Chapter

Exercise Prescriptions for Co-Morbid Conditions

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Abstract

Chronic diseases have a high prevalence with increased life expectancy and the only way we can improve the Quality of life with chronic diseases is exercise. Exercise has been recommended as an advice since long time but adherence of clients to such advices have been found variable and not beneficial. Therefore, exercise prescriptions in such situations becvome must and should be issued lifestyle medicine physicians, Exercise physiologists and health coaches. Since exercise has been quantified in such prescriptions it would certainly help to alleviate co morbid conditions.

Keywords: exercise, lifestyle, prescriptions, co morbid, Fitness

1. Introduction

This chapter will contain the relevant information about co morbid conditions and the exercise prescription (Ex Rx) guidelines, recommendations for individuals with metabolic and cardiovascular disease (CVD) risk factors. The Exercise Treatment guidelines and recommendations are prescribed using the *FITT* principle of Ex Rx. There is a knowledge gap in relation to volume and progression for the chronic diseases and health conditions which will be addressed in this chapter. In these diseases, the recommendations provided for healthy populations should be followed with clinical expertise for the lifestyle diseases. The chapter will include all of these while focusing on new tools available for same.

2. Diabetes mellitus

Diabetes mellitus (DM)- a metabolic diseases involves an elevated blood glucose concentration (*i.e.*, hyperglycemia) as a result of faults in insulin secretion and/or an inability to consume insulin. There are four types of diabetes, based on etiologic origin: Type 1 diabetes mellitus (T1DM), Type 2 diabetes mellitus (T2DM), gestational (*i.e.*, diagnosed during pregnancy), and other specific origins (*i.e.*, genetic defects and drug induced); however, most patients have T2DM (90% of all cases) followed by T1DM (5–10% of all cases). The type of diabetes diagnosed depends on the circumstances present at the time of diagnosis, with some people not exactly fitting into a clear single category (such as having T1DM or T2DM), and clinical presentation and disease progression may vary considerably vary between the various types of diabetes [1].

2.1 Exercise testing

Special considerations in patients suffering from DM for exercise testing needs to be undertaken are:

When initiating an exercise program of light-to-moderate intensity, exercise testing is usually not essential for people with DM or prediabetes who are asymptomatic for CVD and low risk (<10% risk of cardiac event over a 10-yr period using the Framingham risk calculator) [2].

Electrocardiogram (ECG) stress testing may be considered for individuals with DM, especially those who have been following sedentary lifestyle and desires to participate in vigorous intensity activities. If positive or nonspecific ECG changes in response to exercise are discovered or nonspecific ST and T wave changes at rest are observed, the client should undergo follow-up diagnostic testing. Thus, the cost-effectiveness and diagnostic value of such intensive investigations remains in question. Silent ischemia in patients with DM often follows the iceberg phenomenon; therefore, annual CVD risk factor assessments should be conducted [2].

2.2 Exercise prescription

The FITT principle of Exercise prescription (**Table 1**) for healthy adults as well individuals with DM will be similar. Involvement in an exercise program is beneficial to individuals with T1DM and T2DM. Maximizing the cardiovascular benefits as a result of exercise is a pivotal for both types of diabetes. In nondiabetic people, exercise enhances sensitivity to insulin in a gradual dose-dependent manner [3]; thus, cellular uptake of glucose that facilitates improved control of blood glucose should occur in individuals with T2DM or prediabetes.

For those with T1DM, a higher insulin sensitivity has a very less influence on function of pancreas and the demand for exogenous insulin [4]. Weight reduction and moistening body weight are often more serious issues for those with pre diabetes and Type 2 Diabetes Mellitus, but a higher body weight and fat can be

