Chapter

Resistance Training is Medicine: Stay Active and Reap the Reward, Live in your Life!

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Abstract

The world of physical medicine and rehabilitation still believes that exercise is medicine. Muscle mass will naturally decrease with aging, 3–8% every decade after a person turns 30 years old, getting worse over the age of 50 years, which is 5–10% every decade. Some studies state that for healthy people, resistance training (RT) performed 2–3 times per week with 12–20 total sets of exercises will add muscle mass. The addition of 1.4 kg of muscle mass was accompanied by the disappearance of about 1.8 kg of fat. RT plus aerobic exercises (AE) complemented with caloric resistance (CR) can result in a reduction of 5.1 kg or 7.1% of fat. Some research papers state that for stable CAD patients starting with 3 months of AE followed by an RT program of 40–60% intensity 1x RM, 1–2 sets, 8–10 repetitions, 2–3 days per week, duration not more than 60 minutes. Recommendation for a person with intellectual disability can be simple and harmless RT tools. The prescription for COVID-19 survivors consists of AE for 5 to 30 minutes with low to moderate intensity, plus 1–2 sets of RT, 8–10 reps at 30–80% 1xRM.

Keywords: resistance training, exercise, medicine, special condition, prescription

1. Introduction

Resistance training (RT) is part of several types of exercises that can be recommended as one of the lifestyles and has a positive effect on a person's health status [1]. This is one of the exercises that should be done together with other exercises that will form or maintain endurance, balance, flexibility, and strength. Blending these four types of exercises is very important to maintain optimal health and to be able to carry out optimal activities in daily life. Strength training is a form of exercise that focuses on the use of weights or resistance to build muscles, as well as ligaments and bones, increase power, and maintain posture [2].

RT, also known as weight training or strength training, is a physical activity to improve neuromuscular and musculoskeletal fitness and physical performance by training muscles or a group of muscles, which is done by resisting weights from the outside [1, 3, 4]. External load can be in form of disc, barbells, dumbbells, and resistance bands. Folland et al., 2007 [5] and Spiering et al., 2008 [6] state that physical exercise using some kind of resistance exercise can also be incorporated into the

RT [5, 6]. Resistance training can also be performed by using body weight, such as push-ups and squats [1].

The first question that arises is "What is the main purpose of doing this RT activity as the chosen type of sport instead of doing other types of exercises?" It has been proven by many studies and articles that RT can produce a state of muscle hypertrophy [3–6] and produce additional muscle endurance, muscle strength, maximum strength, muscle explosion, and power [4, 7, 8]. In addition to the ability of RT to create muscle hypertrophy, it is also able to create functional additions to the body, besides only the esthetic function of body shape, which we will learn more about in the next chapter.

In contrast to aerobic exercise, which already has standards that are widely accepted in society, RT still needs to be studied for its needs and advantages for the various physical circumstances of a person who will do it, especially people with special conditions. The best procedure for identifying the most adequate and optimal RT exercises is through careful experimentation as well as observations and experiences. Through experiments, observations, and experiences, it can be analyzed and concluded how to obtain a method, a formulation for the dose of load applied to improve the state of health and even improve the quality of life of a person. RT is also expected to be applied not only to healthy individuals but also to individuals with certain health conditions. Suchomel et al., 2018 [9] also DeWeese et al., 2015 [10] remind us that: 1) it is necessary to pay attention to the selection of exercises to produce a balance between determining and using the weight of the load as well as its preparations to achieve the specified goals, 2) management of fatigue begins from anticipating the possibility of overtraining to carrying out rest procedures, and 3) it is necessary to pay attention to the right stages and timing to produce good performance [3, 9, 10].

2. Physiology of exercise

Exercise forces the body to do more movement compared to when resting. Movement during exercise stimulates the sympathetic nervous system and will increase the body's response integrally. This response is necessary for the body to maintain hemostasis over the increased metabolism of the heart, lungs, muscles, brain, and other organs [11].

2.1 Cardiovascular system response

Physiologists say that when a person performs a heavy physical activity, the muscles only show 30% of their maximal capacity, while the respiratory and cardiovascular systems have reached much higher activity, 60% and 90% of their maximal capacity, respectively. Based on this data and information, some physiologists state that the greatest factor affecting the transportation of O2 and nutrients to the muscles that will support metabolism in aerobic exercise is the cardiovascular system. Thus, the exercise is aimed mainly to improve cardiovascular efficiency [2, 12, 13]. The increase in endurance levels of the cardiorespiratory system is not solely produced by AE but also RT. RT helps to add endurance values in cycling (47%), walking (38%), and running (12%) activities. The increase in this value is not due to an increase in the value of VO2max, but mainly because of the increase in fatigue threshold. This can occur due to the recruitment of muscle cells and mitochondria, so we can say that cardiorespiratory endurance is also affected by muscle strength in addition to muscle endurance [14].

