ORIGINAL ARTICLE

EFFECT OF RAMADAN FASTING ON POST-EXERCISE HEART RATE RECOVERY AT TWO MINUTES AND BODY COMPOSITION IN HEALTHY MALE ADULTS

Abida Shaheen, Fahad Azam, Afrose Liaquat*, Khurram Irshad, Hania Ahmer***, Hania Naveed†**

Department of Pharmacology, *Biochemistry, **Physiology, ***Student, †Pathology, Shifa College of Medicine, Shifa Tameer-e-Millat University, Islamabad, Pakistan

Background: The effects of Ramadan fasting on weight loss are well-known but its effects on heart rate recovery after 2 minutes (HRR2) have not been investigated. The present study aims to observe the effects of Ramadan fasting on body composition variables and post-exercise heart rate recovery after two minutes of rest. **Methods:** A prospective, observational study was conducted from April 2019 to July 2020. Sixty-four healthy male participants aged 26 to 53 years were enrolled on the first day of the fasting in the Islamic month of Ramadan and were followed up for two weeks. Baseline anthropometric measurements and body composition measurements were recorded on day 1 of Ramadan in a fasting state. Peak heart rate and heart rate recovery were recorded immediately after exercise and after two minutes of rest. Blood pressure was also recorded after cessation of exercise. After fourteen days of fasting, anthropometric measurements and aforementioned readings with repeat exercise protocol were recorded. **Results:** Mean BMI, waist circumference and body fat ratio of the study participants reduced significantly after fourteen days of Ramadan fasting. The resting heart rate of the study participants was significantly reduced from 74.5±9.7 to 68.4±10.7 bpm (p<0.001). HRR2 of rest significantly increased from 22.9±11.7 to 30.3±13.7 bpm (p=0.001). None of the smokers showed an improvement in heart rate recovery after two minutes of rest. **Conclusion:** Ramadan fasting resulted in significant improvement in body fat ratio, BMI, waist circumference and heart rate recovery after two minutes of rest in healthy adult males.

Keywords: BMI, body composition, fasting, heart rate recovery

Pak J Physiol 2022;18(2):10–4

INTRODUCTION

Fasting has recently generated great interest to combat obesity as a feasible and sustainable strategy as it has shown healthy weight loss with the preservation of muscle mass. There are many variations of fasting which allow normal food and drink consumption in eating windows interposed by periods of energy restriction or fasting to create a state of negative energy balance for weight loss.[1,2] Moreover, accelerated fat loss is associated with several advantages such as improvement in insulin sensitivity, blood sugar, systolic and diastolic blood pressure, total serum cholesterol, inflammatory biomarkers and low-density lipoprotein (LDL).[3,4] There are many approaches for intermittent fasting such as 5:2 modified fasting regimens, alternate day fasting, time-restricted feeding, and religious fasting. One popular version of this approach is the 16:8 fasting protocol with an eating window of eight hours and abstinence from food for 16 hours per day.[5,6]

Fasting is also observed as a religious duty in some cultures and religions. Fasting for 29–30 days is observed by Muslims throughout the world in the lunar month of Ramadan and depending on the season and geographical location of the country, fasting duration can fluctuate from 11 to 22 hours.[7] Though the principle of energy restriction employed by intermittent fasting is not applicable in Islamic fasting, however time-restricted feeding during Ramadan can lead to changes in metabolic and cardiovascular parameters.[8]

The effect of Ramadan fasting on overall health may be assessed by many simple and noninvasive tools such as body mass index (BMI) and body fat ratio (BFR). Post-exercise heart rate recovery (HRR) is another simple and non-invasive method to assess cardiac health by the speed of recovery of heart rate back to normal in a given time after exercise. An abnormal heart rate recovery is defined as less than 12 beats/min (bpm) or less than 22 bpm at 1 and 2 min respectively.[9] Studies have shown that a decrease in body fat ratio by dietary programs leads to improvement in resting heart rate and post-exercise HRR.[10,11] Previous literature has suggested the effect of Ramadan fasting on body composition, biochemical variables, blood pressure and heart rate variability, but to the best of our knowledge, the effect of fasting on HRR2 in healthy volunteers has not been evaluated yet.[12–15] Fasting might prove to be a noninvasive strategy for the improvement of HRR2 and could be employed to improve the overall health of cardiometabolic patients.

