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Health Benefits of Islamic Intermittent Fasting

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ABSTRACT

Introduction: Islamic fasting is observed by millions of Muslims across the world during the holy month of Ramadan and other specific days of the lunar year. Fasting Muslims abstain from eating and drinking from dawn until sunset. Depending on season and geographical location, Muslims maintain fasting for approximately 13-18 hours per day. The present study aimed to review the benefits of Islamic fasting.

Methods: This literature review was conducted via searching in databases like Medline, PubMed, PMC, Google Scholar, ScienceDirect, and reference lists of relevant articles using keywords like health benefits, Islamic fasting, intermittent fasting, alternate-day fasting, time-restricted feeding, and Ramadan intermittent fasting.

Results: Islamic fasting could be considered as intermittent fasting as it is similar to alternate-day fasting and time-restricted feeding. Intermittent fasting is associated with numerous health benefits.

Conclusion: According to this review, some of the main health benefits of Islamic fasting include weight loss, attenuation of metabolic markers (e.g., insulin resistance, blood glucose, and blood pressure), improved lipid profile, prevention of chronic problems (e.g., obesity, diabetes, cardiovascular diseases, and cancer), protection against neurodegeneration, and diminished inflammation.

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Introduction

Islam has five pillars including faith, prayers, alms, fasting, and pilgrimage (1). According to Prophet Muhammad (PBUH), Islamic fasting is a shield to protect believers against sins and lustful desires. Muslims who practice Islamic fasting abstain from eating, drinking, smoking, and sexual intercourse from Sahur (predawn meal) to Iftar (sunset meal). The believers of Islam, practice fasting during the holy month of Ramadan and other specific days of the lunar year as an obligatory task (2).

Islamic fasting is associated with some health discomforts, like headaches, heartburn, constipation, dehydration, anemia, and poor sleep quality (2). Therefore, fasting Muslims are recommended to follow preventive measures in order to minimize the adverse effects of fasting. These individuals must adhere to a balanced diet containing fruits and vegetables, pulses, whole grains, meat, fish, and dairies. In addition, they need to drink fluids abundantly, such as water, fresh juices, and soups, during the interval between Iftar and Sahur. Fasting Muslims are advised to avoid deep-fried foods , sweets, fatty foods, refined carbohydrates, salty foods, and caffeinated and carbonated drinks (2).

Intermittent Fasting

Intermittent fasting (IF) is a dietary pattern, in which the fasting and feasting periods occur in a cycle (3). IF may include alternate -day fasting (ADF) and time-restricted feeding (TRF). ADF consists of 24 hours of fasting and 24 hours

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of feasting (4). In this regard, Islamic fasting is similar to ADF since the feasting and fasting periods in Islamic fasting range between 12-18 hours on average depending on the season and geographical area (5).

TRF is a type of IF, in which the individual intakes a whole day of calories within approximately eight hours, while spending the remaining hours fasting (6). Islamic fasting is also similar to TRF since the believers of Islam fast from sunrise to sunset and feast only at night (approximately eight hours). Therefore, Islamic fasting could be considered as intermittent fasting as it is similar to ADF and TRF.

The present study aimed to review the health benefits of Islamic fasting in the holy month of Ramadan.

Material and methods

This literature review was conducted via searching in databases such as Medline, PubMed, PMC, ScienceDirect, Google scholar, and reference lists of relevant articles using keywords such as health benefits, Islamic fasting, intermittent fasting, alternate-day fasting, time-restricted feeding, and Ramadan intermittent fasting.

Results

Islamic IF has been associated with several metabolic health benefits, including weight loss, reduced insulin resistance, decreased blood glucose, reduced blood pressure, and improved lipid profile (Table 1). Moreover, Islamic IF results in the cardiac protection, prevention and treatment of obesity, diabetes, and cancer, protection against neurodegeneration, reduction of inflammation, promotion of health span, and extension of lifespan (Table 2).

Discussion

Metabolic Health Benefits

Insulin resistance, obesity, hyperglycemia, hypertension, hypertriglyceridemia, and low high-density lipoprotein cholesterol (HDLc) characterize metabolic syndrome (7). Metabolic syndrome is primarily caused by insulin resistance and obesity and increases the risk of cardiovascular disease (CVD), diabetes type II , coronary heart disease (CHD), stroke, vascular dysfunction, polycystic ovary syndrome (PCOS), fatty liver disease, cholesterol gallstones, asthma, sleep disturbances, breast cancer, pancreatic cancer, and colorectal cancer (8-12).

IF consisting of ADF, TRF and Ramadan fasting exerts positive effects on metabolic markers (13). Ramadan IF has been reported to decrease body weight and body mass index (BMI) and improve insulin sensitivity through reducing the levels of fasting glucose and insulin (14). In healthy individuals adhering to ADF, glucose and leptin levels decrease, and adiponectin levels increase (15). In addition, IF

