



HOW CHEST PRESS-BASED EXERCISES CAN ALLEVIATE THE BURDEN OF CARDIOVASCULAR DISEASES

review paper

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ABSTRACT

Unlike in the previous decades, strength training is gaining more scientific attention owing to its numerous benefits on human health. It has major benefits on metabolic processes, cardiovascular system, musculoskeletal system, age-related processes, and mental health. In comparison with aerobic low-intensity exercises, chest press-based strength training cardiovascular adaptations have been ignored for many years. Yet, if properly prescribed and conducted, strength training has shown to be safe and effective in people with cardiovascular disease. This narrative review aims at summarizing the available evidence about the role of chest press-based strength training on the cardiovascular system.

Key words: isokinetic machine, cardiovascular pathology, strength training

Introduction

Physical activity is universally recognized as a useful tool for prevention, treatment, and rehabilitation [1] of several diseases [2, 3], such as metabolic syndrome, cancer, pulmonary and cardiovascular illnesses [4]. Its efficacy has already been proved in numerous studies [5, 6], and the use of physical activity as an effective ‘drug’ is an emerging topic in scientific literature. Physical activity is organized in exercise programs oriented to strength development, low-intensity fitness, or a combination of these two. The design of a program must follow specific rules with regard to the exercise

to be undertaken, as well as its intensity, duration, and frequency, in order to obtain benefits [7]. Strength exercises (or high-intensity exercise or resistance training) is a system of physical conditioning in which muscles are exercised by being worked against an opposite force to increase strength: it involves weight training or use of high-resistance machines and it is limited to few repetitions before exhaustion, since aerobic fitness is not its primary objective [8]. Low-intensity training involves exercise performed for extended periods with large muscle activity and numerous consecutive repetitions.

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Examples of strength training include weight-lifting, resistance band exercises, use of body weight as resistance means (i.e., push-ups and pull-ups [9]), and use of gym weight machines such as leg press, curl bench, or chest press. Health benefits of strength training have been widely described in literature. A properly designed and supervised resistance training program with appropriate instructions for exercise technique is safe not only for healthy adults but also for people with major diseases [10], including cardiovascular pathologies. In this review, we aim at summarizing the available evidence on the role of chest press-based strength training in individuals with cardiovascular diseases.

Strength training and health benefits

While the benefits of aerobic low-intensity training have been largely investigated, strength training has not reached the same level of interest by both scientific community [7] and public opinion (Table 1). However, adults can gain other health benefits from this kind of training besides increased muscle mass and strength [11, 12]. Studies have shown that strength exercises can improve bone mineral density [13, 14], lipoprotein profiles [15], glycaemic control [16], insulin resistance [17], and body composition [18]. They improve symptoms of frailty [19, 20] and quality of life in elderly patients [21], positively impact on metabolic syndrome risk factors [15] and resting metabolism [22], as well as reduce visceral adipose tissue [23]. Studies have further indicated that strength training can decrease the risk of all-cause mortality [24, 25] and counteract aging-related oxidative processes [26]. Moreover, it improves psychosocial health outcomes such as perceived stress [27], depression [28], anxiety [29], and fatigue [30]. Also, strength training has a certain effect in improving quality of life in people with disabilities [31]. It definitely plays a major role in human health, both mental and physical. Most workout programs included in this study consider chest press as one of the exercise machines, highlighting its importance and applicability in strength training.

Chest press exercise

Chest press is a classic upper-body strengthening exercise and it is often used as a measuring stick for evaluating upper body strength. One of the most common ways to effectively exercise at a bench press is when the barbell is first lowered to the chest and then moved to an extended position again [32]. It generally involves pectoralis major, pectoralis minor, anterior

