EXERCISE PRESCRIPTION FOR PREVENTION AND TREATING CARDIORESPIRATORY DISEASES

Dr. Madhavi Konetigari
Professor of Physiotherapy,
Principal at Sri Venkateswara
Institute of Medical Sciences University,
Tirupati.

Background of exercise prescription

Prescribing exercise for persons with chronic diseases is a complex art. The objective is to decrease physiologic limitation and improve physical capacity through specific therapist. The challenge for physiotherapist is not to determine which therapies to use, but in defining the goals choosing the appropriate training intensity, duration and frequency. Thus, the area of exercise medicine is dose-response relationship to various chronic diseases especially related to cardiac and pulmonary conditions. The basic requirement to prescribe an exercise medicine is to have documentation of recorded data, dose-response relationship and documentation of long term follow-up of patients.

Many of therapists prescribe exercise based on experience; it is most accepted form of therapy. But, a systematic approach could be a better choice of prescription. As medicine is presented for patients by doctor in a systematic way. The physiotherapist should also prescribe specific, systematic and scientific way of exercise medicine, e.g: Mode of exercise (eg. Aerobic increase VO2 max.), strength training to increase muscle strength and mass. Exercise dose is a function of intensity and duration i.e. (hard workouts at high intensity or long duration a high number of total MET minutes). Exercise frequency is determined by desired fitness level (therapeutic goal) and the length of time for recovery from an exercise session (half-life).

Prescribing the right dose of exercise is important because one can experience an acute "overdose" of exercise. Acute exercise overdoses and chronic overtraining must be avoided in persons who have limited reserve because of chronic disease or disability.

The follow-up of therapeutic effect of exercise is a challenge. A systematic way to guide frequency of exercise training has not been developed largely because we do not fully understand fatigue and adaptation. Persons starting the level of resistance to fatigue and adaptability to training determines the total dose of exercise required to achieve a given fitness level. Perceived fatigue is proportional to exercise intensity.

Fatigue seems to have threshold. After this threshold is reached, exhaustion occurs quite rapidly. Adaptability is also poorly understood. To increase the adaptation rate by training harder (increasing intensity or frequency) but training too hard leads to decomposition or injury. High doses of exercise increase the risk of exhaustion and high frequency of exercise superimposes more training on incomplete recovery and risks of overtraining.

Musculoskeletal injury, heart attack and sudden death are the complications of exercise. Accurate estimates of these complications are not available; few clinical exercise trials in persons with a chronic disease or disability have reported the life threatening complications. The cost of exercise training includes time, energy and money input into the programme fortunately exercises are inexpensive comparative to other modern medical therapies.

The exercise prescription for various cardiovascular and respiratory conditions is described below.

Exercise Prescription for Cardiovascular and Respiratory Conditions as per ACSM, AACVPR and ATS

With the above principles, the prescription for cardiovascular, respiratory conditions and normal individuals suggested by ACSM, AACVPR and ATS is as follows:

ACSM	**AACVPR**	**ATS**
General recommendations: Use FITT framework	Upper and lower extremity training	Upper and lower extremity training
Modes of aerobic exercise		
Walking (preferred) or cycle ergometer	Walking (treadmill, track, supported walking via walker or wheelchair), cycling, stationary bike, arm ergometry, arm-lifting exercises with or without weights, step exercises, rowing, water	Cycling (cycle ergometer) or walking (treadmill)

	exercises, swimming, modified aerobic dance, and seated aerobics Warm-up before and cool-down	
Frequency >3-5 d/wk of continuous or intermittent exercise	3-5 d/wk	3 d/wk after exercise
Duration 20-60 min/d	20-90 min a session If debilitated, initial sessions can be shorter, with more frequent rest breaks	>30 min Interval training if the patient cannot achieve time and/or intensity
Intensity For mild COPD: RPE 5-6/10 (moderate) RPE 7-8/10 (vigorous) For moderate to severe COPD: 60%-80% of peak work rate or RPE 3-5/10 for dyspnea from graded exercise test	High intensity (60%-80% of peak work rate) Interval training is effective for those who cannot sustain continuous high intensity exercise Intensity should be designed to accomplish patient activity goals Intensity may be at certain level on the Dyspnea Scale or to a predetermined MET level	60% of peak work rate/exercise capacity RPE 4-6/10 for dyspnea or fatigue or predetermined MET level High-intensity exercise yields greater physiological effect; lower-intensity exercise is able to improve symptoms, HRQOL, and some ADL performance

