



Review Article

Exploring the Intersection of Bodybuilding and Ramadan: Strategies for Maintaining Muscle Mass and Performance During Fasting

Khaled Hamlaoui^{1*}

¹Ph.D. Exercise and Nutritional Biochemistry, Algeria

*Correspondence author: Khaled Hamlaoui, Ph.D. Exercise and Nutritional Biochemistry, Algeria; Email: khaled_h12@yahoo.fr

Abstract

Ramadan, the ninth month of the Islamic lunar calendar, involves fasting from dawn until sunset as a spiritual practice. For individuals engaged in bodybuilding and fitness pursuits, Ramadan presents unique challenges and opportunities. This article reviews the scientific literature on the effects of Ramadan fasting on muscle physiology and performance, as well as strategies for optimizing bodybuilding goals during this period. It examines nutritional and training considerations to help individuals maintain muscle mass, strength and performance while observing Ramadan.

Keywords: Ramadan; Fasting; Muscle Mass; Bodybuilding

Introduction

Ramadan fasting entails abstaining from food, drink, smoking and other physical needs from dawn (Suhoor) until sunset (Iftar). The pre-dawn meal (Suhoor) and the evening meal (Iftar) play crucial roles in providing the necessary nutrients and hydration to sustain individuals through the fasting period. However, adhering to a bodybuilding regimen during Ramadan requires careful planning to ensure adequate energy intake, nutrient timing and hydration to support muscle growth, recovery and performance [1-12].

Effects of Ramadan Fasting on Muscle Physiology

Ramadan fasting affects various physiological processes that may influence muscle mass, strength and performance. During the fasting period, individuals experience alterations in hydration status, glycogen stores and nutrient availability, which can impact muscle protein synthesis, energy metabolism and exercise capacity. Prolonged fasting without adequate hydration and

nutrient intake may lead to dehydration, muscle glycogen depletion and impaired muscle protein synthesis, potentially compromising muscle recovery and adaptation to training stimuli [13-24].

1. **Energy Utilization:** During fasting, the body relies on stored energy reserves, primarily glycogen stored in the liver and muscles, followed by fat stores. Initially, glycogen stores are depleted, leading to increased reliance on fat metabolism for energy. This metabolic shift may affect muscle performance during intense exercise
2. **Muscle Protein Metabolism:** Fasting may influence muscle protein metabolism. During prolonged fasting, there is a decrease in insulin levels, leading to reduced protein synthesis and increased protein breakdown. However, studies have shown conflicting results regarding the effect of Ramadan fasting on muscle protein turnover, with some indicating no significant changes
3. **Muscle Mass and Strength:** The impact of Ramadan fasting on muscle mass and strength is a subject of debate. Some studies suggest that fasting may lead to a decrease in muscle mass and strength due to decreased protein intake and increased catabolism. However, other research indicates that muscle mass and strength can be maintained with proper nutrition and exercise outside of fasting hours
4. **Hydration Status:** Dehydration is a concern during fasting, especially in regions with hot climates or during summer months

Citation: Hamlaoui K. Intramedullary Nailing with an Exploring the Intersection of Bodybuilding and Ramadan: Strategies for Maintaining Muscle Mass and Performance During Fasting. J Ortho Sci Res. 2024;5(1):1-9.

<https://doi.org/10.46889/JOSR.2024.5110>

Received Date: 17-03-2024

Accepted Date: 07-04-2024

Published Date: 15-04-2024



Copyright: © 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CCBY) license (<https://creativecommons.org/licenses/by/4.0/>).

when Ramadan falls. Dehydration can impair muscle function, leading to decreased performance and increased risk of injury

5. **Hormonal Changes:** Fasting can affect hormone levels, including cortisol, growth hormone and testosterone, which play roles in muscle metabolism and repair. Changes in these hormones may impact muscle physiology during Ramadan fasting [25-68]

Recovery and Adaptation

Proper nutrition and hydration during non-fasting hours are crucial for muscle recovery and adaptation to exercise. Adequate intake of protein, carbohydrates and fluids during the evening and pre-dawn meals can support muscle repair, glycogen replenishment and hydration, helping to mitigate potential negative effects of fasting on muscle physiology [69,70].

- **Training Adaptations:** Athletes and individuals engaging in regular exercise during Ramadan may need to adjust their training schedules and intensity to accommodate fasting-induced changes in energy levels, hydration status and nutrient availability. Training during non-fasting hours or focusing on low-intensity activities may help maintain fitness levels while minimizing the risk of muscle loss

In summary, Ramadan fasting can have complex effects on muscle physiology, influenced by factors such as nutrient intake, hydration status, exercise regimen and individual variability. With proper nutrition, hydration and exercise management, it is possible to minimize negative impacts on muscle mass, strength and performance during Ramadan [80].