deltoids, and coracobrachialis to horizontally adduct the shoulder, whereas triceps and anconeus are used to extend the elbow. Exercise at bench press involves biceps and overall consists in an isotonic effort [33], against a predetermined resistance and over some range of movement [34]. This exercise should be adapted to the subject's needs and characteristics in terms of fitness, muscle strength, and joint mobility. There are variations in the elbow position that an individual can use when performing this exercise. It is commonly used in rehabilitation to strengthen neuromuscular and articular mobility [35]. External load is a crucial variable, which strictly influences the required muscular effort. It is linked to the maximum force (one-repetition maximum [1RM]) that a person is able to develop [36, 37], and this load is often higher than the body weight [38]. 1RM was inversely and independently associated with deaths of all causes and cancer in 8762 subjects [39] and with the risk of hypertension in prehypertensive man [40]. So, this is a very important value that must be considered regarding chest press exercise to plan safe and effective strength training. Apart from 1RM, other training load monitoring methods that showed a good efficacy in literature include session rating of perceived exertion [41].

Even if chest press exercise has been studied in literature with regard to its different aspects (i.e. its relationship with performance in athletes [42]), little is known about its role in cardiovascular diseases. Chest press elicits a large cardiovascular response [43] since exercises with upper limbs tend to carry greater cardiovascular overload than those performed with lower limbs [44]: probably, this is due to the smaller size of the vascular network present in the upper than lower limbs, which offers greater resistance to blood flow, resulting in higher myocardial demand and thereby considerably increased cardiovascular overload [45]. This is important as chest press has been associated with complications ranging in acuity from pectoral muscle strains to aortic and coronary artery dissection [46].

Strength training and the cardiovascular system

In comparison with low-intensity training, resistance training-induced favourable adaptations of the cardiovascular system have been ignored for many years, thus their mechanisms are still debated. Indeed, the underlying processes, hemodynamic adjustments, and autonomic contributions are not as well documented for strength workout as for low-intensity ex-

Table 1. Health benefits of strength training

Health benefit	Characteristics of strength training	Exercises	Study population	Reference
Increase of muscle mass and strength	8 weeks, 3 sessions per week, 8–12 repetitions per exercise	Flat/incline press, pull-down/row, leg press/lungee/squat, standing calf raises, shoulder press/lateral raises, dumbbell curls/bench curls, triceps push-down/extension, leg curl/back extension	12 males, 7 females (age: 34.64 ± 6.91 years)	[11, 12]
Improvement of bone mineral density	16 weeks, 3 sessions per week, 8–15 repetitions per exercise	Leg press, chest press, seated rows, abdominal crunch, back extension, seated leg curl, hip abduction	37 females (age: 71.9 ± 3.1 years)	[13]
Improvement of lipoprotein profile	8 weeks, 3 sessions per week, 10–15 repetitions per exercise	Chest press, horizontal leg press, seated row, knee extension, preacher curl (free weights), leg curl, triceps push-down, seated calf raise	65 females (age: 68.9 ± 6.1 years)	[15]
Improvement of glycaemic profile	16 weeks, 2 sessions per week, 8–15 repetitions per exercise	Squat, scission squat, crunches	5 females, 5 males (age: 68.2 ± 9.7 years)	[16]
Improvement of body composition	12 weeks, 2–3 sessions per week, 10–15 repetitions per exercise	Chest press, horizontal leg press, seated row, knee extension, preacher curl, leg curl, triceps push-down, seated calf raise	24 females (age: 56.2 ± 9.1 years)	[18]
Decrease of frailty symptoms	24 weeks, 2 sessions per week	Leg presses, knee extensions, leg abduction, seated rowing	37 females, 4 males (age: 81.5 years)	[19]
Decrease of all-cause mortality	48 weeks, 2 sessions per week	High-intensity progressive resistance training	124 subjects	[25]
Decrease of aging-related oxidative processes	14 weeks, 3 sessions per week, 10–12 repetitions per exercise	Seated chest press, latissimus pull-down, leg press, military press, calf raise, arm extension, back extension, abdominal crunch, upright row, knee extension, knee flexion	14 females, 14 males (age: 68.5 ± 5.1 years)	[26]
Improvement of mental illnesses	12 weeks, 60 min weekly + 2 sessions at home 30 min each	Progressive resistance training	19 females, 13 males (age: 56.3 ± 8.1 years)	[27]
Improvement of quality of life in people with disabilities	24 weeks, 3 sessions per week, 20 repetitions per exercise	Leg extension, leg press, leg curl, shoulder press, arm curls, lateral pull-down, bench press, triceps extension	30 females (age: 70.6 ± 4.5 years)	[31]

