CULTURA, CIENCIA Y DEPORTE

DESING OF INDIVIDUALISED COMBINED TRAINING PROGRAMMES FOR ADULTS WITH HYPERTENSION

DISEÑO DE PROGRAMAS DE ENTRENAMIENTO COMBINADO INDIVIDUALIZADO PARA ADULTOS CON HIPERTENSIÓN ARTERIAL

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Individualized Combined Training for Hypertension

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Abstract

Cardiovascular disease is currently the leading cause of death worldwide. High blood pressure is one of the risk factors that can trigger cardiovascular disease related deaths worldwide. Consequently, there are many strategic plans to address and improve blood pressure levels, with the aim of slowing down the high incidence of annual mortality, and physical exercise programs are among these strategies. Therefore, the objective of this work is to provide health professionals with a guide to correctly design an effective individualized combined training program for strength and aerobic endurance, with the aim of improving the cardiometabolic health of this population. This work addresses the current recommendations on prescribing physical exercise for people with hypertension, and provides general considerations to consider when practicing it. In addition, a reference is made to the effect of drugs during physical exercise and how to keep this in mind during its performance, and the acute adaptations to exercise and the recommendations for combined resistance and strength training in this population are described. Finally, an individualized combined training program for people with hypertension lasting 12 weeks, with a training frequency of 2 days/week, is proposed. For strength training, the intensity will be low-moderate and the volume will be low, with both variables individualized through the speed of execution; 2 exercises will be performed, 3 sets/exercise and in a horizontal progression. For endurance training, the intensity will be low progressing to moderate, from 55% to 70% of the heart rate reserve (HRR) increasing every 4 weeks, and this variable will be individualized by means of a clinical test on a cycloergometer; the volume will be 20 min/session on a static bicycle.

Keywords: High blood pressure, exercise, concurrent training, strength, endurance.

Resumen

Actualmente la enfermedad cardiovascular es la causa principal de muerte en el mundo. Entre los factores de riesgo desencadenantes de muerte cardiovascular a nivel mundial se encuentra la hipertensión arterial. En consecuencia, son muchos los planes estratégicos para abordar y mejorar los niveles de presión arterial con el objetivo de frenarla la alta incidencia de mortalidad anual, encontrándose entre estas estrategias los programas de ejercicio físico. Por ello, el objetivo de este trabajo es proporcionar a los profesionales de la salud una guía para poder diseñar correctamente un programa de entrenamiento combinado individualizado efectivo, de fuerza y resistencia aeróbica, con la finalidad de mejorar la salud cardiometabólica de esta población. En el presente trabajo se abordan las actuales recomendaciones sobre prescripción de ejercicio físico en personas con hipertensión, y se aportan consideraciones generales a tener en cuenta para la práctica del mismo. Además, se hace referencia al efecto de los fármacos durante el ejercicio físico y cómo tenerlo presente durante su realización, se describen cuales son las adaptaciones agudas al ejercicio y las recomendaciones para el entrenamiento combinado de resistencia y fuerza en esta población. Por último, se propone un programa de entrenamiento combinado individualizado para personas con hipertensión de 12 semanas de duración con una frecuencia de entrenamiento de 2 días/semana. Para el entrenamiento de fuerza la intensidad será baja-moderada y el volumen será bajo, ambas variables individualizadas a través de la velocidad de ejecución; se relizarán 2 ejercicios, 3 series/ejercicio y en progresión horizontal. Para el entrenamiento de resistencia aeróbica la intensidad será baja progresando a moderada, del 55% al 70% de la FCresv incrementando cada 4 semanas, esta variable será individualizada mediante un test clínico en cicloergómetro; el volumen será de 20 min/sesión en bicicleta estática.

Palabras clave: Presión arterial alta, ejercicio, entrenamiento concurrente, fuerza, resistencia.

Introduction

The latest epidemiological studies place cardiovascular disease as the leading cause of death worldwide, with ischemic heart disease in first place, followed by stroke. These studies also show that high blood pressure remains the leading modifiable risk factor for cardiovascular disease-related death worldwide, which is responsible for more than 10 million deaths per year(Mensah et al., 2023; Unger et al., 2020; Vaduganathan et al., 2022). One of the World Health Organization's (WHO) targets for 2025, in relation to non-communicable diseases, is to reduce the prevalence of high blood pressure by 25% (based on 2010 data) (WHO, 2023), but as of today, the incidence and mortality figures for the disease continue to rise.

