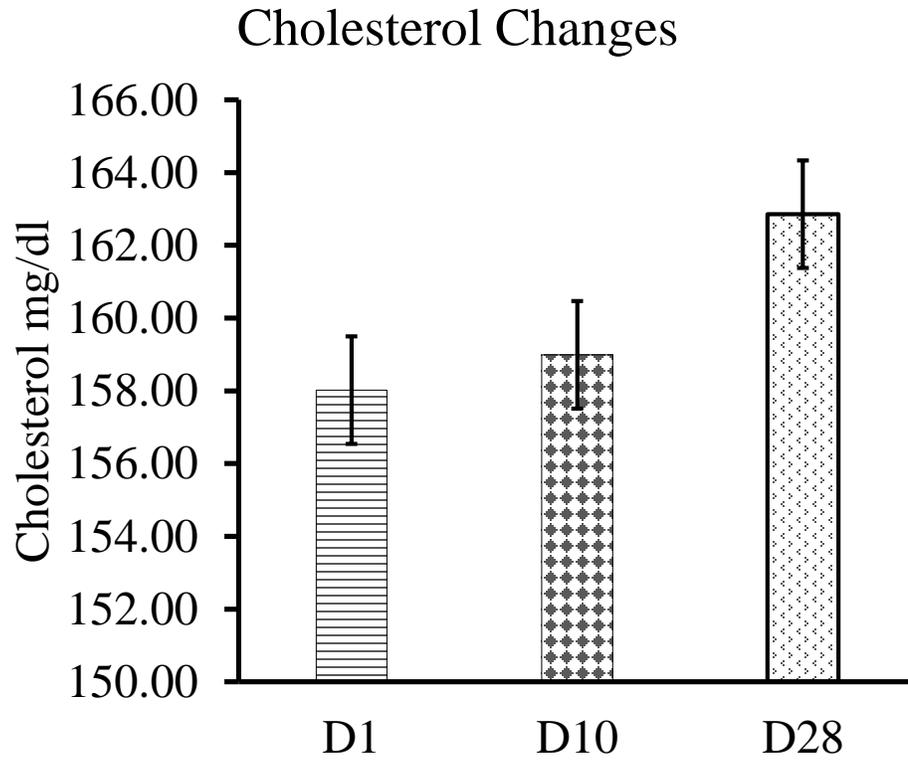


Figure 4.13. Results of Triglycerides data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.

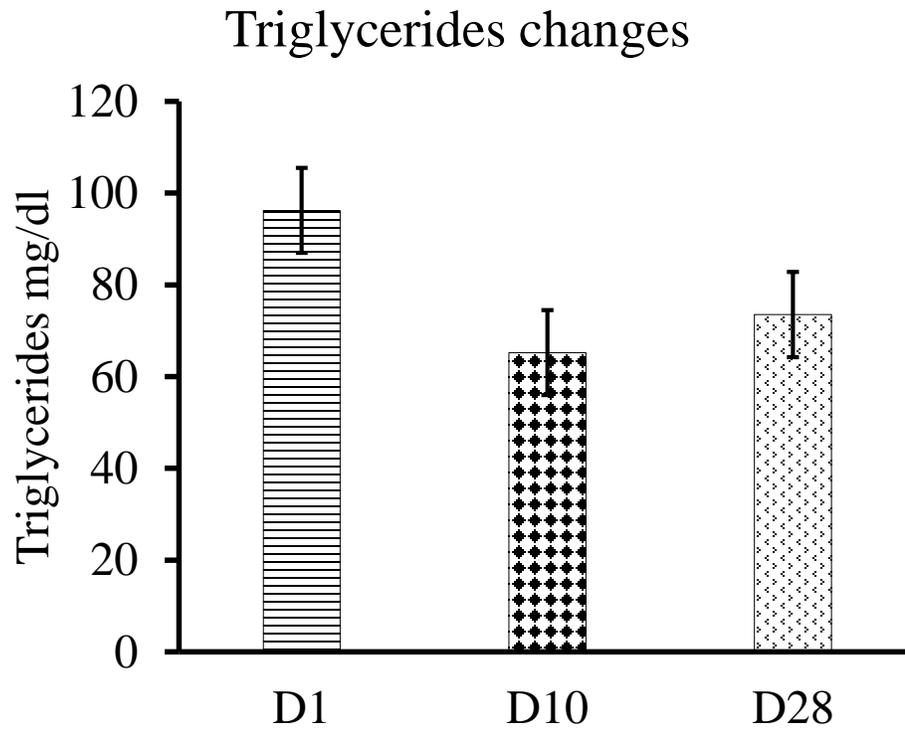


Figure 4.14. Results of Low Density Lipoprotein data for data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28) \*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.

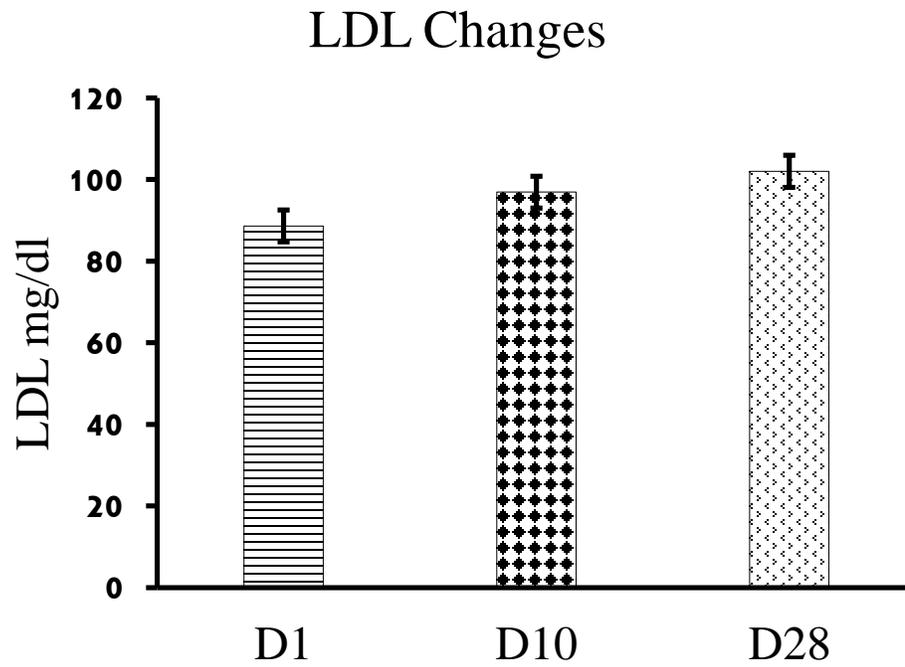


Figure 4.15. Results of High Density Lipoprotein data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \* = significantly different vs. baseline ( $p < 0.05$ ). ^ = significantly different vs. D10.

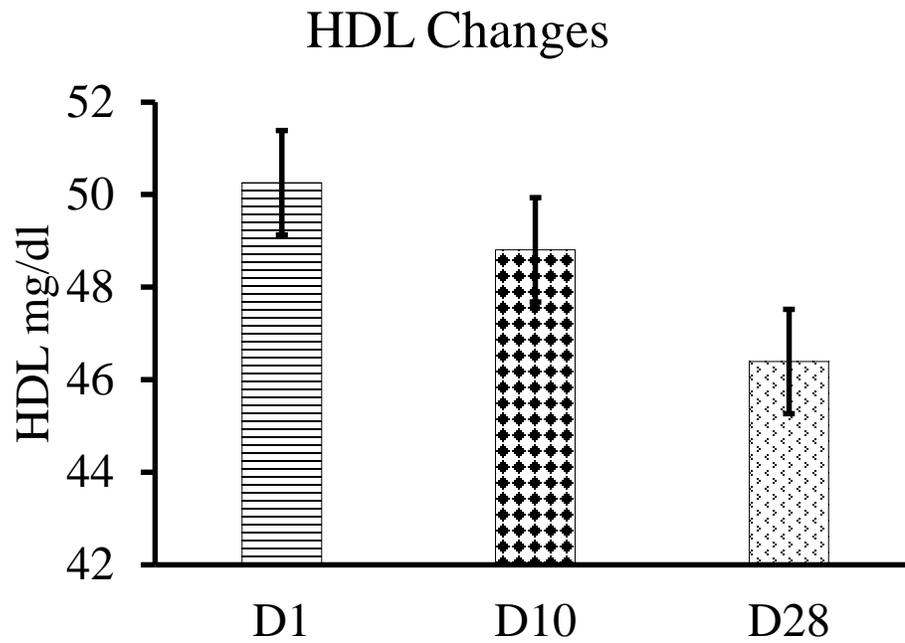


Figure 4.16. Results of High Density Lipoprotein data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \* = significantly different vs. baseline ( $p < 0.05$ ). ^ = significantly different vs. D10.

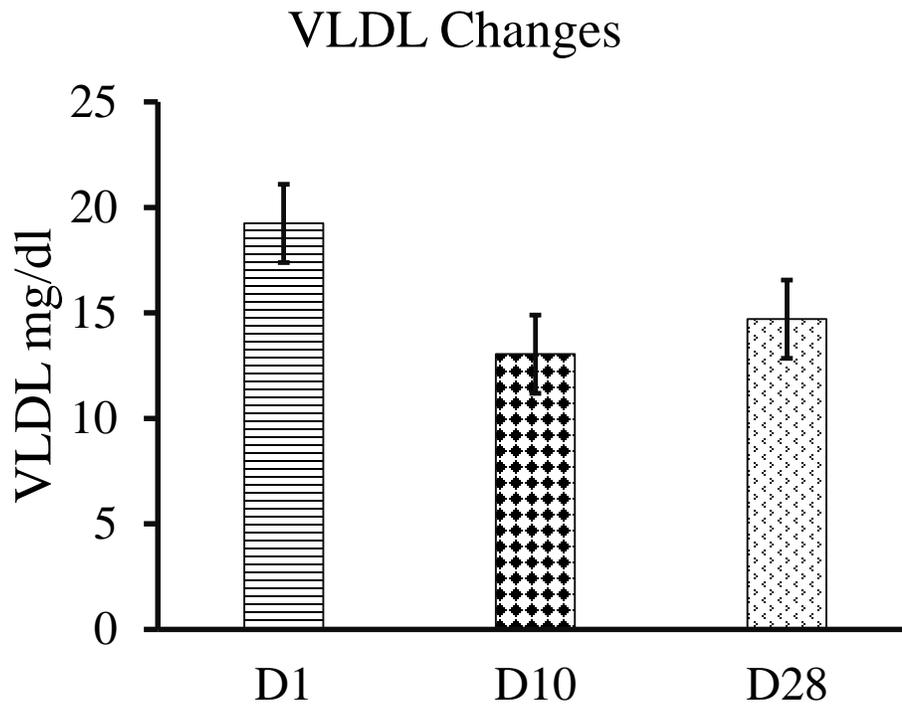


Figure 4.17. Results of Physical Activity data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \* = significantly different vs. baseline ( $p < 0.05$ ). ^ = significantly different vs. D10.

