

Physiological, Metabolic and Biochemical Effects of Ramadan Fasting: A Review of Contemporary Scientific Evidence

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Abstract

Ramadan is one of the fundamental pillars of Islam, providing a comprehensive system of spiritual, moral, and educational instruction. Extensive research in modern medical and biological sciences has shown that the effects of daily fasting cause numerous physiological, metabolic, and biochemical changes in the human body. Fasting results in significant changes in energy levels, glucose, hormones, metabolism, energy utilization, and cellular functions. Islamic teachings describe fasting as a means of piety, self-discipline, and spiritual reformation, while modern scientific research has shown that fasting has numerous medical benefits. The aim of this research paper is to present an analytical review of the physiological, metabolic and biochemical effects of Ramadan fasting in the light of the teachings of the Quran and Sunnah and

contemporary scientific evidence. The paper clarifies that Islamic worship, especially fasting, is not only a means of spiritual evolution but also plays an important role in promoting human health.

Introduction

Islam is a way of life that fulfills the spiritual, moral and complete code of human relationships. There is a unique form of worship among Islamic rituals whose effects are not limited to spiritual life but are also significant on various systems of the human body. In the Holy Quran, Allah Almighty, while ordering the believers to fast, said that the main purpose of fasting is to attain piety.ⁱ From an Islamic perspective, fasting instills patience, tolerance, self-accountability, and discipline in a person, while modern scientific research also highlights its numerous medical benefits.

During Ramadan, abstaining from food and drink and other specific activities from dawn to sunset changes the way the human body uses energy. Initially, the body uses stored glucose, while later fat is used as the main source of energy. This process results in changes in weight, blood sugar levels, insulin sensitivity, and the function of various hormones.ⁱⁱ In contemporary medical literature, Ramadan fasting is considered a unique natural model through which to study the metabolic adaptations of the human body. Numerous studies have shown that fasting, when combined with a proper dietary regimen, can lead to a reduction in cardiovascular health, body weight, fat percentage, and the risk of certain chronic diseases.ⁱⁱⁱ In this context, this paper presents a comprehensive review of the physiological, metabolic, and biochemical effects of Ramadan fasting in the light of Islamic sources and modern scientific evidence.

The concept of fasting in the Holy Quran

Fasting during the month of Ramadan is one of the fundamental pillars of Islam and its obligation is proven in the Holy Quran. Allah Almighty says in Surah Al-Baqarah: "O you who believe! Fasting is prescribed for you as it was prescribed for those before you, that you may attain piety."^{iv} This verse makes it clear that the main purpose of fasting is not just to endure hunger and thirst, but to instill piety, self-responsibility, and spiritual maturity in a person. According to Islamic teachings, fasting is an act of worship that trains a person to control his desires and obey Allah Almighty.

The month of Ramadan is described in the Holy Quran as the month in which the Quran was revealed, further highlighting the spiritual importance of fasting.^v According to commentators, fasting is a means of all-round reformation of the human personality because through it, a person not only avoids sins but also improves his morals and character.^{vi} From a modern scientific perspective, the temporary abstinence from food and drink during fasting places the body in a specific biological state that brings about balance and harmony in the body's systems. Thus, the Quran's concept of piety and self-control is in harmony with the physical benefits revealed by modern medical research.

The Importance of Fasting in Prophetic Hadiths

The Messenger of Allah (ﷺ) has considered fasting as one of the fundamental acts of worship in Islam and has described its spiritual, moral and physical importance in numerous Hadiths. He (ﷺ) said: "Islam is founded on five things," including fasting in Ramadan.^{vii} In another hadith, the Prophet (peace and blessings of Allah be upon him) said, "Fasting is a shield," meaning it serves as a means of protecting a person from sins, moral evils, and the punishment of the hereafter.^{viii} This statement makes it clear that fasting is not just about physical hunger and thirst, but rather a comprehensive training system that improves a person's inner and outer self.