Arterial hypertension is considered a chronic and virtually asymptomatic disorder with a multifactorial etiology and no specific cause. A distinction can be made between primary and secondary hypertension, with the most common being primary hypertension, which accounts for about 90-95% of cases; secondary hypertension, which is much less common, usually occurs in 5-10% of hypertensive patients (Rimoldi et al., 2014; Unger et al., 2020). Primary hypertension is very heterogeneous and presents a series of intrinsic (non-modifiable) risk factors due to its biological origin, and other extrinsic (modifiable) factors due to its environmental nature associated with lifestyle (Gorostidi et al., 2022). More than 50% of people with high blood pressure have additional risk factors such as overweightness-obesity, dyslipidemia, insulin resistance or type II diabetes, or unhealthy lifestyle habits, including sedentary lifestyles and a poor diet (Menéndez et al., 2016; Unger et al., 2020). With respect to secondary hypertension, its etiology can be classified into frequent and infrequent. Common causes include parenchymal kidney disease, renovascular disease, primary hyperaldosteronism, sleep apnoea-hypopnoea syndrome, and drug-induced hypertension (Unger et al., 2020; Whelton et al., 2018).

The latest European guidelines on cardiology and hypertension consider it hypertension when systolic blood pressure levels are equal to or higher than 140 mmHg and/or diastolic blood pressure levels are equal to or higher than 90 mmHg, although the cut-off values for defining hypertension at home or with 24-hour recording devices must show a systolic blood pressure equal to or higher than 135 mmHg, and/or a diastolic blood pressure equal to or higher than 85 mmHg (Mancia et al., 2023).

There is now sufficient evidence to justify that physical exercise acts as an intervention capable of preventing and treating numerous non-communicable diseases, including cardiometabolic, immunological, neurological diseases and even diseases such as cancer (Pedersen, 2006; Pedersen & Saltin, 2015). Along the line of benefits and improvements in the health and quality of life of people, achieved through non-pharmacological therapies, large epidemiological studies have shown an inverse relationship between the incidence of arterial hypertension and the practice of physical exercise (Liu et al., 2017; Rijal et al., 2024). Non-pharmacological interventions are key to the prevention and treatment of this disorder; these interventions require changes in daily habits and behaviors, such as abandoning sedentary lifestyles and starting regular physical exercise (Charchar et al., 2024; Pelliccia et al., 2020; Whelton et al., 2018). In 1989, and for the first time, the WHO and the International Society of Hypertension included recommendations for physical exercise among the non-pharmacological measures aimed at lowering blood pressure values (WHO, 1989).

At the clinical level, the guidelines for cardiovascular pathology and hypertension prescribe physical exercise in this type of population. These international documents provide very general recommendations for the improvement of cardiovascular health (Mancia et al., 2023; Unger et al., 2020; Whelton et al., 2018). The aerobic resistance exercise modality has been well-studied by the scientific community, and is considered, to date, to be the most important type of training for subjects with hypertension, as this modality provides the greatest benefits on blood pressure levels, with reductions of -4.9 to -12 mmHg in systolic blood pressure and -3.4 to -5.8 mmHg in diastolic blood pressure (Hanssen et al., 2021; Mancia et al., 2023; Pescatello et al., 2015). Strength training is recommended as complementary training to resistance training, so that patients can benefit from the improvements offered by this modality, which may include reductions of -3.0 to -4.7 mmHg in systolic blood pressure and -3.2 to -3.8 mmHg in diastolic blood pressure (Hanssen et al., 2021; Mancia et al., 2023). Combining both strength and endurance training in the same training session also offers great benefits for cardiometabolic health, as previous studies have shown (Corso et al., 2016; López-Ruiz et al., 2023). This combined modality is a good tool to address high blood pressure, due to the significant reductions observed in blood pressure levels, up to -21.68 mmHg in systolic blood pressure levels and up to -13.92 mmHg in diastolic blood pressure levels, even greater reductions than resistance training alone, which are up to -12.8 mmHg, -6.8 mmHg, respectively.