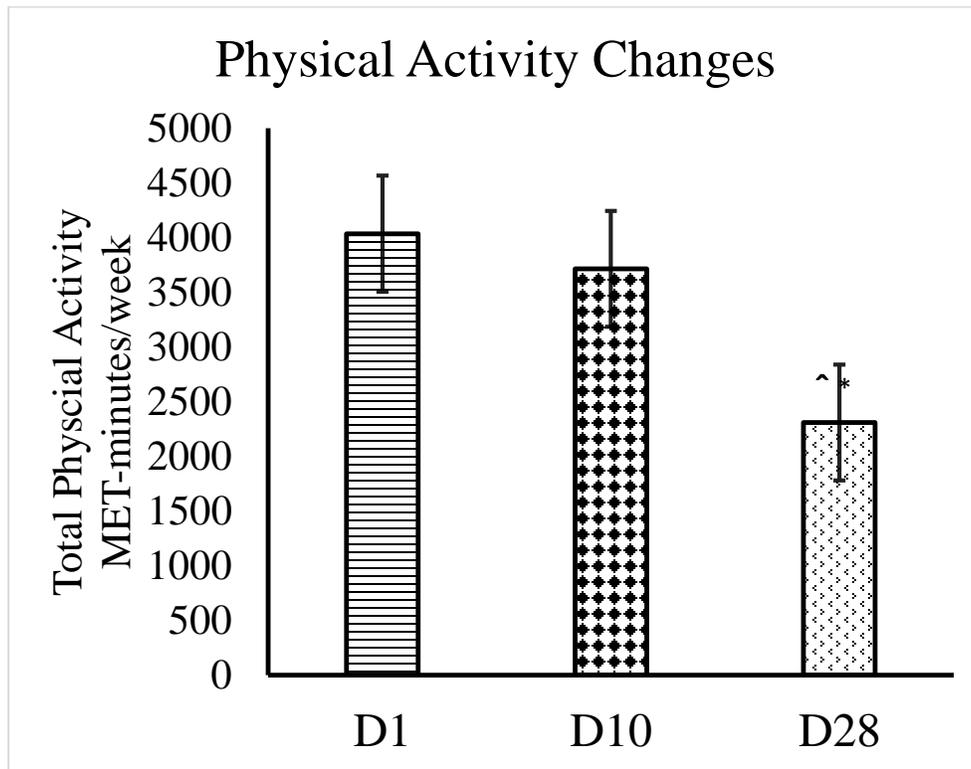


Figure 4.18. Results of Vigorous Physical Activity data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \* = significantly different vs. baseline ( $p < 0.05$ ). ^ = significantly different vs. D10.

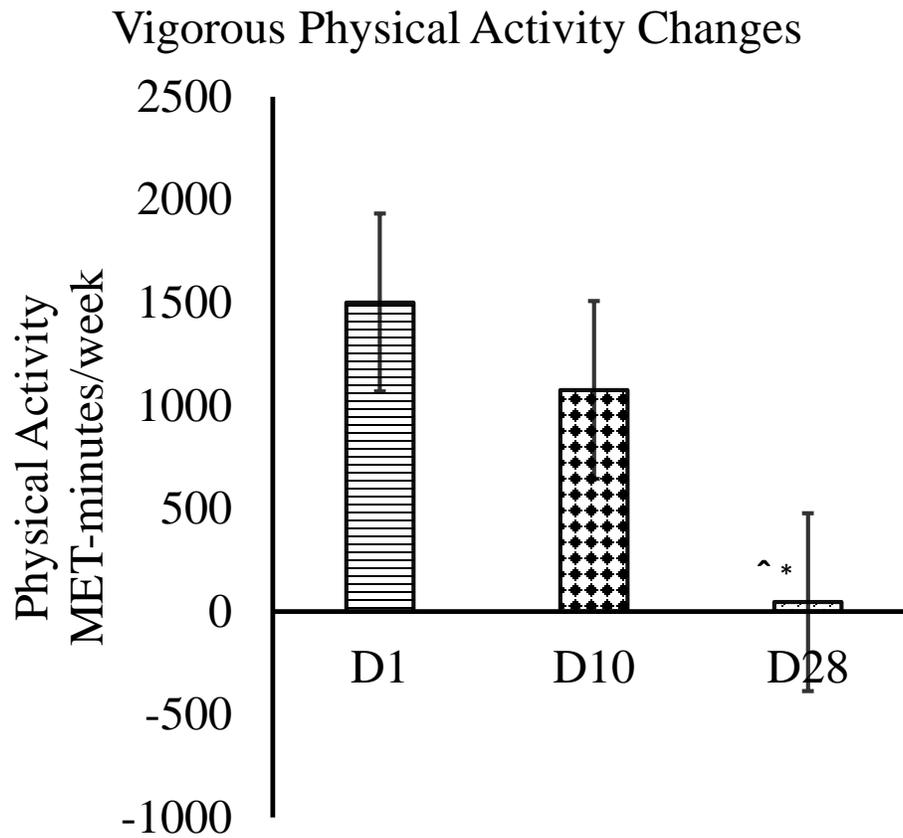


Figure 4.19. Results of Moderate Physical Activity data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \* = significantly different vs. baseline ( $p < 0.05$ ). ^ = significantly different vs. D10.

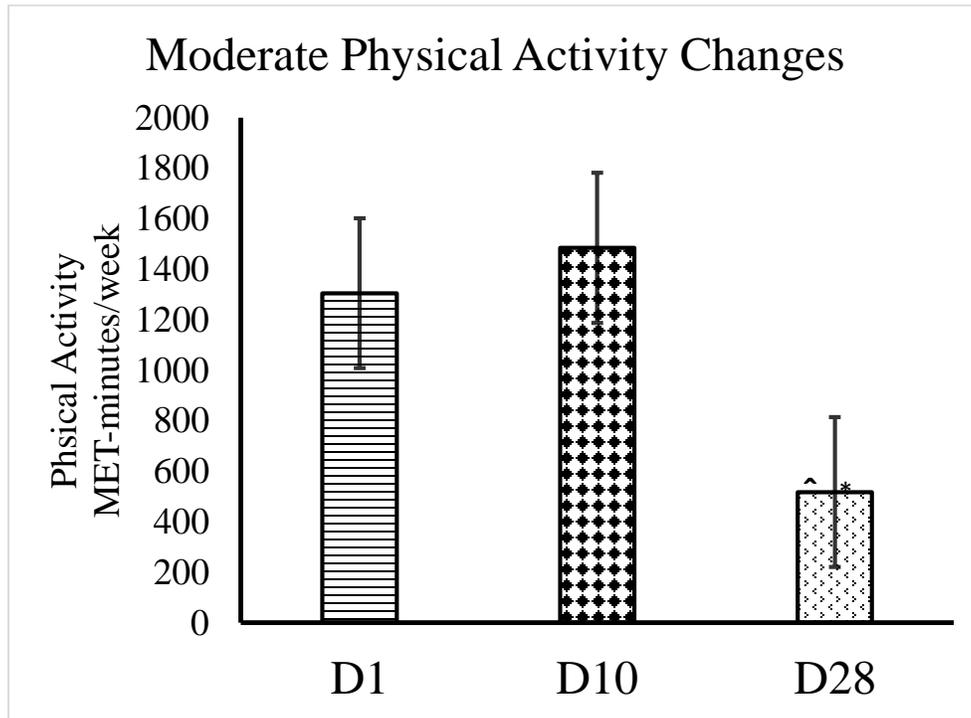


Figure 4.20. Results of Walking Physical Activity data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \* = significantly different vs. baseline ( $p < 0.05$ ). ^ = significantly different vs. D10.

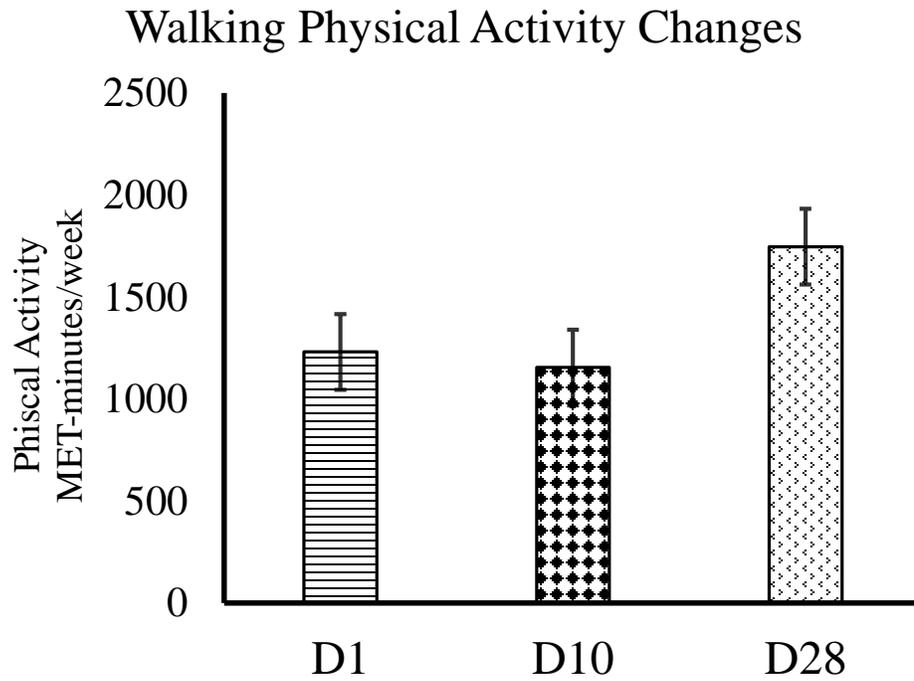


Figure 4.21. Results of Energy Intake Kcal data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \* = significantly different vs. baseline ( $p < 0.05$ ). ^ = significantly different vs. D10.