Table 1. Metabolic Health Benefits of Islamic Intermittent Fasting

Health Benefit	Author(s)	Proposed Mechanisms
Weight Loss	Ziaee V et al. (26), Fedail SS et al. (27), and Hallak MH et al. (28)	Reduced energy intake
	Rohin MA et al. (29)	Reduction of total body fluids
	Kassab S et al. (30)	Altered serum levels of leptin, insulin, and cortisol due to changes in sleeping patterns and daily energy consumption
	Sweileh N et al. (31)	Absence of fluid intake
	Sanders SW et al. (32)	Consuming foods and drinks only at night, which could delay absorption due to decreased gastric emptying and blood flow compared to daytime.
Reduced Insulin Resistance	Boden G et al. (37)	Reduction of serum leptin levels
Reduced Blood Glucose	Kul S et al. (22)	Altered sleep–wakefulness cycle leads to changes in levels of factors involved in regulation of energy intake and energy expenditure, such as leptin, neuropeptide-Y, insulin, melatonin, and steroid hormones (e.g., cortisol and, testosterone).
Reduced Blood Pressure	Dewanti L et al. (46)	Dehydration
	Al-Shafei AI et al. (47)	Decreased ventricular ejection and arterial stiffness
Improved Lipid Profile	Adlouni A et al. (48), Faris ME et al. (53), and Lamri-Senhadji MY et al. (54)	Qualitative feeding behavior
	Al-Shafei AI (47)	Calorie restriction and timing of food intake

Table 2. Other Health Benefits of Islamic Intermittent Fasting

Health Benefit	Author(s)	Proposed Mechanisms
Cardiac Protection	Wan R et al. (57), Gonon AT et al. (58), and Shinmura K et al. (59)	Reduction of inflammation and apoptosis of myocardial cells
	Mattson MP et al. (60)	Reduction of oxidative damage and increased cellular stress resistance
Obesity Prevention	Norouzy A et al. (62)	Increased adiponectin and decreased leptin levels
Diabetes Prevention	Brown JE et al. (68)	Decreased insulin resistance and fasting insulin levels, increased insulin sensitivity and glucose uptake, decreased lipolysis and assistance in weight loss
	Krizova E et al. (71)	Decreased lipolysis and circulating concentrations of free fatty acids
Cancer Prevention and Treatment	Rogozina OP et al. (74), and Rogozina OP et al. (75)	Reduced serum insulin-like growth factor-1 (IGF-1), which regulates cellular proliferation, growth, and apoptosis.
	Marinac CR et al. (76)	Prolonged nightly fasting decreases the risk of breast cancer recurrence by improving glucoregulation and sleep.
	Descamps O et al. (77)	Decreased generation of mitochondrial reactive oxygen species.
Protection against Neurodegeneration	Arumugam TV et al. (81)	Stimulation of neuroprotective and neurotrophic pathways through elevation of antioxidant defense and BDNF and suppressing inflammation through reducing pro-inflammatory cytokines (TNF-α, IL-1β, and IL-6)
	Lee J et al. (82)	Stimulation of production of new neurons from neural stem cells (neurogenesis) and synapse formation by increasing expression of BDNF and neurotrophin-3 to restore damaged nerve cell circuits
Reduction of Inflammation	Kacimi S et al. (83)	Reduction of expression of proinflammatory cytokines like Interleukin-6 (IL-6) and Tumor necrosis factor *α (*TNF α*)*.
	Aksungar FB et al (84)	Decreased levels of other inflammatory markers (e.g., homocysteine and C-reactive protein)
Promotion of Health Span	Johnson JB et al. (87)	Reduction of asthma-related symptoms and oxidative stress markers
	Teng NI et al. (88)	Decreased episodes of depression
	Akuchekian S et al. (89)	Reduction of cravings by elevating plasma levels of endogenous opioids (e.g., β-endorphin)
	Zangeneh F et al. (90)	Decreased serum levels of stress hormones in women with polycystic ovary syndrome
Extension of Lifespan	Mattson MP et al. (60) and Sohal RS et al. (92)	Anti-ageing effects (reduction of metabolic markers of diabetes, cardiovascular diseases and cancer, reduced oxidative damage, and increased cellular stress resistance)
	Fontana L et al. (93)	Anti-ageing effects by reducing levels of hormones regulating thermogenesis and cellular metabolism (e.g., thyroid hormones and catecholamines) and anabolic hormones (e.g., testosterone, estradiol, insulin and leptin) and increasing levels of hormones suppressing inflammation (e.g., glucocorticoids, adiponectin, and ghrelin)
	Heilbronn LK et al. (39)	Delayed onset of age-related declines in size, number, and function of mitochondria
	Fontana L et al. (94) and Blüher M et al. (95)	Activation of anti-ageing pathways through down-regulation of insulin/IGF-1 and mTOR pathways

has been shown to decrease the levels of insulin (16, 17), glucose, and triglycerides (18).

In young, healthy individuals adhering to TRF, glucose and triglycerides reduce, and the level of high-density lipoprotein increases (19). On the other hand, IF has been reported to decrease body weight, increase insulin sensitivity, and reduce the resting heart rate and blood pressure in rats (20). According to the studies conducted on animal models and human volunteers, IF effectively reduces the risk of chronic conditions, such as cardiovascular diseases, diabetes, and cancer (4).

Weight Loss

Islamic fasting could achieve and maintain significant weight loss (21). According to the clinical trials in this regard, Islamic fasting could induce a statistically significant weight loss in fasting individuals (22-25). Furthermore, it has been postulated that Islamic IF may induce weight loss through various mechanisms, including reduced energy intake (26-28), reduction of total body fluids (29), changes in the serum levels of leptin, insulin, and cortisol due to the altered sleeping patterns and daily energy consumption (30), absence of fluid

intake (31), and food and drink consumption at night only, which could delay the absorption due to lower gastric emptying and blood flow compared to daytime (32). However, the findings of a study performed on eight healthy men adhering to IF indicated no significant weight changes in the participants (15). The lost weight during Ramadan IF could be regained quickly (33); consequently fasting Muslims should adopt structured and consistent lifestyle modifications for long-lasting weight maintenance (34, 35).

