Optimizing Fat Loss: A Biochemical and Physiological Comparison of Aerobic, Resistance, and Concurrent Training Methods

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ABSTRACT

Due to obesity becoming the number one disease around the world, diet, as a result, is a part of our lives. Exercise has been shown to be impactful in the way of enhancing the effectiveness of diet and lowering fat mass. This review will represent a short comparison between aerobic, resistance, and concurrent exercise methods to display the physiological and biochemical effects of each. Comparing them can enhance public awareness and result in more conscious choices between them, whether they are athletic individuals or individuals who want to have an active lifestyle.

Literature has yet to discover the most beneficial exercise for each individual, and engaging in more discussion would allow scientists to prevent obesity in the long run. This review showed that using concurrent might be the most effective exercise in the short run. However, more practical implications are needed in the long run to gather a general conclusion, making it more straightforward for the public and academia to discuss underlying effects, impactfulness, and easier access openly.

Considering the diet, calorie intake, and required energy intake would always stay prior to choosing different exercises for lowering fat mass.

Keywords: *Aerobic Exercise, Resistance Training, Combined Training, Obesity, Public Health*

1. *INTRODUCTION*

Obesity is becoming the number one problem of the population in general, yet the most efficient exercise protocol has yet to be discovered to implicate the best result individuals seek. This review discusses the underlying effects of different training protocols, aerobic, resistance, and concurrent, which are well-known in scientific approaches for enhancing the physical activity of the body, helping the body to expend more energy and gain benefits from putting under more stress [1]. A significant factor of weight loss is using less or expending more energy compared to receiving it, which makes the body, enhance using body fat storage in the form of triglyceride in adipose tissue, known as subcutaneous fat under the skin, and visceral fat in internal organs [2].

Enhancing existing awareness and engaging this literature is important to boost fundamental knowledge regarding the use of each one of these exercises. However, it has always been noted that energy expenditure should be discussed from a broader perspective of calorie intake, not just using more of the body to seek energy usage initiation. Diet is the stance first in this regard, and the effectiveness of each of these exercises is directly related to the individual's approach and background.

2. *Method*

This review presents existing literature as a synthesized reference for rapid fat loss, comparing different training protocols. As existing literature has yet failed to build a robust narrative review on how and which might be most impactful, considering all sorts of factors, this review article tries to represent compact-practical information on choosing the most beneficial way for individuals, regardless of their potentiality in sports performance, ranging from sedentary lifestyles to professional-level athletes.

3. *Aerobic Exercise*

Aerobic exercise burns fat through a series of interconnected biochemical processes that begin with lipolysis; initially, stored triglycerides in adipose tissues, white or brown, are broken down into free fatty acids (FFAs) and glycerol under the influence of hormones like adrenaline [5]. These FFAs are transported into the muscle cells and then into mitochondria via the carnitine shuttle [6]. Inside the mitochondria, β-oxidation systematically breaks down the fatty acyl-CoA molecules into acetyl-CoA, NADH, and $FADH_2$. After the citric acid cycle, it produces more NADH and $FADH_2$ [5, 6]. These electron carriers. then feed into the electron transport chain which works exactly like a machine and turning to produce ATP, their energy is gathered to produce ATP through oxidative phosphorylation, which is uses for prolonged physical activity. Catecholamines in stress come from the kidney's upper gland (adrenal gland); dopamine, epinephrine, and norepinephrine cause the lowering of insulin levels. This initiation may start from splanchnic nerve activity, helping regulate hormones by realizing endogenous compounds such as histamine, bradykinin, or angiotensin II: these hormones and neurotransmitters, presynaptic nerve terminals at the end of axons or from glands as hormones. As a result of this initiation, insulin is controlled, and then the body initiates the fat burning. Promoting this chain of events would further lipolysis and fatty acid oxidation. Regular aerobic training enhances mitochondrial density and enzyme activity by increasing mitochondria's total amount or function, improving the body's capacity to oxidize fats efficiently. Hence, aerobic exercise shifts the body's metabolism to prioritize fat as a primary energy source, facilitating sustained energy production and effective fat burning [5-7].

