

Exercise Prescription in Patients with Diabetes Type 2

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Abstract

Sedentary life style is considered as a main risk factor for DM-II. The role of regular exercise is appreciated in both primary prevention and treatment. Diabetic people can benefit from physical activity in order to have a better control on blood glucose level, lipid profile, body weight, and blood pressure. Furthermore, psychological improvements may follow such as decreasing anxiety or depression and improvement of sleep quality.

Different kinds of training including aerobic, resistive, and flexibility exercises could be recommended, but some parameters like intensity, duration, and frequency of exercises as well as safety measures should be explained to the patient when prescribing an exercise program.

A thorough medical evaluation is required before starting an unaccustomed exercise program in order to modify it, as needed.

It is recommended that diabetic people participate in moderate aerobic (40-60% VO_{2max}) and resistive (30-50% 1RM) exercises 3-5 and 2-3 sessions per week, respectively. However, it is a general recommendation, and an expert in exercise therapy should tailor the program with respect to individual conditions.

Key words: exercise, diabetes type 2, training

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Background

As the level of activities has decreased in today's living, the incidence of many chronic physical and psychological problems has increased. Obesity and insulin resistance, two component of the metabolic syndrome, are both consequences of this reduced physical activity during daily life. Metabolic syndrome, predicts an increased risk of developing type II diabetes and also cardiovascular diseases. Unfortunately, modern life style, dictates us to spend a big portion of lifetime without any significant physical activity. Thus, it's extremely important to include appropriate exercise routine in our daily lives. This would be of benefit in improving the society's general health and also in managing lots of the related pathologies. In this regard, one must avoid incomprehensive recommendations for exercise, as this could confuse the patient and even encourage him to pursuit activities that may be hazardous to his health. Of course, the clinician prescribing exercise regimens should either familiarize himself to the basics of exercise therapy or seek expert opinion in this regard. Given the high incidence of diabetes type II, the proven benefit of exercise routines in its management and the fact that many practitioners are unfamiliar with these subjects, we are going to review the essential practical points in this field.

Epidemiology

More than 90% of diabetic population has the type II disease. The incidence of this disease is more in societies with sedentary life styles and obesity. The expert consensus is that diabetes type II is evolving into a pandemic which will be one of the health related burdens of the 21st century [1, 2]. In 2001, a study estimated that more than 1.5 million Iranians suffer from DM-II and also suggested that 14.5-22.5% of the population over 30 years of age have either insulin resistance or frank diabetes [3]. More recently, the results of the first Survey of Risk Factors of Non-

Communicable Diseases of Iran, 2005, revealed that 7.7% of adults aged 25-64 years (about 2 million adults) have diabetes, among whom one-half are undiagnosed and an additional 16.8% (4.4 million of Iranian adults) have impaired fasting glucose. [4]. Although, DM-II typically affects the population over 30 years of age, but its incidence is on the rise among the pediatric and adolescence population. The increased prevalence of obesity in these groups has been suggested as an etiology for the increased incidence of diabetes [5].

BASIC CONCEPTS IN EXERCISE TRAINING

Given the use of specific terminology during discussing the exercise routines, we will first briefly review the essential terminology:

Exercise training: Is a type of physical activity that has been tailored to improve or maintain one or more aspects of physical fitness [6].

An exercise prescription is based on four characteristics including the type of exertion, frequency, intensity and duration [7].

Type of exertion: Exercise routines are categorized based on different aspects as we will review here.

-Aerobic exercises: Activities that incorporate use of large groups of muscle with low to moderate intensity and in longer durations. Walking, jogging, swimming and bicycling are some examples of aerobic activities. These activities have major roles in improving one's cardiovascular fitness.

-Anaerobic exercises: These activities are generally more intensive than the aerobics and due to gradual accumulation of lactic acid in the involved muscles and the subsequent pain and fatigue, are not suitable for long duration practice. Fast running, swimming, bicycling and, also,

heavy weight lifting are some examples of anaerobic activities. These exercises are generally used to increase one's speed and strength.

-Resistive exercises: This term is usually given to activities done against a resistance. The resistance here may be the body weight or elastic force or external weights. The main goal of these activities is to increase one's strength and endurance [1]. One must keep in mind that, with quitting these routines for a long time, the improvements may be lost. Thus adherence to regular exercise routines is strongly recommended.

