

# A review of the effect of resistance training with high and moderate intensities on the blood levels of cortisol and testosterone hormones in the muscle strength of people

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**Abstract:** With increasing age, the body composition has changes that can include negative effects. Resistance training is one of the ways to reduce muscle mass and increase muscle diameter, which is considered to reduce muscle wasting (sarcopenia) in middle age and adulthood. With increasing muscle mass, anabolic (Manufacturer) hormones increase and catabolic (decomposer) hormones decrease. Testosterone is considered one of the anabolic hormones, which decreases in the serum after muscle loss, but instead of cortisol, which is a catabolic hormone, it shows the reverse of this process due to the increase in life. Resistance training shows a greater increase in increasing testosterone compared to old age. This research, which has been conducted as a review, has tried to investigate and evaluate the research in the last 10 years in resistance training with high and moderate intensity in the reduction and increase of testosterone and cortisol hormones. The results of this research show that moderate and high intensity resistance training in middle-aged and elderly people increases testosterone and decreases cortisol. But due to the fact that resistance training with high intensity leads to injury, this exercise is recommended for elderly people with moderate intensity at least once a week. However, high-intensity training two sessions a week is recommended for middle-aged people.

**Keywords:** resistance training, intensity, hormones, testosterone, cortisol, muscle strength

## INTRODUCTION

Skeletal muscle is one of the most abundant parts of body tissue that converts chemical energy into mechanical energy. Therefore, maintaining muscle mass for the physiological actions of the body has a very important role. Using resistance training is a way to increase muscle mass and skeletal strength in the elderly (Allsopp 2021). With the passage of time and age, hormonal changes are a definite thing. A 2010 study by Fry et al showed that high-intensity resistance training can promote an anabolic hormonal response with this type of training and may partially account for the muscle

hypertrophy observed in athletes who routinely use high-intensity resistance training ) (Fry and Lohnes 2010). These changes include an increase in catabolic hormones and a decrease in anabolic hormones. In the meantime, testosterone is a productive hormone that decreases due to aging and with muscle wasting, but cortisol, which is a disintegrating hormone, increases and causes muscle wasting and the development of various diseases. Due to the reduction of cortisol (stress hormone), it is considered effective in increasing muscle strength and improving sarcopenia. In the research of Agha Ali Nejad and colleagues in 2013, anabolic and catabolic hormones were investigated and their role in determining body homeostasis was considered important (AGHAALINEJAD, KOHANPOUR et al. 2013).

More cortisol in the blood will lead to many diseases such as type 2 diabetes, acute stress, muscle weakness, muscle wasting, etc. Regular exercise is considered very important in reducing cortisol and adjusting its time when necessary. On the other hand, the permanent and permanent increase of cortisol is considered as one of the pathological factors (disease). But resistance training with high and moderate intensities is considered effective in improving the secretion of this hormone.

All sports do not have the same effect on increasing testosterone. Testosterone is a male sex hormone that is made in the testicles and in women it is made in the ovaries, but its levels are different in different maps. Various researches show that regular exercise increases testosterone levels, especially in men, and even decreases with weight loss due to muscle wasting. Testosterone increases due to weight sports or resistance sports. The intensity and volume of training are considered two basic factors in increasing this hormone. In a 2014 study by Tavasli et al., it can be seen that during 12 weeks of circuit resistance training with 60% intensity, cortisol levels show a significant decrease (Tavasli, Hassan et al. 2014) .During the research of Attarzadeh et al. in 2016, eight weeks of resistance training with an intensity of 40-65% of one repetition maximum for postmenopausal women aged 48 to 62 years shows an increase in serum testosterone levels compared to cortisol (Zare, Attarzade Hosseini et al. 2016).During the 2024 study by Houshmandi et al., at least one session of high-intensity resistance training (HIIRT) is necessary to maintain hormonal adaptations in sarcopenia-aged women(Hooshmandi, Daryanoosh et al. 2024).Our goal in this article is to review articles about getting the best solution for reducing muscle mass and improving hormones in people over 40 years old. We are trying to find the best way to reduce testosterone and increase cortisol at this age with moderate and high intensity resistance exercise. Various researches have been conducted on the effect of resistance training in reducing catabolic hormones and increasing anabolic hormones and show the same and different results. Although resistance training with any intensity results in an anabolic increase, high and moderate intensities and on the other hand, the number of sessions per week are very important. In general, the number of high-

intensity resistance training sessions is not recommended for the elderly. The number of sessions per week should be considered so that the person can recover and relieve fatigue. The elderly and middle-aged person should engage in exercises that can include all muscle groups and have a few days to a week of rest between different training periods.