ercise [47]. However, as scientifically validated [48], prescribed and supervised strength training has a favourable effect in people with cardiovascular disease, improving their muscle strength and endurance, functional skills, and independence: so, it has a major role in reducing disability. Several mechanisms have been proposed to explain why muscle strength may improve prognosis of cardiovascular disease [49], and these include reducing abdominal fat, improving values of metabolic syndrome components (blood pressure [BP], waist circumference, triglycerides, glycaemia, and cholesterol), decreasing the risk of developing hypertension, cutting down insulin resistance, and decreasing chronic inflammation biomarkers. The effects of resistance training on the cardiovascular system have been studied in individuals with and without cardiovascular diseases and have been summarized in several reviews [50]. During isometric exercise, typical of strength training, increases in heart rate (HR) and BP are nearly proportional to the force exerted (Table 2 [51]). Combination of vasoconstriction and increased

cardiac output results in a disproportionate rise in HR and BP. The impact of the Valsalva manoeuvre (a forced expiration against a closed glottis) and high levels of muscle tension to lift can result in dramatic changes to physiological responses to strength training. Depending on its duration and intensity, an increase in intrathoracic pressure leading to decreased venous return and potentially reduced cardiac output may occur [52, 53]. During heavy resistance exercise, especially if accompanied by the Valsalva manoeuvre, symptoms of light-headedness or dizziness may occur if cardiac output is reduced. Syncope is therefore one of the worst adverse effects in subjects with cardiovascular disease [54, 55]. However, a smaller pressure load on the cardiovascular system will occur during this type of exercise if relative resistance is not too great, contraction period is relatively short (1–3 seconds), and there is at least a 1–2-second rest period between contractions [55]: these are important precautions to take in consideration. However, such potential HR and BP responses are very unlikely to occur

Table 2. Cardiovascular adaptations to strength training

Cardiovascular adaptations	Characteristics of strength training	Exercises	Study population	Reference
Increase of HR and BP (short term)	2 min of contraction per exercise	Adductions of digits II and III, handgrip, knee extension	11 males (age: 23 years)	[51]
Decrease of venous return to heart	50–75–100% of 4RM per exercise	Deadlift, slide row, leg press, bench press, box lift, vertical jump, drop jump, Valsalva manoeuvre	11 males	[52]
Increase of LV wall thickness and mass	Weight-lifters engaged in serious power-lifting for at least 2 years and trained at least 3 times per week for several hours	All weight lifters could bench-press at least 250 pounds (113 kg)	65 subjects (age: 19–38 years)	[64]
No deterioration in LV function	1 set, 10 repetitions per exercise	Leg press, shoulder press, biceps curl	5 females, 7 males (age: 62 ± 9 years)	[67]
Decrease of HR and BP (long term)	24 weeks, 3 sessions per week, 15 repetitions per exercise	Unilateral leg press, chest press, unilateral leg curl, lateral pull-down, unilateral leg extension, overhead shoulder press, upper back rowing, triceps push-down, abdominal crunch	23 females	[68]
Improvement of oxygen balance	Maximal number of repetitions	Overhead press, biceps curl, quadriceps extension, supine press	12 males (age: 55 ± 9 years)	[69]
Reduction of vasoconstrictor substances	8 weeks, 3 sessions per week, 10 repetitions per exercise	Squats, leg extensions, leg curls, bench presses, lateral pull-downs, abdominal crunch	15 males (age: 21 ± 1.5 years)	[71]

HR – heart rate, BP – blood pressure, LV – left ventricle, RM – repetition maximum