In hadiths, fasting is described as a practical exercise in patience, tolerance, and self-discipline. The Prophet (peace and blessings of Allah be upon him) advised the fasting person to avoid quarreling, backbiting, and other negative behaviors.^{ix} Thus, fasting strengthens the moral aspect of the human personality. Furthermore, the Holy Prophet (peace and blessings of Allah be upon him) also guided us towards a healthy

diet by describing the etiquette of Suhoor and Iftar.^x Modern medical research shows that regular mealtimes and eating at specific intervals have positive effects on human metabolism. These benefits include improved insulin sensitivity, balanced energy expenditure, and a relaxed digestive system.^{xi} Thus, the wisdom of fasting as described in the Prophetic hadiths seems to be consistent with the findings of modern scientific research. Fasting is a spiritual act of worship as well as a lifestyle that serves as a means of improving both human health and character.

3. Fasting and the Physiological System of the Human Body

The human body is a very complex biological system that depends on a continuous supply of food, water, and energy. During the fasting period of Ramadan, when food and drink are avoided for several hours, the body undergoes various physiological changes to maintain essential functions. In the first few hours, the body uses glycogen stored in the liver and muscles for energy.^{xii} When these reserves begin to deplete, the body begins to convert fat stores into energy, which is called metabolic adaptation.^{xiii} During fasting, various body systems, such as the digestive system, circulatory system, nervous system, and hormonal system, undergo specific changes. The digestive system receives a temporary rest, while the decrease in insulin levels and the increase in glucagon secretion activate alternative energy sources.^{xiv} As a result, the body becomes more efficient in using energy.

Research studies have shown that properly maintained Ramadan fasting can reduce certain markers of inflammation in the body, improve blood fat balance, and stimulate cellular repair processes.^{xv} Additionally, fasting can also help the body develop better resistance to oxidative stress.^{xvi} Islamic teachings emphasize moderation and moderation. When fasting is combined with a balanced diet during suhoor and iftar, it not only provides spiritual benefits but can also help improve the physiological systems of the human body.

4. Metabolic changes during fasting

During the fasting period of Ramadan, the human body undergoes a systematic metabolic change process called metabolic switching. In this process, the body changes its primary source of energy. Initially, glucose in the blood is used, but after a few hours, the glycogen reserves in the liver begin to run out and the body starts using fat (fatty acids) for energy.^{xvii} This change is a natural adaptation of the human body that enables the efficient use of energy.

Metabolic changes include a significant decrease in insulin levels and an increase in glucagon levels, which accelerate lipolysis, the process of breaking down fat.^{xviii} This results in the production of ketone bodies, which provide alternative energy for the brain and muscles. According to modern research, this condition improves metabolic flexibility in the body.^{xix}

Additionally, improvements in mitochondrial efficiency and activation of cellular repair mechanisms (autophagy) have also been observed during fasting.^{xx} This process helps to eliminate harmful components at the cellular level and form new cells. Thus, fasting not only changes energy consumption but also has positive effects on cellular health. From an Islamic perspective, these metabolic changes are part of the process of creating discipline and moderation in the human body, which is in accordance with the principles of the Quran and Sunnah.

5. Glucose and energy balance

Glucose is the primary energy source in the human body, essential for brain, nerve, and muscle function. During fasting, when food intake is restricted, the body uses various hormonal and metabolic mechanisms to maintain blood glucose levels. Initially, glucose stored in the liver is released into the blood through glycogenolysis, while in the long term, the process of gluconeogenesis is activated.^{xxi} The decrease in insulin levels and the increase in glucagon result in the body using energy in a safe

manner and maintaining stable blood sugar levels.^{xxii} This process is especially important for people who are at risk for metabolic diseases such as diabetes. Several studies have shown that fasting can improve insulin sensitivity.^{xxiii} An important aspect of energy balance is increased lipid oxidation, which allows the body to use fat more efficiently. This not only helps with weight control but may also reduce cardiovascular risk factors.^{xxiv} Islamic teachings emphasize moderation in diet, and fasting is a practical embodiment of this principle that naturally leads the human body towards energy balance.

Effects of fasting on the hormonal system

During the fasting period of Ramadan, the endocrine or hormonal system of the human body undergoes significant changes. These changes regulate the body's energy use, appetite, metabolism and stress response. During fasting, insulin levels decrease while glucagon, cortisol and growth hormone levels increase.^{xxv} This hormonal balance enables the body to use alternative sources of energy.