Prescription of Physical Exercise for the Improvement of Cardiometabolic Health in Adults With Hypertension

General Considerations for the Practice of Physical Exercise

Before starting a training program, it is important that the subject undergoes a medical examination in which routine tests recommended for subjects with arterial hypertension are performed, in order to rule out an increased risk of cardiovascular disease (CVD) or relevant comorbidities, and to guarantee safety in the development of training programs. These tests include: blood tests to measure glycosylated hemoglobin (HbA1C), electrolytes, creatinine, glomerular filtration rate, and lipid profile; urinalysis to estimate the albumin/creatinine ratio, and to check for hematuria with a dipstick; examination of the fundus to detect the presence of hypertensive retinopathy; and finally, a 12-lead electrocardiogram (McEvoy et al., 2024; NICE, 2023; Unger et al., 2020).

International clinical guidelines on cardiology and hypertension recommend the practice of physical exercise as a non-pharmacological treatment for the improvement and control of arterial hypertension (Charchar et al., 2024; Rabi et al., 2020; Unger et al., 2020; Whelton et al., 2018). These guidelines recommend resistance training of 150 to 300 min/week (5-7 days/week) at moderate intensity, which can be alternated with 75 to 150 min/week (2-3 days/week) at vigorous intensity (Charchar et al., 2024; McEvoy et al., 2024; Pelliccia et al., 2020; Rabi et al., 2020). Some of these documents also recommend incorporating 2 to 3 days per week of strength training, as a complement to aerobic endurance training, without going into detail about its prescription (Brook et al., 2013; Charchar et al., 2024; Hanssen et al., 2021; Whelton et al., 2018).

These exercise patterns must be integrated into a complete training session that must always maintain the same structure, whatever the exercise program or sporting discipline to be performed. The structure of the session is composed of three solid and successive phases, the warm-up phase, the main phase, and the post-workout recovery phase, which guarantee the improvement in the health and performance of the subject (Bishop, 2003a, 2003b; Fradkin et al., 2010; McGowan et al., 2015).

Presently, clinical guidelines do not refer to all phases of this structure, focusing exclusively on the main phase of the session (Arnett et al., 2019; Brook et al., 2013; Charchar et al., 2024; Mancia et al., 2023; Pelliccia et al., 2020; Rabi et al., 2020). Before starting the main phase, it is necessary to carry out a specific preparatory (warm-up) phase that gradually increases the heart rate (HR), pulmonary activity, and blood flow, to increase the oxygen supply to the body in general and to the muscles in particular; this increases the temperature of the muscles involved, improving muscle elasticity to avoid strains, tears and ruptures, and synovial viscosity to facilitate the sliding of the joints. Once the main phase is over, it is necessary to perform a post-training recovery phase to gradually return to a state of rest. It is important to know that antihypertensive medication can cause sudden and excessive reductions in blood pressure after exercise, and this period of return to a state of rest must be prolonged and controlled (Bishop, 2003a, 2003b; Fradkin et al., 2010; McGowan et al., 2015; Pescatello, 2020; Safran et al., 1989; Taylor et al., 2019; Woods et al., 2007).

These general guidelines, at first, can help hypertensive patients to begin to move and lead a more active life. However, individualization is one of the basic principles of training, and selecting the exercises depending on the objectives and needs of each subject, accurately programming the workload, and using the most appropriate methodology, will be very important to achieve the best results (Fleck & Kraemer, 2014; Pescatello, 2020; San-Millán, 2023).

Other recommendations to be taken into account in this type of population are, on the one hand, to avoid the Valsalva maneuver during the technical execution of strength exercises; to pay special attention to upper body exercises and/or exercises with the arms above the head, due to the hypertensive response they provoke; to be careful with static exercises and reaching muscle failure, due to the difficulty of controlling the Valsalva maneuver, the hypertensive response, or the risk of injury (Nazir et al., 2024; Williams et al., 2007).

On the other hand, clothing will also be important for safe physical exercise. Some antihypertensive drugs, beta-blockers, or diuretics, affect the body's ability to regulate its temperature during exercise, especially in warm and/or humid environments, which can lead to hypoglycemia. The subject should wear breathable and comfortable clothing to avoid excessive sweating and skin lesions. Regarding footwear, the use of sneakers is recommended. Sauna effect garments and girdles that may favor syncopes should be avoided (Marcos-Pardo et al., 2021; Pescatello, 2020).

Finally, hydration is a relevant factor in this population group, as they are usually treated with beta-blockers or diuretics, before, during, and after training, to avoid possible dehydration (Marcos-Pardo et al., 2021; Pescatello, 2020).

Based on the above, and with the aim of preventing and treating arterial hypertension, the medical field should encourage patients to seek help from physical exercise professionals to take part in the correct and individualized training program, and for advice and recommendations during the training session.