Table 3. Cardiovascular diseases that benefit from strength training

Cardiovascular disease	Characteristics of strength training	Exercises	Study population	Reference
High blood pressure	24 weeks, 3 sessions per week, 10–15 repetitions per exercise	Latissimus dorsi pull-down, leg extension, leg curl, bench press, leg press, shoulder press, seated mid-rowing + low-intensity exercise	104 subjects (age: 63.6 ± 5.7 years)	[74]
Coronary artery disease	Weight carrying test	5 min of treadmill ambulation with graded weight loads of 10–30 pounds (5–15 kg)	27 males	[81]
Congestive heart failure	11 weeks, 30–60 s per exercise	Chest push-pull, knee extension/flexion, shoulder push-pull	9 males (age: 63 ± 11 years)	[84]
Atrial fibrillation	6 weeks, 3 sessions per week	Strengthening exercise for the back, thighs, and stomach + low-intensity exercise	2 females, 28 males (age: 64 ± 7 years)	[89]

with appropriate instruction and supervision of strength training participants, owing to relatively moderate intensities of effort [56].

The prescription of strength training therefore involves the control of several variables, such as number of sets and repetitions, order of exercises, type of exercises, interval time, speed, intensity, and rest interval [57]. Such variables can trigger different physiological responses, having a direct impact on cardiovascular safety during training [58], and therefore these are absolutely crucial to control in training programming in cardiac patients. A safe strength training should take in consideration low intensity and high number of repetitions [11, 59], adequate rest interval [60], and little time under tension [61]. It should be individualized for the patients we are prescribing for. Also, the bench press exercise performed with low volume and high intensity promotes a more pronounced cardiovascular response than the same exercise performed with high volume and low intensity [59, 62]. Moreover, breathing is crucial to avoid the Valsalva manoeuvre and a subsequent increase in HR and BP: inhaling during the lowering (eccentric) phase of the bench press and exhaling during the lifting (concentric) phase are important aims to reach [63].

Although equivocal results exist, intensive resistance training has been found to characteristically increase left ventricular (LV) wall thickness and mass, with little or no change in LV diameter [50, 64, 65]. Both systolic and diastolic LV function (assessed with the determinants of LV filling velocities and relaxation by non-invasive imaging methods) was normal after strength training and consistent with physiological hypertrophy [65–67]. Even if resistance training does not impose a large low-intensity burden, some studies have demonstrated a modest increase in peak

oxygen uptake and long-term decreases in submaximal HR and systolic BP [68]. It appears that mild- to moderate-intensity resistance exercise evokes a lower rate-pressure product, an indirect index of myocardial oxygen demand [69]. Therefore, it seems to promote a better balance between oxygen support and demand [70]. Furthermore, strength training reduces plasma concentration of endothelin-1, a potent vasoconstrictor and vascular smooth muscle proliferative agent, in young men [71, 72]. Moreover, some studies in older adults suggest that low- to moderate-intensity training may attenuate oxidative stress markers [26], promoters of the atherosclerosis process.

Strength training and cardiovascular diseases

Although some absolute contraindications exist (unstable angina, uncontrolled arrhythmias or hypertension, severe and symptomatic aortic and pulmonary stenosis) [48], controlled strength physical activity can be performed safely and positively in numerous cardiovascular conditions, often combined with low-intensity exercise (Table 3). Much evidence highlights the benefits of strength training in decreasing BP [73, 74], and the improvement of BP profile results in lower rates of major cardiovascular events and death of any cause [75]. With an adequate weight, short contraction time, and enough between-contraction rest time, 20–30 repetitions can be performed safely [48] in a hypertensive patient. Many papers [70, 74–76] emphasize this anti-hypertensive role of resistance training. To prevent BP increase, breathing correctly and avoiding the Valsalva manoeuvre are crucial when performing this type of exercise. Individuals with controlled hypertension and no cardiovascular or renal

complications may participate in an exercise or competitive program, but should be evaluated, treated, and monitored closely [77].

Strength training combined with aerobic low-intensity training is well tolerated in patients with coronary syndrome and the combination is associated with improvements of their quality of life [78], strength, and endurance [79]. Strength exercise can be initiated approximately 3 weeks after stent implantation or 5 weeks after bypass surgery [80]. There are reports [81] that light weightlifting activity is safe in heart attack patients only after 3 weeks from the event. A special consideration for coronary artery bypass graft patients is to avoid heavy loads being placed upon the chest to allow for proper scar healing [56]. Moreover, a recent meta-analysis found that resistance training was associated with reductions in cardiac mortality, recurrence of myocardial infarction, repeated percutaneous coronary intervention, coronary artery bypass grafting, and restenosis [82]. Moreover, decreased mortality and hospital readmission for coronary artery disease were observed in patients undergoing specific training sessions [83].