Nutritional Strategies for Bodybuilders During Ramadan

Maintaining optimal nutrition during Ramadan is essential for supporting muscle growth, recovery and performance. Bodybuilders observing Ramadan should focus on consuming nutrient-dense foods during Suhoor and Iftar to meet their energy and macronutrient requirements. Emphasis should be placed on consuming high-quality protein sources, such as lean meats, poultry, fish, eggs, dairy and plant-based proteins, to support muscle protein synthesis and repair.

Carbohydrate intake should be strategically timed around workouts to replenish glycogen stores and provide energy for training sessions. Slow-digesting carbohydrates, such as whole grains, fruits and vegetables, can help sustain energy levels throughout the fasting period. Additionally, adequate hydration is crucial for preventing dehydration and maintaining exercise performance. Individuals should aim to drink plenty of water and electrolyte-rich fluids during non-fasting hours to offset fluid losses incurred during fasting [80-96].

Suhoor (Pre-dawn Meal)

Emphasize complex carbohydrates such as whole grains (oats, brown rice, quinoa) to provide sustained energy throughout the day.

Include lean protein sources like eggs, poultry, fish, or dairy to support muscle maintenance and repair during the fasting period. Incorporate healthy fats from sources like nuts, seeds, avocados and olive oil for satiety and to aid in nutrient absorption [97-100].

Hydration

Drink plenty of water and hydrating fluids like electrolyte-rich beverages during non-fasting hours to prevent dehydration, especially in hot climates. Avoid excessive caffeine and sugary drinks that can lead to dehydration.

Iftar (Breaking the Fast)

Start with hydrating foods like water-rich fruits (watermelon, cucumber) and vegetables to replenish fluid levels. Consume a balanced meal including lean protein sources (chicken, fish, tofu), complex carbohydrates (brown rice, sweet potatoes, whole wheat bread) and healthy fats (olive oil, nuts, avocado) to support muscle recovery and replenish energy stores. Include a variety of colorful fruits and vegetables to provide essential vitamins, minerals and antioxidants for overall health and recovery [101-109].

Post-Workout Nutrition

Time your workouts around iftar or shortly after to capitalize on the post-exercise anabolic window for optimal muscle recovery. Consume a combination of fast-digesting protein (whey protein) and carbohydrates (e.g., dextrose, fruit) to replenish glycogen stores and support muscle repair.

Meal Timing and Frequency

Consider dividing your daily food intake into smaller, more frequent meals during non-fasting hours to better manage hunger, maintain energy levels and optimize nutrient absorption. Focus on nutrient-dense foods to make the most of limited eating opportunities.

Supplementation

Consult with a healthcare professional or nutritionist before incorporating supplements, especially during fasting hours. Consider supplements like Branched-Chain Amino Acids (BCAAs), creatine and protein powders to support muscle recovery and performance, particularly during non-fasting hours.

Rest and Recovery

Prioritize adequate sleep and rest to support muscle recovery and overall well-being during Ramadan. Listen to your body and adjust your training intensity and volume as needed to accommodate fasting-induced changes in energy levels and hydration status. By implementing these strategies, bodybuilders can help maintain muscle mass, strength and performance while observing Ramadan. It's essential to prioritize balanced nutrition, hydration and recovery to support overall health and fitness goals during this period [110].

- **Training Considerations During Ramadan:** Adjusting training schedules and intensity levels may be necessary to accommodate the physiological effects of Ramadan fasting. Given the potential for reduced energy levels and hydration status during fasting, individuals may benefit from modifying training volume, frequency and timing to optimize performance and recovery. Prioritizing compound exercises that target multiple muscle groups and focusing on quality over quantity can help maximize training efficiency while minimizing fatigue

Furthermore, scheduling workouts during non-fasting hours, such as after Iftar or before Suhoor, may allow individuals to maintain adequate energy levels and hydration status during training. Alternatively, splitting training sessions into shorter, more frequent sessions throughout the day can help distribute physical exertion and facilitate recovery during Ramadan. Additionally, incorporating low-intensity activities, such as walking or yoga, during fasting hours can help maintain physical activity levels without exacerbating fatigue or dehydration [111].