Lower extremity training NA	Involves large muscle groups: Walking, cycling, stair climbing, and swimming	Treadmill or cycle ergometer
Upper extremity training NA	Recommended in conjunction with lower extremity training Training is task specific Note: Direct exercise training to muscles involved in functional living	Arm cycle ergometer, free weights, and elastic bands
Strength training Train each muscle group (may be multiple groups) 2-4 sets, 2-3 times per week, at least 48-h apart; rest intervals of 2-3 min between sets Intensity: 60%-80% of 1 RM; if goal is increased muscle endurance, 15-25 reps at ≤50% 1 RM Older and/or deconditioned patients: 10-15 reps at RPE 5-6/10	Hand and ankle weights, free weights, and machine weights Elastic resistance, using body weight, eg, stairs or squats Intensity: Begin with lower resistance and higher reps to work on muscle endurance On individual basis, higher resistance and fewer reps may be indicated to promote strength development	2-4 sets of 6-12 reps at 50%-85% of 1-RM intensity
Flexibility, posture, and body mechanics Minimum of 2-3 d/wk targeting major muscle tendon groups for ≥4 reps per muscle group;	Balance training and stretching to increase range of motion, eg,	NA

stretching options include static, ballistic, and proprioceptive neuromuscular facilitation stretching	modified yoga for whole body stretching with coordinated breathing	

Abbreviations: AACVPR, American Association of Cardiovascular and Pulmonary Rehabilitation; ACSM, American College of Sports Medicine; ATS, American Thoracic Society; ADL, activities of daily living; COPD, chronic obstructive lung disease; FITT, frequency, intensity, time, and type; HRQOL, health-related quality of life; MET, metabolic equivalents; RPE, Rating of Perceived Exertion; RM, repetition maximum.

Evidence based physical training and possible mechanisms (hypertension, coronary artery disease, intermittant claudication, copd, asthma, cystic fibrosis)

The evidence based basis for prescribing exercise as a medicine in the treatment of cardiovascular diseases and pulmonary diseases enlightening the effect of exercise therapy on disease pathogenesis, symptoms with possible mechanism of actions are described with optimal type and dose for prescription of exercises based on Cochrane reviews, evidence, experience and common sense.(B.K.Pedersen,B.Saltin Scand J MedSci sports 2015(suppl.3) 25:1-72).

Hypertension

- **Evidence-based physical training (Effect on resting blood pressure (normotensive and hypertensive)**

  Several meta-analyses have concluded that physical exercise has a positive effect on blood pressure in both normotensive and hypertensive cases (Stewart, 2001; Whelton et al., 2002; Pescatello et al., 2004; Fagard & Cornelissen, 2007; Cornelissen & Smart, 2013; Cornelissen et al., 2013; Garcia-Hermoso et al., 2013; Huang et al., 2013; Carlson et al., 2014). Reductions in diastolic BP (DBP) were observed after endurance (−2.5 mmHg [−3.2 to −1.7]), dynamic resistance (−3.2 mmHg [−4.5 to −2.0]), isometric resistance (−6.2 mmHg [−10.3 to −2.0]), and combined (−2.2 mmHg [−3.9 to −0.48]) training.

- **Acute effect of physical activity**

  Physical activity induced a decrease in blood pressure after it was carried out. This decrease in blood pressure typically lasted for 4–10 h, but was measured up to 22 h later. The average decrease was 15 mmHg and 4 mmHg for systolic and diastolic blood pressure, respectively (Pescatello et al., 2004). This means that people with hypertension can achieve normotensive values many hours of the day, which should be seen as having considerable clinical significance (Pescatello et al., 2004).

