

## REVIEW ARTICLE

# Exercise and Hypertension: A Review on Exercise Recommendation, Mechanism of Action, Exercise-Related Risk and Innovative Exercise Approach.

Wan Muhammad Ihsan Wan Nawi<sup>1</sup>, Mohamad Hafiz Abu Seman<sup>2</sup>, Nurshazana Akmal Jamaludin<sup>2</sup>, Rabiatul Adawiah Abdul Rahman<sup>2</sup>, Muhammad Iqbal Shahrudin<sup>2</sup>, Nur Ainah Mohd Shipah<sup>2</sup>.

<sup>1</sup>Unit Fisioterapi, Hospital Putrajaya, Presint 7, 62550 Wilayah Persekutuan Putrajaya, Malaysia.

<sup>2</sup>Physiotherapy Program, Faculty of Health Sciences, Universiti Teknologi MARA Cawangan Pulau Pinang Kampus Bertam, 13200 Kepala Batas, Penang, Malaysia.

### Corresponding Author

Mohamad Hafiz Abu Seman

Physiotherapy Program, Faculty of Health Sciences, Universiti Teknologi MARA Cawangan Pulau Pinang Kampus Bertam, 13200 Kepala Batas, Penang, Malaysia.

Email: [hafizabuseman@uitm.edu.my](mailto:hafizabuseman@uitm.edu.my)

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### Abstract

Hypertension, commonly known as high blood pressure, is a condition in which the force of blood pushing against the walls of the arteries is consistently higher than normal. This condition can lead to serious health problems such as heart disease, stroke, and kidney disease. There are several strategies that individuals with hypertension can adopt to manage their condition and engaging in exercise is among the most effective non-pharmacological approaches. This study examines the critical role that exercise plays in controlling hypertension, a condition that is heavily impacted by stress and modern sedentary lifestyles, underscoring the need for efficient intervention measures. The paper explains biological mechanisms supporting blood pressure regulation while highlighting the advantages of consistent physical activity, including reduced blood pressure and improved cardiovascular health, through a variety of exercise modalities, including aerobic activities, resistance training, high-intensity interval training (HIIT), and circuit training (CT). These include a decrease in inflammatory markers, an improvement in autonomic balance, and vasodilation. The review also covers the significance of tailoring exercise regimens to each patient's unique health profile to maximise benefits and minimise dangers. Exercise planning is important for people with hypertension since it affects their blood pressure. Factors to consider include the intensity, duration, and any interactions with medications. Innovative exercise approaches, particularly HIIT and CT, are examined for their effectiveness in cardiovascular improvement and hypertension management. Conclusively, the document advocates for integrating exercise into hypertension management and prevention, underscoring its pivotal role in enhancing patient health outcomes and quality of life in a comprehensive care strategy.

**Keywords:** *Hypertension, exercise, exercise-related risk, innovative exercise approach physical activity.*

## Introduction

In today's fast-paced world, where stress and sedentary lifestyles prevail, the prevalence of hypertension, commonly known as high blood pressure, has reached alarming levels [1]. Hypertension poses a significant threat to global health, increasing the risk of heart disease, stroke, and other cardiovascular complications [2]. Fortunately, amidst this health crisis, exercise emerges as a potent tool for combating hypertension and promoting overall well-being. Hypertension is classified when Systolic Blood Pressure (SBP) is more than 140 mmHg and/ or Diastolic Blood Pressure (DBP) is more than 90 mmHg. Blood Pressure (BP) should be taken more than two times and space of 1 to 2 minutes apart in more than two occasions. The average reading will determine the level of BP [3]. Prehypertension is diagnosed when SBP is between 120 mmHg to 139 mmHg and DBP is between 80 mmHg to 89 mmHg [4]. Hypertension, characterized by elevated blood pressure levels, arises from a variety of factors, including genetics, diet, obesity, and lack of physical activity [5]. It silently creeps into our lives, often unnoticed, gradually damaging our arteries and putting undue strain on the heart [6]. However, research over the years has unequivocally demonstrated the positive impact of exercise in managing and preventing hypertension [7].