Antihypertensive Drugs and Physical Exercise

There are many medications available to treat high blood pressure, and the potential side effects of these drugs should be considered when starting an exercise program, as they can result in detrimental physiological responses (Khalil & Zelster, 2020; Laurent, 2017; Pelliccia et al., 2020):

- Angiotensin-converting enzyme inhibitors (ACE inhibitors): may cause skin rash, loss of taste, or dry and persistent cough, but do not affect exercise capacity. They should not be administered to women of reproductive age due to possible fetal/neonatal adverse effects.
- Angiotensin II receptor antagonists (ARA-II): may cause occasional dizziness, but do not affect exercise capacity. They should not be administered to women of reproductive age due to possible fetal/neonatal adverse effects.
- Calcium channel blockers or calcium antagonists: these are the best alternative to ACE inhibitors and ARBs. They can cause palpitations, ankle swelling, headaches and dizziness, but do not affect exercise capacity.

- Beta-blockers: may cause insomnia, coldness of hands and feet, asthma and depression. These drugs affect the ability to exercise, since they reduce heart rate and decrease tolerance to exertion by increasing the sensation of fatigue.
- Diuretics: may cause fatigue, weakness or muscle cramps, gout attacks, irritability, depression, and urinary incontinence. These drugs do affect the ability to exercise, since they increase diuresis and favor dehydration.

When a subject with arterial hypertension begins a physical exercise program and is under antihypertensive treatment, the following possible effects should be taken into account: (a) the post-exercise hypotensive response; (b) the hypotensive response due to changes in position, (orthostatic hypotension); (c) the hypotensive response as a consequence of temperature (heat and humidity); and (d) the hypotensive response due to the practice of physical exercise on a regular and sustained basis over time; these situations may cause the subject to experience dizziness, lightheadedness, unsteadiness, nausea and a feeling of tiredness and/or fatigue (Khalil & Zelster, 2020; Laurent, 2017). In any situation of hypotension with symptoms, the subject should be referred to his/her physician for review and adjustment of the treatment if necessary. Special attention should be paid to subjects treated with beta-blockers, since this drug decreases the heart rate on exertion, and if it is too strongly attenuated, it could also cause dizziness, instability, and a feeling of tiredness and/or fatigue (Khalil & Zelster, 2020; Laurent, 2017; Mitchell et al., 2019). Of all the antihypertensive drugs, beta-blockers can most affect the physical capacity to exercise, since a decrease in heart rate during exercise will make it more difficult to control and correctly adjust the training load or stimulus, and achieve the desired heart rate, which implies having to look for another tool or alternative method to control this variable (Adami et al., 2022; Mitchell et al., 2019). Monitoring exercise intensity through the perceived exertion scale can be a reliable and commonly used method in cardiac rehabilitation programs as a complement to heart rate monitoring (Mitchell et al., 2019; Taylor et al., 2019). In relation to this, it is important to understand that the equations for estimating maximum heart rate (HRmax), such as Fox's formula (HRmax = 220-age) or Tanaka's formula (HRmax = 208-(0.7*age), are based on healthy subjects who do not suffer from arterial hypertension, heart failure, or coronary heart disease and who are not on beta-blocker therapy, so these types of equations do not seem to be very valid for this type of population. However, other formulas for estimating HRmax take into account cardiovascular disease treated with beta-blockers. Therefore, the following formula is proposed for the population with this type of condition: 164 – 0.7 x age, as it is a more accurate equation in this population group (Brawner et al., 2004; Fernandes Silva et al., 2012; Taylor et al., 2019).

Acute Adaptation of Blood Pressure to Physical Exercise

The practice of physical exercise induces a series of physiological responses in the organism, among which we find changes in blood pressure dynamics.

At the beginning of physical exercise, blood pressure increases in response to the activation of the motor cortex, which is aimed at preparing the body for a higher activity. Subsequently, blood pressure values may decrease due to the vasodilation of the active zones, depending on the size of the area of the zones involved. As training intensity increases, systolic blood pressure generally increases in a linear fashion, while diastolic blood pressure increases less, remains relatively stable, or even decreases slightly. At the end of physical exercise, resting blood pressure levels gradually recover, and it may take some time to return to pre-training levels. If the return to a state of rest is not gradual, post-exercise hypotension may occur, mainly in susceptible subjects or in unfavorable climatic conditions, leading to malaise, dumping, or lipothymia (Halliwill, 2001; Halliwill et al., 2013; Seeley et al., 2021).