2.2 Muscle response

The human body has three types of muscle tissue: skeletal muscle, smooth muscle, and special muscle, called the cardiac muscle. As the name implies, most skeletal muscles are attached to skeletal bones, and they have the main function for active movement [2]. Skeletal muscles make up most of the body mass, it is estimated to be about 40% of body mass in total. Tendon is further classified into two parts, one part is immobile and attached closer to the torso, called origo. The other part of a tendon can relatively move and is attached farther to the body, called insersio [2].

What requirements are needed to move the skeleton? How can muscles move the skeleton? The answer is by contracting. The muscle contraction will bring the bone closer or away according to the condition. The movement is possible due to the presence of joints, which connect the bones. The driving muscle is called the flexor when the task is to bring the two bones connected to the joint closer, and the movement is called flexion. In contrast, when the contraction of the skeletal muscle drives the two bones away, the muscle is called extensor and the movement is called extension. The flexor muscle will be paired with the extensor muscle, and together they are called antagonist muscle group. The task of these antagonist muscles is to move closer and further from the fulcrum point. Contracting alternately, relaxing alternately. The coordinated movement between these muscles allows us to do daily activities effectively [15].

Active muscle contraction requires a supply of energy coming from adenosine triphosphate (ATP), while relaxation of the muscle is a state of relinquishment from a state of contraction. Muscle movement always requires energy, both when contracting and relaxing. When contracting, muscles need energy to move interlocking. When relaxing, muscle requires energy to pump $Ca2+$ ions back into the sarcoplasmic reticulum, and also to return $Na +$ ions to extracellular and $K+$ ions to intracellular [15].

Where do muscles get energy (ATP) from to perform their duties? Can muscles run out of ATP? The amount of ATP energy available in the muscle fibers is only enough to do about 8 to 10 wrinkles. As the source of energy stored in the muscle, it is very limited in quantity. Muscles must use other sources of energy to still be able to carry out their duties, that is to transfer energy from chemical bonds stored in nutrients into ATP. Carbohydrates, especially glucose, are the fastest and most efficient sources of energy. Glucose molecules will produce 30 ATP when metabolized using oxygen (called aerobic metabolism). However, when the oxygen supply is exhausted, this metabolism will enter the anaerobic process, which only produces 2 ATP. Muscles also get energy from fatty acids, which also always require oxygen, and this process is relatively slow. Skeletal muscles in carrying out their tasks still prefer to rely on glucose. Protein is also not a major producer of energy sources for muscle contraction, preferably used for cell repair [15].

2.3 Hormones response

The fundamental difference in physiology exercises can be seen from gender differences, where the hormone testosterone gives the different characteristics in males and females. This hormone has a more influential role for males in exercise in terms of increasing male muscle mass. Besides testosterone, it turns out that there are many other hormones that are affected and affecting the ability to carry out the exercise as well as in terms of the results of the exercise. Gharahdaghi et al., 2021 [16] mentioned that the body during exercise requires work initiated by these hormones, especially when we talk about maintaining and even developing muscle mass as a goal of exercising. Hormones such as testosterone, estrogen, growth hormone (GH), and insulin-like growth factor (IGF) have a role in the success of an exercise [16].

Hooper et al., 2017 [17] stated that muscle contraction exercises in RT remain the leading major role in muscle hypertrophy through the formation of muscle protein synthesis (MPS) [17]. This response is controlled by the combination of weight training and the associated hormone release. Skeletal muscle mass, which at least comprises 40–45% of the entire body mass, will be preserved from sarcopenia problems caused by aging [18].

The RT pathway of inducing an anabolic response to the skeletal muscles can be traced from several studies and statements from experts in the field. RT will stimulate the work of the hormone testosterone, GH, and estrogen (in accordance with the rhythm of the body of a menstrual woman), as well as IGF. Basically, stimulation of these hormones functions to repair the damaged cells that occur in the muscles while doing exercises. Owing to the balanced work between MPS and muscle protein breakdown (MPB), muscle cells can be repaired, maintained, and developed to increase muscle fiber [16].

The release of testosterone is induced by exercise, both acutely and chronically (as exercise becomes a habit of life), and affected by sex and age. Hooper et al. stated that in the acute phase of exercising, the level of serum testosterone rises from 13 (resting level) to 38 (in 30 minutes) $nmol.L^{-1}$. Then it will decrease back to the baseline immediately after finishing the exercise [17]. If this exercise becomes a habit of life, it is not impossible that this phenomenon will play a very long role in the development and growth of muscles. This is reinforced by statements from Hansen et al., 2001 [18] and Ahtiainen et al., 2003 [19], where they confirmed that after 9 weeks of RE, the level of serum of these hormones was found to be increased steadily, leading to even more optimal muscle growth [18, 19]. There are authors who also state that the role of testosterone response and adaptation of exercise in women must still be tested and studied further.

Hermansen et al., 2017 [20] stated that the physiological increment of GH values after doing RT is basically adding protein synthesis, which also has the ability to repair muscle tissue and also affects muscle mass without affecting the ability to function muscles [20]. It was also reported that there was a correlation between RT stimulating an increase in GH and the presence of muscle hypertrophy of type I and II muscle fiber types [21].