Engaging in regular physical activity not only reduces blood pressure but also improves cardiovascular health in numerous ways [8]. Exercise promotes vasodilation, which widens blood vessels, enhancing blood flow and reducing resistance [7]. Additionally, it helps strengthen the heart muscle, making it more efficient in pumping blood, and improves overall blood lipid profiles, reducing the risk of atherosclerosis and plaque build-up [8].

The type, intensity, and duration of exercise play crucial roles in effectively managing hypertension [8]. Aerobic exercises, such as brisk walking, jogging, swimming, and cycling, have been widely recommended by healthcare professionals [7]. These activities stimulate the

heart and lungs, increasing oxygen supply to the body and promoting cardiovascular fitness. Resistance training, involving weights or resistance bands, can also contribute to blood pressure management by improving muscle strength and enhancing metabolic rate [8].

Furthermore, exercise not only benefits physical health but also has a profound impact on mental well-being. Regular physical activity releases endorphins, the "feel-good" hormones, reducing stress, anxiety, and depression [9]. By promoting better sleep patterns and boosting self-esteem, exercise creates a positive feedback loop that supports overall health and reduces the risk of hypertension. It is important to note that individuals with hypertension should consult their healthcare providers before embarking on an exercise regimen. Healthcare professionals can provide personalized recommendations, considering the individual's health status, age, and any existing medical conditions [7].

In short, hypertension poses a significant global health challenge, but exercise offers a powerful countermeasure. Engaging in regular physical activity can help to manage blood pressure levels, improve cardiovascular health, and enhance overall well-being [8]. By incorporating exercise into our daily routines, we can take proactive steps towards a healthier heart and a better quality of life.

Given the well-established benefits of exercise in managing hypertension, there is a crucial need to develop specific exercise prescriptions tailored to hypertensive patients based on the FITT (Frequency, Intensity, Time, and Type) principle. This review aims to fill that gap by providing detailed guidelines on the most effective exercise regimens for this population. By focusing on personalized exercise plans that consider the unique needs and limitations of individuals with hypertension, the study seeks to optimize cardiovascular outcomes and overall health. Understanding the ideal combinations of exercise frequency, intensity, duration, and type will empower healthcare professionals to offer more targeted and effective interventions, thereby

improving patient adherence and long-term management of hypertension.

## Discussion

### Hypertension in Malaysia

Hypertension has emerged as a significant global health challenge, contributing to a rise in chronic diseases such as stroke, myocardial infarction (MI), other heart diseases, and renal problems. It is estimated that approximately 6% of global deaths are attributed to hypertension [10]. Research reveals that among cardiovascular patients in 21 regions globally, complications of hypertension have led to the death of 9 million individuals. Furthermore, it has contributed to 6.7 million deaths from stroke and 7.4 million deaths from coronary heart disease [11]. The World Health Organization (WHO) predicts that by the year 2025, nearly 29.2% of the world's population will be affected by hypertension [12]. WHO also emphasizes the disparities in the prevalence of hypertension between low- and middle-income countries, which can be attributed to weak healthcare systems. Additionally, variations in the number of hypertension cases exist within regions and subgroups of populations within the same country [13].

In Malaysia, the prevalence of hypertension remains high with limited improvement among the population, despite the implementation of several government policies related to hypertension [14]. The incidence of hypertension increased by 0.7% from 34.6% in 2006 to 35.3% in 2015 [10]. National Health and Morbidity Survey (NHMS) [15] conducted across different states in Malaysia has revealed that Perak has the highest prevalence of hypertension, which is 22.7%, followed by Negeri Sembilan (19.8%) and Sarawak (19.6%). On the other hand, the lowest prevalence of hypertension in 2019 was observed in Selangor with the prevalence of 12.7% [15].

Analysis of surveys conducted by the National Health and Morbidity Survey in 2006, 2011, and 2015 indicates that the number of hypertension cases was higher in rural areas compared to urban

areas [13]. Over the past decade, there has been no significant change in the distribution of cases between genders. Moreover, the surveys have shown that the prevalence of hypertension is higher among the population aged above 60 years compared to the younger population. Additionally, there is a higher incidence of hypertension among individuals with a Body Mass Index (BMI) higher than 30.0 kg/m<sup>2</sup>, which falls under the obese category [36].