Resistance training is the best solution from the point of view of experts and doctors, which is recommended for the target people in this research. By activating mTOR1, this exercise has a great effect on increasing muscle mass and reducing muscle wasting.

**Material and Method:** This research was conducted as a systematic review and included most of the research in the last 10 years. In this review article, 26 researches are used, which are mostly experimental researches.

**Results and Discussions:** Resistance training is a solution to increase muscle mass and skeletal strength in the elderly (Allsopp 2021). Exercise is a primary stimulus that disrupts homeostasis and potentially improves various functions. In particular, resistance training is a powerful stimulus that takes place over a period of hours to days. Mechanical stress and subsequent skeletal muscle damage caused by RE with volume and intensity cause structural disturbances in contractile elements in active muscle fibers. Considering the amount of risk and damage that is caused, it may involve physiological embezzlement for several days. Muscle repair of rupture and damage of muscle fibers creates a response to the damage, brain effects and other responses are observed and the results are new syntheses. It involves an immune process that is strongly influenced by the endocrine system. Symbols play a role in anabolism (tissue growth, bed repair and recovery) and catabolism (tissue breakdown and metabolism regulation). The endocrine system supports the body's normal homeostatic function and helps with responses and adaptations to external stimuli. Instead, a specific response and adaptation should be observed in the environment of the entire endocrine system and its relationship with other physiological systems. The role of training with different intensities is important in causing problems. Basically, it activates satellite cells for further regeneration. In the 2021 research of Alsop et al., resistance training is considered vital for muscle strength and endurance, and it is considered a way to prevent people from falling at this age. On the other hand, he has recommended training in all muscle groups for the elderly at least two sessions a week with moderate to high intensity. Different exercises, dwell periods and volume, resistance training programs should be done carefully. Choose training methods to enhance all aspects of muscle function. (Kraemer, Ratamess et al. 2017) However, well-trained athletes may incorporate advanced techniques and methods into their programs as a stimulus in addition to breaking plateaus and preventing a workout (Krzysztofik, Wilk et al. 2019). Since resistance training will be effective in reducing muscle mass and increasing

muscle volume, it will have a modulating effect on catabolic-anabolic hormones. In this research, the decrease and increase of two opposite hormones, namely cortisol and testosterone, will be studied in a review way with moderate intensity resistance exercises and on middle-aged and elderly people. Resistance training interventions with higher intensity and more total load (intensity and more repetitions) are better for improving muscle strength and endurance, but sufficient rest intervals should be placed between repetitions and training sessions so that the best hypertrophy occurs in old age. As shown in a 2010 study by Fry et al., high-intensity resistance training can contribute to a natural anabolic response with this type of training and may be performed in athletes who routinely use resistance training. High power is used to explain. (Fry and Lohnes 2010).

The main androgen, testosterone, is an anabolic-androgenic steroid hormone synthesized from cholesterol. Testosterone exerts many of its ergogenic, anabolic, and anti-catabolic functions in skeletal muscle, unregulated to dihydrotestosterone (DHT). Testosterones also affect bone, connective tissue and nerve growth. which leads to increased strength, endurance and muscle hypertrophy in a dose-dependent manner. Analogs of gonadotropin-releasing analogs, which induce endogenous testosterone, prevent the increase in muscle strength and reduce the increase in muscle mass(Gharahdaghi, Phillips et al. 2021).

Since regular resistance training has a positive effect on physiological and psychological health (Becker, Semmlinger et al. 2021) .So, there is no doubt that it will show a significant effect in increasing testosterone, which inhibits inhibitory hormones, especially cortisol. In order for the body to perform its actions properly, it needs a hormonal balance to work well in the process of physiological actions. In the research of Agha Ali Nejad and colleagues in 2013, anabolic and catabolic hormones were investigated and their role in determining body homeostasis was considered important(AGHAALINEJAD, KOHANPOUR et al. 2013) . Resistance training plays a role in activating anabolic processes and increases hypertrophy and muscle strength by activating the signal. In the research of Gonzalez et al. in 2016, it can be seen that resistance exercise activates the metabolic mechanism by signaling through mTOR1(Gonzalez, Hoffman et al. 2016) .So when this mechanism is activated, it can be a sign of increased muscle mass and an overall increase in testosterone. Also, in Behpour et al.'s 2022 research, it can be seen that weight lifting with an intensity of 65-80% of maximum strength (1RM) was effective in reducing cortisol and increasing testosterone in elderly people (Behpoor 2022) .The adrenocorticotrophic hormone produced by the pituitary gland in the brain, corticotropin-releasing hormone (CRH) acts through membrane receptors and the cyclic adenosine monophosphate (cAMP) mechanism and causes the release of ACTH. It plays a major role in regulating the level of cortisol (stress hormone). Adrenocorticotropin is synthesized from the