Timing of Workouts

Schedule workouts during times when energy levels are likely to be highest, such as shortly before iftar (breaking the fast) or after consuming the pre-dawn meal (suhoor). Alternatively, consider splitting your training session into smaller sessions throughout the day to accommodate fasting hours.

Intensity and Volume:

Adjust training intensity and volume based on energy levels and hydration status during fasting hours. Focus on maintaining strength and performance rather than pushing for new personal records during Ramadan. Consider reducing training volume slightly while maintaining intensity to prevent excessive fatigue and support recovery.

Exercise Selection

Prioritize compound exercises that target multiple muscle groups, such as squats, deadlifts, bench presses and rows, to maximize efficiency and effectiveness during shorter training sessions. Include exercises that emphasize muscle hypertrophy (e.g., isolation exercises, high-rep sets) to stimulate muscle growth and maintenance [112].

Rest Between Sets

Allow for adequate rest between sets to optimize recovery and maintain performance levels, especially considering potential dehydration and fatigue during fasting hours [113].

Nutrient Timing

Coordinate nutrient intake around training sessions to maximize muscle recovery and glycogen replenishment. Consume a post-workout meal or shake containing fast-digesting protein and carbohydrates to facilitate muscle repair and glycogen resynthesis [114].

Hydration

Prioritize hydration before, during and after workouts to counteract dehydration resulting from fasting.

Drink plenty of water and electrolyte-rich beverages during non-fasting hours to maintain hydration levels and support exercise performance [115].

Listen to Your Body

Pay close attention to your body's signals and adjust your training accordingly. If you feel excessively fatigued or dehydrated, consider reducing training intensity or taking additional rest days as needed to prevent overtraining and support recovery [116].

Consistency

Aim for consistency in your training routine throughout Ramadan to maintain muscle mass, strength and overall fitness. While adjustments may be necessary to accommodate fasting, strive to stay active and adhere to your training program as closely as possible [117].

By implementing these training considerations, bodybuilders can continue to make progress and maintain their fitness levels during Ramadan while respecting the challenges of fasting. Prioritizing recovery, hydration and smart training adjustments will help support muscle growth, strength and overall well-being during this period [118].

Conclusion

In conclusion, bodybuilders observing Ramadan can optimize their muscle mass, strength and performance by implementing strategic nutritional and training strategies. Maintaining adequate energy intake, nutrient timing and hydration during Suhoor and Iftar is essential for supporting muscle growth, recovery and exercise performance during fasting. Adjusting training schedules and intensity levels to accommodate fasting-induced physiological changes can help individuals maintain training consistency and achieve their bodybuilding goals during Ramadan. By integrating these strategies, individuals can effectively balance their religious observance with their fitness objectives during the holy month of Ramadan.

Conflicts of Interests

The author declares that there is no conflict of interest for this paper.

References

1. Calle EE, Kaaks R. Overweight, obesity and cancer: epidemiological evidence and proposed mechanisms. *Nat Rev Cancer*. 2004;4(8):579.
2. Persynaki A, Karras S, Pichard C. Unraveling the metabolic health benefits of fasting related to religious beliefs: a narrative review. *Nutrition*. 2017;35:14-20.
3. Wallis GA, Gonzalez JT. Is exercise best served on an empty stomach? *Proc Nutr Soc*. 2019;78(1):110-17.
4. Horowitz JF, Mora-Rodriguez R, Byerley LO, Coyle EF. Lipolytic suppression following carbohydrate ingestion limits fat oxidation during exercise. *Am J Physiol Endocrinol Metab*. 1997;273(4):E768-75.
5. Horowitz JF, Mora-Rodriguez R, Byerley LO, Coyle EF. Substrate metabolism when subjects are fed carbohydrate during exercise. *Am J Physiol Endocrinol Metab*. 1999;276(5):E828-35.
6. Maughan R, Fallah J, Coyle EF. The effects of fasting on metabolism and performance. *Br J Sports Med*. 2010;44(7):490-4.