Reduction of Insulin Resistance

Overweight and obese individuals often have a high plasma leptin/adiponectin ratio due to high leptin and low adiponectin secretion from the hypertrophic adipocytes, which leads to insulin resistance (36). IF could reduce serum leptin levels (37), thereby decreasing the leptin/adiponectin ratio and insulin resistance. According to a randomized clinical trial conducted on young, overweight women, levels of fasting insulin and insulin resistance decreased as a result of IF (38).

Reduction of Blood Glucose

ADF is associated with the elevation of insulin-mediated glucose uptake (15) and improved insulin sensitivity (39). Sleep-wakefulness cycle is altered during Islamic IF, leading to changes in the levels of the factors regulating energy intake and expenditure, such as leptin, neuropeptide-Y, insulin, melatonin, and steroid hormones (cortisol and testosterone) (22).

In a research performed on eight men and eight women, ADF was reported to cause no significant changes in the blood glucose level (16).

On the other hand, previous findings have indicated that ADF could decrease the fasting glucose concentration in animal models (40, 41).

Reduction of Blood Pressure

Fasting could employ as an effective non-pharmacological measure to diminish hypertension (42, 43). Ramadan fasting has been reported to reduce the systolic and diastolic blood pressures significantly (44, 45). Additionally, the dehydration associated with Islamic fasting could lower the blood pressure (46), ventricular ejection, and arterial stiffness (47).

Improvement of Lipid Profile

Ramadan IF has been reported to decrease triglyceride levels and increase HDLc significantly (47-51). HDLc levels increase during Ramadan fasting and could be maintained for a minimum of one month after Ramadan (51, 52). Qualitative feeding behaviors (48, 53, 54), calorie restriction, and timing of food intake (47) contribute to the improvement of the lipid profile associated with Islamic IF.

Cardiovascular Health Benefits

Ramadan IF is associated with improved cardiovascular risk factors, including low-density lipoprotein cholesterol (LDLc), very low-density lipoprotein cholesterol, triglycerides, systolic blood pressure, BMI, waist circumference, and elevated HDLc levels (4, 55). In obese individuals, calorie restriction has been shown to reduce the risk of CVD (56).

Hypoadiponectinemia induced by IF could protect the heart against ischemic injury (57). Adiponectin activates the cyclic 5' adenosine monophosphate-activated protein kinase pathway and protect the myocardial cells against ischemic injury through reducing the inflammation and apoptosis of myocardial cells (57-59). Moreover, IF provides cardiac protection through reducing oxidative damage and increasing cellular stress resistance (60). Islamic IF could be an effective dietary strategy to decrease the risk of CHD (61).

Obesity Prevention

Ramadan IF has been reported to decrease body weight, waist and hip circumferences, and BMI significantly in the majority of study subjects (62-64). Obesity is characterized by adipocyte hypertrophy. Adipocytes produce adipocytokines and adipokines, including leptin, adiponectin, resistin, tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), adipsin, and visfatin.

Adipocyte hypertrophy leads to the dysregulated production of adipokines and development of the metabolic syndrome (65). Adiponectin is an adipokine with anti-atherogenic, insulin-sensitizing, and anti-

inflammatory properties. Obese individuals have low levels of adiponectin, which increase following weight loss (66).

Leptin is another adipokine that is involved in the regulation of food intake and energy expenditure. Excessive body weight and metabolic syndrome induce Leptin resistance by increasing the plasma levels of leptin. Leptin resistance may be present in pathophysiological conditions, such as obesity, insulin resistance, hypertension, hyperlipidemia, inflammation, atherosclerosis, ischemic heart disease, and heart failure (67).

Diabetes Prevention

Islamic IF may decrease the incidence of diabetes through decreasing insulin resistance and fasting insulin levels, increasing insulin sensitivity and glucose uptake, decreasing lipolysis, and assisting in weight loss (41, 68). Insulin resistance is the major cause of diabetes type II, prediabetes, and gestational diabetes. Insulin resistance could be reduced by IF through the reduction of serum leptin levels (69) and elevation of adiponectin levels (70).

Insulin levels have been reported to decrease by IF in non-obese volunteers (16). Furthermore, IF could improve insulin sensitivity by decreasing the ectopic accumulation of intracellular lipid in animals (71). Insulin-mediated glucose uptake has been shown to elevate in human volunteers, and animal studies have demonstrated that fasting glucose and insulin concentrations may decrease by ADF (4). IF could also reduce the risk of diabetes indirectly through decreasing lipolysis and the circulating concentrations of free fatty acids (72).

Cancer Prevention and Treatment

Islamic IF reduce the levels of insulin-like growth factor-1 (IGF-1), insulin, and glucose to protect cells against DNA damage through diminished cell growth and augmented apoptosis of damaged cells (73). In addition, IF could decrease the incidence of breast cancer possibly through reducing the serum IGF-1 levels (74, 75), which regulates cellular proliferation, growth, and apoptosis.

Prolonged nightly fasting has been reported to decrease the risk of breast cancer recurrence by improving glucoregulation and sleep patterns (76). Furthermore, ADF could decrease mitochondrial reactive oxygen species (ROS) generation which results in significant reduction of incidence of age-associated lymphoma in mice (77). Fasting and chemotherapy could synergistically promote the DNA breaks in cancer cells (78). Moreover, fasting results in the reduction of chemotherapy-induced complications (79).