precursor (pre-POMC) and its half-life is ten minutes. Various studies have shown that resistance training increases muscle mass. It enlarges the muscle diameter and causes an increase in the testosterone hormone, while the cortisol hormone, which is a catabolic (decomposing) hormone, decreases. The effect of resistance training in reducing this hormone increases testosterone. One of the things that should be addressed is muscle wasting (sarcopenia). Sarcopenia or muscle wasting is one of the important things that increases with age and causes a decrease in muscle volume and strength in the elderly. Resume Introduction Aging is associated with a decrease in the functional capacity of the nervous, endocrine, and neuromuscular systems, which leads to a decrease in maximal strength, muscle power, and muscle mass (sarcopenia). (Buch, Kis et al. 2017) With increasing age, serum concentrations of anabolic hormones and growth factors decrease along with a decrease in anabolic hormone concentrations, which is related to a documented decrease in skeletal muscle mass and strength. Also, with increasing age, the serum concentration of catabolic hormones shows an increase. Loss of skeletal muscle mass or muscle strength due to aging begins in middle age and gradually accelerates thereafter. Resistance training increases muscle strength and volume through a variety of mechanisms, such as increased voluntary activation of the exercised muscles and changes in muscle cross-sectional area and muscle fiber subtypes, even when resistance training is started at an older age. With resistance exercises, it is possible to prevent or delay the decrease in skeletal muscle mass caused by aging and the decrease in muscle strength and power in middle-aged and elderly people. In a 2014 study by Tavasli et al., it can be seen that during 12 weeks of circuit resistance training with 60% intensity, cortisol levels show a significant decrease (Tavasli et al. 2014). In the research of Attarzadeh et al. in 2016, eight weeks of resistance training with an intensity of 40-65% of a maximum repetition on postmenopausal women aged 48 to 62 years shows that the serum level of the test shows an increase in cortisol (Zare, Attarzade Hosseini et al. 2016). During the 2024 study by Houshmandi et al., at least one session of high-intensity resistance training (HIIRT) is necessary to maintain hormonal adaptations in sarcopenia-aged women (13). Testosterone is an anabolic hormone that stimulates protein synthesis and plays an important role in the growth and maintenance of muscle tissue. Despite numerous recommendations for high-intensity resistance training (more than 80% of 1RM) to prevent muscle mass loss, these exercises have practical limitations for some people, especially the elderly and those with cardiovascular disease. Recently, the results of studies in the field of physical fitness and rehabilitation have presented a new form of resistance training that has fewer administrative restrictions than high-intensity resistance training, while still meeting the goals expected of high-intensity training (Mohamadi, Khoshdel et al. 2015). In the research of Che Wang et al. in 2014, it can be seen that moderate resistance training was effective in reducing cortisol (Tsai,



Wang et al. 2014) .One of the most important methods for determining exercise intensity in athletes is measuring biochemical variables, measuring enzymes, hormones and metabolites. The ratio of testosterone to cortisol expresses the balance of anabolic and catabolic muscle metabolism. Cortisol and testosterone are known as neutral physical activity. Testosterone increases at the beginning of long-term sports training and decreases as the action continues. Endocrine adaptation regulates muscle activity, stimulates glycogenolysis, and facilitates gluconeogenesis. Cortisol, a glucocorticoid produced by the adrenal glands, is the main and most important anti-stress hormone in the body. However, increasing long-term problems cause problems with the immune system and the breakdown of its most important proteins. Cortisol in muscle and fat tissue breaks down protein into amino acids. In Kramer et al.'s 2005 research, it can be seen that protocols with high volume, moderate to high intensity, using short rest intervals and pressure on a large muscle mass, compared to low volume and high intensity, have the greatest acute hormonal increase, such as They create testosterone and the catabolic hormone cortisol(Kraemer and Ratamess 2005) Following the research of Rastad et al. in 2000, it can be seen that the hormonal responses of nine male athletes to strength training were investigated. Blood samples were analyzed for testosterone, cortisol, and adrenocorticotrophic hormone (ACTH). Acute testosterone and cortisol responses were greater during the high-intensity protocol compared to the moderate-intensity protocol. Cortisol response was associated with increased ACTH concentration(Raastad, Bjøro et al. 2000) .