A decrease in insulin accelerates the process of converting fat stores into energy, while glucagon activates glycogenolysis and gluconeogenesis.^{xxvi} Similarly, an increase in growth hormone leads to the preservation of muscle mass and improvement in fat metabolism. According to modern research, these hormonal changes improve metabolic efficiency and help maintain physical performance.^{xxvii}

A slight increase in cortisol levels ensures energy availability during fasting, but this change is temporary and does not cause any negative effects in healthy individuals.^{xxviii} Overall, fasting creates a balanced and natural adjustment in the body's hormonal system. The training in patience and self-control that is given in Islamic teachings is actually consistent with the same physical and psychological changes that are described in modern endocrine science.

Fasting and Cardiovascular Health

The cardiovascular system is a very important system of the human body, responsible for blood circulation, oxygen supply, and nutrient delivery. Fasting has positive effects on the heart and blood vessels, especially an improvement in the lipid profile. Studies have shown that fasting during Ramadan can reduce LDL cholesterol and triglycerides while increasing HDL cholesterol.^{xxix}

Additionally, fasting may also help balance blood pressure. This effect is partly due to weight loss, improved insulin sensitivity, and reduced inflammation.^{xxx} Modern research indicates that intermittent fasting may help reduce the risk of heart disease.^{xxxi} An important aspect of the positive effects of fasting on cardiovascular health is the reduction in oxidative stress, which reduces the risk of atherosclerosis.^{xxxii} Thus, fasting is not only a spiritual act of worship but also acts as a protective mechanism that improves heart health. Moderation and moderation are fundamental principles in Islamic teachings, and fasting is a practical example of this principle that guides the human body towards a healthy lifestyle.

Fasting and the Immune System

The immune system is the primary defense system of the human body that provides protection against bacteria, viruses, and other diseases. Various positive effects have been observed on the performance of the immune system in the body during the fasting period of Ramadan. According to modern research, fasting balances the activity of white blood cells and reduces unnecessary inflammatory responses.^{xxxiii} This process improves the body's immune regulation.

Additionally, changes in the gut microbiota also occur during fasting, which play an important role in strengthening the immune system.^{xxxiv} Research shows that intermittent fasting increases the growth of beneficial bacteria, which improves the overall health of the body. In addition, the process of autophagy also helps in the

cleansing and regeneration of immune cells.^{xxxv} From an Islamic perspective, fasting is a means of purifying both body and soul, and modern scientific evidence supports that the practice can also improve the body's defense system.

Fasting and Oxidative Stress

Oxidative stress is a biological condition in which the balance between free radicals and the antioxidant defense system within the body is disturbed. This imbalance is considered one of the main causes of cellular damage, premature aging, cardiovascular disease, diabetes, and other chronic diseases. According to modern biochemistry, oxidative stress occurs when the amount of reactive oxygen species (ROS) increases and the body's defense system is unable to neutralize it.^{xxxvi}

Several research studies have shown that during the fasting period of Ramadan, there is a significant reduction in markers of oxidative stress in the body. This is mainly due to the reduction in meal intervals, balanced calorie consumption, and metabolic switching, which results in the body's energy system becoming more efficient.^{xxxvii}

During fasting, the activity of antioxidant enzymes such as superoxide dismutase (SOD), catalase, and glutathione peroxidase has been observed to increase in the body, which protect cells from damage.

Additionally, fasting also helps improve mitochondrial function, which results in fewer free radicals being produced during energy production.^{xxxviii} In addition, the process of autophagy eliminates unnecessary or damaged cellular components, which improves cellular health. All these factors together improve the overall oxidative balance in the body. From the perspective of Islamic teachings, fasting is not only a spiritual act of worship but also a means of physical purification. The teachings of moderation, moderation, and self-control given in the Quran and Sunnah seem to be in line with the principles of oxidative stress reduction described in modern scientific research. Thus, fasting not only provides spiritual purity to the human body, but also protects it at a biological level.