Examining the ethnic distribution of hypertension cases in Malaysia, Chinese individuals had the highest number of cases in 2006; however, the number of cases reduced in 2015 [10]. In 2019, Bumiputra Sarawak ethnicities had the highest prevalence of hypertension, followed by Indian, Chinese, and Bumiputera Sabah populations [15]. Another study conducted by Naidu et al. [12] reported that the prevalence of hypertension is slightly higher in men compared to women, with an increase in the older population and a higher incidence among households with lower incomes [12].

The prevalence and severity of hypertension in Malaysia vary across different groups. Prehypertension, a precursor to hypertension, is more prevalent in men compared to women. Additionally, certain ethnicities such as Baba, Sikh, Eurasian, Chitty, and foreigners, as well as individuals with no formal education, smokers, married adults, and those with a BMI over 25 kg/m<sup>2</sup>, show a higher prevalence of prehypertension [12].

Regarding stage 1 hypertension (SBP: 130-139 mmHg; DBP: 80-89 mmHg), is more prevalent among men, individuals residing in rural areas, those of Malay ethnicity, those with lower incomes, less education, widowed individuals, and those with underlying chronic diseases such as diabetes Mellitus (DM), high cholesterol levels, and abdominal obesity. In contrast, stage 2 hypertension (SBP: >140 mmHg; DBP: >90 mmHg) is more prevalent in women compared to men. The study also reveals a higher number of cases among individuals living in rural areas, those of Malay ethnicity, individuals with lower

education levels, widowed individuals, those with lower incomes, non-smokers, and individuals with underlying DM, abnormal cholesterol levels, and obesity [12].

### **Exercise recommendation for hypertension**

Practicing a healthy lifestyle is an effective method for controlling BP. Incorporating healthy habits such as engaging in a daily exercise program, preventing smoking, maintaining an ideal body weight, following a balanced diet, and reducing sodium intake can contribute to BP control [16]. Exercise is well-known for its positive effects on BP regulation. However, it is crucial to select the appropriate exercise modalities and prescriptions, as they can yield different effects on individuals [17].

Aerobic exercise (AE) such as running, swimming and cycling is a recommended modality for reducing BP and has demonstrated effectiveness in treating chronic conditions like diabetes mellitus (DM), hypertension, cardiovascular disease (CVD), and coronary artery disease [3]. Chulvi-Medrano, Sanchis-Cervera, Tortosa-Martínez, and Cortell-Tormo [18] also support the use of AE as a primary modality for the prevention, treatment, and control of BP. According to the American College of Sports Medicine (ACSM) [19] guidelines, AE should be performed for at least 5 days a week, with each session consisting of at least 30 minutes of moderate-intensity exercise, or alternatively, at least 3 days a week with at least 20 minutes of high-intensity exercise. However, it is essential to tailor the exercise prescription to the individual needs of hypertension patients to achieve optimal effects [20].

Additionally, dynamic resistance exercise is another modality that can be utilized for the treatment of hypertension. Individuals who engage in this type of exercise can experience a reduction in their SBP by up to 1.8 mmHg and their DBP by up to 3.3 mmHg [37]. The recommended protocol for dynamic resistance exercise includes 2 to 3 sessions per week at a

moderate intensity of 60% to 80% of 1 Repetition Maximum (1RM), involving 8 to 10 exercises targeting major muscle groups, with 10 to 12 repetitions and 2 to 3 sets for each muscle group [18]. Other studies suggest that exercising 3 days a week with low to moderate intensity at 60% to 65% of 1 RM, performing 10 to 12 repetitions and 3 sets of exercises, can lead to a reduction of resting blood pressure by as much as 6 mmHg [21]. The most significant benefits of dynamic resistance exercise are typically observed within 6 to 48 weeks of regular exercise sessions. Furthermore, recent studies have proposed isometric resistance exercise as a potential treatment for hypertension patients. Unlike dynamic resistance exercise, isometric exercise involves muscle contraction without affecting the range of joint motion [3]. Some studies have demonstrated that isometric exercise provides greater benefits in lowering blood pressure compared to other forms of training. The recommended protocol for isometric exercise included 3 to 4 sessions per week, with 4 repetitions of 20% to 50% of maximal voluntary contraction, holding for 2 minutes and resting for 1 to 4 minutes between repetitions, for 4 to 10 weeks of exercise sessions [22]. Another study recommended performing 4 sets of 2 minutes of isometric exercise with 2 minutes of rest between trials, 3 times a week for 4 weeks, which effectively lowered blood pressure levels [23]. Reductions in blood pressure have also been observed in male patients who performed unilateral arm exercises during 8 weeks of isometric exercise sessions [24]. Unilateral exercise has shown a greater reduction in blood pressure compared to bilateral exercise, and the effect is more pronounced in individuals aged 45 years and above. Studies have also indicated that upper limb isometric exercise provides more benefits compared to lower limb exercise [3]. Combining aerobic exercise (AE) and dynamic resistance training on the same day or alternate days can also be beneficial for individuals with hypertension. This combination has been shown to lower blood pressure by approximately 3