Protection against Neurodegeneration

Fasting induces neuroprotection by stimulating the production of brain-derived neurotrophic factor (BDNF), through increased neuronal network activity. BDNF is also involved in the improvement of cognitive function, food intake inhibition, and energy expenditure acceleration (80). IF may protect the neurons against tissue injury by stimulating the neuroprotective and neurotrophic pathways through the elevation of antioxidant defense and BDNF levels, as well as the suppression of inflammation through reducing pro-inflammatory cytokines such as IL-6, IL-1β, and TNF-α (81). IF could also stimulate the production of new neurons from the neural stem cells (i.e., neurogenesis) and synapse formation by increasing BDNF and neurotrophin-3 levels, to restore damaged nerve cell circuits (82).

Reduction of Inflammation

Elevated levels of pro-inflammatory cytokines may increase the risk of inflammatory diseases, such as insulin resistance, diabetes, atherosclerosis, and cardiovascular diseases (83). In healthy individuals, Ramadan IF has been shown to decrease the expression of pro-inflammatory cytokines, including TNF-α and IL-6 leading to decreased inflammatory status of the body (83). Moreover, Ramadan IF has been reported to decrease the levels of other inflammatory markers (e.g., homocysteine, C-reactive protein, and IL-6 in healthy subjects (84).

Promotion of Health Span

IF has been shown to attenuate the risk of chronic conditions such as diabetes, cardiovascular diseases, cancer, and neurode-generation (85). The incidence of conditions like cardiovascular diseases, cancer, osteoporosis and Alzheimer's disease decreased by calorie

restriction through the reduction of chronic inflammation (86). In overweight individuals with asthma, ADF reported to decrease oxidative stress markers and asthma-related symptoms (87). On the other hand, episodes of depression have been shown to reduce by two days of fasting per week in elderly males (88). Fasting could also elevate the plasma levels of endogenous opioids (e.g., β-endorphin), thereby diminishing cravings (89). Ramadan IF could significantly lower the serum levels of stress hormones in the women with PCOS (90).

Extension of Lifespan

The aging process is associated with the gradual loss of the function of various organs and increased vulnerability to diseases. Evidence suggest that IF significantly contributes to the extension of lifespan (85, 91) through exerting anti-aging effects, such as the reduction of diabetic metabolic markers, cardiovascular diseases, cancer, and oxidative damage and increasing cellular stress resistance (60, 92). Calorie restriction may enhance the levels of hormones suppressing inflammation (e.g., adiponectin and ghrelin) and decrease the levels of the hormones regulating thermogenesis and cellular metabolism (e.g., thyroid hormones and catecholamines) and anabolic hormones (e.g., testosterone, estradiol, insulin, and leptin) to exhibit anti-aging effects (93).

According to animal studies, ADF could extend lifespan by delaying the onset of age-related decreases in the size, number, and function of mitochondria (39). Calorie restriction has also been shown to activate the anti-ageing pathways through the down-regulation of insulin/IGF-1 and mTOR pathways (94, 95).

Conclusion

Muslims practicing Islamic IF enjoy various health benefits, including weight loss, reduced insulin resistance, blood glucose, and blood pressure, improved lipid profile, prevention of obesity, diabetes, cardiovascular diseases, and cancer, protection against neurodegeneration, and diminished inflammation. Islamic IF could also improve health span and extend life span. Therefore, it is generally considered safe for healthy individuals (96). However, the patients having chronic health conditions, like diabetes (97-99), hypertension (100, 101), active ulcers (102-104), urolithiasis (105), and chronic kidney disease (106, 107) should consult healthcare professionals, before initiating fasting. Moreover, certain individuals are exempt from Islamic fasting, including patients, travelers, menstruating women, pregnant women, and breastfeeding mothers (108).

Islamic fasting is associated with common health problems, including dehydration, headaches, heartburn, constipation, anemia, and poor sleep quality, which could be minimized by preventive measures (2). Therefore, fasting individuals are recommended to adhere to a balanced diet containing fruits and vegetables, whole grains, pulses, meat, fish, and dairies. In addition, they need to drink fluids abundantly, such as water, fresh juices, and soups during Islamic IF. Fasting Muslims are advised to avoid deep-fried foods, sweets, and fatty foods (2).

According to the results of the current review, the health benefits of Islamic IF could be sustained by leading a healthy lifestyle and practicing optional fasting regularly after the holy month of Ramadan twice a week on Mondays and Thursdays.

References

1. Abuznaid S. Islam and management: what can be learned? Thunderbird Int Busin Rev. 2006; 48(1):125-39.
2. Maideen P, Mohamed N, Jumale A, Balasubramaniam R. Adverse health effects associated with Islamic fasting-A literature review. J Fast Health. 2017; 5(3):113-8.
3. Mager DE, Wan R, Brown M, Cheng A, Wareski P, Abernethy DR, et al. Caloric restriction and intermittent fasting alter spectral measures of heart rate and blood pressure variability in rats. FASEB J. 2006; 20(6):631-7.
4. Varady KA, Hellerstein MK. Alternate-day fasting and chronic disease prevention: a review of human and animal trials. Am J Clin Nutr. 2007; 86(1):7-13.
5. Bakhit AA, Kurdi AM, Wadera JJ, Alsuwaida AO. Effects of Ramadan fasting on moderate to severe chronic kidney disease: a prospective observational study. Saudi Med J. 2017; 38(1): 48-52.
6. Melkani GC, Panda S. Time-restricted feeding for prevention and treatment of cardiometabolic disorders. J Physiol. 2017; 595(12):3691-700.
7. Alberti KG, Zimmet P, Shaw J; IDF Epidemiology Task Force Consensus Group. The metabolic