Fasting and Mental Health (Brain and Neurobiological Effects)

The brain is the central control system of the human body that regulates emotions, thinking, memory, and physical functions. Several positive effects on mental health have been observed during Ramadan fasting, which are related not only to spiritual peace but also to biological and neurochemical changes. According to modern neuroscience, fasting improves neuroplasticity in the brain, which improves learning and memory capacity.^{xxxix}

During fasting, levels of brain-derived neurotrophic factor (BDNF) have been observed to increase in the brain, which plays an important role in the development and protection of neurons.^{xl} In addition, fasting improves the balance of neurotransmitters such as dopamine and serotonin, which can reduce the likelihood of stress, anxiety, and depression.^{xli} These changes have a positive effect on human mood and emotional stability.

Additionally, the state of ketosis during fasting provides an effective energy source for the brain, which increases cognitive clarity and focus. Research has also shown that intermittent fasting may help reduce the risk of neurodegenerative diseases such as Alzheimer's and Parkinson's.^{xlii} In Islamic teachings, fasting is not just a physical act of worship, but also a means of spiritual peace and mental purity. Through patience, self-control, and worship, a person's mental stress is reduced, which is consistent with the findings of modern neuroscience. Thus, fasting plays a comprehensive role in improving mental health.

Critical Review of Contemporary Scientific Evidence

Modern scientific research on Ramadan fasting has demonstrated its numerous biological and medical benefits, however, these studies also have some limitations.

The most important problems are the small sample size and the differences in dietary habits in different countries, which lead to variability in the results.^{xliii}

Some studies have reported positive effects of fasting, such as weight loss, improvements in lipid profiles, and increased insulin sensitivity, while others have reported minor or transient effects.^{xliv} A major reason for this discrepancy is the lack of study design and control groups. Furthermore, changes in sleep patterns and mealtimes during Ramadan also affect the results.

Nevertheless, the overall scientific evidence indicates that intermittent fasting as a metabolic intervention can be beneficial for human health, if it is adopted in conjunction with a balanced diet and a healthy lifestyle.^{xlv} From an Islamic perspective, fasting is a complete spiritual and physical system that promotes moderation, patience, and self-discipline. Although modern science has not yet fully elucidated all its aspects, current research confirms that fasting has positive effects on multiple systems of the human body.

Fasting and Immune System Modulation

The immune system is the primary defense system of the human body that protects the body from bacteria, viruses, and other disease-causing agents. According to modern immunology, the performance of the immune system depends not only on genetic factors but also on dietary habits, lifestyle, and metabolic status. Several balanced changes have been observed in the immune system during the fasting period of Ramadan, which can be helpful in improving overall health.^{xlvi}

Research studies show that fasting reduces levels of pro-inflammatory cytokines such as TNF- α and IL-6, which reduces the likelihood of chronic inflammation in the body.^{xlvii} At the same time, anti-inflammatory pathways are activated, which makes the body's defense system more balanced. This change is especially important for diseases associated with chronic inflammation, such as heart disease and diabetes.

Additionally, positive changes occur in the gut microbiota during fasting. The growth of beneficial bacteria increases while the number of harmful bacteria may decrease, which not only improves the digestive system but also strengthens the immune system.^{xlviii} Similarly, the process of autophagy helps in the cleansing and regeneration of immune cells, by which the body eliminates old or damaged cells and produces new and active cells.^{xlix} According to Islamic teachings, fasting is a means of purification of both the body and the soul. It not only provides spiritual purity but also helps in bringing the body's defense system into a balanced state, which is in line with modern scientific research.

Fasting and Weight Management and Metabolic Disorders

Obesity and metabolic disorders are among the major health problems of today, including diabetes, hypertension, and dyslipidemia. Ramadan fasting can play a significant role in reducing the risk of these diseases, provided it is combined with a balanced diet and a healthy lifestyle. Several studies have shown that body weight can be reduced during Ramadan, especially visceral fat.¹

During fasting, there is a natural decrease in calorie intake, which shifts the body towards fat oxidation. This process results in improved insulin sensitivity and more stable blood glucose levels.ⁱⁱ In addition, improvements in the lipid profile have also been observed, including a decrease in LDL cholesterol and an increase in HDL cholesterol.