7. Michalsen A, Li C. Fasting therapy for treating and preventing disease-current state of evidence. *Complementary Med Res.* 2013;20(6):444-53.
8. Chaouachi A, Coutts AJ, Chamari K. Effect of Ramadan intermittent fasting on aerobic and anaerobic performance and perception of fatigue in male elite judo athletes. *J Strength Cond Res.* 2009;23(9):2702-9.
9. Karli U, Guvenc A, Aslan A, Hazir T, Acikada C. Influence of Ramadan fasting on anaerobic performance and recovery following short time high intensity exercise. *J Sports Sci Med.* 2007;6(4):490.
10. Kirkendall DT, Leiper JB, Bartagi Z, Dvorak J, Zerguini Y. The influence of Ramadan on physical performance measures in young Muslim footballers. *J Sports Sci.* 2008;26(S3):S15-27.
11. Meckel Y, Ismaeel A, Eliakim A. The effect of the Ramadan fast on physical performance and dietary habits in adolescent soccer players. *Eur J Appl Physiol.* 2008;102(6):651-7.
12. Zerguini Y, Kirkendall D, Junge A, Dvorak J. Impact of Ramadan on physical performance in professional soccer players. *Br J Sports Med.* 2007;41(6):398-400.
13. Leiper JB, Junge A, Maughan RJ, Zerguini Y, Dvorak J. Alteration of subjective feelings in football players undertaking their usual training and match schedule during the Ramadan fast. *J Sports Sci.* 2008;26(S3):S55-69.
14. Aloui A, Chtourou H, Hammouda O. Effects of Ramadan on the diurnal variations of physical performance and perceived exertion in adolescent soccer players. *Biol Rhythm Res.* 2013;44(6):869-75.
15. Tinsley GM, La Bounty PM. Effects of intermittent fasting on body composition and clinical health markers in humans. *Nutr Rev.* 2015;73(10):661-74.
16. Longo VD, Panda S. Fasting, circadian rhythms and time-restricted feeding in healthy lifespan. *Cell Metab.* 2016;23(6):1048-59.
17. de Toledo FW, Grundler F, Bergouignan A, Drinda S, Michalsen A. Safety, health improvement and well-being during a 4 to 21-day fasting period in an observational study including 1422 subjects. *PLoS One.* 2019;14(1):e0209353.
18. Trepanowski JF, Kroeger CM, Barnosky A. Effect of alternate-day fasting on weight loss, weight maintenance and cardioprotection among metabolically healthy obese adults: a randomized clinical trial. *JAMA Intern Med.* 2017;177(7):930-8.
19. Cherif A, Roelands B, Meeusen R, Chamari K. Effects of intermittent fasting, caloric restriction and Ramadan intermittent fasting on cognitive performance at rest and during exercise in adults. *Sports Med.* 2016;46(1):35-47.
20. Stockman M-C, Thomas D, Burke J, Apovian CM. Intermittent fasting: is the wait worth the weight? *Curr Obes Rep.* 2018;7(2):172-85.
21. Antoni R, Johnston KL, Collins AL, Robertson MD. Effects of intermittent fasting on glucose and lipid metabolism. *Proc Nutr Soc.* 2017;76(3):361-8.
22. Solianik R, Sujeta A, Terentjevienė A, Skurvydas A. Effect of 48 h fasting on autonomic function, brain activity, cognition and mood in amateur weight lifters. *Biomed Res Int.* 2016;2016.
23. Azizi F. Islamic fasting and health. *Ann Nutr Metab.* 2010;56(4):273-82.
24. Hussin N, Shahar S, Teng N, Ngah W, Das S. Efficacy of Fasting and Calorie Restriction (FCR) on mood and depression among ageing men. *J Nutr Health Aging.* 2013;17(8):674-80.
25. Teng NIMF, Shahar S, Rajab NF, Manaf ZA, Johari MH, Ngah WZW. Improvement of metabolic parameters in healthy older adult men following a fasting calorie restriction intervention. *Aging Male.* 2013;16(4):177-83.
26. Klempel MC, Kroeger CM, Bhutani S, Trepanowski JF, Varady KA. Intermittent fasting combined with calorie restriction is effective for weight loss and cardio-protection in obese women. *Nutr J.* 2012;11(1):98.
27. Teng NIMF, Shahar S, Manaf ZA, Das SK, Taha CSC, Ngah WZW. Efficacy of fasting calorie restriction on quality of life among ageing men. *Physiol Behav.* 2011;104(5):1059-64.
28. Fitzgerald KC, Vizthum D, Henry-Barron B. Effect of intermittent vs. daily calorie restriction on changes in weight and patient-reported outcomes in people with multiple sclerosis. *Mult Scler Relat Disord.* 2018;23:33-9.
29. Schübel R, Nattenmüller J, Sookthai D. Effects of intermittent and continuous calorie restriction on body weight and metabolism over 50 wk: a randomized controlled trial. *Am J Clin Nutr.* 2018;108(5):933-45.
30. Oh M, Kim S, An KY. Effects of alternate day calorie restriction and exercise on cardio-metabolic risk factors in overweight and obese adults: an exploratory randomized controlled study. *BMC Public Health.* 2018;18(1):1124.
31. Trepanowski JF, Kroeger CM, Barnosky A. Effects of alternate-day fasting or daily calorie restriction on body composition, fat distribution and circulating adipokines: secondary analysis of a randomized controlled trial. *Clin Nutr.* 2018;37(6):1871-

