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REVIEW ARTICLE

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Exercise and Non-Communicable Diseases: Part I Cardiovascular Diseases, Respiratory Diseases, Obesity, Depression, Liver Diseases

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Abstract

Physical activity has established itself as a major risk factor for many chronic diseases. Individuals who lead a sedentary life have higher morbidity and mortality. Exercise, a subcategory of physical activity, is usually planned and structured involving large muscle groups. It is a major recommendation from all professional health associations to prevent and beneficially modulate the course of several chronic diseases. There are also emotional benefits and exercising individuals experience a better quality of life. This manuscript discusses the beneficial effects of exercise on five major non-communicable diseases, namely cardiovascular diseases, respiratory diseases, obesity, depression, and liver diseases.

Keywords: exercise, non-communicable diseases, cardiovascular diseases, COPD, obesity, depression, liver diseases

1 | INTRODUCTION

Physical activity (PA) is defined as any bodily movement produced by the contraction of skeletal muscles resulting in a substantial increase in resting energy expenditure[1]. Exercise is defined as 'any sport or activity that works large groups of muscles, is continually maintained and performed rhythmically[2]. Physical activity includes all movement that increases energy use, whereas exercise is planned, structured physical activity[3]. Exercises may be aerobic or resistance, but may also involve stretching, balance, and gait workouts and non-traditional activities such as tai chi and yoga[4–6]. Activities such as walking, cycling, jogging, and swimming are primarily aerobic exercises. They increase mitochondrial density, insulin sensitivity, oxidative enzymes, blood vessel compliance and reactivity, lung function, immune function, and cardiac output[5]. Resistance exercises include workouts with free weights, weight machines, bodyweight, or elastic resistance bands[6]. They result in improvements in muscle mass, body composition, strength, physical function, bone mineral density, insulin sensitivity, blood pressure,

lipid profiles, and cardiovascular health[7]. Stretching increases the range of motion around joints and enhances flexibility[8]. Balance training can reduce falls risk by improving balance and gait[9]. Activities like Tai Chi and Yoga combine flexibility, balance, and resistance exercises[10]. Besides the physical benefits, all exercises benefit mental and emotional health[11]. The World Health Organization recommends that adult men and women should accumulate at least 150 min of moderate-intensity physical exercise per week and young people aged 5–17 years should accumulate at least 60 min of physical exercise of moderate to vigorous intensity daily[12].

The benefits of exercise for common chronic medical conditions are discussed in this two-part manuscript. Part I discusses the role of exercise in cardiovascular diseases (CVD), chronic obstructive pulmonary disease (COPD), obesity, depression, and liver diseases. Part II discusses its role in cancer, diabetes mellitus, kidney diseases, Alzheimer's disease, and arthritis.

2 | DISCUSSION

The Centers for Disease Control and Prevention (CDC) defines chronic diseases as "conditions that last 1 year or more and require ongoing medical attention or limit activities of daily living or both"[13]. Chronic diseases are usually non-communicable diseases (NCDs) and inflict a heavy global health burden[14]. They include CVD (including hypertension, coronary artery disease, stroke, and heart failure), cancers, chronic respiratory diseases (chronic obstructive pulmonary disease, sleep apnea, and asthma), diabetes, Alzheimer's disease, chronic kidney disease, arthritis, depression, obesity, and liver diseases (nonalcoholic and alcoholic hepatitis, viral hepatitis, cirrhosis of the liver)[15]. Cardiovascular diseases are the leading NCDs worldwide and are the leading cause of loss of disability-adjusted life years and deaths globally[16]. Chronic respiratory diseases (such as asthma, chronic obstructive pulmonary disease (COPD), and lung cancer) contribute significantly to the rising burden of NCDs globally[17]. Overweight/obesity is a pandemic – its worldwide prevalence has doubled since 1980, and it is now affecting nearly a third of the world's population[18]. Affected individuals face an increased risk of a multitude of comorbidities, including cardiovascular disease, diabetes, and many cancers[19]. Depression is a common disease and is on the increase[20]. Depression cases worldwide registered an increase of 49.86% - incident cases increased from 172 million in 1990 to 25,8 million in 2017[20]. Depression affects both mental and physical health and is often a potentially lethal disease[21]. The burden of liver diseases, such as nonalcoholic fatty liver disease (NAFLD), alcoholic liver disease, and hepatocellular carcinoma, continues to rise worldwide[22].