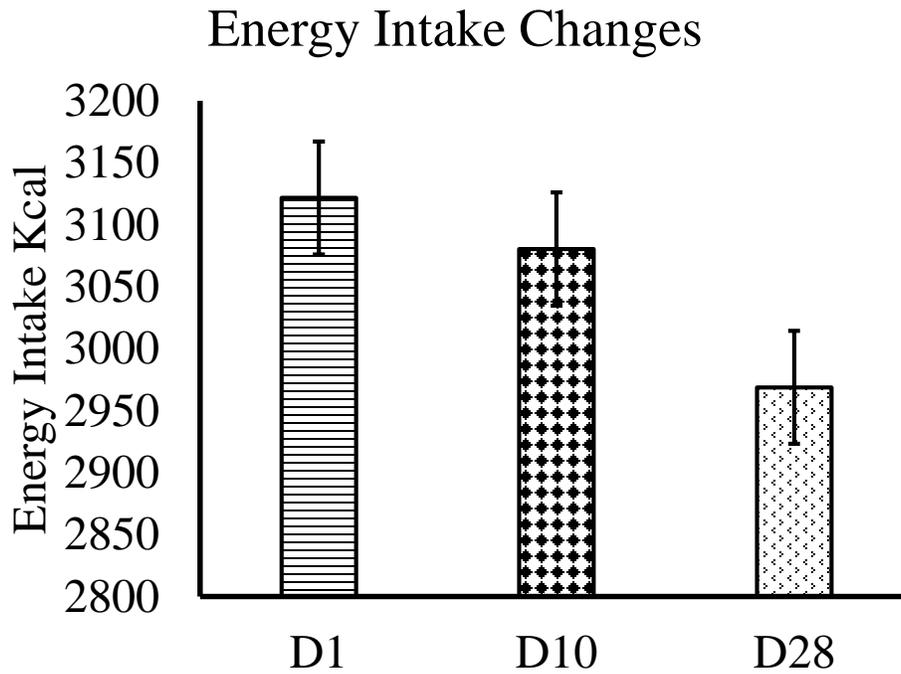


Figure 4.22. Results of Percentage of Calories from Protein data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.

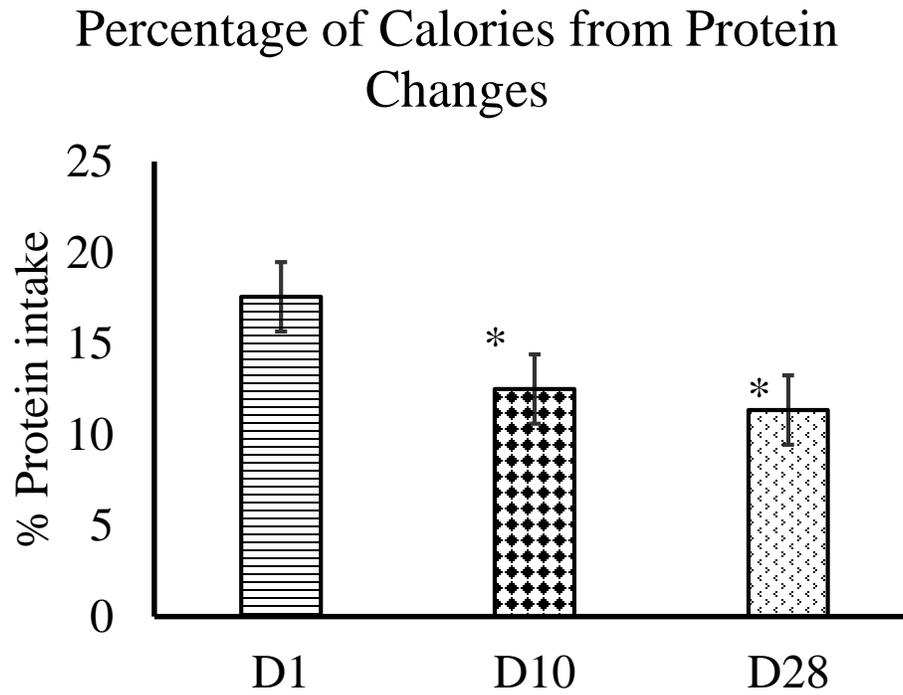


Figure 4.23. Results of Percentage of Calories from Fat data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \* = significantly different vs. baseline ( $p < 0.05$ ). ^ = significantly different vs. D10.

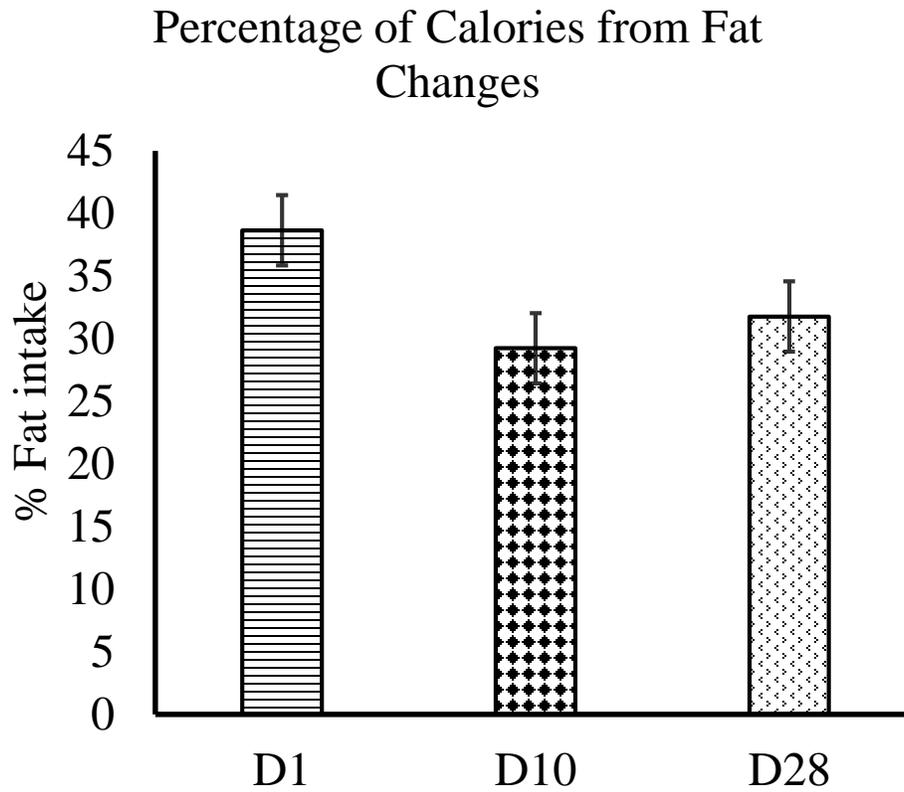
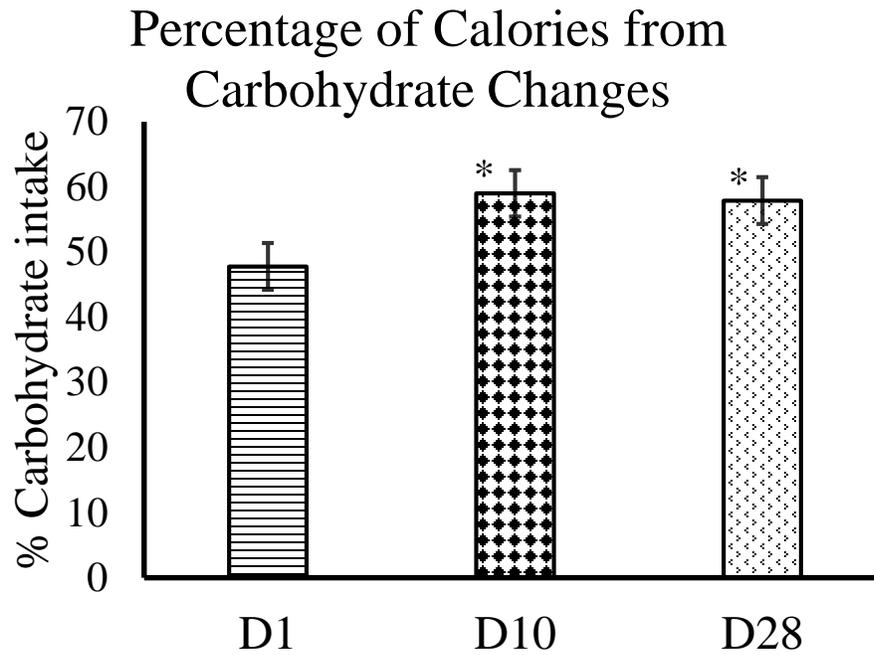


Figure 4.23. Results of Percentage of Calories from Carbohydrate data for baseline (D1), ten days of fasting Ramadan (D10) and twenty-eight days of fasting Ramadan (D28). \*=significantly different vs. baseline ( $p < 0.05$ ). ^ =significantly different vs. D10.



## DISCUSSION

The goal of this investigation was to examine the effects of fasting during the month of Ramadan on anthropometrics, Lipid Profile, serum protein, Glucose, hormones, physical activity, and food intake. Studies related to body weight and food intake during Ramadan, although well documented, are inconsistent and contain vastly differing results. In order to maintain positive energy balance, energy consumed must be greater than energy expended, thus increasing stored energy. Negative energy balance occurs when energy expenditure is greater than energy consumed resulting in an energy decrease and loss of body weight (Wardlaw and Kessel, 2002). A study done by Forst and Pirani (1987) showed that when caloric intake increased, body weight also increased during the month of Ramadan. However, Khan and Khattak (2002) found a decrease in caloric intake with a decrease in body weight. Decreases in caloric intake with reductions in body weight are frequently noted in studies (Angel and Schwartz, 1974). A study by El Ati et al (1995) found no significant differences related to food intake pre- and post-Ramadan and body weight. Other studies documented no notable variations in body weight and fat mass correlations (Maislos et al 1993, Beltaifa et al 2002 and El Ati et al, 1995). Studies that investigate interrelated components of weight loss, caloric intake and levels of physical activity during Ramadan are less documented.