RT also provides a rapid response to an increase in systemic levels of IGF-1 from 45 (resting state) to 65 nM when performing RT and returning to the baseline after completing RT. Ogasawara et al., 2016 [22] stated that this situation is also alleged to be an important thing in muscle growth [22]. Likewise, the statement of Bjersing et al., 2017 [23], who proved the existence of an increase in muscle strength after doing RT by taking into account IGF-1 levels [23]. Similar to the influence of GH, the role of IGF-1 will stimulate a pathway that will improve the state of muscle hypertrophy, which also greatly affects the absorption of glucose into the muscles to be able to produce available energy for the continuation of the active movement of muscles [24].

2.4 Fats metabolism response

Research explains that after 30 minutes from the start of physical exercise, particularly aerobic, the concentration of free fatty acids in the blood will increase significantly. That is, at that 30th minute, the fat will be mobilized from the adipose tissue. However, the process of breaking down these fatty acids is slower than glucose metabolism through the glycolysis process, so the energy production that occurs in the muscles is both from fatty acids and glucose. In lower-intensity and aerobic physical exercise, the largest source of energy production, ATP, comes from fat with a time of more than 30 minutes, while during medium–high-intensity physical exercise, the main source of energy is carbohydrates [2].

3. Resistance training is medicine

RT is now publicly known, not necessarily only applicable to athletes, such as weightlifters, bodybuilders, and footballers. In these sports, athletes are demanded to have much higher muscle strength or be esthetically pleasing for competitions. However, people in general do not have a reason to do RT, especially people with certain medical conditions. Fear and disbelief, despite of popularity of RT, still do not make RT a part of everyday life [25]. The world of physical medicine and rehabilitation still believes that exercise is medicine. Many authors implement endurance exercise as a therapeutic exercise for patients with stroke, heart disease, and DM while emphasizing RT for patients with postinjury. Nowadays, some of the authors, through their experience and personal daily clinical observations, began to show the courage to choose RT as a type of therapeutic exercise for patients with certain diseases. Prescription of RT as a medicine seems to have more advantages than disadvantages, when done carefully and full of caution (always looking at the patient's response and vital signs).

Muscle mass will naturally decrease with aging, 3–8% every decade after a person turns 30 years old. Flack et al. and Frontera et al. stated that at least 0.2 kg of muscle is lost annually [26, 27]. Marcell also gives even more surprising data for muscle mass loss over the age of 50 years, which is 5–10% every decade [28]. Nelson et al. [29] stated that muscle mass was close to 0.4 kg per year [29]. Skeletal muscles that weigh about 40% of our body have a role in burning glucose and triglyceride, so losing muscle mass will increase glucose intolerance. Even in untrained muscles, skeletal muscles are responsible for a massive overhaul and synthesis of proteins. This overhauling metabolism will be responsible for calorie expenditure needed even at rest. Calories that must be prepared for this metabolic process have values ranging from 11 to 12 $cal.d^{-1}.kg^{-1}$ [30]. One can imagine the disadvantages of losing muscle that occurs both due to sarcopenia and sedentary lifestyle. Inactive living habits will decrease muscle mass, which will lead to a decrement in the metabolic rate of the body. A decrease in metabolic rate will lead to the growth of body fat tissue, especially intraabdominal fat. The accumulation of fat and the reduction of muscle mass will certainly have an impact on decreasing metabolic rates. This condition will occur as a cyclic process and affect one another, becoming the so-called vicious circle. Efforts are needed to break the loop, and according to some studies it turns out that RT can give quite promising answers.

Some studies state that RT exercises performed 2–3 times per week with 12–20 total sets of exercises will add muscle mass in all adults in a wide age range. The addition of an average of 1.4 kg of muscle mass occurs after performing 3 months of RT. It can be concluded that RT helps restore muscle mass gain, even in nonathlete population. The addition of 1.4 kg of muscle mass was accompanied by the disappearance of about 1.8 kg of fat [31–34]. The research become more interesting because it showed a reduction in abdominal adipose fat tissue in elderly women who do RT, not just a reduction in abdominal fat in elderly men. Participants who regularly do RT for 2 years were able to remove 2/3 of intra-abdominal fat, compared to the participants who did not do exercise [35–38]. Hurley et al. [39] believe that the addition of metabolic rates, even at rest, plays a major role in increasing insulin sensitivity and sympathetic nerve activation, two of many factors affecting intraabdominal fat accumulation. The addition of metabolic rate is an intraabdominal fat loss factor with this calculation: if RT is done twice per week for 20 minutes each day, it will be close to the energy use of 5000 calories per month [39].

In a study of nursing home residents (with an average age of 89 years), the participants performed 1 set of exercises of RT with 6 machines twice per week for 14 weeks. At the end of this study, an evaluation was obtained and the results of the analysis found that all the participants increased their muscle strength by 60%, with the addition of 1.7 kg of muscle mass as well as a functional increase in independence by 14 [25].