Several personal factors play an important role in the genesis and progression of chronic NCDs – both modifiable and non-modifiable[23]. Non-modifiable risk factors include heredity, age, race, and gender[24]. Lifestyle behaviors are modifiable risk factors and include diet, obesity, smoking, and alcohol consumption[24]. Another modifiable risk factor is sedentary behavior and exercise[24]. The beneficial effects of increased physical activity, including structured activity such as exercise, on NCDs, are enormous[25,26]. Its effect on cardiovascular diseases, respiratory diseases, obesity, depression, and liver diseases is discussed in this manuscript.

2.1 | CARDIOVASCULAR DISEASES

A reduction in sedentary time and an increase in exercise time beneficially modulate CVDs[27–29]. Exercise lowers CVD risk in a dose-dependent manner; moderate physical activity is associated with a 26% reduction in CVD risk, whereas high-intensity activities impart a 42% risk reduction[30–32]. Physical activity and pro-active physical exercise can even slow down or reverse CVD progression[33–37]. Regular PA also reduces the risk of CVD mortality, both

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in healthy individuals[38] and in cardiac patients[39,40]. Moderate to high-intensity exercise has been shown to increase life expectancy by 1.3 to 3.7 years and active individuals remain free of CVD 1–3 years longer than their sedentary peers[41].

Aerobic exercise lowers blood pressure (BP) by 5-7 mmHg[42] while dynamic resistance training lowers BP by 2–3 mmHg[43] in adults with hypertension (in both unmedicated and medicated patients). Interestingly, the magnitude of these BP reductions rivals the magnitude of those obtained with first-line antihypertensive medications[44]. Exercising as little as one day per week is as effective as pharmacotherapy for reducing all-cause mortality among hypertensive patients[45]. In coronary artery disease patients, exercise reduces angina, myocardial infarction, and sudden cardiac death[46]. Following a myocardial infarction, exercise reduces re-infarction, cardiac mortality, and all-cause mortality[47]. Physical inactivity[48] and low levels of fitness[49] are also risk factors for stroke. Following a stroke, moderate to high-intensity aerobic exercise (of 20–40 min and 3–5 days per week) helps improve physical fitness, maximal walking speed, and walking endurance[50]. Exercise is preventive for heart failure (HF)[51,52]. Khan et al. demonstrated that men in the top quartile of longterm fitness levels had a 53% lower risk of developing HF[52]. In those with established heart failure[53], exercise improves their quality of life[54], reduces hospitalizations[55], and lowers mortality[56]. Physical activity has been noted to reduce the risk of atrial fibrillation[57]. Several studies have shown that exercise not only helps prevent peripheral artery disease (PAD)[58] but also helps improve walking distance[59] and the quality of life in these patients[60,61]. Physical activity often reduces the risk of erectile dysfunction (ED)[62]. It also helps improve function in men with established ED[63]. Exercise also helps reduce several CVD risk factors, such as smoking[64], obesity[65], diabetes mellitus[66], hyperlipidemia[67], alcohol abuse[68], chronic kidney disease[69], depression[70], loneliness[71], psychosomatic stress[71], sleep disturbances[72], and illicit drug use[73].

Many mechanisms play a role in the beneficial effects of exercise[74]. Regular exercise can help to reduce weight, reduce blood pressure, and improve lipid disorders, including raising HDL, decreasing LDL, and lowering triglycerides[75]. It also decreases insulin resistance, reduces blood coagulation and systemic inflammation[76]. Vigorous physical activity reduces heart rate, increases myocardial oxygen supply, improves myocardial contraction and stroke volume, establishes electrical stability, and increases physiological cardiac hypertrophy[77−79].

However, older adults with chronic medical conditions must be careful about exercising vigorously, and stress testing may be required in people with known CVD[80]. Further, in certain conditions, such as decompensated congestive heart failure or severe aortic stenosis, exercise may be restricted or contraindicated[81].

2.2 | RESPIRATORY DISEASES

Exercise, both aerobic and resistance, decreases respiratory symptoms and leads to significant improvements in functional capacity in patients with respiratory diseases[82]. The benefits of exercise training in patients with COPD have been documented in several systematic review meta-analyses and in two Cochrane reviews[83,84.] Exercise training is an essential strategy in managing COPD, and results in an improvement in 6-minute walk test (6MWT) distance[84]. Several studies using an incremental cycle ergometer test to measure maximal exercise capacity also showed a significant improvement in those patients allocated to pulmonary rehabilitation[84]. Besides a reduction in exercise-induced hyperinflation, there is an increase in muscle function, delaying the onset of peripheral muscle fatigue and resulting in less dyspnea and an increase in exercise tolerance[84]. People with COPD often have comorbidities that markedly affect their functional capacity[85]. These include chronic heart disease, metabolic syndrome, musculoskeletal or neurological comorbidities, and many types of cancer[86]. Many of these chronic co-morbidities also improve with regular exercise in patients with respiratory diseases[87].