4. *Resistance training*

Resistance training burns fat through several biochemical mechanisms that enhance muscle mass. This can start from elevating basal metabolic rate initiated from muscle gained as a result of more demand for protein synthesis and repairing muscle tissues that were damaged from resistance training and from optimizing hormonal balance independent of the aerobic processes discussed [8]. By stimulating muscle hypertrophy, resistance training increases the body's basal metabolic rate, demanding more energy while at rest, consequently leading to higher calorie expenditure. Furthermore, resistance training induces excess post-exercise oxygen consumption (EPOC), which, as a result of this increase in demand for oxygen consumption, causes continued calorie burning as the body repairs and builds muscle tissue in rest [9, 10]. Hormonal adaptations, such as elevated levels of anabolic hormones like testosterone and growth hormone, as well would promote lipolysis (the breakdown of fats) while improving insulin sensitivity with increasing in GLUT 4 (glucose transporter 4), which reduces fat storage and facilitates the mobilization of fatty acids for energy use both to provide energy for recovery and muscle protein synthesis. Enhanced protein synthesis during muscle repair increases the thermic effect of food, it further boosting metabolism in general and in short time [1, 3, 11, 12]. Resistance training also contributes to increased mitochondrial density and enzyme activity within muscle cells. It results in improving the efficiency of energy utilization and supporting fat metabolism. Furthermore, resistance exercises can shift muscle fiber composition towards more oxidative types and enhance the muscle's ability to utilize fat as an energy source [5, 10]. These combined effects create a favorable metabolic environment for fat loss by increasing overall energy expenditure, thus reducing fat storage and improving the body's ability to mobilize and burn fat stores, thereby promoting effective and sustained fat loss over time in both the short and long run.

5. *Concurrent training*

Concurrent training, which combines both resistance and aerobic exercise within a single session, enhances fat burning through a multifaceted biochemical interplay that optimizes overall energy metabolism and hormonal balance [7, 13, 14]. This exercise method stimulates greater mitochondrial biogenesis and enzyme activity, and it improves the muscles' capacity to oxidize fatty acids more efficiently both by putting more stress on the body during training and after recovery [5, 10, 15]. The simultaneous synchronized engagement of different muscle fiber types increases overall energy expenditure and promotes a more substantial release of catecholamines, which facilitate lipolysis and the mobilization of fatty acids from adipose tissue. Additionally, concurrent training enhances insulin sensitivity more effectively than either exercise modality alone, which would allow better glucose uptake and reduced fat storage [7, 9, 13]. The synergistic effect of combining these training types also elevates basal metabolic rate by increasing lean muscle mass and sustaining higher energy demands even at rest. Furthermore, the hormonal adaptations induced by concurrent training, such as elevated levels of growth hormone and testosterone, support both

muscle hypertrophy and fat metabolism [1, 4, 11, 15]. This comprehensive biochemical response would not only maximize fat oxidation during and after exercise but also enable a more resilient and adaptable metabolic system.

Table 1: Comparison of Aerobic, Resistance, and Concurrent Training Based

Exercise Type	Effectiveness in Rapid Fat Loss (Short-Term)	Effectiveness in Rapid Fat Loss (Long-Term)	Additional Benefits
Aerobic Training	Highly effective; significant reductions in body fat percentage, BMI, and fat mass [1-3, 10, 16]	Maintains fat loss and improves cardiovascular health [1-3, 16]	Enhances VO2max, insulin sensitivity, and metabolic rate; elevated post-exercise metabolism [1-3, 14, 16]
Resistance Training	Indirectly effective; maintains/increases muscle mass which supports BMR [2, 9, 10, 15]	Sustains fat loss by preserving lean muscle mass; improves metabolic rate [8-10, 15]	Increases muscle strength and endurance; improves insulin sensitivity [8-10, 15]
Concurrent Training	Most effective; combines rapid fat loss benefits of aerobic with muscle-preserving effects of resistance [10, 15]	Optimizes long-term fat loss and body composition; sustained metabolic benefits [10, 15]	Enhances overall fitness, insulin sensitivity, and hormonal balance; increases lean muscle mass [8, 10, 15]

Table 2: Synthesized information of each study (Physiological and Biochemical perspective)

Exercise Type	Physiological Effects	Biochemical Effects	Reference
Concurrent Training	Increased total lean mass, reduced resting heart rate	Minor effects on insulin sensitivity (HOMA-IR), no change in RBP4	[15]
Aerobic, Resistance, Mixed	Significant reduction in BMI, body weight, fat mass; increased skeletal muscle mass	Improved body composition, enhanced muscle mass supports metabolic rate	[10]
Resistance Training	Maintained muscle mass; no significant change in body fat percentage	Resistance training during fasting maintains muscle mass, potentially supports metabolic rate	[9]
Aerobic Training	Reduced body weight, BMI, fat mass; improved VO2max	Enhanced metabolic health markers, reduced glucose and insulin levels	[8]
Aerobic Training	Elevated post-exercise oxygen consumption; increased fat oxidation	Greater fat oxidation rates post-exercise, enhanced metabolic rate	[16]
Aerobic Training	Increased VO2max in HIIT with long rest; no change in strength parameters	Elevated fat oxidation in HIIT and SIT compared to control	[17]
Aerobic Training	Reduced body fat; improved body composition	Enhanced metabolic health and aerobic capacity with supplements	[1]