The objective of our study was to investigate the effect of Ramadan fasting on weight loss, fat loss and post-exercise heart rate recovery as a non-invasive indicator of cardiovascular health.

METHODOLOGY

This was a prospective observational study and carried out in the lunar month of Ramadan. Ethical approval was sought from Institutional Review Board and Ethics Committee (IRB#903-178-2017) and complied with the ethical standards laid down by the Helsinki declaration of 1964 and its later amendments. Sixty-four faculty and staff male members from our university who fasted in the month of Ramadan volunteered for this study. Written informed consent was obtained from all study participants. Participants with hypertension, diabetes mellitus, cardiovascular or respiratory disorders or any other disorder susceptible to sudden weight loss or gain in body weight in the past three months were excluded from the study on initial interviews. The participants were enrolled on the first day of the fasting lunar month and were followed up for two weeks after recording baseline data. We did not recruit any female participants in this study as Muslim females do not fast during the menstrual phase of the menstrual cycle and there was a possibility of many female participants discontinuing fasting during the study period.

We took baseline anthropometric measurements of every male participant such as weight, height, waist circumference and BMI on the first day of fasting in fasting state. Body composition measurements such as body fat, lean muscle mass and weight of each participant were recorded by a leg-to-leg bioelectrical impedance commercial glass body composition analyzer (Beurer living glass diagnostic scale BG-42). Height was measured with the help of a vertical stadiometer. BMI was calculated using the formula of body weight (Kg)/height $(m)^2$. Participants were categorized into three groups: 18.5–22.9 Kg/m^2 (normal weight), 23–27.5 Kg/m^2 (overweight) and ≥27.5 Kg/m^2 (obese) according to WHO recommended BMI cut-off points for Asians.[16] Waist circumference was measured in Cm to the nearest decimal by using a tape measure.

Systolic and diastolic blood pressure, resting heart rate was measured before exercise. Fitbit Charge 3 device was used for continuous monitoring of heart rate before and after exercise. Details of the exercise protocol have been mentioned in our previously published findings from the same study project in which we have reported the association of HRR2 with body composition variables.[17] The participants were asked to stop walking and take a rest in case they experienced breathlessness, palpitations, leg cramps and dizziness. The peak heart rate of participants was recorded immediately after exercise and after two minutes. Blood pressure was also recorded after cessation of exercise. HRR2 was calculated by measuring the difference between the peak heart rate immediately post-exercise and after resting for two minutes. A difference of less than 22 bpm after two minutes was considered as an impaired heart rate recovery.[9]

According to the Islamic calendar based on the lunar cycle average duration of fasting was 16 hours per day in Ramadan in Pakistan in the year 2019. Subjects consumed food without calorie restriction in the eating window of non-fasting eight hours per day. After fourteen days of fasting weight, height, waist circumference, BMI and body compositions were measured again. The exercise protocol was repeated and all the readings of blood pressure, resting heart rate, peak heart rate and HRR2 were recorded.

Collected data were analyzed using Statistical Package for Social Sciences (SPSS-23) program. Shapiro-Wilk test was applied to data for normality. Students' *t*-test and Wilcoxon signed-rank test were applied for comparison between different groups for normally distributed data and non normally distributed data respectively. Continuous variables were specified in Mean±SD. Categorical variables were described as frequencies, percentages and computed by Chi-square and Fisher's exact test considering $p \leq 0.05$ as statistically significant.