The findings of this investigation showed a significant decrease of -1.82 % in body weight at the end of Ramadan. Reflectively, this weight loss could conceivably be due to the significant decrease of -6.22 % and -40.57 in percentage of calories from protein and the physical activity, respectively. Is weight loss in fat body mass or in lean body mass? This study verified that weight loss occurred in lean body mass of -2.08 % at the end of Ramadan fasting. The loss of lean body mass may have negative impact on the athletic performance (Fogelholm, 1994). During the first ten days of Ramadan there were no significant changes in body weight which could be due to the non-significant changes of energy intake and physical activity during the first ten days compared to pre Ramadan. Physical activity levels, Vigorous and Moderate at the end of Ramadan were considerably diminished. Valdimarsson with others conducted a study in 1999 that showed a significant positive relationship between lean mass and the physical activity. Interestingly, the reduction in lean body mass may correlated to the significant reduction of physical activity and insufficient dietary protein intake from 10<sup>th</sup> of Ramadan until the end of Ramadan. It has been confirmed that increasing protein intake reduced loss of lean body mass (Mettler et al, 2010). Moreover, the calories intake from fat was decreased -6.88 % at the end of Ramadan compare to pre-Ramadan. However, the reduction of calories from fat was not significant.

Blood parameters were also investigated in this study. Albumin which produced by the liver was significantly decreased to -11.76 % at the end of Ramadan. Albumin may be a marker of malnutrition status such as protein intake and dehydration. However, Most metabolic and physiological functions in the human body derive its' energy from Glucose. Reliable data on the exploration of the effects of fasting on Glucose levels are becoming increasingly documented (Asgary et al, 2000 and Nagra et al, 1998). In this study, the researcher also examined Fasting Glucose levels were considerably elevated at the end of Ramadan when compared to pre-Ramadan to 11.15 %. The results of this study are in conflict with previous studies which noted no changes in Glucose levels (Fedail et al, 1982 and Bouhelel et al, 2008). One study in concurrence with our findings related to elevated Glucose levels was Temizhan et al in 2000. Reflectively, the significant increase of Glucose level could possibly be due to the significant increase of carbohydrate to 10. % at the end of Ramadan. Other blood constituents such as Glucagon have also been investigated in this study. Glucagon decreased significantly after the first ten days of Ramadan. However, at the end of Ramadan, it returned back almost to pre Ramadan levels. The reason why Glucagon levels returned to baseline is unclear. The other blood parameters such as Insulin, Cortisol and total protein did not show any significant differences throughout the three measurements.

The changes in eating habits during Ramadan have been well documented. One main findings in this study that relate to lipid profiles was the significant increase of the LDL/HDL ratio, but was still within normal and healthy range. All other lipid profile values were without significant change. Interpretation of data varies somewhat per study. However, smaller meals combined with the specific types of caloric intake such as increased carbohydrate and decreased fat intake may have a more direct and beneficial outcome in controlling lipid levels than one or two large meals during the Ramadan fast. Having multiple small meals instead of one or two large meals should also be considered a viable contributing factor in lowering total cholesterol levels (Lamri-Senhadji et al 2009, Barkia et al 2011, Aldouni et al 1997, Asgary et al 2000, Bouhlel et al, 2008).

The physical activity levels were significantly decreased at the end of Ramadan because the subjects did not maintain their usual training. During the last ten days of Ramadan nightly, the subjects have a tendency to stay up until later for praying. The vigorous and moderate physical activity levels were significantly reduced at the end of Ramadan. As regards the intensity of physical activity, the findings of the present study were consistent with the result of Meckel et al 2007. A study conducted by Karli with others confirmed that if the daily habits of training, food intake, body fluid balance and sleeping were similar in pre and post Ramadan, there would be no effect

of Ramadan fasting on body composition and athletic performance.

## Summary

The conflict of our results with the previous studies may be due to the possibility of subjects consuming varying amounts of calories between pre- and post-Ramadan measurements. The inconsistencies of previous studies appears to have a direct correlation to the fact that the majority of the studies do not control the amount of food intake; nor do they control the level of physical activity between these two measurements. Moreover, more research needs to be conducted to investigate further the fast of Ramadan in relationship not only to body weight, but also to the level of physical activity along with the amount and type of food intake. In this study shows that the reduction in body weight is related to the loss of lean body mass. Therefore, examining the effects of intermittent fasting on human muscle intracellular signaling pathways is the future of research in fasting Ramadan. Finally, the need for improved control over specific biochemical markers is required. Heart disease and diabetes are spreading throughout the world. If altering and or varying dietary patterns as studies are beginning to suggest can control, elevate and lower these markers without major dietary and pharmacological changes, the medical community will gain vital knowledge (Fischbach et al, 1998 and Venes et al, 2005).

## ASSUMPTIONS AND LIMITATIONS

The information collected in this study may show people who fast during the month of Ramadan that no change will occur when the demand in energy intake reaches the demand required by the body in consideration of the recommendation dietary allowances per day. In addition, they can fast for an extended period of time without harmful physiological or metabolic. Likewise, study shows that exercising regularly after breaking the fast with complete attention to the time of eating and sleeping has impact on lean body mass. Ostensible limitation of this study was the size of the sample. The sample was small in size because people think that donating blood while fasting is not recommended in Islam unless it is absolutely necessary. Donating blood while fasting for research purposes seemed unnecessary to the subjects. Another limitation was that the measurement times. Instead of having only three times of measuring the subjects it would be better they come for testing every three or four days to know at which time the changes occur.

### Suggestions for further research

An area for further research is to conduct a study to scan the effect of intermittent fasting on human muscle intracellular signaling pathways. A question for further research is “which part of the lean body mass changes? A careful study needs to be conducted in order to answer that question.

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## Appendix A

### INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (August 2002)

#### SHORT LAST 7 DAYS SELF-ADMINISTERED FORMAT

#### FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health-related physical activity.

#### *Background on IPAQ*

The development of an international measure for physical activity commenced in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages, and are suitable for national population-based prevalence studies of participation in physical activity.

#### *Using IPAQ*

Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

#### *Translation from English and Cultural Adaptation*

Translation from English is supported to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at [www.ipaq.ki.se](http://www.ipaq.ki.se). If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

#### *Further Developments of IPAQ*

International collaboration on IPAQ is on-going and an *International Physical Activity Prevalence Study* is in progress. For further information see the IPAQ website.

#### *More Information*

More detailed information on the IPAQ process and the research methods used in the development of IPAQ instruments is available at [www.ipaq.ki.se](http://www.ipaq.ki.se) and Booth, M.L. (2000). *Assessment of Physical Activity: An International Perspective*. *Research Quarterly for Exercise and Sport*, 71 (2): s114-20. Other scientific publications and presentations on the use of IPAQ are summarized on the website.

## INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

\_\_\_\_\_ days per week

No vigorous physical activities      **➔** *Skip to question 3*

2. How much time did you usually spend doing vigorous physical activities on one of those days?

\_\_\_\_\_ hours per day

\_\_\_\_\_ minutes per day

Don't know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

\_\_\_\_\_ days per week

No moderate physical activities      **➔** *Skip to question 5*

4. How much time did you usually spend doing moderate physical activities on one of those days?

\_\_\_\_\_ hours per day

\_\_\_\_\_ minutes per day

Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

\_\_\_\_\_ days per week

No walking → *Skip to question 7*

6. How much time did you usually spend walking on one of those days?

\_\_\_\_\_ hours per day

\_\_\_\_\_ minutes per day

Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

\_\_\_\_\_ hours per day

\_\_\_\_\_ minutes per day

Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

## استبانة النشاط البدني الدولية لقياس مستوى النشاط البدني في الأيام السبعة الماضية (للشباب والكبار 15-69 سنة) الصيغة المختصرة للاستبانة، للاستخدام بواسطة الهاتف

تتضمن استبانة النشاط البدني الدولية (IPAQ) أربع مجموعات من الاستبانات؛ صيغة مطولة (تتكون من 5 حقول مستقلة من الأنشطة البدنية)، وصيغة مختصرة (مكونة من 4 بنود عامة). لكل صيغة من الصيغتين استبانتان، إحداها للاستخدام بواسطة الهاتف، والأخرى للاستخدام الذاتي (يتم تعبئتها من قبل الشخص نفسه). إن هدف هذه الاستبانات هو توفير أداة مشتركة يمكن من خلال استخدامها الحصول على بيانات عن مستوى النشاط البدني المرتبط بالصحة، قابلة للمقارنة دولياً.

### خلفية عن استبانة النشاط البدني الدولية

بدأت عملية بناء مقياس دولي للنشاط البدني في مدينة جنيف في عام 1998م، وتبع ذلك في عام 2000م إجراء اختبارات مكثفة لصدق المقياس وثباته، شملت 12 دولة (14 موقعاً). ولقد أظهرت النتائج النهائية أن المقاييس المستخدمة تمتاز بخواص قياس مقبولة، لاستخدامها في أماكن متعددة وبلغات مختلفة، مع صلاحيتها للاستعمال في الدراسات الوطنية لمعرفة شيوخ ممارسة النشاط البدني لدى السكان.

### استخدام استبانة النشاط البدني الدولية

يُحث على استخدام استبانة النشاط البدني الدولية لمراقبة مستوى النشاط البدني، ولغرض البحث العلمي. ويوصي بعدم إحداث أي تغيير في ترتيب الأسئلة أو في الكلمات المستخدمة، لأن ذلك يؤثر في الخصائص السيكومترية للأداة.

### الترجمة من اللغة الإنجليزية والملاءمة الثقافية

إن ترجمة استبانة النشاط البدني الدولية من اللغة الإنجليزية إلى لغات أخرى أمر يستحق التأييد، مما يسهل استعمالها على نطاق واسع. ويمكن الحصول على المعلومات المتعلقة بتوفر الاستبانة الدولية للنشاط البدني بلغات مختلفة من الموقع التالي: [www.ipaq.ki.se](http://www.ipaq.ki.se)، وفي حالة الشروع في ترجمة الاستبانة، فإننا نوصي بشدة أن يتم استخدام طريقة الترجمة العكسية (Back translation) الموضحة على موقع الاستبانة الإلكتروني. فضلاً، إذا كان ممكناً، ضع في الاعتبار إتاحة النسخة المترجمة من الاستبانة الدولية للآخرين، وذلك بوضعها في الموقع الإلكتروني، ويمكن الحصول على معلومات إضافية حول الترجمة والملاءمة الثقافية من خلال موقع استبانة النشاط البدني الدولية.