4. Prescription of resistance training for healthy people, what do we want to achieve?

The Canadian Physical Activity Guidelines 2011 have recommended aerobic exercise and training as excellent things to do to add health value. This applies to all healthy people aged 18 to 64, even to people over the age of 65. This recommendation states that one person should do at least 150 minutes of exercise in a week (7 days). They recommend moderate to vigorous intensity exercise. They also add that it will be better if a person continues to do RT to maintain muscle and bone strength by exercising groups of major muscles at least twice a week [1].

A systematic review of selected 11 studies with 382,627 participants, from 2009 to 2019, looked for facts by comparing two large groups, the intervention group doing RT and the group that does not do RT. In the group that performed RT, it was recorded and statistically proven that there was a correlation between doing RT and reduction of death for any reason, decrease in the occurrence of cardiovascular disease, and increase in physical functional capacity. The effects related to cognitive function are not yet clear, they must be further proven. Unwanted side effects were not consistently monitored or reported in these studies. However, it is stated that there are no serious or injurious side effects or uncommon side effects. Overall, RT is beneficial in improving the health status of adults and the benefits outweigh the disadvantages [40].

RT can be a fun exercise with a variety of tools with certain weights. RT can also be done simply by relying on one's own body weight with certain movements that resist the force of gravity. In line with the advancement of RT technology, it can be done using machines and even robotic tools that can be programmed and adjusted to one's needs and abilities. If the advance tools are not available, we can make simple tools with simple materials around us. For instance, we can make a load from a used mineral water drinking bottle filled with fine sand. Determine the weight of the tool load we need.

No matter how healthy a person is, try to determine the RT load and the practice prescribing method with an initial test first. This initial data can be used as a reference for a basic or initial program and can be used to evaluate the progress of the program being trained. As one of the suggestions for training and achieving a defined goal, no

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matter how much your target load is, start by practicing multi-joint involving large muscles and then train by involving a single joint targeting more focused muscles.

Here is the RT reference taken from ACSM:

See **Table 1.**

To achieve the optimal goal of RT, there are 4 factors that should be considered, namely muscle strength, muscle power, muscle hypertrophy, and local muscle endurance. These four factors can be developed if the RT prescription is tailor-made, determined and carried out according to the needs and capabilities. RT prescription should always consider the load, volume, rest period between sets, and frequency of each exercise.

1. Load: how heavy it should be lifted based on how much % 1xRM.

2. Volume: total how many kinds of exercises (muscle groups trained), how many sets in each kind of movement, and how many reps in each set.

3. Rest time: the distance of resting time from one movement to another.

4. Frequency: the number of days on which training sessions are conducted each week.

See **Table 2.**

Frequency can be done by considering the reference as follows:

1. When you do it all together (upper as well as lower body) at once, you can do it two to three times per week, per muscle group.

2. If you do it separately, for example, upper body only, other days lower body only; you can do it up to four times per week.

3. An athlete can do it 4–6 times per week because they do have the ability and goals to win the competition.

	Free-Weight	**Machine-Based**	**Body Weight**
Chest	Supine Bench Press	Seated Chest Press	Push-ups
Back	Bent-over Barbell Rows	Lat Pulldown	Pull-ups
Shoulder	Dumbbell Lateral Raise	Shoulder Press	Arm Circles
Biceps	Barbell/ Dumbbell Curls	Cable Curls	Reverse Grip Pull-ups
Triceps	Dumbbell Kickbacks	Pressdowns	Dips
Abdomen	Weighted Crunches	Seated “Abs” Machine	Crunches. Prone Planks
Quadriceps	Back Squats	Leg Extension	Body Weight Lunges
Hamstring	Stiff-leg Deadlifts	Leg Curls	Hip-ups

Table 1.
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No.	Goal	Exercise level	Loading	Vol: exercise x set x repetition	Resting between
1a.	Muscle strength	Intermediate	60–70%	(6–8) x (1–3) x (8–12)	2–3 min
1b.		Advance	80–100%	(6–8) x (2–6) x (1–8)	1–2 min
2a.	Muscle power	Upper body	30–60%	(3–4) x (1–3) x (3–6)	2–3 min heavy load
					1–2 min easy load
2b.		Lower body	0–60%	(3–4) x (1–3) x (3–6)	2–3 min heavy load
					1–2 min easy load
3a.	Hypertrophy muscle	Intermediate	70–85%	(6–8) x (1–3) x (8–12)	2–3 min heavy load
					1–2 min easy load
3b.		Advance	70–100%	(6–8) x (3–6) x (1–12)	2–3 min heavy load
					1–2 min easy load
4.	Local Muscle Endurance		Max 70%	@muscle group x (2–4) x (10–25)	30 sec – 1 min

Table 2.
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Beware of overtraining. Overtraining can occur because the interventions carried out are exceeding the capabilities of the individual. Symptoms of overtraining in RT can be severe pain, injuries to muscles, joints, tendons, or heavy fatigue. This can be triggered by exceedingly heavy load, too many muscles being exercised, too many repetitions, or doing RT too often. Injuries also often occur because we misposition our posture with the weight that must be lifted. It is best to do the exercise in tiered, gradual, and continuous manner instead of a sudden increment of loads [41]. Ernandini et al. [42] stated that the most important thing is safety in doing exercise, so do an MCU to find out your fitness level medically first [42].