RESULTS

All the recruited participants completed the fasting for fourteen days and there were no dropouts. The mean age of the participants was 35.5±6.6 years. There was a statistically significant decrease in weight, BMI, waist circumference, body fat ratio, blood pressure, and resting heart rate. There was a statistically significant increase in HRR2 after two weeks of fasting. Effects of fasting on baseline parameters and pre and post-exercise variables are shown in Table-1.

There was a significant increase in the HRR2 of all participants but the recovery was more pronounced in participants with BMI <23. Improvement in HRR2 in participants with body fat ratio <25 and moderate physical activity was statistically significant. Changes in heart rate recovery after fourteen days of fasting according to baseline body composition variables and level of physical activity are summarized in Table-2.

Body fat ratio <25 and non-smokers showed a significant association with the increase of ≥20 bpm in HRR2. Association of HRR2 less and more than 20 beats per minute with body fat ratio, BMI, smoking and physical activity are shown in Table-3.

Table-1: Bodyweight, body composition variables, blood pressure, HRR on 1st day and 14th day of fasting

Variables	1st day of fasting (Mean±SD)	14th day of fasting (Mean±SD)	Percent change from baseline	*p*
Weight (Kg)	74.5±11.5	73.2±11.3	-1.7	<0.001*
BMI (Kg/m^2)	25.4±3.9	24.9±3.8	-1.9	<0.001*
†Waist circumference (Cm)	94.4±10.4	91.1±8.2	-3.5	<0.001*
†Body fat (%)	26.1±7.1	22.7±6.4	-13	<0.001*
Systolic BP (mmHg)	121.6±12.3	116.3±6.2	-4.4	0.001*
†Diastolic BP (mmHg)	83.6±8.7	79.1±8.1	-5.4	<0.001*
Mean BP (mmHg)	102.6±9.6	97.7±6.1	-4.8	<0.001*
†Resting HR (bpm)	74.5±9.7	68.4±10.7	-8.2	<0.001*
Peak HR after exercise (bpm)	98.9±10.0	98.2±11.8	-0.7	0.62
†HR after 2 mins of rest (bpm)	76.0±12.87	67.88±13.49	-10.68	< 0.001*
HRR2 (bpm)	22.9±11.7	30.3 ± 13.7	+32.3	0.001*

BMI: Body Mass Index, BP: Blood Pressure, HR: Heart Rate, HRR2: Heart Rate Recovery after two minutes, *Significant, †Wilcoxon signed-rank test

Table-2: Changes in HRR2 after fourteen days of fasting according to body composition variables and physical activity

Variables	Participants n (%)	HRR on 1st day of fasting (Mean±SD)	HRR on the 14th day of fasting (Mean±SD)	Percent change from baseline	*p*
BMI <23	22 (34.4)	20.7±11.0	30.7±12.2	48.3	0.008*
BMI ≥23	42 (65.6)	24.1±12.0	30.1±14.5	24.9	0.026*
BMI <25	30 (46.9)	20.6±12.2	30.7±11.1	49.0	0.002*
BMI ≥25	34 (53.1)	25±10.9	29.9±15.7	19.6	0.096
Fat <25†	22 (34.4)	19.5±11.0	33.7±10.7	72.8	<0.001*
Fat ≥25†	42 (65.6)	24.8±11.7	28.5±14.8	14.9	0.155
Sedentary lifestyle	36 (56.3)	22.6±10.9	27.6±14.6	22.1	0.084
Moderate physical activity	18 (28.1)	24.8±14.8	34.6 ±9.9	39.5	0.004*
Regular physical activity	10 (15.6)	21.0±8.0	32.6 ±14.9	55.2	0.119

*p<0.05, †Wilcoxon signed-rank test

Table-3: Increase in HRR2<20 bpm and ≥20 bpm in participants with different BMI, body fat ratio, smoking and physical activity status