	Aerobic	**Resistance**	**Flexibility**
Frequency	3–7 d. wk. $^{-1}$	A minimum of 2 consecutive d. wk.$^{-1}$, but preferably 3	≥2–3 d. wk.$^{-1}$
Intensity	Moderate (40–59% VO_2R or 11–12 RPE rating) to vigorous (60–89% VO_2R or 14–17 RPE rating)	Moderate (50–69% of 1-RM) to vigorous (70–85% of 1-RM)	Stretch to the point of tightness or slight discomfort.
Time	T1DM: 150 min. wk.$^{-1}$ at moderate intensity or 75 min. wk.$^{-1}$ at vigorous intensity or combination T2DM: 150 min. wk.$^{-1}$ at moderate-to-vigorous intensity	At least 8–10 exercises with 1–3 sets of 10–15 repetitions to near fatigue per set early in training. Gradually progress to heavier weights using 1–3 sets of 8–10 repetitions.	Hold static stretch for 10–30 s; 2–4 repetitions of each exercise
Type	Prolonged, rhythmic activities using large muscle groups (e.g., walking, cycling, swimming)	Resistance machines and free weights	Static, dynamic, and/or PNF stretching

1-RM, one repetition maximum; PNF, proprioceptive neuromuscular facilitation; RPE, rating of perceived exertion; VO_2R, oxygen uptake reserve.

Table 1.
FITT principle in DM.

prevalent in those with T1DM as well, and an exercise program should be beneficial to both. A recent systematic review and meta-analysis found no substantial evidence that resistance exercises has more benefit than aerobic exercise in impact on cardiovascular status in individuals with T2DM. Therefore, selecting one form of exercise over other may be less important than involved in any form of PA [5]. Further, there is evidence that aerobic and resistance training together improves blood glucose control more than either one form of exercise alone [6]. Whether the added benefits are caused by a greater overall energy expenditure [7] or are specific to the combination of aerobic and resistance training has not yet been fully resolved.

3. Dyslipidemia

Dyslipidemia is a derangement of lipids in the blood. It is further defined by the presence of elevated levels of total cholesterol or low-density lipoprotein (LDL-C), elevated levels of triglycerides (TG), or low levels of high-density lipoprotein (HDL-C). Among the causes of dyslipidemia, the most common cause is poor lifestyle choices which includes diet; however, genetic constitution plays a significant contributing role, and increased levels of cholesterol often cluster within familial groups [8]. Lifestyle modifications are the basis of treatment for dyslipidemia even for patients who may ultimately require medicines to manage their dyslipidemia. Exercise has its remarkable effects on dyslipidemia, although the effect is often minimal. Aerobic exercise training persistently reduces LDL-C by 3–6 mg/dL (0.17–0.33 mmol/L) but does not appear to have a consistent effect on HDL-C or TG blood levels [9]. The American College of Sports Medicine makes the following recommendations regarding exercise testing and training of individuals with dyslipidemia.

	Aerobic	**Resistance**	**Flexibility**
Frequency	Minimally 3 d. wk.$^{-1}$; preferably ≥5 d. wk.$^{-1}$	2–3 non-consecutive d. wk.$^{-1}$	≥2–3 d. wk.$^{-1}$ with daily being most effective
Intensity	With an exercise test, use 40–80% of exercise capacity using HRR, VO_2R, or $VO_{2peak.}$ Without an exercise test, use seated or standing HR_{rest} + 20 to +30 beats. Min^{-1} or an RPE of 12–16 on a scale of 6–20 [10].	Perform 10–15 repetitions of each exercise without significant fatigue; RPE 11–13 on a 6–20 scale or 40–60% of 1-RM.	To the point of feeling tightness or slight discomfort
Time	20–60 min	1–3 sets; 8–10 different exercises focused on major muscle groups.	15 s hold for static stretching; ≥4 repetitions of each exercise
Type	Arm ergometer, upper and lower (dual action) extremity ergometer, upright and recumbent cycles, recumbent stepper, rower, elliptical, stair climber, treadmill	Select equipment that is safe and comfortable for the patient to use.	Static and dynamic stretching focused on the major joints of the limbs and the lower back; consider PNF technique.

1-RM, one repetition maximum; HRR, heart rate reserve; HR_{rest}, resting heart rate; PNF, proprioceptive neuromuscular facilitation; RPE, rating of perceived exertion; VO_2R, oxygen uptake reserve; VO_{2peak}, peak oxygen uptake.

Table 2.
FITT principle for Dyslipidaemia.

3.1 Exercise testing

In general, an exercise test is not mandatory for asymptomatic patients prior to beginning an exercise training program at a light to moderate intensity. One should be meticulous when investigating people with dyslipidemia because undiagnosed CVD may be present. Special consideration should be given to the underlying prevalence of chronic diseases and health conditions (*e.g.*, Metabolic syndrome, obesity, hypertension) that may require modifications to standard exercise testing protocols and modalities.