The role of exercise in the management of asthma is not well listed in professional organization guidelines. Studies suggest that exercise improves asthma-related symptoms and cardiopulmonary fitness[88,89].

Exercise training may lower the ventilatory requirementd of mild and moderate exercise thereby reducing the likelihood of provoking exercise-induced asthma[90]. In addition, a 12-week aerobic training program demonstrated reductions in bronchial hyperresponsiveness and serum pro-inflammatory cytokines[91]. There was a decrease in asthma exacerbations in adults with moderate to severe persistent asthma[91]. The quality of life (QOL) also improved in these patients[91].

Exercise training has an established role in cystic fibrosis (CF) management[92]. A Cochrane review (total number of 15 studies with 487 participants) examined the effects of exercise on CF[93]. Physical exercise in these patients improves exercise capacity, pulmonary function, and QOL[93]. There is an increase in sputum clearance through a combination of hyperventilation, mechanical vibration, coughing, and changes in sputum rheology, thereby improving the much-needed bronchial hygiene in patients with CF[94]. Patients with interstitial lung disease also exhibit pulmonary benefits[95−97]. They experience less breathlessness[95]. Their walking distance (during the 6MWT) improves[96]. Similar benefits have been documented by several other studies[97]. These patients also report an improved QOL with exercise rehabilitation and training[97]. In patients with pulmonary arterial hypertension, exercise training improves right ventricular function[98]. Benefits have also been reported in patients with asbestosis and pulmonary fibrosis[99].

2.3 | OBESITY

Sedentary behavior is also associated with obesity[100]. Regular exercise help prevent obesity, maintain weight or even lose weight[101]. A study of >4500 adults from the U.S. National Health and Nutrition Examination Survey showed that greater (moderate to vigorous intensity) physical activity was associated with a lower body mass index or BMI[102]. There is a significant body of evidence supporting the effect of physical activity in both short-term and long-term weight loss in adults[103−105]. Current recommendations from the American College of Sports Medicine state that PA between 150 and 250 minutes per week helps prevent weight gain, PA between 150 and 250 minutes per week provides modest weight loss, while PA >250 minutes per week helps lose clinically significant weight loss[101]. However, recent work by Flack et al suggests that exercise closer to 300 minutes per week is needed for weight loss as there is an approximately 1000-kcal pe week compensatory response that accompanies exercise[106]. Jakicic et al reported that moderate to vigorous PA accumulated in bouts that were >10 min in duration was effective for weight loss at 18 months[107]. These bouts also helped maintain >10% weight loss from 6 to 18 months. Bouts of exercise of <10 min in duration were not effective. A study found that combining 5% to 7% (intentional) weight loss with regular physical activities, such as lifestyle activities or resistance training, resulted in improved mobility and lower extremity physical performance in overweight or obese older adults[108].

Resistance exercises are also effective, but data indicates they produce only minimal reductions in body weight. These exercises, however, help increase the loss of fat mass and help increase fat-free mass. The result is a reduction in the risk of several NCDs[101].

2.4 | DEPRESSION

Depressed people have lower levels of PA[109] and higher levels of sedentary behavior[110]. A recent analysis of data from the Brazilian National Health Survey, (59,399 individuals), found that a lack of PA for leisure was associated with depression in young males, middle aged, and older adults[111]. Several other studies have confirmed the protective effects of physical activity on depression[112,113]. Hamer et al noted that risk reduction for depression was noted at a minimal level of at least 20 min/week of any physical activity, with a greater risk reduction with activity at a higher volume and/or intensity[114]. In a systematic narrative review of 30 prospective cohort studies, Mammen and Faulkner reported that 25 of the 30 studies found that PA resulted in reduced incident depression[115]. In a study of 49 studies (266,939 participants), Schuch and Stubbs found that PA lowered the risk of depression by between 17% to 41%, across all ages and in all continents of the world[116].