Variables	Increase in HRR2 <20 bpm (n=46), n (%)	Increase in HRR2 ≥20 bpm (n=18), n (%)	*p*
BMI <23	14 (21.9)	8 (12.5)	0.289
BMI ≥23	32 (50)	10 (15.6)	
BMI <25	20 (31.3)	10 (15.6)	0.384
BMI ≥25	26 (40.6)	8 (12.5)	
Body fat ratio <25	12 (18.8)	10 (15.6)	0.026*
Body fat ratio ≥25	34 (53.1)	8 (12.5)	
Non smokers†	36 (56.3)	18 (28.1)	0.031*
Smokers	10 (15.6)	0	
Sedentary lifestyle	26 (40.6)	10 (15.6)	
Moderate physical activity	14 (21.9)	4 (6.3)	0.590
Active lifestyle	6 (9.4)	4 (6.3)	

*p<0.05, †Fisher's exact test

DISCUSSION

Intermittent fasting has shown success as a potential strategy for weight loss and fat reduction.[1] Several trials to evaluate the effects of fasting in humans have shown promising results as fasting preserves muscle mass and has an overall positive effect on body composition variables and heart rate variability.[5,14] In this study we investigated the effect of Ramadan fasting on body composition variables and post-exercise heart rate recovery as a non-invasive indicator of cardiovascular health. Overall, Ramadan fasting had a significant impact on the mean BMI, waist circumference, body fat ratio and HRR2 of our study participants. Heart rate recovery after two minutes of rest significantly increased from 22.9±11.7 to 30.3±13.7 bpm (p=0.001).

The results of our study showed that fasting greatly helped in weight loss and reduction in body fat and resulted in a significant increase in heart rate recovery in most of the participants without any attempt to influence physical activity and diet patterns. We observed a significant decrease in the mean weight, BMI, body fat ratio and waist circumference of all study participants who fasted for fourteen days. Our findings are in agreement with previous similar studies which have reported significant weight loss and reduction in body fat ratio and waist circumference after few days of fasting.[18,19]

There was significant improvement in cardiovascular variables including systolic blood pressure, diastolic blood pressure, resting heart rate and

HRR2. Our findings are in contrast to a recent study conducted in Turkey to observe the effect of Ramadan fasting which did not show significant improvement in resting heart rate and blood pressure.[18] Similarly a study conducted in Ajman, UAE also reported a decrease in weight and BMI but did not show significant changes in systolic and diastolic blood pressures which could be due to the recruitment of patients with metabolic syndrome.[20] However, a recent metaanalysis of 70 studies measuring the effect of Ramadan fasting reported consistent albeit transient reduction in weight and body composition.[19]

To our knowledge, the effect of fasting on resting heart rate and heart rate recovery has not been explored yet in healthy volunteers or any patient population. Various studies have explored the contribution of different predictors in abnormal heart rate recovery; a study conducted by Panzer *et al*[21] established the significant association of impaired fasting plasma glucose levels with abnormal heart recovery. Another study[22] demonstrated association of weight loss with significant improvement in HRR1 with no changes in peak heart rate.

Our study participants who had lower body fat ratio and BMI at baseline showed greater improvement in HRR2 after 14 days of fasting in comparison to participants with higher BMI and body fat ratio. Though individuals with both higher and lower BMI and body fat ratio at baseline showed significant improvement in HRR2, the improvement was more marked in the group with already better BMI and body fat ratio at baseline. Our findings are in agreement with the results of a previous study that showed a negative correlation of significant weight loss with heart rate recovery in gastric bypass patients.[23]

In the present study, participants with a sedentary or moderately active lifestyle showed significant improvement in HRR2 but participants who reported regular physical activity did not show significant improvement in HRR2. The changes in HRR2 after Ramadan fasting have not been evaluated, but one previous study has shown significant improvement in HRR2 in cardiac rehabilitation patients after a structured exercise program.[9] A similar study correlated improved HRR with an exercise training program in patients after anterior myocardial infarction.[24] Possible reasons for less improvement in HRR2 in our participants with an active lifestyle could be the fact that these participants already had cardiovascular adaptations as a result of metabolic and molecular remodelling associated with exercise.[25]

None of the smokers showed a significant increase of >20 bpm in HRR2 after the 14-day fasting which shows that even if fasting results in weight loss or a decrease in body fat, this improvement in body composition is less likely to be accompanied by an improvement in HRR2. Participants of our study with a body fat ratio of more than 25 at baseline were less likely to experience improvement in HRR2.