- 8.
32. Bhutani S, Klempel MC, Kroeger CM, Trepanowski JF, Varady KA. Alternate day fasting and endurance exercise combine to reduce body weight and favorably alter plasma lipids in obese humans. *Obesity*. 2013;21(7):1370-9.
33. Eshghinia S, Mohammadzadeh F. The effects of modified alternate-day fasting diet on weight loss and CAD risk factors in overweight and obese women. *J Diabetes Metab Disord*. 2013;12(1):4.
34. 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.
35. Varady KA, Bhutani S, Klempel MC. Alternate day fasting for weight loss in normal weight and overweight subjects: a randomized controlled trial. *Nutr J*. 2013;12(1):146.
36. Catenacci VA, Pan Z, Ostendorf D. A randomized pilot study comparing zero-calorie alternate-day fasting to daily caloric restriction in adults with obesity. *Obesity*. 2016;24(9):1874-83.
37. Aliasghari F, Izadi A, Gargari BP, Ebrahimi S. The effects of Ramadan fasting on body composition, blood pressure, glucose metabolism and markers of inflammation in NAFLD patients: an observational trial. *J Am Coll Nutr*. 2017;36(8):640-5.
38. Racinais S, Périard J, Li C, Grantham J. Activity patterns, body composition and muscle function during Ramadan in a Middle-East Muslim country. *Int J Sports Med*. 2012;33(08):641-6.
39. Klempel M, Kroeger C, Varady K. Alternate day fasting increases LDL particle size independently of dietary fat content in obese humans. *Eur J Clin Nutr*. 2013;67(7):783.
40. Varady KA, Bhutani S, Klempel MC, Kroeger CM. Comparison of effects of diet versus exercise weight loss regimens on LDL and HDL particle size in obese adults. *Lipids Health Dis*. 2011;10(1):119.
41. 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.
42. Moro T, Tinsley G, Bianco A. 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.
43. Stote KS, Baer DJ, Spears K. A controlled trial of reduced meal frequency without caloric restriction in healthy, normal-weight, middle-aged adults. *Am J Clin Nutr*. 2007;85(4):981-8.
44. Halberg N, Henriksen M, Soderhamn N. Effect of intermittent fasting and refeeding on insulin action in healthy men. *J Appl Physiol*. 2005;99(6):2128-36.
45. Soeters MR, Lammers NM, Dubbelhuis PF. Intermittent fasting does not affect whole-body glucose, lipid, or protein metabolism. *Am J Clin Nutr*. 2009;90(5):1244-51.
46. Asl NS. The effects of Ramadan fasting on endurance running performance in male athletes. *Int J Sport Stud*. 2011;1(1):18-22.
47. Sana'a AA, Ismail M, Baker A. The effects of diurnal Ramadan fasting on energy expenditure and substrate oxidation in healthy men. *Br J Nutr*. 2017;118(12):1023-30.
48. Sadeghirad B, Motaghipisheh S, Kolaheidoz F, Zahedi MJ, Haghdoost AA. Islamic fasting and weight loss: a systematic review and meta-analysis. *Public Health Nutr*. 2014;17(2):396-406.
49. Latiri I, Sandid S, Fennani MA. The effects of Ramadan fasting on the spirometric data of healthy adult males. *Am J Mens Health*. 2017;11(4):1214-23.
50. Mazidi M, Rezaie P, Chaudhri O, Karimi E, Nematy M. The effect of Ramadan fasting on cardiometabolic risk factors and anthropometrics parameters: a systematic review. *Pak J Med Sci*. 2015;31(5):1250.
51. Nugraha B, Ghashang SK, Hamdan I, Gutenbrunner C. Effect of Ramadan fasting on fatigue, mood, sleepiness and health-related quality of life of healthy young men in summer time in Germany: A prospective controlled study. *Appetite*. 2017;111:38-45.
52. Sezen Y, Altiparmak IH, Erkus ME. Effects of Ramadan fasting on body composition and arterial stiffness. *J Pak Med Assoc*. 2016;66:1522-7.
53. 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.
54. Hammouda O, Chtourou H, Aloui A. Does Ramadan fasting affect the diurnal variations in metabolic responses and total antioxidant capacity during exercise in young soccer players? *Sport Sci Health*. 2014;10(2):97-104.
55. Hammouda O, Chtourou H, Aloui A. Concomitant effects of Ramadan fasting and time-of-day on apolipoprotein AI, B, Lp-a and homocysteine responses during aerobic exercise in Tunisian soccer players. *PLoS One*. 2013;8(11):e79873.