-Flexibility exercises: These trainings are intended to increase the overall flexibility of body and to improve the range of motion of joints. It is important to point out the correct way of performing, duration, number of repetitions and frequency of stretching movements while prescribing them [1].

Frequency: Frequency refers to the number of sessions practiced weekly. The recommended frequency is usually 3 to 5 sessions weekly. If adhering to the 3 days a week frequency protocol, one may space practice sessions to every other day, so that the overall exertion be distributed more evenly throughout the week [6, 7].

Intensity: One could monitor the intensity of aerobic exercises via different methods. VO_2 Max, Target heart rate and RPE are some of these measures [6].

Given the costs and the needed infrastructure for directly measuring the VO_2 Max, in real world, exercise sessions are prescribed and monitored via easier and more available methods [1].

Heart rate is directly proportional to the intensity of exertion and the VO_2 Max. Accordingly, often the intensity of exercise is determined based on the maximal predicted heart rate (Max HR= 220 - Age). The intensity of exercise should be adjusted as to maintain the HR within a given range during exertion, for example, 60-80% of Max HR. In order to measure this range

more precisely, it is advised to first measure the heart's chronotropic reserve (Max HR – Resting HR). Then multiply the min by max intended percentage of heart rate in this chronotropic reserve and finally add this minimum and maximum rates to the resting heart rate to determine the intended range of HR with the prescribed routine[1,6].

The rating of perceived exertion is used as an estimate of the exercise intensity. RPE offers a numeric measure for different levels of activity, ranging from minimum to maximum exertion. Point scales like the BORG scale, rate the exercise intensity from minimum (equal to Borg scale of 6) to maximum (Borg scale of 20). Studies have shown that RPE correlates well with the VO_2 Max and HR and this method is considered as an invaluable tool in exercise prescribing [6,7].

Repetition maximum (RM) is usually used to determine the intensity of resistive exercises. RM is defined as the maximum weight or load that muscle can bear in a given range of motion with a given repetition. 1RM applies to the maximum weight that muscle can overcome no more than once. Thus, nRM applies to the maximum load that muscle can overcome, n times and not more. Usually a percentage of the RM is used to determine the amount of load or resistance used in resistive exertions [1, 7].

The role of physical activity in diabetics

Diet, prescription anti hyperglycemic drugs and exercise routines are all important contributors to treatment of diabetes. Physical activity and sports are one of the main contributors to both prevention and management of diabetes.

Prevention: Metabolism abnormalities leading to insulin resistance are usually reversed by weight loss, dieting and increase in physical activity. Exercise may increase body's response to intrinsic insulin, by multiple mechanisms including

increasing the amount of transporters of glucose into the muscle cells (GLUT-4), increasing of insulin receptor substrates (IRS) and last but not least, increasing the muscle mass, given that more than 75% of the glucose uptake in response to insulin is by the muscular tissue. The fatty acids released from adipose tissue, concentrate inside the myocytes and reduce the GLUT-4 transportation onto the cell membrane. Exercise, however, will reduce the fatty acid accumulation within the myocytes, by oxidizing them. Therefore Life style modification, by focusing on the weight loss and increase in the physical activity, may prevent progression toward frank diabetes in people who have an impaired glucose tolerance test [5, 8, 9]. A study, which followed about 69000 female nurses for up to 16 years, revealed that obesity and sedentary life style are independent risk factors for developing type II diabetes [10].

Controlling the blood sugar levels:

Regular exercise can not only lower the amount of HbA_{1C} in diabetics [5], but also would decrease the prevalence of hyperglycemia in these patients. A meta-analysis of 14 clinical trials (12 studied aerobics and 2 evaluated resistive exercises) revealed that regular exercise may lower the HgbA_{1C} to a level that could ultimately be effective in prevention of developing hyperglycemic complications [11]. A recent trial evaluated the effects of one session of exertion in reducing serum levels of glucose in diabetic patients. This study showed that total time of hyperglycemia, may decrease about 40% up to 24 hours after each session of exercise. Researchers determined that the effect of this exertion in reducing postprandial hyperglycemia equalizes the effect of limiting calorie intake or use of anti hyperglycemic drugs in these patients [8].