We acknowledge our study limitations in terms of a small cohort of participants that could not be reflective of the entire population and inclusion of apparently healthy males and exclusion of females. Since the main aim of the study was to explore the effects of fasting on HRR and to identify different parameters associated with abnormal heart rate recovery, it was not possible to recruit patients with cardiovascular disease, metabolic syndrome, hormonal imbalances, pregnant and breastfeeding women to avoid hazardous effects of fasting in such population.

CONCLUSION

Significant improvement in HRR2, body fat ratio, BMI and waist circumference was observed in healthy adult males after 14 days of Ramadan fasting. Randomized controlled trials with longterm follow-up periods are needed to see the impact of intermittent fasting on overall fitness and the time of onset of any cardiovascular or metabolic disease in healthy individuals. Carefully designed studies may involve individuals with cardiovascular risk factors or diabetes mellitus to explore the effects of intermittent fasting on cardiovascular fitness.

ACKNOWLEDGEMENT

The authors would like to express their gratitude to the study participants for their participation and full compliance with the study protocol.

REFERENCES

1. Patterson RE, Laughlin GA, LaCroix AZ, Hartman SJ, Natarajan L, Senger CM, *et al*. Intermittent fasting and human metabolic health. J Acad Nutr Diet 2015;115(8):1203–12.
2. Hill JO, Wyatt HR, Peters JC. Energy balance and obesity. Circulation 2012;126(1):126–32.
3. Templeman I, Thompson D, Gonzalez J, Walhin JP, Reeves S, Rogers PJ, *et al*. Intermittent fasting, energy balance and associated health outcomes in adults: study protocol for a randomised controlled trial. Trials 2018;19(1):86.
4. Galani C, Schneider H. Prevention and treatment of obesity with lifestyle interventions: Review and meta-analysis. Int J Public Health 2007;52(6):348–59.
5. Moro T, Tinsley G, Bianco A, Marcolin G, Pacelli QF, Battaglia G, *et al*. Effects of eight weeks of time-restricted feeding (16/8) on basal metabolism, maximal strength, body composition, inflammation, and cardiovascular risk factors in resistance-trained males. J Transl Med 2016;14(1):290.
6. Gabel K, Hoddy KK, Haggerty N, Song J, Kroeger CM, Trepanowski JF, *et al*. Effects of 8-hour time restricted feeding on body weight and metabolic disease risk factors in obese adults: A pilot study. Nutr Heal Aging 2018;4:345–53.
7. Trepanowski JF, Bloomer RJ. The impact of religious fasting on human health. Nutr J 2010;9:57.
8. Sadeghirad B, Motaghipisheh S, Kolahdooz F, Zahedi MJ, Haghdoost AA. Islamic fasting and weight loss: A systematic review and meta-analysis. Public Health Nutr 2014;17:396–406.
9. Jolly MA, Brennan DM, Cho L. Impact of exercise on heart rate recovery. Circulation 2011;124(14):1520–6.