syndrome--a new worldwide definition. Lancet. 2005; 366(9491):1059-62.
8. Srikanthan K, Feyh A, Visweshwar H, Shapiro JI, Sodhi K. Systematic review of metabolic syndrome biomarkers: a panel for early detection, management, and risk stratification in the West Virginian population. Int J Med Sci. 2016; 13(1):25-38.
9. Bhandari R, Kelley GA, Hartley TA, Rockett IR. Metabolic syndrome is associated with increased breast cancer risk: a systematic review with meta-analysis. Int J Breast Cancer. 2014; 2014:189384.
10. Rosato V, Tavani A, Bosetti C, Pelucchi C, Talamini R, Polesel J, et al. Metabolic syndrome and pancreatic cancer risk: a case-control study in Italy and meta-analysis. Metabolism. 2011; 60(10):1372-8.
11. Stocks T, Lukanova A, Johansson M, Rinaldi S, Palmqvist R, Hallmans G, et al. Components of the metabolic syndrome and colorectal cancer risk; a prospective study. Int J Obes. 2008; 32(2):304-14.
12. Esposito K, Chiodini P, Colao A, Lenzi A, Giugliano D. Metabolic syndrome and risk of cancer: a systematic review and meta-analysis. Diabetes Care. 2012; 35(11):2402-11.
13. 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.
14. Gnanou JV, Caszo BA, Khalil KM, Abdullah SL, Knight VF, Bidin MZ. Effects of Ramadan fasting on glucose homeostasis and adiponectin levels in healthy adult males. J Diabetes Metab Disord. 2015; 14(1):55.
15. Halberg N, Henriksen M, Söderhamn N, Stallknecht B, Ploug T, Schjerling P, et al. Effect of intermittent fasting and refeeding on insulin action in healthy men. J Appl Physiol. 2005; 99(6):2128-36.
16. Heilbronn LK, Smith SR, Martin CK, Anton SD, Ravussin E. Alternate-day fasting in nonobese subjects: effects on body weight, body composition, and energy metabolism. Am J Clin Nutr. 2005; 81(1):69-73.
17. Wan R, Camandola S, Mattson MP. Intermittent fasting and dietary supplementation with 2-deoxy-D-glucose improve functional and metabolic cardiovascular risk factors in rats. FASEB J. 2003; 17(9):1133-4.
18. Horne BD, Muhlestein JB, Lappe DL, May HT, Carlquist JF, Galenko O, et al. Randomized cross-over trial of short-term water-only fasting: metabolic and cardiovascular consequences. Nutr Metab Cardiovasc Dis. 2013; 23(11):1050-7.
19. LeCheminant JD, Christenson E, Bailey BW, Tucker LA. Restricting night-time eating reduces daily energy intake in healthy young men: a short-term cross-over study. Br J Nutr. 2013; 110(11): 2108-13.
20. Wan R, Camandola S, Mattson MP. Intermittent food deprivation improves cardiovascular and neuroendocrine responses to stress in rats. J Nutr. 2003; 133(6):1921-9.
21. Johnstone A. Fasting for weight loss: an effective strategy or latest dieting trend? Int J Obes. 2015; 39(5):727-33.
22. Kul S, Savaş E, Öztürk ZA, Karadağ G. Does Ramadan fasting alter body weight and blood lipids and fasting blood glucose in a healthy population? A meta-analysis. J Relig Health. 2014; 53(3):929-42.
23. Meo SA, Hassan A. Physiological changes during fasting in Ramadan. J Pak Med Assoc. 2015; 65(5 Suppl 1):S6-14.
24. Rouhani MH, Azadbakht L. Is Ramadan fasting related to health outcomes? A review on the related evidence. J Res Med Sci. 2014; 19(10): 987-92.
25. Patterson RE, Sears DD. Metabolic effects of intermittent fasting. Ann Rev Nutr. 2017; 37: 371-93.
26. Ziaee V, Razaei M, Ahmadinejad Z, Shaikh H, Yousefi R, Yarmohammadi L, et al. The changes of metabolic profile and weight during Ramadan fasting. Singapore Med J. 2006; 47(5):409-14.
27. Fedail SS, Murphy D, Salih SY, Bolton CH, Harvey RF. Changes in certain blood constituents during Ramadan. Am J Clin Nutr. 1982; 36(2):350-3.
28. Hallak MH, Nomani MZ. Body weight loss and changes in blood lipid levels in normal men on hypocaloric diets during Ramadan fasting. Am J Clin Nutr. 1988; 48(5):1197-210.
29. Rohin MA, Rozano N, Abd Hadi N, Mat Nor MN, Abdullah S, Dandinasivara Venkateshaiah M. Anthropometry and body composition status during Ramadan among higher institution learning centre staffs with different body weight status. Sci World J. 2013; 2013:308041.
30. Kassab S, Abdul-Ghaffar T, Nagalla DS, Sachdeva U, Nayar U. Interactions between leptin, neuropeptide-Y and insulin with chronic diurnal fasting during Ramadan. Ann Saudi Med. 2004; 24(5):345-9.
31. Sweileh N, Schnitzler A, Hunter GR, Davis B. Body composition and energy metabolism in resting and exercising muslims during Ramadan fast. J Sports Med Phys Fitness. 1992; 32(2):156-63.
32. Sanders SW, Moore JG. Gastrointestinal chrono-pharmacology: physiology, pharmacology and therapeutic implications. Pharmacol Ther. 1992; 54(1):1-15.
33. Hajek P, Myers K, Dhanji AR, West O, McRobbie H. Weight change during and after Ramadan fasting. J Public Health. 2011; 34(3):377-81.
34. 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(2):396-406.