3.2 Exercise prescription

An important difference in the FITT principle of Exercise Prescription for clients with dyslipidemia as compared to normal adults is that weight maintenance as per height and age should be highly emphasized. Further, aerobic exercise for the purpose of increasing energy expenditure (EE) for weight loss becomes the basis of the Exercise treatment, and the FITT recommendations (**Table 2**) are in line with the recommendations for healthy weight loss and maintenance of 250–300 min/wk. [11].

Resistance and flexibility exercises are adjuncts to an aerobic training program because these modes of exercise have less consistent beneficial effects in patients with dyslipidemia as compared to healthy adults [12]. Generally, flexibility training is recommended for usual health benefits only.

4. Hypertension

Hypertension is defined by the 7th Report of the Joint National Committee (JNC7) on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure as having a systolic blood pressure (SBP) ≥140 mm Hg at rest and/or a diastolic blood pressure (DBP) ≥90 mm Hg at rest, confirmed by at least two measures taken on two separate days, or consuming antihypertensive drug for the purpose of BP control [13]. Primary hypertension is responsible for 95% of all hypertensive cases and is a risk factor for CVD and premature mortality. The known factors responsible for primary hypertension include genetic constitution and lifestyle factors such as high-fat and high-salt diets and physical inactivity [14]. Secondary hypertension is responsible for the remaining 5%. The principal causes of secondary hypertension are diseases like chronic kidney disease (CKD), renal artery stenosis (RAS), pheochromocytoma, excessive aldosterone secretion, and sleep apnea [15]. The rate of switch from prehypertension to hypertension is related to age, initial BP, and comorbidities. Apparently, hypertension is not a feature of human aging but the result of poor lifestyle choices [16]. The ACSM recommends for Hypertensive clients:

4.1 Exercise testing

Hypertensive patients may have an extraordinary BP response to exercise, even if resting BP is under control [17]. Recommendations over exercise testing for hypertensive patients vary depending on their BP level and the presence of other CVD risk factors, target organ disease, or clinical CVD [18, 19]. For most asymptomatic hypertensive and prehypertensive individuals' adequate control of BP prior to engaging in light-to-moderate intensity exercise programs such as walking is sufficient with no need for evaluation by a physician or exercise testing [20]. Recommendations include the following: Hypertensive patients whose BP is not controlled (*i.e.*, resting SBP ≥140 mm Hg and/or DBP ≥90 mm Hg) should consult

	Aerobic	Resistance	Flexibility
Frequency	≥5 d. wk.$^{-1}$	2–3 d. wk.$^{-1}$	≥2–3 d. wk.$^{-1}$
Intensity	Initial intensity should be moderate (40–59% VO_2R or HRR); progress to vigorous (≥60% VO_2R or HRR) for greater health benefits.	60–70% of 1-RM; gradually increase to enhance strength and muscle mass.	Stretch to the point of feeling tightness or slight discomfort.
Time	30 min. d^{-1} (150 min. wk.$^{-1}$); increase to 60 min. d^{-1} or more (250–300 min. wk.$^{-1}$).	2–4 sets of 8–12 repetitions for each of the major muscle groups.	Hold static stretch for 10–30 s; 2–4 repetitions of each exercise.
Type	Prolonged, rhythmic activities using large muscle groups (e.g., walking, cycling, swimming).	Resistance machines and/or free weights.	Static, dynamic, and/or PNF

1-RM. One repetition maximum; HRR, heart rate reserve; PNF, proprioceptive neuromuscular facilitation; VO_2R, oxygen uptake reserve.

Table 3.
FITT principle for hypertensive patients.

a doctor prior to starting an exercise program to determine if an exercise test is needed. Individuals with stage 2 hypertension (SBP ≥160 mm Hg or DBP ≥100 mm Hg) or with target organ disease (*e.g.*, left ventricular hypertrophy, retinopathy) must not begin exercise regimens, including exercise testing, prior to due evaluation and adequate BP management by a physician. Intensive evaluations may vary depending on results of the exercise test and the lifestyle vital signs of the individual. Exercise testing is performed for the specific purpose of designing the Exercise Prescription, it is always recommended that individuals take their usual antihypertensive medications as recommended [20]. Individuals on β-blocker therapy are likely to have an sub-optimal HR response to exercise and reduced maximal exercise capacity. People on diuresis may experience hypokalemia and other dyselectrolytemia, cardiac dysrhythmias, or potentially a false-positive exercise test.