Related disorders: Regular exercise in diabetics has many beneficial effects other than improving serum glucose levels as it also improves their cardio-respiratory

fitness and psychological state of health. Exercise in diabetics is beneficial in both primary and secondary prophylaxis of cardiovascular diseases (Table-1) [5, 12, and 13]. Mechanisms by which exercise delivers its desired effect include improving endothelial function, decreasing the vascular stiffness, *improving left ventricular diastolic function and, last but not least*, improving the systemic state of inflammation. Exercise also helps reduce both visceral and peripheral fat mass [12]. 5-years follow up of 468 diabetic patients showed that patients with lower aerobic capacity at the beginning of the study tended to have increased incidence of cardiovascular mortality and morbidity [14].

Aerobic exercise with modest intensity can improve the VO₂ Max up to 10% in Type II diabetics. This would result in a significant decrease in the risk of cardiovascular diseases [15]. A recent study, designed to evaluate the effect of aerobic exercise on the plasma levels of inflammatory biomarkers and other indicators of vascular endothelial dysfunction in obese patients with type II diabetes, showed a remarkable decrease in these factors and also increase in serum HDL levels following only two weeks of exercise without any dieting [16]. Exercise may also improve the state of anxiety or depression which is commonly seen in patients with chronic diseases like diabetes [5, 12].

As time passes, the effects of physical activity in prevention and control of type II diabetes are more and more revealed. However, like in other disease, one must also learn about the potential hazards of exercise therapy. The team, who manages diabetic patients, must constantly evaluate the pros and cons of the prescribed exercise routine and modify it as needed. This team consists of patient, physician, nurse, dietician and psychologist and preferably a sports medicine specialist [12, 17].

Table 1. The Effects of Regular Exercise on DM II [5]

Glucose Metabolism:	
Insulin Function	Improved
HbA _{1c} Level	Decreased
Lipid Profile:	
Total Cholesterol	Unchanged
HDL	Increased
LDL	Decreased or Unchanged
VLDL	Decreased
Total Cholesterol/HDL	Decreased
Cardiovascular System:	
Cardio-respiratory Fitness	Improved or Unchanged
Resting Heart Rate	Decreased
Heart Rate at Submaximal Exertion	Decreased
Blood Pressure (in Mild - Moderate Cases)	Decreased
Anthropometric Changes:	
Body Weight	Decreased
Fat Mass (Particularly in Obese Individuals)	Decreased
Fat-free Mass of the Body	Increased or Unchanged
Psychological Features:	
Self- concept	Improved
Self- esteem	Improved
Depression	Decreased
Anxiety	Decreased
Stress Response	Decreased

Table 2. Indications of Performing Exercise Tolerance Test Prior to Exercise

- Age > 35 yrs
- Age > 25 yrs (if more than 10 yrs DMII or more than 15 yrs DMI)
- Any Other Cardiovascular Risk Factor Such As High BP, Smoking , Disordered Lipid Profile, Sedentary Life Style, etc.
- Microvascular Diseases (Proliferative Retinopathy or Microalbuminuria)
- Peripheral Vascular Disease
- Autonomic Neuropathy

Prescription for a Diabetic Patient [17]

Table 3. Classification of Physical Activity (<1hr) Intensity [17]

Intensity	Relative Intensity		
	% Max HR (220-age)	%VO ₂ max	Borg Scale
Very Mild	<35	<20	<10
Mild	35-54	20-39	10-11
Moderate	55-69	40-59	12-13
Hard	70-89	60-84	14-16
Very Hard	>90	>85	17-19
Maximal	100	100	20

Evaluations prior to initiating the exercise program

Before starting an exercise program with intensity higher than daily activities, diabetic patients should be precisely evaluated for potential limitations and possible contraindications to the exercise routines [17, 18]. These evaluations consist of a good clinical history, physical exam and a diagnostic work-up to evaluate for the presence or absence of macro-vascular or micro-vascular complications of diabetes. One must pay close attention to signs and symptoms of cardiovascular, ophthalmologic, renal and neurologic complications of diabetes [17].