These transient oscillations in blood pressure during exercise make it essential to monitor it before, during, and after exercise to avoid unexpected fatal cardiac events. Extreme variations in these responses can be a significant predictor of possible adverse cardiovascular events (Nayor et al., 2023; Pesova et al., 2023). An important aspect to highlight about these extreme changes is the lack of consensus on the definition of hypertensive response to exercise. In spite of this, systolic blood pressure values above or equal to 210 mmHg for men and 190 mmHg for women are the cut-off points used worldwide to stop sports practice and consider that there is a hypertensive response to exercise. (Fletcher et al., 2013; Sabbahi et al., 2018).

Individualized Aerobic Endurance Training on Arterial Hypertension

- The frequency variable refers to the number of training sessions or units performed in a period of time. In the health field, this is normally a week (Elvar & García-Orea, 2019). The minimum training frequency for this population group will be 2-3 days per week.
- The duration of the session will be ≤60 minutes.
- The priority training intensity for improving cardiometabolic health will be moderate, between 55%-70% of VO^2max or HRR, known as Training Zone 2 (Gu et al., 2021; Riddell et al., 2017; San-Millán, 2023). To program the intensity of training in an individualized way, the maximum volume of oxygen (VO^2max), the HRmax, the heart rate reserve (HRR), or the subjective perception of effort (RPE) must be estimated; the use of VO^2max or HRR is preferred because of their linear 1/1 relationship with the energy expenditure (VO^2max/reserve VO^2) (Ferguson, 2014; Liguori & American College of Sports

Medicine, 2020; Manonelles et al., 2016). The calculation of these parameters can be assessed directly or indirectly. One of the most indicated protocols for estimating VO²max in the hypertensive population is by means of a cycloergometer stress test, as it is more accurate, and it is easier to measure blood pressure during exercise (Manonelles et al., 2016). During the test, the heart rate should be monitored and recorded at all times to find the HRmax; simultaneously, the RPE should be recorded (Borg, 1990); In addition, power should be measured to determine the functional threshold power (FTP), which provides an accurate and objective way to measure training intensity (Allen et al., 2019). As mentioned above, HRmax can also be estimated using different formulas. The most commonly used in the field of health care are the aforementioned Fox (Fox et al., 1971; Liguori & American College of Sports Medicine, 2020) or Tanaka formulas (Tanaka et al., 2001), but the resulting value is not precise if not merely indicative, and for a population without any pathologies. We propose the use of the following formula for the calculation of the HRmax in the population with a cardiac pathology (HRmax = 64 – 0.7 x age) (Brawner et al., 2004; Fernandes Silva et al., 2012; Taylor et al., 2019). On the other hand, HRR and its use for the calculation of training intensity will be more precise than the use of HRmax, and for its calculation it will be necessary to know the resting heart rate (RHR). The HRR will be calculated by means of Karvonen's formula: HRR = HRmax - RHR. Once these data are known, the prescribed percentage of intensity will be calculated. The Karvonen formula (% HR= (HRR × % intensity) + RHR) will be used for this purpose (Karvonen et al., 1957).

- In relation to the RPE (Rating of Perceived Exertion) scale, defined as the subjective perception of exertion, tension and/or fatigue experienced during physical exercise, it is a reliable indicator of intensity and commonly used in cardiac rehabilitation programs simultaneously with heart rate monitoring (Mitchell et al., 2019; Taylor et al., 2019). This scale uses values from 0 to 10 to numerically and gradually evaluate effort, where 0 is total rest and 10 is maximum effort (Borg, 1982).
- The training zones and intensities, from maximum ergometry tests, are shown in Table 1 (Hansen et al., 2021; Pelliccia et al., 2020).

Table 1
Resistance Training Zones and Intensities

Zone	Intensity	VO²max (%)	HRmax (%)	HRR (%)
1	Low	< 40	< 55	< 40
2	Moderate	40-69	55-74	40-69
3-4	High	70-85	75-90	70-85
5	Very High	> 85	> 90	> 85

Note. This table shows the equivalence of training zones with training intensity, maximal oxygen volume (VO²max), maximum heart rate (HRmax) and heart rate reserve (HRR) (Pelliccia et al., 2020).