In Shuli et al.'s 2016 research, it can be seen that a combined resistance-endurance training session was effective in increasing testosterone and cortisol hormones. Although it has been said in this research that during a training session, the hormone cortisol increases, especially if the training is acute. So, if cortisol increases, it will undoubtedly lead to a decrease in testosterone. But long-term training will increase testosterone and decrease serum concentration(Sholi, Ghanbarzadeh et al. 2016).

In 2007, Smilavis et al. investigated the endurance resistance training protocol with 60% 1RM in young and old men. The results of this research indicate that a moderate-intensity, high-repetition resistance training protocol to improve strength endurance is sufficient to increase testosterone and cortisol concentrations in aging men. If some hormonal responses are weaker in older people than in young people(Smilios, Pilianidis et al. 2007) .In the 2015 research by Rossa et al., citing Kraimer et al., they suggested that high training volume can cause a sharp increase in the circulating cortisol concentration and create an unsuitable environment for the repair and development of muscle mass, resulting in an imbalance between anabolic hormones (testosterone and growth hormone) (Rosa, Vilaça-Alves et al. 2015) .In a sample of elderly patients who underwent three periods of resistance training with different intensities, a low-to-moderate resistance training was superior to high

intensity in reducing serum cortisol and resulting in less post-exercise stress.(Taha and Mounir 2019) Age, gender, physical fitness level, training intensity, training status and method are all variables that affect cortisol production. Elevated cortisol concentrations strongly indicate muscle catabolism and increase the loss of lean muscle tissue. This is a significant health concern for the growing elderly population. Cortisol production rates change with age and have been observed to respond differently to exercise intensity in men and women. Cortisol production is related to the intensity and duration of exercise, but it does not increase equally in all exercise intensities. Higher intensity and duration of training seem to be the main factors affecting cortisol production, increasing the potential of muscle catabolism and muscle loss (Torres, Koutakis et al. 2021).

In Nascimento et al.'s 2019 research, it was seen that resistance training was effective in increasing muscle mass and testosterone in older women and increased the levels of this anabolic hormone (Nascimento, Gerage et al. 2019) .In Zamani et al.'s research, it can be seen that resistance exercises of upper and lower limbs significantly change testosterone levels(Zamani, Peeri et al. 2016) .Although this research was conducted on resistance training with moderate intensity, exercise with any intensity increases the level of testosterone, and various researches on people show that high, moderate and low intensity training is also effective(Bell, Syrotuik et al. 1997) (Ambroży, Rydzik et al. 2021) .In general, the variables within the variable domains of the acute program should be selected such that the resistance training session contains high volume and metabolic demand to induce an acute testosterone response(Vingren, Kraemer et al. 2010) .Moderate-intensity resistance training significantly increases testosterone following upper-body and lower-body bouts, when total volume is held constant. This may be beneficial for resistance trained novices as it provides evidence that moderate intensity is sufficient to increase testosterone compared to high intensity protocols that can be associated with a higher risk of injury(Rietjens, Stone et al. 2015) .

## CONCLUSION

As it can be seen from the subject of this article, we are looking for the changes of testosterone and cortisol hormones with intense and moderate resistance training in middle-aged and elderly people. The results of various researches on the topic were reviewed. Since testosterone is an anabolic (constructive) hormone, and on the contrary, cortisol is a catabolic (decomposing) hormone, so one of the things that happens to people with age is sarcopenia (muscle breakdown). In this process, muscle strength is reduced and hormonal changes occur in people. Resistance training is one of the ways to reduce disintegrating hormones. Various researches have been conducted in the field and show almost similar results in a short period of time. In this

research, it can be seen that a period of resistance training with high and moderate intensities has been effective in improving testosterone and reducing serum cortisol.

One of the points that is considered very important in muscle recovery is the intensity and duration of exercise considering age. Resistance training opens the metabolic pathway with mTOR signaling and prevents muscle loss in old age. A number of research articles recommend one session of resistance training per week. But sometimes it is seen that it is recommended to do two sessions of resistance training per week. But in general, we can say that two sessions of resistance training of the whole body per week will be better. Of course, for middle-aged people, the possibility of two sessions of resistance training with high intensity and for elderly people with moderate intensity should be considered. High-intensity resistance training is harmful for the elderly and prevents the person from continuing the exercise, so moderate-intensity resistance training is recommended for these people. Appropriate time should be included to eliminate fatigue and recovery so that muscle strength and endurance improves and the anabolic process improves.

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