5. Resistance training as ammunition to combat obesity

The status of obesity is believed to be increasing along with the improving economy, especially in countries with high per capita income. The incidence of obesity is also undeniably caused due to modern lifestyle. Obesity is also believed and proven to be a contributing to DM and cardiovascular and cancer diseases [43]. In this journal, it is also stated that the role of regulating the amount and type of food and exercise will help calorie deficit. A 5% weight loss can add significant value to the improvement of health status and cardiovascular health function [44, 45].

Some studies look for the answers to whether RT plays a role in preventing obesity status over a long period, as well as RT's usage as an exercise to reduce obesity cases. So far, AE has been accepted to help maintain weight and prevent obesity. A systematic review using the prospective cohort study in 2021 involved 11.938 participants [43]. In this study, obesity is defined as BMI results ≥30 kg/m^2 [46], waist circumference (wc) > 102 cm for men and > 88 cm for women [47], and percent body fat (PBF) ≥ 25% and 30% for men and women, respectively. This study included 11,938 adult participants who were not obese and were followed for 6 years. After taking into account several factors that may affect the results of this study such as age, sex, examination year, smoking, alcohol consumption, hypertension, hypercholesterolemia, and DM, the results show that RT will affect at least 20–30% of participants [48] in reducing the risk of becoming obese for the next 6 years [43]. Of course, with a strong commitment to maintaining a healthy lifestyle to maintain BB and ideal body composition to support health.

The main goal of a healthy lifestyle is to maintain good health status. By living a healthy lifestyle, one can get pleasant side effects in the form of balanced body weight and composition. However, in this super comfortable and easy era, it is a challenge for one to keep his body in optimal condition. Until now, it is still believed that the decrease in the amount of visceral fat and subcutaneous fat is very important and can decrease the incidence of metabolic cardiovascular diseases such as DM, heart attacks, and strokes. Obesity can now be considered a threat to the medical world because it is not only esthetically unpleasing but also a risk factor leading to comorbidities as explained above.

Several studies that chose RT as an exercise to combat obesity were collected and analyzed in a systematic review. Electronic data collection from various studies taken till December 2020, recorded 4184 people with obesity and overweight. This study involved participants aged <18 years, >18–35 years, >35–59 years, and ≥ 60 years, which were given exercise as an intervention for at least four weeks. The types of interventions they carried out further differed into RT alone (49.1%), RT + AE (44%), RT + restriction calorie (RC) (5.3%), and RT + AE + RC (7%). The average treatment was 14.6 weeks of exercise, with a frequency of 1 to 5x/week and variety of intensities of RT (low, moderate, and heavy). Outcome measures were the calculation of body fat, fat mass, visceral adipose tissue (VAT), and subcutaneous adipose (SAT), including body weight and BMI as secondary outcomes [49].

The results of RT alone actually already have a significant difference statistically, but the change value is categorized as small to moderate when analyzed statistically. RT alone has a significant enough role to increase muscle mass weight. RT alone can reduce 2.2% of fat or 1.6 kg of fat [49].

SR conducted by Xinhong Liu et al. 2022 involved 15 studies with a total of 669 subjects, observing three types of exercise in RT: own body weight (OBW), resistance bands (RB), and free weight (FW). It is concluded that RB is the most effective tool in RT for fat removal in cases of overweight and obese. RB has a much more flexible form and work than using certain loads. RB is more adjustable and can follow shape of the body. The pull of RB will provide tensile force that will increase along with the elongation of RB. The intensity of this RB tensile force will not be too high, so the body can do its work more slowly with a lower intensity and the body will use aerobic oxidation, which will use glucose and fat as main source of energy [50, 51]. RB is flexible and can follow the direction of the pulling force following a group of muscles used for the movement, and this will greatly help fat burning. However, because the intensity of RB is not high, the stimulation in the muscles will not continue, hence the muscle mass formation will not be optimal. In addition, the light RB will not have a heavy impact, especially on the joints of overweight and obese [50].

When reviewed further, there are more types of exercises and interventions, which also give meaningful results in combating obesity. Multicomplex exercises turned out to have better results since each intervention had its own role. It is necessary to give monitored, implementable, measurable, accountable, and safe prescriptions to achieve optimal results. These results will be even better when RT is complemented by a reduction in the calories. RT + CR exercises will reduce fat by 3.8%. An encouraging result is when RT plus AE exercises, complemented with CR, can result in a reduction of 5.1 kg of fat, or 7.1%. This effect remains consistent for adolescents to the elderly, with the greatest number of meaningful changes in young adulthood. Decrease in VAT and SAT obtained from multicomplex therapy consisting of RT + AE + RC. Meaningful change with a fairly satisfactory value remains consequential at all ages, even postmenopausal women [49].