- The minimum training volume for this type of population will be 150 to 300 min/week (5-7 days/week) if exercise is performed at moderate intensity (zone 2). It can be alternated from 75 to 150 min/week (2-3 days/week) if the intensity is vigorous (zone 3) (Bull et al., 2020; McEvoy et al., 2024).
- The type of activity to be performed must involve large muscle groups and cyclic movements, and must be maintained over a medium to long period of time. These include various activities such as pedaling, running, rowing, swimming, etc.

Individualized Strength Training in Arterial Hypertension

- The minimum training frequency for this population group will be 2-3 non-consecutive days per week.
- The duration of the session will be ≤60 minutes.
- It must include polyarticular exercises involving large muscle groups that simulate activities of daily living (squats, rowing, bench press, etc.).
- The number of exercises per session should be increased from six to 8-10 exercises(López-Ruiz et al., 2023; Pescatello, 2020; Whelton et al., 2018).
- Intensity in strength training will be the most decisive variable in determining the degree of effort required to perform an exercise in each repetition, which should be low-moderate for this population group (Badillo & Serna, 2002; Elvar & García-Orea, 2019). The quantification of the training load will be done through the speed of execution, by means of a progressive load test to estimate the 1RM, in a safe and precise way, and to determine the relative intensity of work. However, the intensity, by itself, is not enough to define the training stimulus and must be linked especially to another variable of the programming, such as the volume (Badillo, 2017; Badillo & Serna, 2002).
- The volume should be determined by testing the percentage of intra-set speed loss with respect to the 1st repetition. The magnitude of speed loss should be low-moderate, between 10%-20%, since higher percentages of speed loss

are not associated with greater benefits and can lead to a reduction in physical performance (Badillo & Serna, 2002; Rodríguez-Rosell et al., 2020; Rodríguez-Rosell et al., 2021).

- The following is a proposed protocol for prescribing intensity in subjects with arterial hypertension. The intensity will be determined through a progressive load test to estimate the 1RM and establish a low-moderate intensity of work, between 50-65% of 1RM for this type of population (Alves et al., 2022; Pescatello, 2020). Current work intensity recommendations for strength training in hypertension, according to the American College of Sports Medicine (ACSM), are as follows: low intensity, between 40%-50% of 1RM, for sedentary subjects or those with muscle weakness; moderate intensity, between 60%-70% of 1RM, for beginners or intermediate subjects; and high intensity, 80% of 1RM, for advanced and experienced trainees (Alves et al., 2022; Pescatello, 2020; Pescatello et al., 2015). The training volume, or number of repetitions per set, will be determined through an intraset velocity loss test for each subject. The magnitude of velocity loss (%VL) should be low-moderate, between 10-15% (Badillo, 2017; Rodríguez-Rosell et al., 2020; Sánchez-Medina & González-Badillo, 2011).
- The effort character (EC) must be medium-low. The EC is understood as the ratio between the repetitions performed in each set with respect to the repetitions that could be performed if muscle failure were reached (Badillo & Serna, 2002), as can be observed in Table 2. EC must not be confused with subjective perception of exertion.

Table 2
Effort Character

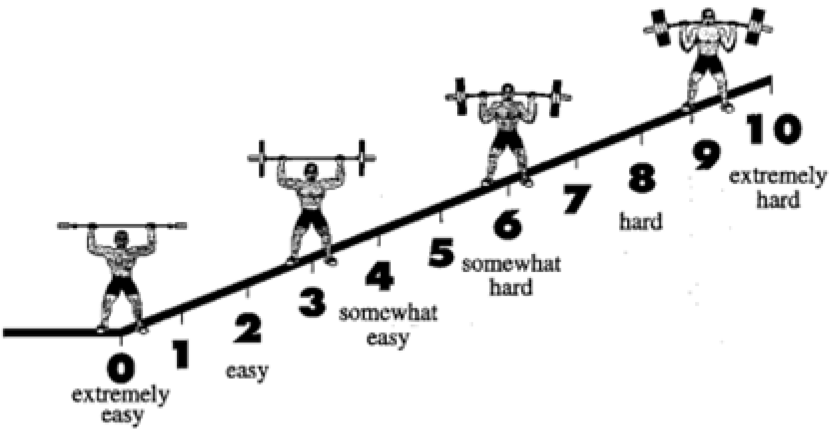
EC	%VL in the series	Repetitions performed in the series
Low	5-10%	Less than half of the possible repetitions
Medium	15-30%	Half of the possible repetitions
High	>30%	Some more than half of the possible repetitions
Maximum	>50%	Maximum or almost maximum number of the possible repetitions

Note. This table shows the relationship between the effort character (EC), the percentage of velocity loss (%VL) intra-set with respect to the 1st repetition and the repetitions performed per set with respect to the maximum that could actually be performed (Badillo & Serna, 2002).