However, these effects are not the same for every individual because differences in dietary habits, sleep patterns, and physical activity affect the results. Some individuals have also been observed to gain weight due to unbalanced iftar and excess calorie intake, indicating that the benefits of fasting also depend on lifestyle.^{lii} From an Islamic perspective, fasting teaches moderation and self-control, which according to modern medical science is a very important principle for metabolic health.

Integrated Physiological Perspective on Fasting and Cardiovascular and Mental Health

Fasting during Ramadan has a holistic effect on the human body, in which the cardiovascular, mental and metabolic systems respond in an integrated manner. According to modern biomedical science, the various systems of the body do not work in isolation but as an interlinked network, and fasting acts as a natural physiological reset to this entire system.^{liii}

In terms of cardiovascular health, fasting improves the blood lipid profile, including a decrease in LDL cholesterol and triglycerides and an increase in HDL. It has also been shown to have a modest but consistent improvement in blood pressure.^{liv} These changes reduce the risk of atherosclerosis overall and improve heart health. Furthermore, increased insulin sensitivity during fasting helps further reduce cardiovascular risks.

In terms of mental health, fasting balances stress hormones such as cortisol while improving serotonin and dopamine pathways, creating mood stability.^{lv} This can result in a reduction in anxiety and depression. The spiritual aspect of fasting, namely worship, prayer and self-accountability, increases mental peace and psychological resilience, which is consistent with the principles of modern psychoneuroimmunology. Islamic teachings emphasize the balance between body and soul, and fasting implements this balance in practice. Modern scientific research supports that physical and mental health are closely linked, and fasting plays a regulatory role in this overall system.

Conclusion

This research review makes it clear that fasting during Ramadan is not just a religious obligation, but also a comprehensive physiological and biochemical system that affects the human body and mind. The teachings of the Quran and Sunnah describe fasting as a means of piety, self-control, and spiritual reform, while modern scientific research further clarifies its physical and medical benefits. Scientific evidence suggests that fasting activates metabolic switching in the human body, resulting in a more efficient energy utilization system. Similarly, important biological effects such as improved insulin sensitivity, better fat utilization, and reduced oxidative stress have been observed. These changes not only improve physical health but may also help reduce the risk of several chronic diseases.

Additionally, fasting balances the immune system, improves cardiovascular health, and helps reduce stress. Chemical changes in the brain, such as the balance of neurotransmitters and increased neuroplasticity, lead to improved mental clarity and concentration. However, it is also an important fact that the benefits of fasting also depend on the individual's lifestyle, dietary habits, and physical activity. An unbalanced diet or irregular routine can limit these benefits. Therefore, it is important to adopt moderation, discipline, and a healthy lifestyle. Overall, it can be said that fasting is an all-round system that improves a person on both spiritual and physical levels. The combination of Islamic teachings and modern scientific research proves that fasting is a natural, balanced, and effective strategy for human health that has existed for centuries as a complete code of life.

Results

Ramadan fasting activates metabolic switching in the human body, which makes the energy utilization system more efficient and the body uses fat as its primary energy source.

Scientific evidence shows that fasting improves insulin sensitivity and helps balance blood sugar levels, which may reduce the risk of diabetes.

During fasting, oxidative stress and inflammation levels in the body decrease, which reduces cellular damage and improves overall health.

Ramadan fasting balances the immune system and improves the body's defenses through positive changes in the gut microbiota.

Fasting has a positive effect not only on physical but also on mental and neurological health, which reduces stress, improves mood stability and cognitive performance.

Recommendations

During Ramadan, individuals should adopt a balanced diet to maximize the scientific and medical benefits of fasting.

Large-scale longitudinal studies are needed across countries and populations to further strengthen the research.

The effects of fasting on healthy individuals as well as diabetics and heart patients should be separately evaluated in detail.

It is important to balance sleep patterns and physical activity during Ramadan so that metabolic benefits are not affected.

Interdisciplinary research frameworks should be promoted by combining Islamic teachings and modern science to better understand all physical and spiritual aspects of fasting.

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