### إدخال البيانات وترميزها

ملحق مع إجابات كل سؤال من أسئلة استبانة النشاط البدني الدولية رموز مقترحة للمتغيرات والمدى المتوقع للإجابات، لتسهيل عملية إدخال البيانات والتعامل معها، وللمساعدة في عملية تدريب القائمين على إجراء المقابلات، ويوصي بأن يتم بالضبط تسجيل الإجابة الفعلية للمجيب، فعلى سبيل المثال: " 120 دقيقة " تكتب 120 في خانة الدقائق، وفي حالة الإجابة بساعتين، فتكتب 2 في خانة الساعات، أما في حالة كون الإجابة " ساعة ونصف " فتكتب على أساس 1 في عامود الساعات، و 30 في عامود الدقائق.

### تطورات استبانة النشاط البدني الدولية

إن التعاون الدولي حول استبانة النشاط البدني الدولية مستمر، وحالياً يتم إنجاز دراسة دولية حول شيوخ ممارسة النشاط البدني. ولمزيد من المعلومات، يمكن الرجوع إلى الموقع الإلكتروني لاستبانة النشاط البدني الدولية.

### معلومات إضافية

يتوافر في الموقع الإلكتروني التالي: [www.ipaq.ki.se](http://www.ipaq.ki.se) معلومات إضافية حول إجراءات استبانة النشاط البدني الدولية وطرق البحث المستخدمة في بنائها، ويمكن الرجوع للمرجع التالي: Booth, M. L. (2000). Assessment of Physical Activity: An International Perspective. Research Quarterly for Exercise and Sport, 71 (2): s 114-20. كما يتوفر، على الموقع الإلكتروني، عرض موجز لبحوث أخرى نشرت أو أقيمت في مؤتمرات علمية، حول استخدام استبانة النشاط البدني الدولية.

## الصيغة المختصرة لاستبانة النشاط البدني الدولية، للاستخدام بواسطة الهاتف

أقرأ على المشارك: سوف أسألك بعض الأسئلة عن الوقت الذي قضيته في ممارسة أنشطة بدنية خلال الأيام السبعة الماضية. فضلاً أجب عن كل سؤال من الأسئلة التالية حتى وإن كنت تعتبر نفسك غير نشيطاً بدنياً. فكر في الأنشطة البدنية التي تمارسها خلال عملك، وكجزء من أعمالك المنزلية، و أثناء تنقلك من مكان لآخر، و تلك التي تقوم بها في وقت فراغك بغرض الترويح أو التمرين أو الرياضة.

أقرأ على المشارك: الآن فكر في جميع الأنشطة البدنية التي تتطلب جهداً بديناً مرتفع الشدة والتي قمت بممارستها خلال الأيام السبعة الماضية. الأنشطة البدنية مرتفعة الشدة هي تلك الأنشطة التي تجعل تنفسك أعلى بكثير من المعتاد، مثل رفع أشياء ثقيلة، أو حرث الأرض، أو ركوب الدراجة بسرعة عالية، أو الجري، أو ممارسة كرة القدم، أو كرة السلة، أو السباحة، أو نط الحبل. فكر فقط في الأنشطة البدنية مرتفعة الشدة التي قمت بممارستها لمدة 10 دقائق على الأقل في كل مرة.

1- خلال الأيام السبعة الماضية، كم يوماً مارست فيه نشاطاً بديناً مرتفع الشدة؟

..... يوم في الأسبوع [VDAY; Range 0-7, 8, 9]

8. لا يدري/ أو غير متأكد

9. رفض الإجابة

( إيضاح من مجري المقابلة: فكر فقط في الأنشطة البدنية مرتفعة الشدة التي قمت بممارستها لمدة 10 دقائق على الأقل في كل مرة).

( ملحوظة لمجري المقابلة: إذا كانت الإجابة عن السؤال رقم (1) هي صفر، أو رفض الإجابة عن السؤال، أو لم يعرف الجواب، انتقل مباشرة إلى السؤال رقم (3).

2- في المعتاد، كم من الوقت قضيته في كل يوم مارست فيه نشاطاً بديناً مرتفع الشدة؟

.. .. ساعة في اليوم [VDHRS; Range 0-16]

.... دقيقة في اليوم [VDMIN; Range 0-960, 998, 999]

998. لا أدري/ أو غير متأكد

999. رفض الإجابة

( إيضاح من مجري المقابلة: فكر فقط في الأنشطة البدنية مرتفعة الشدة التي قمت بممارستها لمدة 10 دقائق على الأقل في كل مرة).

( متابعة من مجري المقابلة: المطلوب هو متوسط الوقت لأحد الأيام التي مارست فيها نشاطاً بديناً مرتفع الشدة. إذا لم يتمكن المجيب من الإجابة عن السؤال، لأن وقت الممارسة تفاوت كثيراً من يوم لآخر، أسأله: كم مجموع الوقت الذي قضيته خلال الأيام السبعة الماضية في ممارسة نشاط بدني مرتفع الشدة؟).

.. .. ساعة في الأسبوع [VWHRS; Range 0-112]

.... دقيقة في الأسبوع [VWMIN; Range 0-6720, 9998, 9999]

9998. لا يدري/ أو غير متأكد

9999. رفض الإجابة

أقرأ على المشارك: الآن فكر في جميع الأنشطة البدنية التي تتطلب جهداً بدنياً معتدل الشدة والتي قمت بممارستها خلال الأيام السبعة الماضية. الأنشطة البدنية معتدلة الشدة هي تلك الأنشطة التي تجعل تنفسك أعلى من المعتاد إلى حد ما، ويمكن أن تتضمن رفع أشياء خفيفة، أو ركوب الدراجة بسرعة عادية، أو ممارسة كرة الطائرة، أو ممارسة تنس الطاولة، أو كنس المنزل، أو غسل الملابس يدوياً، أو غسل السيارة. لا تحسب المشي ضمن هذه الأنشطة. مرة أخرى، فكر فقط في الأنشطة البدنية معتدلة الشدة التي قمت بممارستها لمدة 10 دقائق على الأقل في كل مرة.

3- خلال الأيام السبعة الماضية، كم يوماً مارست فيه نشاطاً بدنياً معتدل الشدة؟

..... يوم في الأسبوع [MDAY; Range 0-7, 8, 9]

8. لا يدري/ أو غير متأكد

9. رفض الإجابة

( إيضاح من مجري المقابلة: فكر فقط في الأنشطة البدنية معتدلة الشدة التي قمت بممارستها لمدة 10 دقائق على الأقل في كل مرة).

( ملحوظة لمجري المقابلة: إذا كانت الإجابة عن السؤال رقم (3) هي صفر، أو رفض الإجابة عن السؤال، أو لم يعرف الجواب، انتقل مباشرة إلى السؤال رقم (5).

4- في المعتاد، كم من الوقت قضيته في كل يوم مارست فيه نشاطاً بدنياً معتدل الشدة؟

.. ساعة في اليوم [MDHRS; Range 0-16]

.... دقيقة في اليوم [MDMIN; Range 0-960, 998, 999]

998. لا يدري/ أو غير متأكد

999. رفض الإجابة

( إيضاح من مجري المقابلة: فكر فقط في الأنشطة البدنية معتدلة الشدة التي قمت بممارستها لمدة 10 دقائق على الأقل في كل مرة).

( متابعة من مجري المقابلة: المطلوب هو متوسط الوقت لأحد الأيام التي مارست فيها نشاطاً بدنياً معتدل الشدة. إذا لم يتمكن المجيب من الإجابة عن السؤال لأن وقت الممارسة تفاوت كثيراً من يوم لآخر، أسأله: كم مجموع الوقت الذي قضيته خلال الأيام السبعة الماضية في ممارسة نشاط بدني معتدل الشدة؟).

.. ساعة في الأسبوع [MWHRS; Range 0-112]

.... دقيقة في الأسبوع [MWMIN; Range 0-6720, 9998, 9999]

9998. لا يدري/ أو غير متأكد

9999. رفض الإجابة

أقرأ على المشارك: الآن فكر في الوقت الذي قضيته في المشي خلال الأيام السبع الماضية، ويتضمن ذلك المشي إلى العمل، والمشي أثناء العمل، وفي البيت، وخلال انتقالك من مكان لآخر، أو أي نوع من أنواع المشي بغرض الترويح أو الرياضة.

5- خلال الأيام السبعة الماضية، كم يوماً مارست فيه المشي لمدة 10 دقائق على الأقل في كل مرة؟

..... يوم في الأسبوع [WDAY; Range 0-7, 8, 9]

8. لا يدري/ أو غير متأكد

9. رفض الإجابة

(إيضاح من مجري المقابلة: فكر فقط في المشي الذي قمت به لمدة 10 دقائق على الأقل في كل مرة).

(ملحوظة لمجري المقابلة: إذا كانت الإجابة عن السؤال رقم (5) هي صفر، أو رفض الإجابة عن السؤال، أو لم يعرف الجواب، أنتقل مباشرة إلى السؤال رقم 7).

6- في المعتاد، كم من الوقت قضيته في كل يوم مارست فيه المشي؟

.. .. ساعة في اليوم [WDHRS; Range 0-16]

----- دقيقة في اليوم [WDMIN; Range 0-960, 998, 999]

998. لا يدري/ أو غير متأكد

999. رفض الإجابة

(متابعة من مجري المقابلة: المطلوب هو متوسط الوقت لأحد الأيام التي مارست فيها المشي. إذا لم يتمكن المجيب من الإجابة عن السؤال لأن وقت الممارسة تفاوت كثيراً من يوم لآخر، أسأله: كم مجموع الوقت الذي قضيته في المشي خلال الأيام السبعة الماضية؟)

.. .. ساعة في الأسبوع [WWHRS; Range 0-112]

----- دقيقة في الأسبوع [WWMIN; Range 0-6720, 9998, 9999]

9998. لا يدري/ أو غير متأكد

9999. رفض الإجابة

أقرأ على المشارك: الآن فكر في الوقت الذي قضيته جالساً خلال الأيام السبعة الماضية. أحسب وقت الجلوس في العمل، وفي المنزل، وفي الدراسة، وفي الترفيه. من الممكن أن يتضمن ذلك وقت الجلوس على المكتب، وأثناء العمل على الكمبيوتر، و أثناء زيارتك لصديق، و أثناء القراءة، و الجلوس أو الاستلقاء لمشاهدة التلفزيون.