mmHg [25]. Such exercises are also recommended by the ACSM where the exercise prescription involves performing AE on all days of the week at a moderate intensity of 40% to 60% of oxygen uptake reserve ( $\text{VO}_2\text{R}$ ), along with 2 to 3 days of moderate-intensity resistance training at 60% to 80% of 1RM, with 2 to 3 sets of 8 to 12 repetitions [3]. In older adults, a study has shown that a 6-month combined exercise protocol can lead to reductions in SBP and DBP. The exercise frequency is 3 times a week, with a moderate intensity ranging from 50% to 80% of 1RM for resistance training, 60% to 90% of maximum heart rate for aerobic training, and exercise durations ranging from 40 to 90 minutes per session [26].

The summary of various exercise modality recommendations for individuals with hypertension is presented in Table 1. These recommendations encompass aerobic exercise (AE), dynamic resistance exercise, isometric resistance exercise, and a combination of AE and dynamic resistance training. Each exercise modality specifies the description or types, frequency, intensity and duration.

### **Mechanism of exercise in improving hypertension**

There are various mechanisms involved in controlling and treating hypertension. Aerobic exercise (AE) has been shown to lower blood pressure by reducing signals to the sympathetic nervous system, leading to vasodilation of blood vessels [27]. Prolonged AE among hypertension patients can cause remodelling of the left ventricle of the heart without chamber enlargement, resulting in reduced oxidative stress, inflammation, and improved autonomic system function [28].

Additionally, AE has a significant impact on body weight reduction, particularly in fat quantity [25]. A 5% reduction in body weight can help to regulate the renin-angiotensin-aldosterone system, which plays a crucial role in blood pressure regulation. Weight loss also contributes

to the repair of kidney injuries, thereby assisting in blood pressure control [28].

During dynamic resistance exercise, there is an initial increase in blood pressure due to the response of the cardiovascular center in the brain (medulla oblongata) when muscles contract. The contraction of muscles raises intramuscular pressure, affecting blood flow in the arteries. To counteract this, the brain signals an increase in blood pressure to ensure adequate muscle perfusion [18]. The effects of resistance exercise become evident a few hours later, characterized by a decrease in norepinephrine, angiotensin II, endothelin, and adenosine. Reduced receptor sensitivity to vasoconstriction mediators in the central nervous system (CNS) contributes to decreased pulmonary vascular resistance (PVR) and improved baroreflex sensitivity. Nitric oxide and prostaglandins released after exercise also promote vasodilation of blood vessels [18].

Isometric resistance exercise affects blood pressure through various mechanisms. Exercise substantially enhances sympathetic vasoconstrictor outflow, aiding in the redistribution of cardiac output to the working muscles. This heightened sympathetic vasoconstrictor activity also limits the rise in blood flow to the contracting muscles during exercise, helping to maintain blood pressure [38]. Isometric handgrip exercise also increases blood flow to other tissues in the body. These effects are related to the alteration of blood vessel resistance, an essential factor in blood pressure regulation. Furthermore, isometric exercise may reduce oxidative stress and the amount of oxygen radicals that contribute to increased blood pressure [29].

Combination exercises, which involve both AE and dynamic resistance training, have been shown to lower blood pressure by reducing baroreflex response and modulating the autonomic nervous system. In hypertension patients, this combination exercise reduces inflammation in the cardiac and renal systems [25]. Moreover, combination exercise reduces oxidative stress-related damage to the heart and kidneys by

decreasing protein oxidation and lipoperoxidation [30]. A four-week program of combination exercise has been shown to improve blood vessel health, promoting post-exercise vasodilation and reducing arterial stiffness or atherosclerosis, which can contribute to elevated blood pressure [31].