Aerobic Training	Reduced body fat, body fat percentage; increased IL-6	Improved body composition, elevated inflammatory markers (IL-6, IL-1β)	[2]
Functional Training vs Walking	Higher energy expenditure and relative intensity in functional training; improved cardiorespiratory fitness	Functional training achieved higher metabolic demands, supporting fat loss	[3]
Aerobic Training	Decreased fat mass; increased muscle mass	Improved lipid profiles, glycemic metabolism, cardiovascular function	[11]
Aerobic and Resistance Training in Diabetic Patients	Reduced HbA1c and fasting blood glucose levels	Enhanced glycemic control; improved insulin sensitivity	[14]
Concurrent Training	Improved muscle strength, upper body endurance, aerobic power in HIFT; no change in anaerobic fitness	Enhanced metabolic rate through increased muscle mass; improved aerobic capacity	[8]

6. *Discussion and Conclusion*

Aerobic training, particularly high-intensity interval training (HIIT), compare to other type of exercise that selected in this study has consistently shown superior efficacy in rapid fat reduction and improvement in cardiovascular health markers across various populations, specially but not entire population; including adolescents, middle-aged adults, and individuals with overweight or obesity from studies selected. Studies such as Wang et al. [2] and Gaweł et al. [1] concluded HIIT's effectiveness in decreasing body fat percentage, enhancing metabolic health, and elevating post-exercise fat oxidation rates. In which this study designed for conclude and compared between three known exercises to synthetize information in this short review (Table 1 &2).

In the other perspective resistance training indirectly contributes to fat loss by increasing lean muscle mass as it discussed, which resulted in elevating basal metabolic rate (BMR), and thus by sustained caloric expenditure, making body demand more for energy in general and rest. Research like that of Pranoto et al. [10] and Malek et al. [9] indicates that while resistance training alone may not produce immediate significant fat loss, but in more broaden perspective it is crucial for maintaining muscle mass during weight loss interventions, if individual plans for fat loss properly and want to maintain their health with further

more help of muscle activation and hypertrophy pathways untriggered by resistance training during their fat loss journey, thereby supporting long-term fat reduction and metabolic health.

Concurrent training lastly, which combines both aerobic and resistance modalities, appears to offer the most balanced and effective approach for rapid fat loss by leveraging the immediate fat-burning benefits of aerobic exercises and the muscle-preserving advantages of resistance training. Studies such as Ratajczak et al. [15] and Pranoto et al. [10] suggest that concurrent training can lead to more substantial reductions in body fat and improvements in body composition compared to either of discussed exercise type alone.

In Regards to biochemical and physiological mechanisms, aerobic and concurrent training enhance fat metabolism through increased lipolysis, elevated catecholamine levels, and enhanced mitochondrial density, which collectively boost fat oxidation and energy expenditure [1, 2, 4, 6, 9, 10, 12, 15]. High-intensity aerobic exercises like HIIT and SIT (Sprint Interval Training) [1-3, 16] significantly elevate EPOC and fat oxidation rates, resulting in rapid fat loss and improving insulin sensitivity. Concurrent training further amplifies these effects by simultaneously stimulating muscle hypertrophy and metabolic rate through resistance components, as evidenced by increased lean muscle mass and improved hormonal profiles [10, 15]. Resistance training alone primarily influences fat loss by increasing muscle mass, which in turn raises BMR and supports long-term caloric expenditure [9, 10]. Additionally, concurrent training promotes a synergistic hormonal environment that promotes lipolysis while inhibiting lipogenesis, thereby optimizing fat metabolism and storage dynamics. The integration of both exercise modalities cannot only accelerate fat loss through immediate energy demands but also it will ensure the maintenance and growth of lean muscle tissue, which is essential for sustained metabolic health and effective long-term fat reduction [8, 10, 15]. Thus, concurrent training might be concluded as the most effective exercise strategy for rapid and sustained fat loss.

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