- **Possible mechanisms**

The blood pressure-lowering effect of physical training is assumed to be multifactorial but appears to be independent of weight loss. The mechanisms include neuro-hormonal, vascular, and structural adaptations. The anti-hypersensitive effect includes decreased sympathetically induced vasoconstriction in a fit condition (Esler et al., 2001) and a decrease in catecholamine levels. Hypertension often occurs in conjunction with insulin resistance and hyperinsulinemia (Zavaroni et al., 1999; Galipeau et al., 2002). Physical training increases insulin sensitivity in the trained muscle and thus reduces hyperinsulinemia. The mechanisms include increased postreceptor insulin signaling (Dela et al., 1993), increased glucose transporter (GLUT4) mRNA and protein (Dela et al., 1994), increased glycogen synthase activity (Ebeling et al., 1993) and hexokinase (Coggan et al., 1993), low release and increased clearance of free fatty acids (Ivy et al., 1999), and increased transport of glucose to the muscles due to a larger muscle capillary network and blood flow (Saltin et al., 1977; Mandroukas et al., 1984; Coggan et al., 1993).

Coronary heart disease

- **Evidence-based physical training**

Exercise-based cardiac rehabilitation is effective in reducing total and cardiovascular mortality (in medium- to long-term studies) and hospital admissions (in short-term studies) but not total MI or revascularization (CABG or PTCA). Physical training of patients with CHD was found to reduce total cholesterol and triglyceride levels and systolic blood pressure.

- **Possible mechanisms**

Physical training is believed to have a beneficial effect by enhancing CRF, reducing myocardial oxygen demand at a certain exercise level, having a beneficial effect on autonomic and coronary endothelial function and improving cardiovascular risk profile, including blood pressure, HDL/LDL ratio, weight, glycemic control, and psychological well-being (Ades, 2001; Giannuzzi et al., 2003).

Intermittent claudication

- **Evidence-based physical training**

  The authors concluded that exercise programs are of significant benefit compared with placebo or usual care in improving walking time and distance in people with leg pain from intermittent claudication who were considered to be fit for exercise intervention**.**

- **Possible mechanisms**

  Physical training programs for patients with heart failure increase local production of the vascular endothelial growth factor (VEGF) (Gustafsson et al., 2001), which induces the production of collaterals and thus increases blood flow.

Pulmonary diseases

Chronic obstructive pulmonary disease:

- **Evidence-based physical training**

  A significant increase in leg muscle strength favoring a combination of resistance and endurance training and recommends that resistance training should be incorporated in rehabilitation of COPD together with endurance training.

- **Possible mechanisms**

  Patients with COPD have higher TNF levels in blood (Eid et al., 2001) and muscle tissue (Palacio et al., 2002). TNF's biological impact on muscle tissue is manifold. TNF affects myocyte differentiation, induces cachexia, and thus a potential decrease in muscle strength (Li & Reid, 2001).Danish study showed that physical training counteracted the increase in protein degradation seen in people with COPD (Petersen et al., 2008).

Bronchial asthma

- **Evidence-based physical training**

  Physical training has a positive effect on the psycho-social morbidity and quality of life of asthma patients (Mendes et al., 2010; Turner et al., 2011).

- **Possible mechanisms**

  Physical activity does not improve lung function in patients with asthma, but it does increase cardiorespiratory condition via its effect on the muscles and heart. A common hypothesis (Ram et al., 2000) is that physical training in asthmatics helps reduce ventilation during exertion, thus reducing the risk of provoking an asthma attack during physical activity. It is also possible that physical training induces an anti-inflammatory effect in the lungs (Silva et al., 2010).

Cystic fibrosis

The goal of physical training for cystic fibrosis patients is to:

- Mobilize the mucus in the lungs and to stimulate an increase in mucociliary transport (Dwyer et al., **2011a**)
- Achieve a satisfactory level of fitness and strength to be able to maintain a normal capacity for exercise
- Maintain normal mobility, especially of the chest, to ensure that mucus clearance therapy is effective (Vibekk, **1991**; Lannefors et al., **2004**)
- Prevent osteoporosis and diseases related to physical inactivity (Borer, **2005**)
- Increase self-confidence (Ekeland et al., **2004**).