### **Limitations and exercise-related risk for hypertensive patients**

Exercise offers numerous benefits for individuals with hypertension, but it is crucial to ensure proper execution to avoid worsening the condition. AE yields maximum benefits when performed at moderate to high intensity, necessitating supervision of therapist to ensure correct intensity. Without therapist supervision and adherence to the prescribed exercise plan, the reduction in blood pressure may be minimal, leading to poor long-term outcomes and exercise discontinuation [32]. The duration of exercise also plays a significant role, with ACSM recommending at least 30 minutes a day, which may be challenging for individuals with busy schedules, as shorter durations yield minimal benefits for hypertension patients [18].

Similarly, dynamic resistance exercise requires adequate preparation before, during, and after the workout. Different equipment can be used, including weight machines, free weights, body weight, or resistance bands. It is important to be cautious when using free weights due to the involvement of coordinated movements, as incorrect execution can lead to injuries. Holding one's breath while lifting weights can also increase blood pressure, emphasizing the importance of proper breathing techniques [4]. Additionally, selecting the appropriate weight is essential, typically ranging from 60% to 80% of the individual's one-repetition maximum (1RM) or based on the Rating Perceived Exertion (RPE) using the Borg Scale. Inadequate weight may not elicit the desired response, while excessive weight can dramatically increase blood pressure during exercise [3].

Isometric strengthening exercise carries a high risk of elevating blood pressure. The protocol for this type of exercise involves constant muscle contraction and rest intervals. However, the recommended hold and rest durations may not be suitable for all hypertension patients, as some individuals may require longer recovery periods. Insufficient recovery time can contribute to increased blood pressure levels [23]. Additionally, patients tend to involuntarily hold their breath during exercise, triggering the Valsalva manoeuvre and further elevating blood pressure [4]. Proper monitoring of isometric strengthening exercise in high-risk hypertension patients is crucial due to limited research on its safety and effectiveness for this population [23].

Combining aerobic and resistance training may lead to a slight increase in weight due to changes in body composition, such as a reduction in total body fat percentage but it elicits beneficial changes in body composition in terms of increased lean body mass [25]. Hypertension patients participating in sports events with weight classifications should be aware of this potential weight increase. It is worth noting that regular exercise can result in lowering blood pressure levels, but in some cases, individuals taking medications like alpha blockers or vasodilators may experience abrupt reductions in blood pressure after exercise, increasing the risk of fainting. Diuretic medications can affect the thermoregulatory system, causing heat intolerance and reducing exercise duration [33]. Overall, exercising with hypertension requires careful attention to various factors, including intensity, duration, technique, and medication management, to ensure safety and maximize the benefits of exercise for blood pressure control.

### **Innovative exercise approaches for hypertensive populations**

First and foremost, high-intensity interval training (HIIT) is well-known for its benefits in improving cardiorespiratory fitness and muscle strength in the general population. HIIT involves alternating between high-intensity aerobic

exercise at 85% to 90% of maximum oxygen consumption ( $VO_{2max}$ ) and periods of low-intensity exercise or rest [32]. Recently, HIIT has been utilized in the treatment of hypertension patients. High-intensity exercise stimulates the sympathetic system and elicits greater adaptations in the body. Additionally, it improves endothelial function, which is crucial for regulating atherosclerosis. Research indicates that HIIT produces similar results of continuous aerobic exercise performed at 60% to 65% of  $VO_{2max}$  in terms of Post Exercise Hypotension (PEH). A 12-week HIIT protocol at 85% to 90% of  $VO_{2max}$  has been shown to reduce blood pressure, enhance cardiac function, and lower mean heart rate more effectively than continuous aerobic exercise performed at 60% to 65% of  $VO_{2max}$  [18]. Another study demonstrated that HIIT, consisting of four intervals of high-intensity exercise (85% to 90% of Peak Heart Rate) for four minutes each, with three minutes of recovery phase at 50% of Peak Heart Rate, performed three times a week for one month, led to improvements in diastolic function and peak oxygen consumption [34].