56. Bouhlef H, Shephard RJ, Gmada N. Effect of Ramadan observance on maximal muscular performance of trained men. *Clin J Sport Med*. 2013;23(3):222-7.
57. Zarrouk N, Hug F, Hammouda O. Effect of Ramadan intermittent fasting on body composition and neuromuscular performance in young athletes: a pilot study. *Biol Rhythm Res*. 2013;44(5):697-709.
58. Mirzaei B, Rahmani-Nia F, Moghadam MG, Ziyaolhagh SJ, Rezaei A. The effect of ramadan fasting on biochemical and performance parameters in collegiate wrestlers. *Iran J Basic Med Sci*. 2012;15(6):1215.
59. Kacimi S, Ref'at A, Fararjeh MA, Bustanji YK, Mohammad MK, Salem ML. Intermittent fasting during Ramadan attenuates proinflammatory cytokines and immune cells in healthy subjects. *Nutr Res*. 2012;32(12):947-55.
60. Trabelsi K, El Abed K, Trepanowski JF. Effects of Ramadan fasting on biochemical and anthropometric parameters in physically active men. *Asian J Sports Med*. 2011;2(3):134.
61. Güvenç A. Effects of Ramadan fasting on body composition, aerobic performance and lactate, heart rate and perceptual responses in young soccer players. *J Hum Kinet*. 2011;29:79-91.
62. Lotfi S, Madani M, Abassi A, Tazi A, Boumahmaza M, Talbi M. CNS activation, reaction time, blood pressure and heart rate variation during ramadan intermittent fasting and exercise. *World J Sports Sci*. 2010;3(1):37-43.
63. Chennaoui M, Desgorges F, Drogou C. Effects of Ramadan fasting on physical performance and metabolic, hormonal and inflammatory parameters in middle-distance runners. *Appl Physiol Nutr Metab*. 2009;34(4):587-94.
64. Chaouachi A, Chamari K, Roky R. Lipid profiles of judo athletes during Ramadan. *Int J Sports Med*. 2008;29(4):282-8.
65. 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.
66. Al-Hourani H, Atoum M. Body composition, nutrient intake and physical activity patterns in young women during Ramadan. *Singapore Med J*. 2007;48(10):906.
67. Bouhlef E, Salhi Z, Bouhlef H. Effect of Ramadan fasting on fuel oxidation during exercise in trained male rugby players. *Diabetes Metab*. 2006;32(6):617-24.
68. Lamine F, Bouguerra R, Jabrane J. Food intake and high-density lipoprotein cholesterol levels changes during Ramadan fasting in healthy young subjects. *Tunis Med*. 2006;84(10):647-50.
69. Yucel A, Degirmenci B, Acar M, Albayrak R, Haktanir A. The effect of fasting month of Ramadan on the abdominal fat distribution: assessment by computed tomography. *Tohoku J Exp Med*. 2004;204(3):179-87.
70. Ramadan J. Does fasting during Ramadan alter body composition, blood constituents and physical performance? *Med Principles Pract*. 2002;11(Suppl. 2):41-6.
71. Ramadan J, Telahoun G, Al-Zaid NS, Barac-Nieto M. Responses to exercise, fluid and energy balances during Ramadan in sedentary and active males. *Nutrition*. 1999;15(10):735-9.
72. 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.
73. Fakhrzadeh H, Lariiani B, Sanjari M, Baradar-Jalili R, Amini M. Effect of Ramadan fasting on clinical and biochemical parameters in healthy adults. *Ann Saudi Med*. 2003;23(3-4):223-6.
74. Nematy M, Alinezhad-Namaghi M, Rashed MM. Effects of Ramadan fasting on cardiovascular risk factors: a prospective observational study. *Nutr J*. 2012;11(1):69.
75. Shehab A, Abdulle A, El Issa A, Al Suwaidi J, Nagelkerke N. Favorable changes in lipid profile: the effects of fasting after Ramadan. *PLoS One*. 2012;7(10):e47615.
76. Beltaifa L, Bouguerra R, Ben CS. Food intake and anthropometrical and biological parameters in adult Tunisians during fasting at Ramadan. *East Mediterr Health J*. 2002;8(4-5):603-11.
77. Shephard RJ. Ramadan and sport: minimizing effects upon the observant athlete. *Sports Med*. 2013;43(12):1217-41.
78. 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.
79. Bak AM, Møller AB, Vendelbo MH. Differential regulation of lipid and protein metabolism in obese vs. lean subjects before and after a 72-h fast. *Am J Physiol Endocrinol Metab*. 2016;311(1):E224-35.
80. Syam AF, Sobur CS, Abdullah M, Makmun D. Ramadan fasting decreases body fat but not protein mass. *Int J Endocrinol Metab*. 2016;14(1):e29687.
81. Ziaee V, Razaee M, Ahmadinejad Z. The changes of metabolic profile and weight during Ramadan fasting. *Singapore Med J*. 2006;47(5):409.