Selected patients with congestive heart failure and coronary heart disease respond to strength training safely and effectively [72, 84]. There is strong scientific evidence [85] that the application of specific dynamic resistance training is safe and induces significant muscular adaptations in screened heart failure individuals. Indeed, it seems to efficiently treat specific myopathy and muscle weakness occurring in the majority of these patients. Also, increasing peak oxygen uptake in their exercise capacity [86], this training protocol could provide several health-related and socioeconomic benefits in this common syndrome.

Patients with atrial fibrillation often report such symptoms as fatigue, decreased exercise tolerance, dyspnoea, and palpitations, leading to a reduced quality of life [87]. Therefore, achieving significant improvements in exercise capacity through a short-term exercise training program [88] could be primary for these subjects. Further studies support these findings [89, 90]. Moreover, a report [91] showed that moderate physical exercises performed for 45 minutes twice a week decreased HR significantly after 4 months and helped to control this arrhythmia. Therefore, although atrial fibrillation could be triggered by exercise itself [92], it is recommended that these patients undergo controlled and safe physical activity [93].

Strength training and guidelines

According to the World Health Organization advice, adults should undertake at least 150 minutes of low- to moderate-intensity physical activity weekly, with at least 2 days of muscle-strengthening activities [94]. Strength training is an important component of training programs for health and physical well-being as for both the 2000 American Heart Association recommendations [56] and the 2020 American College of Sports Medicine guidelines [10].

Facts to consider before exercise include: type of disease, co-morbidities and medical history, ejection fraction, cardiovascular risk factors, exercise capacity, physical limitations, symptoms, medications, physical activity level. The general recommendations for a correct development of a strength exercise workout include 1–3 sets per exercise per muscle group, 8–15 repetitions, 2–3 days per week, with exercises to mimic tasks of daily living [95]. Traditional strength training for cardiovascular subjects includes, for each exercise, 3 sets of 10 repetitions 2–3 times a week [10]. Load choice is important, but a light weight can be lifted early in a rehabilitation protocol [81]. In low-risk patients with cardiovascular disease, loads of 8–15 1RM have been deemed safe [48, 96]. Initial loads should be equal to 50–60% 1RM for lower extremities and 30–40% 1RM for upper extremities, and intensity should be increased when subjects complete 2–3 sets of 12–15 repetitions at a given load [80]. Subjects should perform 1–2 sets of 8–10 exercises for all major muscle groups 2–3 days per week, with 48 hours between sessions and between-set recovery of 30–120 seconds [80]. The use of exercise machines is strongly suggested owing to their load adjustment feature, reducing the risk of accidents. Chest press application [36] has been shown to be a safe and well-structured form of physical exercise: it can be easily supervised and load can be controlled [11]. Regular monitoring of HR and BP during each session is advised to ensure that cardiovascular responses to exercise are normal. It is suggested that these patients undergo a complete medical evaluation by a sports physician before beginning the training protocols [77, 97]. Moreover, the physical exercise should be monitored by a prepared personal trainer [98]. Indeed, it is not recommended that these subjects exercise on their own because of the high risks to their health [99]. Safe and controlled physical activity is mandatory to reach the set goals and to avoid adverse effects.

Conclusions

The available scientific evidence supports the usefulness of strength training, in particular chest press-based exercise, in people with cardiovascular diseases. Studies show that, if properly prescribed and conducted, strength training is safe, does not lead to significant complications, and can have major benefits and advantages. It is, however, recommended that the patients undergo a preventive full medical screening and an effective monitoring during their training. Future large high-quality randomized controlled clinical trials are necessary to confirm these findings.

Ethical approval

The conducted research is not related to either human or animal use.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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