35. Hankir A, Hankir M, Zaman R. Should Ramadan be prescribed after Christmas? Obesity in the healthcare profession and the health benefits of fasting. BMJ Case Reports. 2014; 2014:bcr 2013202704.
36. Finucane FM, Luan J, Wareham NJ, Sharp SJ, O'Rahilly S, Balkau B, et al. Correlation of the leptin: adiponectin ratio with measures of insulin resistance in non-diabetic individuals. Diabetologia. 2009; 52(11):2345-9.
37. Boden G, Chen X, Mozzoli M, Ryan I. Effect of fasting on serum leptin in normal human subjects. J Clin Endocrinol Metab. 1996; 81(9):3419-23.
38. Harvie MN, Pegington M, Mattson MP, Frystyk J, Dillon B, Evans G, et al. The effects of intermittent or continuous energy restriction on weight loss and metabolic disease risk markers: a randomised trial in young overweight women. Int J Obesity. 2011; 35(5):714.
39. Heilbronn LK, Civitarese AE, Bogacka I, Smith SR, Hulver M, Ravussin E. Glucose tolerance and skeletal muscle gene expression in response to alternate day fasting. Obesity. 2005; 13(3): 574-81.
40. Anson RM, Guo Z, de Cabo R, Iyun T, Rios M, Hagepanos A, et al. Intermittent fasting dissociates beneficial effects of dietary restriction on glucose metabolism and neuronal resistance to injury from calorie intake. Proc Natl Acad Sci U S A. 2003; 100(10):6216-20.
41. Pedersen CR, Hagemann I, Bock T, Buschard K. Intermittent feeding and fasting reduces diabetes incidence in BB rats. Autoimmunity. 1999; 30(4):243-50.
42. Goldhamer AC, Lisle DJ, Sultana P, Anderson SV, Parpia B, Hughes B, et al. Medically supervised water-only fasting in the treatment of borderline hypertension. J Altern Complement Med. 2002; 8(5):643-50.
43. Varady KA, Bhutani S, Church EC, Klempel MC. Short-term modified alternate-day fasting: a novel dietary strategy for weight loss and cardioprotection in obese adults. Am J Clin Nutr. 2009; 90(5):1138-43.
44. Salahuddin M, Sayed Ashfak AH, Syed SR, Badaam KM. Effect of Ramadan fasting on body weight, (BP) and biochemical parameters in middle aged hypertensive subjects: an observational trial. J Clin Diagn Res. 2014; 8(3):16-8.
45. Ünalacak M, Kara IH, Baltaci D, Erdem Ö, Bucaktepe PG. Effects of Ramadan fasting on biochemical and hematological parameters and cytokines in healthy and obese individuals. Metab Syndr Relat Disord. 2011; 9(2):157-61.
46. Dewanti L, Watanabe C, Ohtsuka R. Unexpected changes in blood pressure and hematological parameters among fasting and nonfasting workers during Ramadan in Indonesia. Eur J Clin Nutr. 2006; 60(7):877-81.
47. Al-Shafei AI. Ramadan fasting ameliorates arterial pulse pressure and lipid profile, and alleviates oxidative stress in hypertensive patients. Blood Press. 2014; 23(3):160-7.
48. Adlouni A, Ghalim N, Benslimane A, Lecerf JM, Saïle R. Fasting during Ramadan induces a marked increase in high-density lipoprotein cholesterol and decrease in low-density lipoprotein cholesterol. Ann Nutr Metab. 1997; 41(4):242-9.
49. Zare A, Hajhashemi M, Hassan ZM, Zarrin S, Pourpak Z, Moin M, et al. Effect of Ramadan fasting on serum heat shock protein 70 and serum lipid profile. Singapore Med J. 2011; 52(7):491-5.
50. Al-Shafei AI. Ramadan fasting ameliorates oxidative stress and improves glycemic control and lipid profile in diabetic patients. Eur J Nutr. 2014; 53(7):1475-81.
51. Mansi KM. Study the effects of Ramadan fasting on the serum glucose and lipid profile among healthy Jordanian students. Am J Appl Sci. 2007; 4(8): 565-9.
52. Adlouni A, Ghalim N, Saïle R, Hda N, Parra HJ, Benslimane A. Beneficial effect on serum apo AI, apo B and Lp AI levels of Ramadan fasting. Clin Chim Acta. 1998; 271(2):179-89.
53. Faris ME, Hussein RN, Al-Kurd RA, Al-Fararjeh MA, Bustanji YK, Mohammad MK. Impact of Ramadan intermittent fasting on oxidative stress measured by urinary 15--isoprostane. J Nutr Metab. 2012; 2012:802924.
54. Lamri-Senhadji MY, El Kebir B, Belleville J, Bouchenak M. Assessment of dietary consumption and time-course of changes in serum lipids and lipoproteins before, during and after Ramadan in young Algerian adults. Singapore Med J. 2009; 50(3):288-94.
55. Nematy M, Alinezhad-Namaghi M, Rashed MM, Mozhdehifard M, Sajjadi SS, Akhlaghi S, et al. Effects of Ramadan fasting on cardiovascular risk factors: a prospective observational study. Nutr J. 2012; 11(1):69.
56. Lefevre M, Redman LM, Heilbronn LK, Smith JV, Martin CK, Rood JC, et al. Caloric restriction alone and with exercise improves CVD risk in healthy non-obese individuals. Atherosclerosis. 2009; 203(1):206-13.
57. Wan R, Ahmet I, Brown M, Cheng A, Kamimura N, Talan M, et al. Cardioprotective effect of intermittent fasting is associated with an elevation of adiponectin levels in rats. J Nutr Biochem. 2010; 21(5):413-7.
58. Gonon AT, Widegren U, Bulhak A, Salehzadeh F, Persson J, Sjöquist PO, et al. Adiponectin protects against myocardial ischaemia-reperfusion injury via AMP-activated protein kinase, Akt, and nitric