Garrow and Sumerbell predict that a 20–30% reduction in body weight caused by CR alone in adults is not due to a reduction in fat mass. For this reason, more than just CR efforts are needed for overweight and obesity reduction programs [52]. In line with the study, Sardeli et al. [53] stated RT is required to build skeletal muscle as much as 1.8 kg. When skeletal muscles contract, especially during exercises, our body will release myokine, myostatin, interleukin 6 (IL-6), and brain-derived neutrophic factor (BDNF). These substances will provide protection for the body against adipokines proinflammatory in obese bodies. The formation of muscles plays an important role in increasing resting energy expenditure, which leads to a decrement in obesity and overweight status [53].

6. Prescription resistance training for Cardiovascular Disease (CVD)

Hypertension (HBP) is one of nine risk factors leading to CVD. HBP is estimated to cause >7 million deaths annually, 13% of total deaths worldwide [54]. Meta-analysis by Lewington in 2002 stated that the safe blood pressure to be free from the threat of disease and death from CVD is at 115/75 mmHg [55]. On that basis, adequate blood pressure management must be socialized to the community to become a worldwide self-monitoring. Adequate BP control is closely related to life habits, including weight control, moderate intake of alcohol, a diet of fresh fruits and vegetables, reducing saturated fat, and staying active in daily life and exercise [55, 56]. So far, there have been many studies and writings that recommend aerobic exercise such as: walking, jogging, and cycling for controlling and even lowering BP on HBP. This is the time to consider one type of exercise that has an effect on metabolic health as well as in the preventive efforts of CVD [55, 57].

Several studies collected in a meta-analysis show several things about the effect of RT on BP on subject groups that have undergone RT and non-RT groups. This research was conducted from 1987 to June 2010. Based on the type of contraction, RT is also divided into two more groups: RT dynamic and RT static/isometric. Dynamic RT consists of concentric and eccentric contraction by moving an arm or leg that causes the length and tension of muscles and tendons to change. Meanwhile, static RT is a state of contraction against the load by not moving or not extending or stretching muscles or tendons. After 16 weeks of exercise, the subjects were then evaluated and compared to their initial values. To eliminate bias, the subjects were instructed not to change their lifestyles during this time while carrying out the pre-ordered exercise, which is a dynamic RT or static RT, according to their group. The result was then analyzed and it was found that from the two groups, dynamic RT exercises with moderate intensity, as well as low intensity in static RT, had a decreasing BP systole and BP diastole significantly. It was also noted that the dynamic RT group also had a good effect on things that are predictor CVD risk factors, such as increase in VO2pea and decrease in body fat and plasma triglyceride. The results of the analysis in this study can be concluded to have a clinical meaning that a decrease in SBP and DBP in a resting state even though it is only 3 mmHg can reduce the risk of CAD 5%, stroke 8% and other deaths by as much as 4% [54].

The increase in mortality in chronic CVD such as hypertension and diabetes is often associated with arterial stiffness. This stiffness results from the loss of elastic fibers and the accumulation of stiff collagen debris attached to the arterial wall. This stiffness results from the loss of elastic fibers and the accumulation of stiff collagen debris attached to the arterial wall. Many studies have found that this stiffness is strongly related to a person's physical activity. Activities such as walking and running, affect in a positive way to prevent vascular stiffness. The next question will be, whether RT affects arterial stiffness in positive or negative manner? A meta-analysis tried to answer this question, involving 981 participants aged 18 to 88, and they were divided into experimental groups and control groups. The intervention group carried out RT for 8 to 12 weeks with a frequency of 1 to 5 times per week, with intensity ranging from 30 to 90% 1RM. All subjects were measured for their carotid, femoral, tibial, and brachial arterial pulse rates. In conclusion, RT has no effect on the speed of arterial waves. The researchers did not stop there, they carried out a regression analysis to see the involvement of each parameter. After performing a regression analysis, it was found that only the intensity of exercise had a correlation with the change in the speed of the arterial wave rate. Light to moderate intensity significantly reduces the speed of arterial wave beating, while high intensity has no meaningful effect. Then the researchers also continued the regression analysis of age, then found that the barrier was seen meaningfully in subjects with an age of more than 40 years. Researchers then concluded that RT with mild to moderate intensity meaningfully decreases arterial stiffness in groups over 40 and also has a moderate correlation in those under 40 years of age [57].

The increase in the rate of arterial waves of 1 m/s alone will increase the risk factor of CVD by around 12–14% and the mortality rate by 13–15%. Although it is asserted that RT with mild and moderate intensity will have a good impact on the prevention and improvement of arterial stiffness, the exact explanation of it has not been obtained satisfactorily. Researchers made a hypothesis that states that RT with an intensity of 30–70% will activate only a small amount of the sympathetic nervous system, so it will not increase muscle tone. This has a beneficial effect on the blood circulation system by increasing endothelial function [57].

Haslan et al. [58] reported that CAD patients with mild hypertension were declared safe doing RT with an intensity of 40–60% 1xRM [58]. Recommendation for safe rehabilitation program for stable CAD patients without complaints starting with 3 months of AE followed by an RT program of 40–60% intensity 1x RM, 1–2 sets, 8–10 repetitions, 2–3 days per week, duration not more than 60 minutes. There is no recurrence of symptoms and it is shown to increase muscular strength and endurance [59]. Especially for postoperative patients with cardiac and post-myocardial infraction (MI) cases, it is recommended to postpone RT by at least 4 to 6 months [60, 61]. RT should be done progressively, starting low and gradually increasing until a certain goal.