82. 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.
83. Larijani B, Zahedi F, Sanjari M. The effect of Ramadan fasting on fasting serum glucose in healthy adults. *Med J Malaysia.* 2003;58(5):678-80.
84. Vicente-Salar N, Otegui AU, Collado ER. Endurance training in fasting conditions: biological adaptations and body weight management. *Nutr Hosp.* 2015;32(6):2409-20.
85. Ba A, Samb A, Seck D. Comparative study of the effect of fasting during Ramadan on the glycaemia at rest in sportsmen and sedentaries. *Dakar Med.* 2005;50(1):22-5.
86. Mehdioui H, Aberkane A, Bouroubi O, Bougrida M, Benhlassa L, Beltrache C. Influence de la pratique du jeûne Ramadan sur l'endurance maximale aérobie des coureurs de fond (Effects of Ramadan fasting on the maximal aerobic endurance of distance runners). *J Alger Med.* 1996;6(1):1-5.
87. Brisswalter J, Bouhlef E, Falola JM, Abbiss CR, Vallier JM, Hauswirth C. Effects of Ramadan intermittent fasting on middle-distance running performance in well-trained runners. *Clin J Sport Med.* 2011;21(5):422-7.
88. Png W, Bhaskaran K, Sinclair AJ, Aziz AR. Effects of ingesting low glycemic index carbohydrate food for the sahur meal on subjective, metabolic and physiological responses and endurance performance in Ramadan fasted men. *Int J Food Sci Nutr.* 2014;65(5):629-36.
89. Aziz AR, Wahid MF, Png W, Jesuvadian CV. Effects of Ramadan fasting on 60 min of endurance running performance in moderately trained men. *Br J Sports Med.* 2010;44(7):516-21.
90. van Loon LJ, Koopman R, Stegen JH, Wagenmakers AJ, Keizer HA, Saris WH. Intramyocellular lipids form an important substrate source during moderate intensity exercise in endurance-trained males in a fasted state. *J Physiol.* 2003;553(2):611-25.
91. Fouad C. Effects of Ramadan on aerobic fitness, anthropometric and biochemical parameters in footballers. *Rev Sci Hum.* 2008;30:25-41.
92. Sweileh N, Schnitzler A, Hunter G, 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.
93. Bassuk SS, Manson JE. Epidemiological evidence for the role of physical activity in reducing risk of type 2 diabetes and cardiovascular disease. *J Appl Physiol.* 2005;99(3):1193-204.
94. Donnelly JE, Blair SN, Jakicic JM, Manore MM, Rankin JW, Smith BK. American College of Sports Medicine Position Stand. Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. *Med Sci Sports Exerc.* 2009;41(2):459-71.
95. Goodpaster BH, Katsiaras A, Kelley DE. Enhanced fat oxidation through physical activity is associated with improvements in insulin sensitivity in obesity. *Diabetes.* 2003;52(9):2191-7.
96. Vieira AF, Costa RR, Macedo RCO, Coconcelli L, Kruel LFM. Effects of aerobic exercise performed in fasted v. fed state on fat and carbohydrate metabolism in adults: a systematic review and meta-analysis. *Br J Nutr.* 2016;116(7):1153-64.
97. Andersson Hall U, Edin F, Pedersen A, Madsen K. Whole-body fat oxidation increases more by prior exercise than overnight fasting in elite endurance athletes. *Appl Physiol Nutr Metab.* 2015;41(4):430-7.
98. De Bock K, Richter EA, Russell A. Exercise in the fasted state facilitates fibre type-specific intramyocellular lipid breakdown and stimulates glycogen resynthesis in humans. *J Physiol.* 2005;564(2):649-60.
99. Spriet LL. New insights into the interaction of carbohydrate and fat metabolism during exercise. *Sports Med.* 2014;44(1):87-96.
100. Van Proeyen K, Szulc K, Nielens H, Ramaekers M, Hespel P. Beneficial metabolic adaptations due to endurance exercise training in the fasted state. *J Appl Physiol.* 2010;110(1):236-45.
101. Coyle E, Hagberg J, Hurley B, Martin W, Ehsani A, Holloszy J. Carbohydrate feeding during prolonged strenuous exercise can delay fatigue. *J Appl Physiol.* 1983;55(1):230-5.
102. Coyle EF, Coggan AR, Hemmert M, Ivy JL. Muscle glycogen utilization during prolonged strenuous exercise when fed carbohydrate. *J Appl Physiol.* 1986;61(1):165-72.
103. Hagan RD, Upton SJ, Wong L, Whittam J. The effects of aerobic conditioning and/or caloric restriction in overweight men and women. *Med Sci Sports Exerc.* 1986;18(1):87-94.
104. Loy SF, Conlee RK, Winder WW, Nelson AG, Arnall DA, Fisher AG. Effects of 24-hour fast on cycling endurance time at two different intensities. *J Appl Physiol.* 1986;61(2):654-9.