oxide. Cardiovasc Res. 2008; 78(1):116-22.
59. Shinmura K, Tamaki K, Saito K, Nakano Y, Tobe T, Bolli R. Cardioprotective effects of short-term caloric restriction are mediated by adiponectin via activation of AMP-activated protein kinase. Circulation. 2007; 116(24):2809-17.
60. Mattson MP, Wan R. Beneficial effects of intermittent fasting and caloric restriction on the cardiovascular and cerebrovascular systems. J Nutr Biochem. 2005; 16(3):129-37
61. Varady KA, Hudak CS, Hellerstein MK. Modified alternate-day fasting and cardioprotection: relation to adipose tissue dynamics and dietary fat intake. Metabolism. 2009; 58(6):803-11.
62. Norouzy A, Salehi M, Philippou E, Arabi H, Shiva F, Mehrnoosh S, et al. Effect of fasting in Ramadan on body composition and nutritional intake: a prospective study. J Hum Nutr Diet. 2013; 26(Suppl 1):97-104.
63. Attarzadeh Hosseini SR, Sardar MA, Hejazi K, Farahati S. The effect of Ramadan fasting and physical activity on body composition, serum osmolarity levels and some parameters of electrolytes in females. Int J Endocrinol Metab. 2013; 11(2):88-94.
64. Memari AH, Kordi R, Panahi N, Nikookar LR, Abdollahi M, Akbarnejad A. Effect of Ramadan fasting on body composition and physical performance in female athletes. Asian J Sports Med. 2011; 2(3):161-6.
65. Pyrzak B, Ruminska M, Popko K, Demkow U. Adiponectin as a biomarker of the metabolic syndrome in children and adolescents. Eur J Med Res. 2010; 15(2):147-51.
66. Ryo M, Nakamura T, Kihara S, Kumada M, Shibazaki S, Takahashi M, et al. Adiponectin as a biomarker of the metabolic syndrome. Circ J. 2004; 68(11):975-81.
67. Dong M, Ren J. What fans the fire: insights into mechanisms of leptin in metabolic syndrome-associated heart diseases. Curr Pharm Design. 2014; 20(4):652-8.
68. Brown JE, Mosley M, Aldred S. Intermittent fasting: a dietary intervention for prevention of diabetes and cardiovascular disease? Br J Diabetes Vascular Dis. 2013; 13(2):68-72.
69. Rogozina OP, Bonorden MJ, Seppanen CN, Grande JP, Cleary MP. Effect of chronic and intermittent calorie restriction on serum adiponectin and leptin and mammary tumorigenesis. Cancer Prev Res. 2011; 4(4):568-81.
70. Feizollahzadeh S, Rasuli J, Kheirouri S, Alizadeh M. Augmented plasma adiponectin after prolonged fasting during Ramadan in men. Health Promot Perspect. 2014; 4(1):77-81.
71. Krizova E, Simek V. Effect of intermittent feeding with high-fat diet on changes of glycogen, protein and fat content in liver and skeletal muscle in the laboratory mouse. Physiol Res. 1995; 45(5): 379-83.
72. Boden G. Fatty acid-induced inflammation and insulin resistance in skeletal muscle and liver. Curr Diab Rep. 2006; 6(3):177-81.
73. Longo VD, Mattson MP. Fasting: molecular mechanisms and clinical applications. Cell Metab. 2014; 19(2):181-92.
74. Rogozina OP, Nkhata KJ, Nagle EJ, Grande JP, Cleary MP. The protective effect of intermittent calorie restriction on mammary tumorigenesis is not compromised by consumption of a high fat diet during refeeding. Breast Cancer Res Treat. 2013; 138(2):395-406.
75. Rogozina OP, Bonorden MJ, Grande JP, Cleary MP. Serum Insulin-like growth factor-I and mammary tumor development in ad libitum-fed, chronic calorie–restricted, and intermittent calorie–restricted MMTV-TGF-α Mice. Cancer Prev Res. 2009; 2(8):712-9.
76. Marinac CR, Nelson SH, Breen CI, Hartman SJ, Natarajan L, Pierce JP, et al. Prolonged nightly fasting and breast cancer prognosis. JAMA Oncol. 2016; 2(8):1049-55.
77. Descamps O, Riondel J, Ducros V, Roussel AM. Mitochondrial production of reactive oxygen species and incidence of age-associated lymphoma in OF1 mice: effect of alternate-day fasting. Mech Ageing Dev. 2005; 126(11):1185-91.
78. Lee C, Raffaghello L, Brandhorst S, Safdie FM, Bianchi G, Martin-Montalvo A, et al. Fasting cycles retard growth of tumors and sensitize a range of cancer cell types to chemotherapy. Sci Transl Med. 2012; 4(124):124ra27.
79. Safdie FM, Dorff T, Quinn D, Fontana L, Wei M, Lee C, et al. Fasting and cancer treatment in humans: a case series report. Aging (Albany NY). 2009; 1(12):988-1007.
80. Rothman SM, Griffioen KJ, Wan R, Mattson MP. Brain-derived neurotrophic factor as a regulator of systemic and brain energy metabolism and cardiovascular health. Ann N Y Acad Sci. 2012; 1264(1):49-63.
81. Arumugam TV, Phillips TM, Cheng A, Morrell CH, Mattson MP, Wan R. Age and energy intake interact to modify cell stress pathways and stroke outcome. Ann Neurol. 2010; 67(1):41-52.
82. Lee J, Seroogy KB, Mattson MP. Dietary restriction enhances neurotrophin expression and neurogenesis in the hippocampus of adult mice. J Neurochem. 2002; 80(3):539-47.
83. Faris MA, Kacimi S, Al-Kurd RA, Fararjeh MA, Bustanji YK, Mohammad MK, et al. Intermittent fasting during Ramadan attenuates proinflammatory cytokines and immune cells in healthy subjects. Nutr Res. 2012; 32(12):947-55.
84. Aksungar FB, Topkaya AE, Akyildiz M. Interleukin-6, C-reactive protein and biochemical parameters