If you are going to do isometric RT, do a mild one. Because isometric movement means making the same muscle contraction without moving the joint so that there is no extension of the length of the muscle involved, causing a disproportionate increase in blood pressure [14].

7. Recommendation and effects of RT for intellectual disability of people

There are not many studies about RT programs for adults with intellectual impairments (ID). They often have intellectual problems as well as emotional problems, although many of them also have adequate gross motor ability. According to American Psychiatric Association, ID is a disorder due to deficit in person's cognition as well as a disorder in the concept of thinking, which certainly has an impact on practical matters in social activity, and this condition is diagnosed before the age of 18 years [61]. Several studies done by Dairo et al. [62] and Harris L et al. [63] reported that IDs are a group of people who are at risk of injury and tend to have a sedentary lifestyle, which increases the risk for cardiovascular disease, hypertension, obesity, and DM [62, 63].

The lower the IQ, the lower the ability to record memory. Their ability to concentrate and communicate can also be seriously lacking, so monitoring by training instructors and caregivers is still very necessary. Safety remains a major issue for individuals with intellectual disability in doing exercise [64].

The guidelines for prescribing RT from ACSM must still be maintained to obtain excellent health quality. RT is still sought to involve at least 6 to 8 large muscle groups, performed by involving both multi joints and single joint. Possibilities have to be considered: how about exercise using muscle contraction (either eccentric and concentric), also isotonic, isometric and isokinetic exercise, and also exercise using equipment.

A systematic review observation consisting of several studies, involving 280 subjects who had an IQ below 70 with an average age of 18.23 years ±2.86 years, wanted to see how the prescribing and effects of RT for IDs. Interventions performed were varying duration of RT with an average of 12 weeks, 2–5 times a week. All the studies involved gave encouraging results by showing the success of reducing body fat mass, increasing fat-free mass, reducing waist circumference size, reducing BMI, and increasing body balance. These studies also successfully recorded immunoglobulin concentrations in saliva, testosterone levels, and the ability to perform ordered tasks [65]. The increments of salivary IgA values are shown to help prevent respiratory infections [66].

Improvement in functional capacity is also achieved by increasing walking speed as well as the results of body balance tests. This is in line with the addition of strength to the leg muscles [67]. An encouraging result was obtained, that by doing exercise, the subjects gained the effect of meaningful thinking ability. That ability to think and act may not be able to achieve normal IQ value, but at least it adds value to short-term memory ability and vocabulary and improves the ability to act and problem-solving [68].

One obstacle that participants with an intellectual disability face is getting distracted easily. The duration of maintaining concentration is also shorter than that of people with normal IQ. This situation greatly affects their motivation to complete the exercise session. In order to produce the desired exercises and their effects, the coaching team must intervene directly to interact with the participants with IDs. Caregiver involvement, as well as family, is very important to provide motivation and real examples of doing these movements. A cheerful atmosphere can be prevented by tuning in to the spirit-boosting music. IDs will be encouraged if they are given the expectation of rewards and appreciation, even if the rewards are simple. The coaching team must always be creative to be able to make the exercises as interesting games for them. It should also be realized that most IDs have mood patterns that are easy to change drastically [64].

Stijn et al. reiterated that safety is the priority concern for this group. The equipment used for this exercise has to be safe and not pose any danger, both intentional and unintentional. Basic equipment that was originally used to complement and help IDs in exercise can turn into a dangerous weapon, without them knowing or planning. It is also necessary to avoid sophisticated equipment such as robots. Movements have to be as simple as possible for them to comprehend and do properly and correctly [64, 65]. A simple example that they apparently cannot do is the squatting movement with ball between the back and the wall. They also cannot perform bridge pose. However, some research and observations explain that there is one movement they like and 100% are willing to repeat, and it is the biceps curl movement. There are times when the IDs do not want to make the movements ordered, so it is appropriate that the coaching team accompanies them by providing examples of these movements and opening up good communication.

Some research and observations state that there are also groups that can use simple and harmless RT tools. For example, using a chest press device is considered easier than using a bench press [69].

RT Recommendations for IDs:

1. Frequency 3x/week, with AE, preceded as warm-up also at the same time cooling-down, such as easy cycling and walking.

2. Short duration to prevent boredom, 45 minutes to a maximum of 60 minutes.

3. It is best to do RT in groups. There is a team that provides direct examples, also the participation of caregivers and families plays a very important role.

4. Full music, by designing the exercise as a team game. Whenever possible, hold gifts as encouragement.

5. Be careful when using tools, especially heavy or robotic equipment, because it can be an injurious weapon even if it is accidental.

6. The movements must be repeated frequently and as carefully as possible so they can do the movements properly and correctly.