7- خلال الأيام السبعة الماضية، كم من الوقت قضيته جالساً في أحد هذه الأيام من غير أيام الإجازة الأسبوعية؟

-- -- ساعة في اليوم [SDHRS; Range 0-16]

-- -- دقيقة في اليوم [SDMIN; Range 0-960, 998, 999]

998. لا يدري/ أو غير متأكد

999. رفض الإجابة

( إيضاح من مجري المقابلة: يدخل ضمن ذلك، الوقت الذي كنت فيه مستلقياً وأنت مستيقظ، وكذلك وقت الجلوس).

( متابعة من مجري المقابلة: المطلوب هو متوسط الوقت في اليوم الواحد الذي قضيته جالساً. إذا لم يتمكن المجيب من الإجابة عن السؤال لأن وقت الجلوس يتفاوت كثيراً من يوم لآخر، أسأله: كم مجموع الوقت الذي قضيته جالساً في يوم الاثنين الماضي؟).

-- -- ساعة في يوم الاثنين [SWHRS; Range 0-16]

-- -- دقيقة في يوم الاثنين [SWMIN; Range 0-960, 998, 999]

998. لا يدري/ أو غير متأكد

999. رفض الإجابة







# Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ)

## – Short and Long Forms

November 2005

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- Appendix 2. At A Glance IPAQ Scoring Protocol – Long Forms

## 1. Introduction

This document describes recommended methods of scoring the data derived from the telephone / interview administered and self-administered IPAQ short and long form instruments. The methods outlined provide a revision to earlier scoring protocols for the IPAQ short form and provide for the first time a comparable scoring method for IPAQ long form. Latest versions of IPAQ instruments are available from [www.ipaq.ki.se](http://www.ipaq.ki.se).

Although there are many different ways to analyse physical activity data, to date there is no formal consensus on a 'correct' method for defining or describing levels of physical activity based on self-report population surveys. The use of different scoring protocols makes it very difficult to compare within and between countries, even when the same instrument has been used. Use of these scoring methods will enhance the comparability between surveys, provided identical sampling and survey methods have been used.

## 2. Uses of IPAQ Instruments

IPAQ short form is an instrument designed primarily for population surveillance of physical activity among adults. It has been developed and tested for use in adults (age range of 15-69 years) and until further development and testing is undertaken the use of IPAQ with older and younger age groups is not recommended.

IPAQ short and long forms are sometimes being used as an evaluation tool in intervention studies, but this was not the intended purpose of IPAQ. Users should carefully note the range of domains and types of activities included in IPAQ before using it in this context. Use as an outcome measure in small scale intervention studies is not recommended.

## 3. Summary Characteristics of IPAQ Short and Long Forms

1. IPAQ assesses physical activity undertaken across a comprehensive set of domains including:
  - a. leisure time physical activity
  - b. domestic and gardening (yard) activities
  - c. work-related physical activity
  - d. transport-related physical activity;
2. The IPAQ short form asks about three specific types of activity undertaken in the four domains introduced above. The specific types of activity that are assessed are walking, moderate-intensity activities and vigorous-intensity activities.
3. The items in the short IPAQ form were structured to provide separate scores on walking, moderate-intensity and vigorous-intensity activity. Computation of the total score for the short form requires summation of the duration (in minutes) and frequency (days) of walking, moderate-intensity and vigorous-intensity activities. Domain specific estimates cannot be estimated.

4. The IPAQ long form asks details about the specific types of activities undertaken within each of the four domains. Examples include walking for transportation and moderate-intensity leisure-time activity.
5. The items in the long IPAQ form were structured to provide separate domain specific scores for walking, moderate-intensity and vigorous-intensity activity within each of the work, transportation, domestic chores and gardening (yard) and leisure-time domains. Computation of the total scores for the long form requires summation of the duration (in minutes) and frequency (days) for all the types of activities in all domains. Domain specific scores or activity specific sub- scores may be calculated. Domain specific scores require summation of the scores for walking, moderate-intensity and vigorous-intensity activities within the specific domain, whereas activity-specific scores require summation of the scores for the specific type of activity across domains.

#### 4. Overview of Continuous and Categorical Analyses of IPAQ

Both categorical and continuous indicators of physical activity are possible from both IPAQ forms. However, given the non-normal distribution of energy expenditure in many populations, it is suggested that the continuous indicator be presented as median minutes/week or median MET–minutes/week rather than means (such as mean minutes/week or mean MET-minutes/week).

##### 4.1 Continuous Variables

Data collected with IPAQ can be reported as a continuous measure. One measure of the volume of activity can be computed by weighting each type of activity by its energy requirements defined in METs to yield a score in MET–minutes. METs are multiples of the resting metabolic rate and a MET-minute is computed by multiplying the MET score of an activity by the minutes performed. MET-minute scores are equivalent to kilocalories for a 60 kilogram person. Kilocalories may be computed from MET-minutes using the following equation:  $\text{MET-min} \times (\text{weight in kilograms}/60 \text{ kilograms})$ . MET-minutes/day or MET-minutes/week can be presented although the latter is more frequently used and is thus suggested.

Details for the computation for summary variables from IPAQ short and long forms are detailed below. As there are no established thresholds for presenting MET- minutes, the IPAQ Research Committee propose that these data are reported as comparisons of median values and interquartile ranges for different populations.

##### 4.2 Categorical Variable: Rationale for Cut Point Values

There are three levels of physical activity proposed to classify populations:

1. Low
2. Moderate
3. High

The algorithms for the short and long forms are defined in more detail in Sections 5.3 and 6.3, respectively. Rules for data cleaning and processing prior to computing the algorithms appear in Section 7.

Regular participation is a key concept included in current public health guidelines for physical activity.<sup>1</sup> Therefore, both the total volume and the number of days/sessions are included in the IPAQ analysis algorithms.

The criteria for these levels have been set taking into account that IPAQ asks questions in all domains of daily life, resulting in higher median MET-minutes estimates than would have been estimated from leisure-time participation alone. The criteria for these three levels are shown below.

Given that measures such as IPAQ assess total physical activity in all domains, the “leisure time physical activity” based public health recommendation of 30 minutes on most days will be achieved by most adults in a population. Although widely accepted as a goal, in absolute terms 30 minutes of moderate-intensity activity is low and broadly equivalent to the background or basal levels of activity adult individuals would accumulate in a day. Therefore a new, higher cutpoint is needed to describe the levels of physical activity associated with health benefits for measures such as IPAQ, which report on a broad range of domains of physical activity.

### ‘High’

This category was developed to describe higher levels of participation. Although it is known that greater health benefits are associated with increased levels of activity there is no consensus on the exact amount of activity for maximal benefit. In the absence of any established criteria, the IPAQ Research Committee proposes a measure which equates to approximately at least one hour per day or more, of at least moderate-intensity activity above the basal level of physical activity. Considering that basal activity may be considered to be equivalent to approximately 5000 steps per day, it is proposed that “high active” category be considered as those who move at least 12,500 steps per day, or the equivalent in moderate and vigorous activities. This represents at least an hour more moderate-intensity activity over and above the basal level of activity, or half an hour of vigorous-intensity activity over and above basal levels daily. These calculations were based on emerging results of pedometers studies.<sup>2</sup>

This category provides a higher threshold of measures of total physical activity and is a useful mechanism to distinguish variation in population groups. Also it could be used to set population targets for health-enhancing physical activity when multi-domain instruments, such as IPAQ are used.

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<sup>1</sup> Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of American Medical Association* 1995; 273(5):402-7. and U.S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, The Presidents' Council on Physical Fitness and Sports: Atlanta, GA:USA. 1996.

<sup>2</sup> Tudor-Locke C, Bassett DR Jr. How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Med.* 2004;34(1):1-8.

## ‘Moderate’

This category is defined as doing some activity, more than the low active category. It is proposed that it is a level of activity equivalent to “half an hour of at least moderate-intensity PA on most days”, the former leisure time-based physical activity population health recommendation.

## ‘Low’

This category is simply defined as not meeting any of the criteria for either of the previous categories.

### 5. Protocol for IPAQ Short Form

#### 5.1 Continuous Scores

Median values and interquartile ranges can be computed for walking (W), moderate- intensity activities (M), vigorous-intensity activities (V) and a combined total physical activity score. All continuous scores are expressed in MET-minutes/week as defined below.

#### 5.2 MET Values and Formula for Computation of MET-minutes/week

The selected MET values were derived from work undertaken during the IPAQ Reliability Study undertaken in 2000-2001<sup>3</sup>. Using the Ainsworth et al. Compendium (*Med Sci Sports Med* 2000) an average MET score was derived for each type of activity. For example; all types of walking were included and an average MET value for walking was created. The same procedure was undertaken for moderate-intensity activities and vigorous-intensity activities. The following values continue to be used for the analysis of IPAQ data: Walking = 3.3 METs, Moderate PA = 4.0 METs and Vigorous PA = 8.0 METs. Using these values, four continuous scores are defined:

Walking MET-minutes/week = 3.3 \* walking minutes \* walking days

Moderate MET-minutes/week = 4.0 \* moderate-intensity activity minutes \* moderate

days Vigorous MET-minutes/week = 8.0 \* vigorous-intensity activity minutes \*

vigorous-intensity days Total physical activity MET-minutes/week = sum of Walking +

Moderate + Vigorous MET- minutes/week scores.

#### 5.3 Categorical Score

##### Category 1 Low

This is the lowest level of physical activity. Those individuals who not meet criteria for Categories 2 or 3 are considered to have a ‘low’ physical activity level.