- **Evidence-based physical training**

  In general, the evidence is poor for the effect of physical training in patients with cystic fibrosis, but it has been found that physical activity improves exercise capacity, slows the decline in lung function, and improves quality of life in patients with cystic fibrosis (Dwyer et al., 2011b; Hulzebos et al., 2013). Inspiratory muscle training has been suggested as a mode of training to improve the lung function and quality of life of people with cystic fibrosis

- **Possible mechanisms**

  Physical activity improves fitness and muscle strength, allowing the patient to be active physically. Physical training increases pulmonary function by clearing lung secretions (O'Neill et al., 1987).

Pre-operative rehabilitation (coronary bypass and valvular surgeries,congenital heart surgeries,lung surgeries)

Two supervised exercise sessions per week

- Warm up of approximately 15 min including stretching
- 10 – 30 min aerobic exercise at 40-60% of heart rate reserve progressing to high intensity interval training upto 80% of aerobic capacity.
- 10 min cool down period.

Four educational sessions of topics including risk factor reduction, medication use , cardio vascular physiology, smoking cessation, healthy eating , stress management and promotion of self-managed care is given (Andrew M stammers 2014).

The following table exhibits phase 1 of cardiac rehabilitation:

Phase I (0-8 days)

1-2 days	Stabilization Phase	Breathing exercises, postural awareness and care with monitoring.
3-5 days		Mobilization of UL and Early ambulation
6- 8 days		(Out of intensive care unit) pre discharge plan, patients will be reevaluated

Phase II (Structured graded aerobic exercise programme)

Exercise protocol

	Warm up Walk slowly	Target zone Walk briskly	Cool- down Walk slowly
Week 1	5 minutes	5 minutes	5 minutes
Week 2	5 minutes	7 minutes	5 minutes
Week 3	5 minutes	9 minutes	5 minutes
Week 4	5 minutes	11 minutes	5 minutes
Week 5	5 minutes	13 minutes	5 minutes

Week 6	5 minutes	15 minutes	5 minutes
Week 7	5 minutes	18 minutes	5 minutes
Week 8	5 minutes	20 minutes	5 minutes
Week 9	5 minutes	23 minutes	5 minutes
Week 10	5 minutes	26 minutes	5 minutes
Week 11	5 minutes	28 minutes	5 minutes
Week 12	5 minutes	30 minutes	5 minutes

Along with the above exercise protocol, the following exercise needs to be done.

- Breathing exercises - 2-5 minutes
- Body exercises - 5- 10 minutes
- Slow walk - 5 minutes
- Breathing exercises & relax

Instructions:

- Heart rate is recorded daily while exercising.
- Gradually the intensity and duration of exercise is increased.
- Deep breathing exercise to be carried out for a period of three months.
- Warm up and cool down exercises include range of motion exercise of major joints and slow walking.
- Exercise should be withheld of terminated if you feel any discomfort or any of these problems (Breathing difficulty, chest pain, palpitation, over sweating & giddiness).

Conclusion:

In the medical world it is traditional to prescribe the evidence-based treatment known to be the most effective and entailing the fewest side effects or risks. The evidence suggests that in selected cases exercise therapy is just as effective as medical treatment and in special situations more effective or adds to its effect. Exercise medicine with appropriate training intensity, duration and frequency enhances Physiological limitation, physical capacity and Quality of life through specific therapist.

Still the research needs to define the dosage and type of exercise to be given optimally for specific conditions. The long term follow-up of patients needs to be done. It is now time that the health system should create the necessary infrastructure to ensure that supervised exercise can be prescribed as a medicine.

Moreover, it is important that society in general support a physical active lifestyle. People do not move, when you tell them to. People move when the context compels them to do so. In order to enhance the physical activity level of a population, accessibility is important. There is a need for political interference and laws about "health consequences, health awareness and continuous health education at community level" for chronic non communicable diseases.