Next, Circuit Training (CT) is another innovative modality for treating hypertension patients. CT involves strength exercises targeting major muscle groups using light loads and higher repetitions. The CT program typically includes several stations, with patients moving from one station to another after completing 8 to 20 repetitions with different major muscle involvement. The rest period between stations ranges from 15 to 30 seconds, depending on the patient's fitness level [35]. A CT program consisting of six stations of strength exercises performed three times a week for one month has shown improvements in vascular function and a reduction in blood pressure levels [31].

In clinical settings, exercise progression should be adjusted based on the patient's fitness level. Progression should be gradual and not abruptly increase exercise intensity, as this can lead to an increase in blood pressure and a higher risk of injury [18]. Patients who are not accustomed to

the new exercise intensity may experience fatigue and slower recovery, which can disrupt their exercise program [22]. Therapists should also consider the medications patients are taking, as changes in antihypertensive drugs during an exercise program can affect their ability to exercise [32]. Finally, warm-up before exercise and cool-down after exercise sessions are crucial for hypertension patients. Warm-up prepares the body for exercise and helps to prevent a drastic increase in blood pressure during exercise. Cooling down is essential to prevent a rapid decrease in blood pressure, especially in patients taking medications such as alpha-blockers [33].

## Conclusion

In conclusion, exercise plays a significant role in the management and treatment of hypertension. Various forms of exercise, such as aerobic exercise, dynamic resistance training, HIIT and CT, have been shown to effectively lower blood pressure, improve cardiovascular fitness, and enhance overall health in hypertension patients. Aerobic exercise helps lower blood pressure by reducing sympathetic nervous system activity and promoting vasodilation of blood vessels. It also aids in weight loss, which can further contribute to blood pressure control and improve kidney function. Dynamic resistance exercise, although initially causing a temporary increase in blood pressure, leads to long-term benefits by improving autonomic system function, and by reducing inflammation and oxidative stress.

HIIT with its alternating high-intensity and low-intensity intervals, offers a time-efficient approach to improving cardiorespiratory fitness and reducing blood pressure levels. CT, on the other hand, focuses on strengthening major muscle groups and has shown positive effects on vascular function and blood pressure reduction. For the future studies, researcher might also examine the role of individualized exercise prescriptions based on genetic factors, age, and comorbidities, to better tailor exercise interventions for hypertension patients. Not to

forget, understanding the barriers to exercise adherence and developing strategies to overcome them could enhance the effectiveness of exercise as a therapeutic tool in hypertension management. By incorporating regular exercise into their lifestyle, hypertension patients can significantly improve their blood pressure control, reduce the risk of cardiovascular complications, and enhance their overall well-being. It is important for healthcare professionals to emphasize the importance of exercise in hypertension management and provide appropriate guidance to ensure safe and effective implementation.

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**Authors contribution**

Wan Muhammad Ihsan Wan Nawi and Mohamad Hafiz Abu Seman: conceptualization of research, drafting and writing the manuscript; Nurshazana Akmal Jamaludin and Rabiatal Adawiah Abdul Rahman: method analysis and editing manuscript; Muhammad Iqbal Shahrudin and Nur Ainah Mohd Shipah: final checking and editing manuscript.



Table 1. Summary of exercise modality recommendation for hypertensive population.

Exercise Modality	Frequency	Intensity	Duration	Type or Description
Aerobic Exercise (AE)	At least 5 days a week, or alternatively, at least 3 days a week	Moderate to high intensity	At least 30 minutes for moderate intensity, or at least 20 minutes for high intensity	Running, swimming, cycling
Dynamic Resistance Exercise	2 to 3 sessions per week	60% to 80% of 1 Repetition Maximum (RM)	8 to 10 exercises targeting major muscle groups, with 10 to 12 repetitions and 2 to 3 sets for each muscle group	Free weights or machine weights
Isometric Resistance Exercise	3 to 4 sessions per week	20% to 50% of maximal voluntary contraction	4 repetitions of 20% to 50% of maximal voluntary contraction, holding for 2 minutes and resting for 1 to 4 minutes between repetitions	Muscle contraction without joint motion (isometric handgrip exercise)
Combination of AE and Dynamic Resistance Training	5 to 7 days of AE; 2 to 3 days of resistance training	Moderate intensity of AE; 60% to 80% of 1RM for resistance training	At least 30 minutes for AE; 2 to 3 sets for each muscle group for resistance training	Running, swimming or cycling for AE; machine or free weight for resistance exercise

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