4.2 Exercise prescription

Aerobic exercise of adequate intensity, duration, and volume that promotes an increased exercise capacity leads to reductions in resting SBP and DBP of 5–7 mm Hg and decrease in exercise SBP at suboptimal workloads in hypertensive patients [21]. Decrease in cardiac wall thickness and left ventricular mass in hypertensive patients who participate in persistent aerobic exercise training [22] and a lower left ventricular mass in prehypertensive patients and a moderate-to-high physical fitness status have also been reported [23]. Emphasis is laid on aerobic activities; however, these may be augmented with moderate intensity resistance training (**Table 3**). Some evidence exists that resistance exercise alone can lower BP, although the evidence is inconsistent. Flexibility exercise should be performed after a considerable warm-up or during the cool-down period following the guidelines for healthy adults.

5. Metabolic syndrome

A consensus definition of Metsyn [10] includes hyperglycemia (or current blood glucose medication use), elevated BP (or current hypertension medication

use), dyslipidemia (or current lipid-lowering medication use), and national or regional cut points for central adiposity based on waist circumference; however, differences in specific value within these criteria remain. It is further agreed that an individual is categorized as having Metsyn when he or she displays at least three of the defining risk factors.

5.1 Exercise testing

Metsyn *per se* does not require an exercise test prior to beginning a low-to-moderate intensity exercise program. If an exercise test is performed, the general recommendations can be adhered to, with particular consideration for dyslipidemia, hypertension, or hyperglycemia when present. Because many patients with the Metsyn are either overweight or obese, exercise testing recommendations specific to those individuals should be followed [24]. The lower potential for exercise in overweight or obese individuals' stresses upon to start with low initial workload (*i.e.*, 2–3 metabolic equivalents [METs]) and then make step up approach per testing stage (0.5–1.0 MET). Presence of increased BP warrants protocols for assessing BP before and during exercise testing [25].

5.2 Exercise prescription/special considerations

The FITT principle of Exercise prescriptions in Metsyn is usually in line with the recommendations for healthy population regarding diverse array of exercises. Similarly, the min amount of PA to improve health/fitness outcomes is in line with the public health recommendations of 150 min/week or 30 mins of moderate intensity PA on most days of the week [26]. However, due to the aggravated CVD and DM risk factors, along with the likely presence of chronic diseases and health conditions that accompany Metsyn, the following Exercise Prescription considerations are recommended: When developing the Ex Rx for Metsyn, focus is to be given to each risk factor present, with the most conservative criteria used to set initial workloads. Gradually and as tolerated, longer duration and higher intensities may be required to achieve substantial health and fitness outcomes. To reduce the impact of the Metsyn, risk factors for CVD and DM, initial exercise training should be performed at a moderate intensity (*i.e.*, 40–59% O_2R or HRR) totaling a min of 150 min/wk. or 30 min/d most days of the week to allow for optimal health/fitness improvements. When appropriate, progress to a more vigorous intensity (*i.e.*, ≥60% O_2R or HRR). Reduction of body weight, an important target in Metsyn [27]; therefore, gradually increasing PA levels to approximately 250–300 min/week or 50–60 min on 5d/wk. may be necessary when appropriate. Daily and weekly amounts of PA may be accumulated in multiple shorter bouts (≥10 min in duration) and can include various forms of moderate intensity lifestyle PAs. For some individuals, progression to 60–90 min/d of PA may be mandatory to promote or maintain weight loss. Resistance and aerobic training together, can produce greater decreases in Metsyn prevalence as compared to aerobic training alone. Reported participation in ≥2 d/wk. of muscle strengthening activity reduces the risk of acquiring dyslipidemia, IFG, prehypertension, and increased waist circumference, all part of the Metabolic syndrome [28].