- The number of sets per exercise can be from 2-4, depending on the starting point and the improvement of the subject.
- The recovery time between training sets should be 3 to 5 minutes.
- The recovery time between training sessions will be 48 to 72 hours.

With regard to the programming of training, although an increasing number of technological resources and devices are becoming available, which have undoubtedly made it possible to program the intensity and volume of training more precisely, and to make advances in the dosage of effort, we should not underestimate other simpler tools or indicators that are easily accessible for this same purpose. One of these tools is the OMNI-RES scale, which is presented as visual descriptors where the subject identifies his or her own perception of effort or fatigue on a numerically graded scale from 0 to 10, as shown in Figure 1, where 0 is very easy and 10 is very difficult, during or immediately after exercise (Robertson et al., 2003).

Figure 1
OMNI-RES scale for strength



Note. This scale represents the subject's own perception of effort or fatigue on a numerical progression from 0 (very easy) to 10 (very difficult) (Robertson et al., 2003).

Individualized Combined Training on Arterial Hypertension

The Heart and Health clinical trial focuses on combined training programs, understood as training that combines different training units, strength, and aerobic endurance work, in the same training session. Combined training has been shown to be effective in reducing blood pressure levels and improving cardiometabolic health in subjects with hypertension (Herrod et al., 2018; López-Ruiz et al., 2023). Several controlled trials have shown significant reductions in SBP and DBP levels with combined training program interventions (Dos Santos et al., 2014; Lima et al., 2017; Masroor et al., 2018; Sousa et al., 2013). In addition, systematic reviews and meta-analyses can be found whose results have also shown that interventions with combined training were able to significantly reduce SBP and DBP levels (Corso et al., 2016; López-Ruiz et al., 2023; Pescatello et al., 2019).

The intention of the present project is to serve as a guide for health professionals that will enable them to design combined training programs in an individualized manner for each subject with a minimum, but effective, dose of exercise. These interventions are aimed at adult subjects with arterial hypertension, who are sedentary, who do not suffer from osteoarticular or musculoskeletal problems (osteoarthritis, recent fracture, tendinitis, or use of prosthesis), acute or chronic diseases (heart disease, unstable coronary disease, heart failure, renal failure, severe pulmonary hypertension or uncontrolled diabetes), neurological problems, cognitive difficulties, morbid obesity or pregnant women.

Combined Heart and Health Training Program

The following section described the design of an individualized combined strength and aerobic endurance training program taking into account the exercise guidelines described above for adult subjects with arterial hypertension. This exercise prescription has shown great benefits for cardiometabolic health, body composition and physical fitness in this type of population.

Each training session will last approximately 60 minutes and will be divided into three phases, which is summarized in Table 3.

Table 3
Combined Heart and Health Training Program

Intervention Period		12 Weeks
Weekly Frequency		2 sessions/week; 4 training units/week (2 strength; 2 endurance)
Strength Training Unit		
Warm-up		10 min (3-5 min general warm up and 5-7 min specific warm up)
Volume	N. Exercise	2 general exercises (Squat and Bench Press)
	N. Sets	3
	N. Repetitions	Individualized for each patient by intra-set %VL
	% Velocity Loss (intra-set)	Squat: Low 10% Bench Press: Moderate 15%
Intensity	% 1RM MPV 1st repetition	Squat: 60% of 1RM Bench Press: 50% of 1RM
	Execution Velocity	Concentric phase: maximum possible Eccentric phase: moderate
Effort Character		Medium-Low
OMNI-RES		4-5
Inter-set rest		3 min
Selection of exercise		Squat and Bench Press
Method		Horizontal Progression
Aerobic Endurance Training Unit		
Volume		20 min
Intensity		Progression every four weeks from 55% to 70% of $VO^{2}max$/HRR
Training Zone		2
RPE (0-10)		Moderate 3-4
Selection of exercise		Cycloergometer
Method		Extensive continuous training
Cool Down		10 min (3-5 min cool down and 5-7 min passive static stretching)