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<sup>3</sup> Craig CL, Marshall A, Sjostrom M et al. International Physical Activity Questionnaire: 12 country reliability and validity *Med Sci Sports Exerc* 2003;August

## Category 2 Moderate

The pattern of activity to be classified as 'moderate' is either of the following criteria:

- a) 3 or more days of vigorous-intensity activity of at least 20 minutes per day  
OR
- b) 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day  
OR
- c) 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum Total physical activity of at least 600 MET-minutes/week.

Individuals meeting at least one of the above criteria would be defined as accumulating a minimum level of activity and therefore be classified as 'moderate'. See Section 7.5 for information about combining days across categories.

## Category 3 High

A separate category labelled 'high' can be computed to describe higher levels of participation.

The two criteria for classification as 'high' are:

- a) vigorous-intensity activity on at least 3 days achieving a minimum Total physical activity of at least 1500 MET-minutes/week  
OR
- b) 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum Total physical activity of at least 3000 MET-minutes/week.

See Section 7.5 for information about combining days across categories.

## 5.4 Sitting Question in IPAQ Short Form

The IPAQ sitting question is an additional indicator variable of time spent in sedentary activity and is not included as part of any summary score of physical activity. Data on sitting should be reported as median values and interquartile ranges. To-date there are few data on sedentary (sitting) behaviours and no well-accepted thresholds for data presented as categorical levels.

## 6. Protocol for IPAQ Long Form

The long form of IPAQ asks in detail about walking, moderate-intensity and vigorous-intensity physical activity in each of the four domains. Note: asking more detailed questions regarding physical activity within domains is likely to produce higher prevalence estimates than the more generic IPAQ short form.

## 6.1 Continuous Score

Data collected with the IPAQ long form can be reported as a continuous measure and reported as median MET-minutes. Median values and interquartile ranges can be computed for walking (W), moderate-intensity activities (M), and vigorous-intensity activities (V) within each domain using the formulas below. Total scores may also be calculated for walking (W), moderate-intensity activities (M), and vigorous-intensity activities (V); for each domain (work, transport, domestic and garden, and leisure) and for an overall grand total.

## 6.2 MET Values and Formula for Computation of MET-minutes

### Work Domain

Walking MET-minutes/week at work =  $3.3 * \text{walking minutes} * \text{walking days at work}$

Moderate MET-minutes/week at work =  $4.0 * \text{moderate-intensity activity minutes} * \text{moderate-intensity days at work}$

Vigorous MET-minutes/week at work =  $8.0 * \text{vigorous-intensity activity minutes} * \text{vigorous-intensity days at work}$

Total Work MET-minutes/week = sum of Walking + Moderate + Vigorous MET-minutes/week scores at work.

### Active Transportation Domain

Walking MET-minutes/week for transport =  $3.3 * \text{walking minutes} * \text{walking days for transportation}$

Cycle MET-minutes/week for transport =  $6.0 * \text{cycling minutes} * \text{cycle days for transportation}$

Total Transport MET-minutes/week = sum of Walking + Cycling MET-minutes/week scores for transportation.

### Domestic and Garden [Yard Work] Domain

Vigorous MET-minutes/week yard chores =  $5.5 * \text{vigorous-intensity activity minutes} * \text{vigorous-intensity days doing yard work}$  (Note: the MET value of 5.5 indicates that vigorous garden/yard work should be considered a moderate-intensity activity for scoring and computing total moderate intensity activities.)

Moderate MET-minutes/week yard chores =  $4.0 * \text{moderate-intensity activity minutes} * \text{moderate-intensity days doing yard work}$

Moderate MET-minutes/week inside chores =  $3.0 * \text{moderate-intensity activity minutes} * \text{moderate-intensity days doing inside chores}$ .

Total Domestic and Garden MET-minutes/week = sum of Vigorous yard + Moderate yard + Moderate inside chores MET-minutes/week scores.

### Leisure-Time Domain

Walking MET-minutes/week leisure =  $3.3 * \text{walking minutes} * \text{walking days in leisure}$

Moderate MET-minutes/week leisure =  $4.0 * \text{moderate-intensity activity minutes} * \text{moderate-intensity days in leisure}$

Vigorous MET-minutes/week leisure =  $8.0 * \text{vigorous-intensity activity minutes} * \text{vigorous-intensity days in leisure}$

Total Leisure-Time MET-minutes/week = sum of Walking + Moderate + Vigorous MET-minutes/week scores in leisure.

### Total Scores for all Walking, Moderate and Vigorous Physical Activities

Total Walking MET-minutes/week = Walking MET-minutes/week (at Work + for Transport + in Leisure) Total

Moderate MET-minutes/week total = Moderate MET-minutes/week (at Work + Yard chores + inside chores + in Leisure time) + Cycling Met-minutes/week for Transport + Vigorous Yard chores MET-minutes/week

Total Vigorous MET-minutes/week = Vigorous MET-minutes/week (at Work + in Leisure)

Note: Cycling MET value and Vigorous garden/yard work MET value fall within the coding range of moderate-intensity activities.

### Total Physical Activity Scores

An overall total physical activity MET-minutes/week score can be computed as:

Total physical activity MET-minutes/week = sum of Total (Walking + Moderate + Vigorous) MET-minutes/week scores.

This is equivalent to computing:

Total physical activity MET-minutes/week = sum of Total Work + Total Transport + Total Domestic and Garden + Total Leisure-Time MET-minutes/week scores.

As there are no established thresholds for presenting MET-minutes, the IPAQ Research Committee proposes that these data are reported as comparisons of median values and interquartile ranges for different populations.

## 6.3 Categorical Score

As noted earlier, regular participation is a key concept included in current public health guidelines for physical activity.<sup>4</sup> Therefore, both the total volume and the number of day/sessions are included in the IPAQ analysis algorithms. There are three levels of physical activity proposed to classify populations – ‘low’, ‘moderate’, and ‘high’. The criteria for these levels are the same as for the IPAQ short [described earlier in Section 4.2]

### Category 1 Low

This is the lowest level of physical activity. Those individuals who not meet criteria for Categories 2 or 3 are considered ‘low’.

### Category 2 Moderate

The pattern of activity to be classified as ‘moderate’ is either of the following criteria:

- d) 3 or more days of vigorous-intensity activity of at least 20 minutes per day
- OR
- e) 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day
- OR

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<sup>4</sup> Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of American Medical Association* 1995; 273(5):402-7. and U.S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, The Presidents' Council on Physical Fitness and Sports: Atlanta, GA:USA. 1996.

- f) 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum Total physical activity of at least 600 MET-minutes/week.

Individuals meeting at least one of the above criteria would be defined as accumulating a moderate level of activity. See Section 7.5 for information about combining days across categories.

### Category 3 High

A separate category labelled 'high' can be computed to describe higher levels of participation.

The two criteria for classification as 'high' are:

- a) vigorous-intensity activity on at least 3 days achieving a minimum Total physical activity of at least 1500 MET-minutes/week
- OR
- b) 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum Total physical activity of at least 3000 MET-minutes/week.

See Section 7.5 for information about combining days across categories.

## 6.4 IPAQ Sitting Question IPAQ Long Form

The IPAQ sitting question is an additional indicator variable and is not included as part of any summary score of physical activity. To-date there are few data on sedentary (sitting) behaviours and no well-accepted thresholds for data presented as categorical levels. For the sitting question 'Minutes' is used as the indicator to reflect time spent in sitting rather than MET-minutes which would suggest an estimate of energy expenditure.

IPAQ long assesses an estimate of sitting on a typical weekday, weekend day and time spent sitting during travel (see transport domain questions).

Summary sitting variables include

Sitting Total Minutes/week = weekday sitting minutes\* 5 weekdays + weekend day sitting minutes\* 2 weekend days

Average Sitting Total Minutes/day = (weekday sitting minutes\* 5 weekdays + weekend day sitting minutes\* 2 weekend days) / 7

Note: The above calculation of 'Sitting Total' excludes time spent sitting during travel because the introduction in IPAQ long directs the responder to NOT include this component as it would have already been captured under the Transport section. If a summary sitting variable including time spent sitting for transport is required, it should be calculated by adding the time reported (travelling in a motor vehicle) under transport to the above formula. Care should be taken in reporting these alternate data to clearly distinguish the 'total sitting' variable from a 'total sitting – including transport' variable.

## 7. Data Processing Rules

In addition to a standardized approach to computing categorical and continuous measures of physical activity, it is necessary to undertake standard methods for the cleaning and treatment of IPAQ datasets. The use of different approaches and rules would introduce variability and reduce the comparability of data.

There are no established rules for data cleaning and processing on physical activity. Thus, to allow more accurate comparisons across studies IPAQ Research Committee has established and recommends the following guidelines:

### 7.1 Data Cleaning

- I. Any responses to duration (time) provided in the hours and minutes response option should be converted from hours and minutes into minutes.
- II. To ensure that responses in 'minutes' were not entered in the 'hours' column by mistake during self-completion or during data entry process, values of '15', '30', '45', '60' and '90' in the 'hours' column should be converted to '15', '30', '45', '60' and '90' minutes, respectively, in the minutes column.
- III. In some cases duration (time) will be reported as weekly (not daily) e.g., VWHRS, VWMINS. These data should be converted into an average daily time by dividing by 7.
- IV. If 'don't know' or 'refused' or data are missing for time or days then that case is removed from analysis.

Note: Both the number of days *and* daily time are required for the creation of categorical and continuous summary variables

### 7.2 Maximum Values for Excluding Outliers

This rule is to exclude data which are unreasonably high; these data are to be considered outliers and thus are excluded from analysis. All cases in which the sum total of all Walking, Moderate and Vigorous time variables is greater than 960 minutes (16 hours) should be excluded from the analysis. This assumes that on average an individual of 8 hours per day is spent sleeping.

The 'days' variables can take the range 0-7 days, or 8, 9 (don't know or refused); values greater than 9 should not be allowed and those cases excluded from analysis.

### 7.3 Minimum Values for Duration of Activity

Only values of 10 or more minutes of activity should be included in the calculation of summary scores. The rationale being that the scientific evidence indicates that episodes or bouts of at least 10 minutes are required to achieve health benefits. Responses of less than 10 minutes [and their associated days] should be re-coded to 'zero'.

#### 7.4 Truncation of Data Rules

This rule attempts to normalize the distribution of levels of activity which are usually skewed in national or large population data sets.