during prolonged intermittent fasting. Ann Nutr Metab. 2007; 51(1):88-95.
85. Longo VD, Mattson MP. Fasting: molecular mechanisms and clinical applications. Cell Metab. 2014; 19(2):181-92.
86. Ye J, Keller JN. Regulation of energy metabolism by inflammation: a feedback response in obesity and calorie restriction. Aging (Albany NY). 2010; 2(6):361-8.
87. Johnson JB, Summer W, Cutler RG, Martin B, Hyun DH, Dixit VD, et al. Alternate day calorie restriction improves clinical findings and reduces markers of oxidative stress and inflammation in overweight adults with moderate asthma. Free Radic Biol Med. 2007; 42(5):665-74.
88. Teng NI, Shahar S, Manaf ZA, Das SK, Taha CS, Ngah WZ. Efficacy of fasting calorie restriction on quality of life among aging men. Physiol Behav. 2011; 104(5):1059-64.
89. Akuchekian S, Ebrahimi A, Alvandian S. Effect of the holy month of Ramadan on coping strategies. J Res Med Sci. 2004; 9(2):65-8.
90. Zangeneh F, Salman Yazdi R, Naghizadeh MM, Abedinia N. Effect of Ramadan fasting on stress neurohormones in women with polycystic ovary syndrome. J Family Reprod Health. 2015; 9(2):51-7.
91. Mercken EM, Carboneau BA, Krzysik-Walker SM, de Cabo R. Of mice and men: the benefits of caloric restriction, exercise, and mimetics. Ageing Res Rev. 2012; 11(3):390-8.
92. Sohal RS, Weindruch R. Oxidative stress, caloric restriction, and aging. Science. 1996; 273(5271): 59-63.
93. Fontana L, Klein S. Aging, adiposity, and calorie restriction. JAMA. 2007; 297(9):986-94.
94. Fontana L, Partridge L, Longo VD. Extending healthy life span--from yeast to humans. Science. 2010; 328(5976):321-6.
95. Blüher M, Kahn BB, Kahn CR. Extended longevity in mice lacking the insulin receptor in adipose tissue. Science. 2003; 299(5606):572-4.
96. Sadeghpour S, Keshteli AH, Daneshpajouhnejad P, Jahangiri P, Adibi P. Ramadan fasting and digestive disorders: SEPAHAN systematic review. J Res Med Sci. 2012; 7:17.
97. Al-Arouj M, Assaad-Khalil S, Buse J, Fahdil I, Fahmy M, Hafez S, et al. Recommendations for management of diabetes during Ramadan: update 2010. Diabetes Care. 2010; 33(8):1895-902.
98. Bravis V, Hui E, Salih S, Mehar S, Hassanein M, Devendra D. Ramadan education and awareness in diabetes (READ) programme for Muslims with type 2 diabetes who fast during Ramadan. Diabet Med. 2010; 27(3):327-31.
99. Hui E, Bravis V, Hassanein M, Hanif W, Malik R, Chowdhury TA, et al. Management of people with diabetes wanting to fast during Ramadan. BMJ. 2010; 340:c3053.
100. Perk G, Ghanem J, Aamar S, Ben-Ishay D, Bursztyn M. The effect of the fast of Ramadan on ambulatory blood pressure in treated hypertensives. J Hum Hypertens. 2001; 15(10): 723-5.
101. Habbal R, Azzouzi L, Adnan K, Tahiri A, Chraibi N. Variations of blood pressure during the month of Ramadan. Arch Mal Coeur Vaiss. 1998; 91(8):995-8.
102. Hosseini-Asl K, Rafieian-Kopaei M. Can patients with active duodenal ulcer fast Ramadan? Am J Gastroenterol. 2002; 97(9):2471-2
103. Gokakin AK, Kurt A, Akgol G, Karakus BC, Atabey M, Koyuncu A, et al. Effects of Ramadan fasting on peptic ulcer disease as diagnosed by upper gastrointestinal endoscopy. Arab J Gastroenterol. 2012; 13(4):180-3.
104. Gökakın AK, Kurt A, Atabey M, Koyuncu A, Topçu Ö, Aydın C, et al. The impact of Ramadan on peptic ulcer perforation. Ulus Travma Acil Cerrahi Derg. 2012; 18(4):339-43.
105. Sagy I, Zeldetz V, Halperin D, Abu Tailakh M, Novack V. The effect of Ramadan fast on the incidence of renal colic emergency department visits. QJM. 2017; 110(9):571-6.
106. Bragazzi NL. Ramadan fasting and chronic kidney disease: a systematic review. J Res Med Sci. 2014; 19(7):665-76.
107. NasrAllah MM, Osman, NA. Fasting during the month of Ramadan among patients with chronic kidney disease: renal and cardiovascular outcomes. Clin Kidney J. 2014; 7(4):348-53.
108. Sakr AH. Fasting in Islam. J Am Diet Assoc. 1975; 67(1):17-21.