6. Overweight and obesity

Overweight and *obesity* are defined by a body mass index (BMI) of 25–29.9 kg/m^2 and 30 kg/m^2 or greater, respectively. Although the prevalence of obesity has steadily increased over the last three decades, recent data indicate a plateau in the

overall prevalence of obesity. Statistics relating to young adult population indicate that 32% of children and adolescents are overweight or obese. Data on overweight/obesity prevalence among the adult and pediatric populations and its health implications have augmented awareness in the value of identifying and treating individuals with excess body weight [29]. Overweight and obese patients are linked to an increased risk of the development of chronic diseases including CVD, DM, some forms of cancer, and musculoskeletal problems. The body weight dynamics is dependent on energy balance that is determined by EI and EE. For an individual who is overweight or obese to reduce body weight, EE must exceed EI. Continuous weight loss of 3–5% is likely to result in clinically meaningful reductions in several CVD risk factors, including TG, blood glucose, and HbA1C levels, and the risk of developing T2DM. Lifestyle modifications for loosing weight combine reductions in Energy Intake (EI) with increase in EE (energy expenditure) through exercise and other forms of PA often result in an initial 5–10% reduction in body weight. Apparently, PA has a modest impact on the amount of weight loss, relative to initial weight loss intervention in comparison to reductions in EI [30]. The ACSM's recommends that (a) <150 min/wk. of PA promotes minimal weight loss, (b) >150 min/wk. of PA results in modest weight loss of ~2–3 kg, and (c) >225–420 min/wk. of PA results in a 5- to 7.5-kg weight loss. However, there is literature that suggests it may take more than the consensus public health recommendation for PA of 150 min/wk. or 30 min of PA on most days of the week to prevent weight gain after weight loss. There is some evidence for ~200–300 min/wk. of PA during weight maintenance to reduce weight regain after weight loss, and the more the better [31]. The ACSM makes the following recommendations regarding exercise testing and training for individuals with overweight and obesity.

6.1 Exercise testing

Exercise testing is often not necessary in the overweight/obese population prior to beginning a low-to-moderate intensity exercise program. Overweight and obese individuals are at risk for other comorbidities (*e.g.*, dyslipidemia, hypertension, hyperinsulinemia, hyperglycemia), which are associated with CVD risk. The timing

	Aerobic	**Resistance**	**Flexibility**
Frequency	5–7 d. wk.$^{-1}$	2–3 d. wk.$^{-1}$	≥2–3 d. wk.$^{-1}$
Intensity	Moderate intensity (i.e., 40–59% VO_2R or HRR; RPE 12–13 on a 6–20 scale).	60–70% 1-RM; may progress to 80% 1-RM. For older individuals and novice exercisers, begin with 40–50% 1-RM.	Stretch to the point of feeling tightness or slight discomfort.
Time	≥30 min. d-1 of continuous or accumulated exercise. If intermittent exercise performed, begin with a minimum of 10 min bouts.	2–4 sets of 8–12 repetitions for each of the major muscle groups.	Hold static stretch for 10–30 s; 2–4 repetitions of each exercise.
Type	Prolonged, rhythmic activities using large muscle groups (e.g., walking, cycling, swimming).	Resistance machines, free weights, and/or body weight.	Static, dynamic, and/or PNF stretching.

1-RM, one repetition maximum; HRR, heart rate reserve; PNF, proprioceptive neuromuscular facilitation; RPE, rating of perceived exertion; VO_2R, oxygen uptake reserve.

Table 4.
FITT principle for obesity.

of intake of medications to treat comorbidities relative to exercise testing should be kept in mind, particularly in those who take β-blockers and antidiabetic medications. Low exercise capacities in individuals who are overweight and obese may necessitate a low initial workload (*i.e.*, 2–3 METs) and a step wise increase as per testing stage of 0.5–1.0 MET. Exercise equipment must be adequate to meet the weight specification of individuals with overweight and obesity for safety and calibration purposes. The appropriate cuff size should be used to measure BP in overweight and obese individuals to minimize the potential for inaccurate measurement.

6.2 Exercise prescription

The goals of exercise during the active weight loss phase are to (a) maximize the amount of caloric expenditure to accelerate the amount of weight loss and (b) integrate exercise into the individual's lifestyle to prepare them for a successful weight loss maintenance phase (**Table 4**).