In IPAQ short - it is recommended that all Walking, Moderate and Vigorous time variables exceeding '3 hours' or '180 minutes' are truncated (that is re-coded) to be equal to '180 minutes' in a new variable. This rule permits a maximum of 21 hours of activity in a week to be reported for each category (3 hours \* 7 days).

In IPAQ long – the truncation process is more complicated, but to be consistent with the approach for IPAQ short requires that the variables total Walking, total Moderate- intensity and total Vigorous-intensity activity are calculated and then, for each of these summed behaviours, the total value should be truncated to 3 hours (180 minutes).

When analysing the data as categorical variable or presenting median and interquartile ranges of the MET-minute scores, the application of the truncation rule will not affect the results. This rule does have the important effect of preventing misclassification in the 'high' category. For example, an individual who reports walking for 10 minutes on 6 days and 12 hours of moderate activity on one day could be coded as 'high' because this pattern meets the '7 day' and "3000 MET-min" criteria for 'high'. However, this uncommon pattern of activity is unlikely to yield the health benefits that the 'high' category is intended to represent.

Although using median is recommended due to the skewed distribution of scores, if IPAQ data are analysed and presented as a continuous variable using mean values, the application of the truncation rule will produce slightly lower mean values than would otherwise be obtained.

#### 7.5 Calculating MET-minute/week Scores

Data processing rules 7.2, 7.3, and 7.4 deals first with excluding outlier data, then secondly, with recoding minimum values and then finally dealing with high values. These rules will ensure that highly active people remain classified as 'high', while decreasing the chances that less active individuals are misclassified and coded as 'high'.

Using the resulting variables, convert time and days to MET-minute/week scores [see above Sections 5.2 and 6.2; METS x days x daily time].

#### 7.6 Calculating Total Days for Presenting Categorical Data on Moderate and High Levels

Presenting IPAQ data using categorical variables requires the total number of 'days' on which all physical activity was undertaken to be assessed. This is difficult because frequency in 'days' is asked separately for walking, moderate-intensity and vigorous- intensity activities, thus allowing the total number of 'days' to range from a minimum

of 0 to a maximum of 21 'days' per week in IPAQ short and higher in IPAQ long. The IPAQ instrument does not record if different types of activity are undertaken on the same day.

In calculating 'moderately active', the primary requirement is to identify those individuals who undertake activity on at least '5 days'/week [see Sections 4.2 and 5.3]. Individuals who meet this criterion should be coded in a new variable called "*at least five days*" and this variable should be used to identify those meeting criterion b) at least 30 minutes of moderate-intensity activity and/or walking; and those meeting criterion c) any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of 600 MET-minutes/week.

Below are two examples showing this coding in practice:

- i) an individual who reports '2 days of moderate-intensity' and '3 days of walking' should be coded as a value indicating "*at least five days*";
- ii) an individual reporting '2 days of vigorous-intensity', '2 days of moderate-intensity' and '2 days of walking' should be coded as a value to indicate "*at least five days*" [even though the actual total is 6].

The original frequency of 'days' for each type of activity should remain in the data file for use in the other calculations.

The same approach as described above is used to calculate total days for computing the 'high' category. The primary requirement according to the stated criteria is to identify those individuals who undertake a combination of walking, moderate-intensity and or vigorous-intensity activity on at least 7 days/week [See section 4.2].

Individuals who meet this criterion should be coded as a value in a new variable to reflect "*at least 7 days*".

Below are two examples showing this coding in practice:

- i) an individual who reports '4 days of moderate-intensity' and '3 days of walking' should be coded as the new variable "*at least 7 days*".
- ii) an individual reporting '3 days of vigorous-intensity', '3 days moderate-intensity' and '3 days walking' should be coded as "*at least 7 days*" [even though the total adds to 9] .

## 8. Summary algorithms

The algorithms in Appendix 1 and Appendix 2 to this document show how these rules work in an analysis plan, to develop the categories 1 [Low], 2 [Moderate], and 3 [High] levels of activity.

## APPENDIX 1

### At A Glance IPAQ Scoring Protocol (Short Forms)

#### Continuous Score

Expressed as MET-min per week: MET level x minutes of activity/day x days per week

#### *Sample Calculation*

MET levels	MET-minutes/week for 30 min/day, 5 days
Walking = 3.3 METs	$3.3 * 30 * 5 = 495$ MET-minutes/week Moderate Intensity
= 4.0 METs	$4.0 * 30 * 5 = 600$ MET-minutes/week Vigorous Intensity = 8.0 METs
$8.0 * 30 * 5 = 1,200$ MET-minutes/week	

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TOTAL = 2,295 MET-minutes/week

Total MET-minutes/week = Walk (METs\*min\*days) + Mod (METs\*min\*days) + Vig (METs\*min\*days)

Categorical Score- three levels of physical activity are proposed

1. Low

- No activity is reported OR
- Some activity is reported but not enough to meet Categories 2 or 3.

2. Moderate

Either of the following 3 criteria

- 3 or more days of vigorous activity of at least 20 minutes per day OR
- 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day OR
- 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of at least 600 MET-minutes/week.

3. High

Any one of the following 2 criteria

- Vigorous-intensity activity on at least 3 days and accumulating at least 1500 MET-minutes/week OR
- 7 or more days of any combination of walking, moderate- or vigorous-intensity activities accumulating at least 3000 MET-minutes/week

Please review the full document “Guidelines for the data processing and analysis of the International Physical Activity Questionnaire” for more detailed description of IPAQ analysis and recommendations for data cleaning and processing [[www.ipaq.ki.se](http://www.ipaq.ki.se)].

## APPENDIX 2

### At A Glance

#### IPAQ Scoring Protocol (Long Forms)

##### Continuous Score

Expressed as MET-minutes per week: MET level x minutes of activity/day x days per week

##### *Sample Calculation*

MET levels	MET-minutes/week for 30 min/day, 5 days
Walking at work= 3.3 METs	$3.3*30*5 = 495$ MET-minutes/week
transportation= 6.0 METs	$6.0*30*5 = 900$ MET-minutes/week
Moderate yard work= 4.0 METs	$4.0*30*5 = 600$ MET-minutes/week
Vigorous intensity in leisure= 8.0 METs	$8.0*30*5 = 1,200$ MET-minutes/week

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TOTAL = 3,195 MET-minutes/week

##### Domain Sub Scores

Total MET-minutes/week at work = Walk (METs\*min\*days) + Mod (METs\*min\*days) + Vig (METs\*min\*days) at work

Total MET-minutes/week for transportation = Walk (METs\*min\*days) + Cycle (METs\*min\*days) for transportation

Total MET-minutes/week from domestic and garden = Vig (METs\*min\*days) yard work + Mod (METs\*min\*days) yard work + Mod (METs\*min\*days) inside chores

Total MET-minutes/week in leisure-time = Walk (METs\*min\*days) + Mod (METs\*min\*days) + Vig (METs\*min\*days) in leisure-time

##### Walking, Moderate-Intensity and Vigorous-Intensity Sub Scores

Total Walking MET-minutes/week = Walk MET-minutes/week (at Work + for Transport + in Leisure)

Total Moderate MET-minutes/week = Cycle MET-minutes/week for Transport + Mod MET- minutes/week (Work + Yard chores + Inside chores + Leisure) + Vigorous Yard chores MET- minutes

Note: The above is a total moderate activities only score. If you require a total of all moderate-intensity physical activities you would sum Total Walking and Total Moderate

Total Vigorous MET-minutes/week = Vig MET-minutes/week (at Work + in Leisure) Total Physical

##### Activity Score

Total Physical Activity MET-minutes/week = Walking MET-minutes/week + Moderate MET- minutes/week + Total Vigorous MET-minutes/week

Continued.....

Also

Total Physical Activity MET-minutes/week = Total MET-minutes/week (at Work + for Transport + in Chores + in Leisure)

Categorical Score- three levels of physical activity are proposed

1. Low

No activity is reported OR

- a. Some activity is reported but not enough to meet Categories 2 or 3.

2. Moderate

Either of the following 3 criteria

- a. 3 or more days of vigorous-intensity activity of at least 20 minutes per day OR
- b. 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day OR
- c. 5 or more days of any combination of walking, moderate-intensity or vigorous- intensity activities achieving a minimum of at least 600 MET-min/week.

3. High

Any one of the following 2 criteria

- Vigorous-intensity activity on at least 3 days and accumulating at least 1500 MET-minutes/week OR
- 7 or more days of any combination of walking, moderate- or vigorous- intensity activities accumulating at least 3000 MET-minutes/week

Please review the full document “Guidelines for the data processing and analysis of the International Physical Activity Questionnaire” for more detailed description of IPAQ analysis and recommendations for data cleaning and processing [[www.ipaq.ki.se](http://www.ipaq.ki.se)].

## Appendix D

### The range levels of Blood parameters

Blood Parameter	SI Units (International system)	Traditional Units (USA)
Glucose	3.3 – 5.8 mmol/L	59 – 105 mg/dL
Insulin	36 – 179 pmol/L	5 – 25 $\mu$ U/L
Glucagon	50 – 200 ng/L	50 200 pg/mL
Cortisol	nmol/L	$\mu$ g/dl
Time: am	110 – 607	5 – 25
Time: pm	83 – 469	3.1 – 16.7
Albumin	35 – 50 g/L	3.5 – 5.0 g/dL
Total Protein	60 – 80 g/L	6.0 – 8.0 g/dL
Total Cholesterol	mmol/L	
Desirable	>5.2	> 200
Borderline	5.3 – 6.2	201- 239
high	< 6.2	< 240
Triglycerides	mmol/L	mg/dL
Desirable	>5.2	> 150
Borderline	5.3 – 6.2	150- 199
high	< 6.2	< 199
Low density lipoprotein (LDL)	mmol/L	mg/dL
Desirable	>5.2	> 130
Borderline	5.3 – 6.2	130 – 159
high	< 6.2	< 195
High density lipoprotein (HDL)	mmol/L	mg/dL
Desirable	>5.2	> 130
Borderline	5.3 – 6.2	130 – 159
high	< 6.2	< 195
Very low density lipoprotein	0.128 – 0.645 mmol/L	5 – 40 mg/dL