Note. N.= number; RM= repetition maximum; $VO^{2}max$= maximal oxygen volume; HRR= heart rate reserve; MPV= mean propulsive velocity; OMNI-RES= perceived exertion scale for endurance exercise; RPE= rating of perceived exertion

DESING OF INDIVIDUALISED COMBINED TRAINING PROGRAMMES FOR ADULTS WITH HYPERTENSION

Preparatory Phase to the Training

This first phase will last about 10 min and will be divided into a general warm-up and a specific warm-up. The general warm-up will include 5 min of Nordic walking on an elliptical bike; joint mobility exercises for upper and lower limbs, and dynamic stretching. The specific warm-up will include two compound exercises, squat and bench press; the subject will perform 2 sets per exercise with only the weight of the training bar (5 kg weight) and rest 2 min between sets; the first set of 8-10 repetitions and the second set of 6-8 repetitions.

Main Phase

The second phase has a duration of 40 min and will be composed of two training units, one of strength and the other of aerobic endurance. The strength training unit will be performed during the first 20 min of the session and will include two exercises that reproduce basic motor actions. The first exercise will be a lower body push-up, a squat, which each subject will perform at an intensity of 60% of their 1RM. The volume of work will be three sets with a rest between each of them of 3 min. The number of repetitions per set will be individualized for each subject by means of the initial velocity loss test. The effort character will be low-medium. Between the two exercises there will also be a 3 min rest. The second exercise will be an upper body push-up, a bench press, which each subject will perform at an intensity of 50% of their 1RM. The volume of work will be three sets with a rest period between each of them of 3 min. The number of repetitions per set will be individualized for each subject by means of the initial velocity loss test. The effort character will be low-medium. As explained above, if the necessary tools are not available to estimate the 1RM, the OMNI-RES scale can be used. The last 20 min of the session will be for the aerobic endurance training unit, which will be performed on a cycloergometer. The subject will work with an extensive continuous method at a moderate intensity that will progress every 4 weeks: from week 1 to 4 work will be performed in zones 1-2 with an intensity between 55%-60% HRR; from week 5 to 8 work will be performed in zone 2 with an intensity between 60%-65% HRR; and from week 9 to 12 work will be performed in zone 2 with an intensity between 65%-70% HRR.

Post-training Recovery Phase

The time dedicated to the last part of the training will be 10 min. This phase will consist of a return to a state of rest for 3-5 min, in which the subject will recover from the effort with a soft pedaling exercise without load, and then move on to a static stretching part lasting about 5-7 min. The muscles with tonic/postural predominance should be stretched due to their permanent state of tension and their tendency to shorten to avoid possible musculoskeletal problems that affect the locomotor system (Chang et al., 2023; Sadler et al., 2017). The tonic musculature includes: upper fibers of the trapezius, latissimus dorsi and quadratus lumborum; pectoralis, anterior deltoid and biceps; psoas iliacus and rectus anterior quadriceps; abductors; pyramidalis, ischiosuralis and triceps suralis (calf and soleus). The use of the passive static technique is recommended, through the performance of 3-4 sets per stretch, with a duration per set of 20-30 seconds (Bayles, 2023; Liguori & American College of Sports Medicine, 2020).

Conclusion

The combined training program designed in the Heart and Health project provides a guide for exercise and health professionals based on scientific evidence and the latest advances in the prescription of physical exercise in the population with arterial hypertension, one of the most prevalent non-communicable diseases in modern society and responsible for 10.8 million deaths per year worldwide. This study sets out the guidelines to be followed to design a correct, adequate, and safe combined training program to achieve the benefits provided by both exercise modalities, both strength training and aerobic endurance training, with the aim of improving hemodynamic parameters, body composition, and physical condition of adult subjects with arterial hypertension.

Statement of the Ethics Committee

Not applicable due to the non-involvement of living beings during the development of this article.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Author's Contribution

Conceptualization L.-R.I. & G.G.N.; Methodology L.-R.I. & G.G.N.; Validation L.-R.I., L.G., M.M.D., & G.G.N.; Investigation L.-R.I. & G.G.N.; Writing – Original Draft L.-R.I. & G.G.N.; Writing – Review & Editing L.-R.I. & G.G.N.; Visualization L.-R.I., L.G., M.M.D., & G.G.N.; Supervision G.G.N.; Todos los autores han leído y están de acuerdo con la versión publicada del manuscrito.

Data Availability Statement

Data are not available because no data have been generated.

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