7. Cardiac diseases

People with cardiac disease are benefitted from taking part in lifestyle modifications. Cardiac rehabilitation (CR) is used to implement exercise and lifestyle modifications and consists of a holistic intervention to reduce risk and promote an active lifestyle for individuals with cardiovascular disease (CVD) [32]. CR is typically delivered in both inpatient (previously termed *phase I CR*) and outpatient (previously termed *phase II CR*) settings and reduces the death rate and incidence of disease in persons with various cardiac diseases by stabilizing, slowing, or even reversing the progression of the atherosclerosis. The benefits provided by CR are significant at population as well as individual level as subsequent health care costs may be reduced following participation [33], with cost-effectiveness greater in patients with a higher chance for subsequent cardiac events. The following are the indications and contraindications for Exercise prescriptions:

7.1 Indications

Stable angina
Coronary artery bypass graft surgery
Post-myocardial infarction (stable)
Stable heart failure caused by either systolic or diastolic dysfunction (cardiomyopathy)
Valvular heart disease/surgery
Peripheral arterial disease
At risk for coronary artery disease with diagnoses of diabetes mellitus, dyslipidemia, hypertension, or obesity

7.2 Contraindications

Uncontrolled hypertension — that is, resting systolic blood pressure > 180 mm Hg and/or resting diastolic blood pressure > 110 mm Hg
Uncontrolled atrial or ventricular arrhythmias
Orthostatic blood pressure drop of >20 mm Hg with symptoms
Uncontrolled sinus tachycardia (>120 beats · min − 1)
Significant aortic stenosis (aortic valve area < 1.0 cm2)
Unstable angina
Uncompensated heart failure.

Third-degree atrioventricular block without pacemaker.
Active pericarditis or myocarditis
Recent embolism (pulmonary or systemic)
Acute thrombophlebitis
Aortic dissection
Acute systemic illness or fever
Uncontrolled diabetes mellitus
Severe orthopedic conditions that would prohibit exercise
Other metabolic conditions, such as acute thyroiditis, hypokalemia, hyperkalemia, or hypovolemia (until adequately treated)
Severe psychological disorder

7.2.1 Exercise testing

The American College of Cardiology (ACC)/American Heart Association (AHA) 2002 recommends exercise testing [34] early (2–3 wk) or later (3–6 wk) after hospital discharge is beneficial for framing of an exercise prescription in patients who had MI without (Class I recommendation) or with (Class IIa recommendation) coronary revascularization. An exercise test may also be used after certain period of time in patients who undergo supervised exercise training and CR (Class IIb recommendation). The following points of exercise testing should be noted: The test should be limited to symptoms and use standard exercise testing procedures. The test should be completed while the patient is on medications. e.g., the timing of a β-blocker with respect to the exercise test because it influences the HR response and ultimately on the HR-based Ex Rx. The following section on Ex Rx provides methodology for guiding exercise intensity.

7.2.2 Exercise prescription

The Ex Rx techniques used for the apparently healthy adult population may be applied to many patients with CVD. This section provides recommendations of the Ex Rx for patients with known CVD (**Table 5**).

	Aerobic	**Resistance**	**Flexibility**
Frequency	≥5 d/wk. to maximize caloric expenditure.	2–3 d/wk	≥2–3 d/wk
Intensity	40–75% VO_2R or HRR.	Moderate (50–69% of 1-RM) to vigorous (70–85% of 1-RM) to improve strength; <50% 1-RM to improve muscle endurance.	Stretching to the point of tightness or slight discomfort.
Time	30–60 min/d. To promote or maintain weight loss, 50–60 min/d or more of daily exercise is recommended.	2–4 sets, 8–12 repetitions for strength; ≤2 sets, 12–20 repetitions for muscular endurance.	Hold static stretch for 10-30secs; 2–4 repetitions of each type exercise.
Type	Prolonged, rhythmic activities using large muscle groups (e.g., walking, cycling, swimming).	Resistance machines, free weights and/or body weight.	Static, dynamic, and/or PNF stretching.

1-RM, one repetition maximum; HRR, heart rate reserve; PNF, proprioceptive neuromuscular facilitation; VO_2R, oxygen uptake reserve.