105. Nieman DC, Carlson KA, Brandstater ME, Naegele RT, Blankenship JW. Running endurance in 27-h-fasted humans. *J Appl Physiol*. 1987;63(6):2502-9.
106. Gleeson M, Greenhaff P, Maughan R. Influence of a 24 h fast on high intensity cycle exercise performance in man. *Eur J Appl Physiol Occup Physiol*. 1988;57(6):653-9.
107. Keim NL, Barbieri TF, Van Loan MD, Anderson BL. Energy expenditure and physical performance in overweight women: response to training with and without caloric restriction. *Metabolism*. 1990;39(6):651-8.
108. Zinker BA, Britz K, Brooks GA. Effects of a 36-hour fast on human endurance and substrate utilization. *J Appl Physiol*. 1990;69(5):1849-55.
109. Gueye L, Samb A, Seck D, Cissé F, Camara K, Martineaud J. Influence of a 12 hours-fast on maximal exercise. *Script Medica (Brno)*. 2004;77:5-8.
110. Aragón-Vargas LF. Effects of fasting on endurance exercise. *Sports Med*. 1993;16(4):255-65.
111. Ferguson LM, Rossi KA, Ward E, Jadwin E, Miller TA, Miller WC. Effects of caloric restriction and overnight fasting on cycling endurance performance. *J Strength Cond Res*. 2009;23(2):560-70.
112. Knapik JJ, Jones BH, Meredith C, Evans WJ. Influence of a 3.5 day fast on physical performance. *Eur J Appl Physiol Occup Physiol*. 1987;56(4):428-32.
113. Stannard SR, Buckley AJ, Edge JA, Thompson MW. Adaptations to skeletal muscle with endurance exercise training in the acutely fed versus overnight-fasted state. *J Sci Med Sport*. 2010;13(4):465-9.
114. Golbidi S, Daiber A, Korac B, Li H, Essop MF, Laher I. Health benefits of fasting and caloric restriction. *Curr Diab Rep*. 2017;17(12):123.
115. Vicente-Salar N, Urdampilleta Otegui A, Roche Collado E. Entrenamiento aeróbico en ayunas: adaptaciones biológicas y efectos en el control de peso. *Nutr Hosp*. 2015;32(6):2409-20.
116. Bouguerra L, Ben Abderrahman A, Chtourou H, Zouhal H, Tabka Z, Prioux J. The effect of time-of-day of training during Ramadan on physiological parameters in highly trained endurance athletes. *Biol Rhythm Res*. 2017;48(4):541-55.
117. Chtourou H, Souissi N. The effect of training at a specific time of day: a review. *J Strength Cond Res*. 2012;26(7):1984-2005.
118. Mujika I. Intense training: the key to optimal performance before and during the taper. *Scand J Med Sci Sports*. 2010;20:24-31.

Journal of Orthopaedic Science and Research



Publish your work in this journal

Journal of Orthopaedic Science and Research is an international, peer-reviewed, open access journal publishing original research, reports, editorials, reviews and commentaries. All aspects of orthopaedic health maintenance, preventative measures and disease treatment interventions are addressed within the journal. Orthopaedicians and other researchers are invited to submit their work in the journal. The manuscript submission system is online and journal follows a fair peer-review practices.

Submit your manuscript here: <https://athenaeumpub.com/submit-manuscript/>