7. Exercise involving 6–7 main muscles.

8. Two to three sets with 6–10 reps to avoid boredom.

8. Practical recommendations of RT for COVID-19 survivors

The new virus known as COVID-19 had shaken the world violently, and WHO in 2020 established pandemic status against COVID-19. WHO recorded 98 million people infected with 2.2 million deaths. Until now, the world remains vigilant and continues to fight COVID-19. Even after recovering from COVID-19, many writings and clinicians stated that there were many functional and even psychological declines complained by survivors. Sequelae felt, such as persistent muscle pain, fatigue even with minimal activity, muscle weakness, and frequent choking, the point is that they feel that their fitness status has deteriorated when compared to before getting COVID-19 [70].

This general functional deterioration is likely due to muscle atrophy resulting from immobilization during COVID-19 infection, as well as from muscle necrosis. This general functional deterioration is likely due to muscle atrophy resulting from immobilization during COVID-19 infection, as well as from muscle necrosis. Activation of the virus causes oxidative stress that induces overproduction of proinflammatory cytokines, resulting in corrosive cells damaging the myocyte. This damage will be more detrimental to the elderly population [71–73]. This is understandable because physiologically, people above 50 years will experience decrements of muscle mass 5–10% of the existing muscle mass. This decrease in muscle mass will result in the decrease in the functional capacity of the survivors. It is also aggravated by the disruption or difficulty of sleeping due to COVID-19. It is reported that this functional decline will result in depression. This condition will further reduce capacity of the immune system [74, 75].

Could exercise be used as a mean to restore physical functionality and reduce the level of depression in COVID-19 survivors? Deschenes MR [76] stated that exercise can improve morphological adaptations, such as increasing the amount of protein responsible for muscle contractiles and increasing the number of mitochondria [76]. Exercise is also believed to increase the immune system when done with a trusted, staged and sustainable dose.

A systematic review uploaded in 2022 involved research from November 2020 to January 2021, examining exercises given to 286 subject survivors of COVID-19 aged 20 to 84 years. In this study, survivors were trained in AE and RT. The intervention was AE (such as stationary bikes, walking, steps, and treadmill running), carried with low intensity (40–60%) and limited to 30 minutes. Meanwhile, RT was carried out with an average intensity of 50–70% 1xRM, 2 to 3 sets, with an average of 8–12 reps. Pre- and post-exercise evaluations were carried out by assessing the outcome of isokinetic strength, isometric strength, maximal strength, functional capacity, 6MWT, TUG, and strength grip. Exercises were performed for 10 to 12 weeks. Interventions targeted the lower and upper body [71]. Subjective feelings must also be maintained so that fatigue does not occur, which will then reduce the immune system [77]. There needs to be a restriction on subjective feelings limited to a scale of 4–6 out of 10 on the Modified Borg scale. All studies conducted showed better performance and decreased anxiety levels, which aimed certainly to improve the quality of life [70].

Exercise intensity, volume (set and reps) of RT, as well as duration must be carefully observed, so that the prescription of exercise is based on the initial value of functional performance. Some studies show that high-intensity exercise for about 1.5 hours per session is not recommended, because fatigue will occur and lead to decrease in the immune system [78–80]. Keep in mind that COVID-19 is closely related to the immune system, so the physical medicine and rehabilitation team must remain aware of possibility of decline in the immune system induced by exercise. Betschart et al. [81] shared their experience and noted that three patients were unable to continue their exercise therapy due to repeated bouts of the same infection [81]. Davis et al. in 1997 conducted a study on the effects of physical exercise on susceptibility to respiratory infection by using a murine model. They gave three different treatments: no exercise, moderate short-term exercise (30 minutes), and prolonged exercise to voluntary fatigue (2.5–3.5 h). It turned out that the results of exercise that are too long will cause fatigue that can trigger a higher mortality rate (41%) compared to groups with no exercise and moderate short-term exercise. Deaths in a group with no exercise reached 19%, while those who did moderate short-term exercise were only 9% [82]. According to the analysis carried out by Siedlik et al. in 2016 [83], heavy and longer exercise (more than 1 hour) can induce a suppressive effect on lymphocyte proliferative responses, with moderate strength statistically analyzed [83]. Some authors, such as Udina et al. [84], stated that short training period of 10 days has shown significant physical performance progress. Survivors do RT exercises: 30–80% 1xRM and limiting subjective feelings 3 to 5 of the modified Borgs scale [84]. Likewise, Herman et al. [85] reported there was no death case or hospitalization case in doing AE with moderate intensity, followed by 20 reps of RT exercises [85].

From these researchers' experiences, it can be concluded that COVID-19 survivors can carry out the combined exercise of AE and RT with safe composition. The prescription consists of AE: 5 to 30 minutes with low to moderate intensity, plus RT: 1–2 sets, 8–10 reps at 30–80% 1xRM. This prescription is also proven to increase muscle mass, muscle strength, reduce tightness when doing activities, reduce fatigue during activities, increase independence and ultimately improve quality of life. We have to stay alert and remain responsible for supervising every exercise. These studies still have shortcomings, such as not including the severity level of COVID-19.

Conflict of interest

The authors declare no conflict of interest.

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