Table 5.
FITT principle for cardiovascular diseases.

8. Patients with heart failure

Chronic HF consists of exertional dyspnea and fatigue in the setting of HFrEF (*i.e.*, systolic dysfunction), a preserved left ventricular ejection fraction (HFpEF, *i.e.*, diastolic dysfunction), or a combination of the two. The prevalence of HF is increasing such that decompensated HF is the single most common admitting diagnosis and results in more than 1 million hospitalizations annually [35]. 25% of patients are readmitted within a month and 66% within one year of their initial HF hospital admission [36]. The merits of exercise training in patients with HFrEF include improved clinical outcomes (*e.g.*, hospitalizations) and health-related quality of life [37]. Exercise also helps to augment capacity of exercise (10–30%, as measured by O_2peak), central hemodynamic function, autonomic nervous system function, and peripheral vascular and skeletal muscle function in patients with HFrEF. These adaptations help patients to exercise to an increased peak work rates or exercise at a suboptimal level with a lower HR, less perceived effort, and less dyspnea and fatigue. Emerging data indicates that patients with HFpEF also benefit from exercise training, as evidenced by improved skeletal muscle function, quality of life, and exercise capacity [38].

8.1 Exercise testing

Symptom-limited exercise testing is safe in patients with HFrEF and when combined with the indirect measurement of expired gases provides not only useful information pertaining to electrocardiographic and hemodynamic responses to exercise but prognostic information as well [39]. Age-matched healthy individuals, patients with HFrEF exhibit a lesser peak HR, peak stroke volume, and peak cardiac output response to exercise. Vasodilation of the larger vessels and resistance vasculature are weakened, reducing regional and local blood flow. Exercise tolerance

	Aerobic	Resistance	Flexibility
Frequency	Minimally 3 d/wk.; preferably ≥5 d/wk	2–3 nonconsecutive d. $wk.^{-1}$	≥2–3 d/wk. with daily being most effective
Intensity	With an exercise test, use 40–80% of exercise capacity using HRR, VO_2R, or VO_{2peak}. Without an exercise test, use seated or standing HR_{rest} + 20 to +30 beats/min or an RPE of 12–16 on a scale of 6–20 [10].	Perform 10–15 repetitions of each exercise without significant fatigue; RPE 11–13 on a 6–20 scale or 40–60% of 1-RM.	To the point of feeling tightness or slight discomfort.
Time	20–60 min	1–3 sets; 8–10 different exercises focused on major muscle groups.	15 s hold for static stretching; ≥4 repetitions of each exercise
Type	Arm ergometer, upper and lower (dual action) extremity ergometer, upright and recumbent cycles, recumbent stepper, rower, elliptical, stair climber, treadmill.	Select equipment that is safe and comfortable for the patient to use.	Static and dynamic stretching focused on the major joints of the limbs and the lower back; consider PNF technique.

Table 6.
FITT principle for patients with heart failure.

falls to 30–40% as compared to controls. An exercise regimen that starts at a lower work rate and uses stepwise increase in work rate per stage is commonly used. Both O_2 peak and the slope relationship between minute ventilation and carbon dioxide production (E– CO_2 slope) are related to prognosis and can serve as a guide as to when to consult Cardiologist [39].

8.2 Exercise prescription

The two main goals for exercise training in patients with HF are to reverse exercise intolerance and decrease subsequent risk for a clinical event, the principle of specificity of training dictates the use of exercise modalities that were used in trials that reported improved functional and clinical benefits (**Table 6**). Therefore, exercise regimens should always include aerobic activities.

9. Conclusions

Exercise used to be recommended as an advice earlier which did not find any beneficial outcomes in clients. Exercise prescription for diseases like Diabetes, Dyslipidemia, Metabolic Syndrome, Cardiovascular diseases are essential and they augment existing medical management of the diseases mentioned and therefore provide a holistic approach towards treating co morbid conditions. It is essential that exercise is issued as prescription and not simply as advices which becomes one of the factors of not taking it seriously by individuals. The FITT principle is the basic guiding method on whose basis the exercise prescriptions are issued. There are lot of diseases for which Exercise Prescriptions are issued, but discussion on such diseases are beyond scope of this chapter.

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