Exercise has recently also shown promise as an effective non-pharmaceutical treatment for depression[117−120]. Exercise of lower duration or lower intensity also imparts a reduction in depressive symptoms[118,119.] A Cochrane Review and meta-analysis of 35 randomized controlled trials (1356 individuals) found that exercise was moderately effective at reducing depressive symptoms in depressed adults[117]. Dunn et al. found that in patients with mild to moderate severity of major depressive disorder or MDD, a reduction in symptoms was noted in 47% of patients with exercise **(**17.5 kcal/kg/week) for 12 weeks[120] **.** In their study, they found that rates of response and remission with exercise were comparable to the rates reported in trials of cognitive-behavioral therapy and antidepressant medication. Schuch et al in a meta-analysis of 25 studies (757 individuals randomized to exercise and 730 to control conditions) found a significant antidepressant effect with exercise[121].

Patients with depression also have a higher risk of type II diabetes[122] and cardiovascular disease[123] and exercise helps reduce the risk of both. Exercise therapy also improves general physical health, body image, patients coping strategies with stress, and the quality of life in depressed individuals[124]. It also helps them become more independent in activities of daily living[124].

Evidence suggests that both exercise and antidepressant medication may alleviate depression through several processes, such as increased expression of neurotrophic factors[125,126] and reduced systemic inflammation[127]. These influence neuronal growth and plasticity, leading to an increase in neurons, synaptic connections between neurons, and cerebral vasculature[128−130]. There is evidence that exercise induces *increases* in hippocampal, prefrontal cortex, and anterior cingulate cortex volume[131].

2.5 | LIVER DISEASES

Physical inactivity and its related reduced cardiorespiratory fitness have been associated with increased nonalcoholic steatohepatitis (NASH) severity[132]. Among obese people, sedentary individuals have an increased risk of having a fatty liver in comparison with weight-matched physically active individuals[133]. These data provide support for the hypothesis that increasing physical activity through exercise, defined as a planned, structured, and repetitive physical activity with a specific intensity, frequency, and duration, has beneficial effects on nonalcoholic fatty liver disease (NAFLD)[134−136]. The American Gastroenterological Association, the American Association for the Study of Liver Diseases, and the American College of Gastroenterology all recommend physical exercise as a treatment for NAFLD[137]. Whitsett et al. conducted a systematic review of 18 studies and concluded that exercise significantly reduced hepatic fat content[138]. Wong et al demonstrated in a randomized trial of 145 NASH patients, aerobic and resistance exercise along with dietary restriction resulted in a 64% remission rate compared to a 20% remission rate in the non-intervention control group[139]. Several randomized trials provide evidence that aerobic exercise and resistance exercises are both effective in reducing liver fat[140,141]. This occurs even if there is no loss in body weight. Exercise in patients with NASH may also reduce progression to hepatocellular cancer[142]. Exercise has a direct effect on the liver. Aerobic and resistance training improve insulin resistance, liver fatty acid metabolism, and mitochondrial function[143]. Exercise also affects inflammation[144]. The result is a reduction in liver fat in these patients. Hepatitis C (HCV) patients are at an increased risk of CVD and have a lower QOL[145]. Studies have shown that HCV patients have lower physical activity than the general population[146]. Exercise in these patients not only reduces the CVD risk but also improves their QOL[147]. An improvement in the cognition function of these patients with exercise has also been noted[148].

In cirrhotic patients, exercise can improve endurance and functional outcomes without any adverse effects[149]. In this systematic narrative review, moderate-intensity aerobic exercise or resistance training, 4 days/week, 20 minutes, for at least 8 weeks, helps cirrhotic patients to improve their cardiorespiratory system[149].

Pretransplant exercise helps to improve the physical and mental status of the patient while on the wait-list. An exercise and nutritional program appear to benefit their cardiopulmonary and musculoskeletal

functions[150]. The patients notice an improved functional status and a sense of well-being. Following transplantation, exercise training was associated with a shorter length of hospital stay and a reduced 90-day readmission rate[151].

3 | CONCLUSION

Physicians often overlook exercise as a prophylactic measure or therapeutic modality for many common diseases and ailments. The evidence for the preventive and therapeutic effects of exercise on NCDs is strong. Even small amounts of exercise help most conditions, although the beneficial effect is greater with moderate to vigorous exercise. Patients with major risk factors for silent coronary artery disease, such as diabetes, or those with pre-existing CVD, should get a physician evaluation, with possibly a stress test, before embarking on a vigorous exercise program.

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