10. Malinowski B, Zalewska K, Węsierska A, Sokołowska MM, Socha M, Liczner G, *et al*. Intermittent fasting in cardiovascular disorders —an overview. Nutrients 2019;11(3):673.
11. Kim MK. Effects of low calorie diet-induced weight loss on post-exercise heart rate recovery in obese men. J Exerc Nutr Biochem 2014;18(2):181–8.
12. Akkoca M, Metin ZE, Topaloğlu O, Tokgöz S, Cihan G, Şan İ. An evaluation of the effects of Ramadan fasting on anthropometric, metabolic and endocrine parameters. Prog Nutr 2018;20(3):503–9.
13. Fahrial Syam A, Suryani Sobur C, Abdullah M, Makmun D. Ramadan Fasting Decreases Body Fat but Not Protein Mass. Int J Endocrinol Metab 2016;14(1):e29687.
14. Cansel M, Taşolar H, Yağmur J, Ermiş N, Açıkgöz N, Eyyüpkoca F, *et al*. The effects of Ramadan fasting on heart rate variability in healthy individuals: a prospective study. Anadolu Kardiyol Derg 2014;14(5):413–6.
15. Samad F, Qazi F, Pervaiz MB, Kella DK, Mansoor M, Osmani BZ, *et al*. Effects of Ramadan fasting on blood pressure in normotensive males. J Ayub Med Coll Abbottabad 2015;27(2):338–42.
16. Misra A. Ethnic-specific criteria for classification of body mass index: A perspective for Asian Indians and American Diabetes Association Position Statement. Diabetes Technol Ther 2015;17(9):667–71.
17. Azam F, Shaheen A, Irshad K, Liaquat A, Naveed H, Shah SU. Association of postexercise heart rate recovery with body composition in healthy male adults: Findings from Pakistan. Ann Noninvasive Electrocardiol 2019;25(3):e12711.
18. Sezen Y, Altiparmak IH, Erkus ME, Kocarslan A, Kaya Z, Günebakmaz O, *et al.* Effects of Ramadan fasting on body composition and arterial stiffness. J Pak Med Assoc 2016;66(12):1522–7.
19. Fernando HA, Zibellini J, Harris RA, Seimon RV, Sainsbury A. Effect of ramadan fasting on weight and body composition in healthy non-athlete adults: A systematic review and meta-analysis. Nutrients 2019;11(2):478.
20. Sadiya A, Ahmed S, Siddieg HH, Babas IJ, Carlsson M. Effect of Ramadan fasting on metabolic markers, body composition, and dietary intake in Emiratis of Ajman (UAE) with metabolic syndrome. Diabetes Metab Syndr Obes 2011;4:409–16.
21. Panzer C, Lauer MS, Brieke A, Blackstone E, Hoogwerf B. Association of fasting plasma glucose with heart rate recovery in healthy adults: A population-based study. Diabetes 2002;51(3):803–7.
22. Brinkworth GD, Noakes M, Buckley JD, Clifton PM. Weight loss improves heart rate recovery in overweight and obese men with features of the metabolic syndrome. Am Heart J 2006;152(4):693.
23. Wasmund SL, Owan T, Yanowitz FG, Adams TD, Hunt SC, Hamdan MH, *et al*. Improved heart rate recovery after marked weight loss induced by gastric bypass surgery: Two-year follow up in the Utah Obesity Study. Heart Rhythm 2011;8(1):84–90.
24. Elshazly A, Khorshid H, Hanna H, Ali A. Effect of exercise training on heart rate recovery in patients post anterior myocardial infarction. Egypt Hear J 2018;70(4):283–5.
25. Nystoriak MA, Bhatnagar A. Cardiovascular effects and benefits of exercise. Front Cardiovasc Med 2018;5:135.

Addresss for Correspondence:

Hania Ahmer, Shifa College of Medicine, Shifa Tameer-e-Millat University, Pitras Bukhari Road, Sector H-8/4, Islamabad-44000, Pakistan. **Cell:** +92-303-9113342
Email: haniaahmer9917@gmail.com

Received: 9 May 2021 **Reviewed:** 7 Jun 2022 **Accepted:** 7 Jun 2022

Contribution of Authors:

AS: Concept, Methodology, Data curation, Original draft preparation, Validation
FA: Concept, Methodology, Data curation, Original draft preparation, Validation
AL: Data curation**,** Methodology, Original draft preparation
KI: Data curation**,** Revision and Editing
HA: Data curation**,** Methodology, Revision
HN: Visualization, Methodology, Supervision

Conflict of interest: None to declare.
Funding/Support: None to declare.