Cardiovascular complications in diabetes:

Given that many of diabetics suffer from frank or silent coronary diseases, there is a risk of pathologic response to the exercise. Silent ischemia prevalence in diabetics is up to 25% [12]. Thus, it is reasonable to further evaluate diabetics who fit in with one of the [table-2](#) conditions and want to join exercise routines with moderate or higher intensities ([Table-3](#)), and also with exercise tolerance test [12]. Exercise tolerance test is done with aerobic exertion

with a sub-maximal constant-workload. These tests may not be necessary for those diabetics who are at low risk for cardiovascular disease and may inadvertently lead to extra costs which in turn could reduce patient's compliance with exercise [18]. Anyhow, for the time being, adhering to current guidelines is logical unless newer evidence and recommendations arrive.

For those diabetics who do have no specific electrocardiographic response to exertion or those with baseline ST-T changes at rest, supplementation of the exercise tolerance test with nuclear cardiac imaging is recommended. Patients with known cardiac disease must be evaluated during exercise for any myocardial ischemic response, threshold of ischemia onset, and tendency for exercise-induced arrhythmias [17].

The physician prescribing mild intensity exercise (requiring less than 60% Max HR) like slow walking must use their clinical judgment to decide on whether or not pre-screening with exercise tolerance is needed [17].

Peripheral vascular diseases:

Evaluation for peripheral vascular disease in diabetics is based on related symptoms

and signs. These symptoms and signs include claudication, poor distal pulsation in the affected extremity, subcutaneous atrophy and hair loss in the affected vascular territory. One must note that presence of the dorsalis pedis and posterior tibialis pulsation does not exclude presence of distal ischemia in the foot. Thus, if there is any suspicion of distal limb ischemia, further evaluations such as Doppler ultrasonography will be indicated [5].

Diabetic retinopathy:

Annual ophthalmic exams should be done routinely in all diabetics. Presence of diabetic retinopathy indicates a closer interval of ophthalmic eye exam every six months. Progression of retinopathy to proliferative stages requires even closer follow-up. If one is intending to evaluate diabetic patient with proliferative retinopathy with exercise tolerance test, it is recommended to use a sub-maximal protocol [5].

Diabetic nephropathy:

About 20-30% of diabetics will suffer from diabetic nephropathy. The incidence of nephropathy increases with longer duration of diabetic state. Thus, in type I diabetes, screening for nephropathy should begin five years after diagnosis is made. In type II diabetes, patient must be screened for proteinuria once diabetes is diagnosed [19].

Diabetic peripheral neuropathy:

Peripheral neuropathy typically involves the distal parts of extremities particularly the lower legs and feet, causing loss of sensation in the affected area. The affected persons are more prone to foot ulcers [5, 19]. A thorough pre-participation evaluation of a diabetic person should include sensory and proprioceptive examinations.

Diabetic autonomic neuropathy:

This complication of diabetes diffusely impairs all autonomic functions in the body. When the involved autonomic system

is cardiac, this is referred to as cardiovascular diabetic dysautonomia. The clinical signs of cardiovascular dysautonomia includes silent myocardial ischemia or infarction, inappropriate resting tachycardia or early onset of tachycardia with exercise, reduced maximal heart rate, decreased exercise tolerance, hypotensive response to resistive exercises, impaired control of body's temperature, increased incidence of dehydration and impaired noradrenergic response to hypoglycemia [5]. Thus during physical examination of a diabetic patient, one must pay close attention to patient's heart rate, orthostatic hypotension (a positional drop of more than 20 mmHg in blood pressure upon standing) and other signs of dysautonomia involving the skin, pupils, gastrointestinal and genitourinary systems.

Myocardial thallium scanning is a non-invasive method to evaluate the extent of coronary involvement in these patients. Also for exercise tolerance testing in this patient, a sub-maximal protocol is recommended [5].

Psychiatric evaluation in diabetics:

One must not forget about the role of psychiatric evaluations in succeeding with the exercise therapy. Patient or their acquaintances may have a misunderstanding about exercise in the context of diabetes. Depression is more common in those with chronic diseases and it may prevent initiation of exercise therapy in diabetics. Thus by appropriate psychological evaluation and intervention in diabetics, there would be better chance of starting an exercise therapy and compliance with it [20].

Prescribing exercise in type II diabetes

As previously said, physical activity has tremendous benefits in patients with type II diabetes. Recent studies emphasize on the importance of long term exercise programs in prevention and management of this very

common metabolic disease. There is good evidence in those with impaired glucose tolerance, showing that increasing the daily physical activity along with some weight loss leads to lower incidence of progression toward frank diabetes [18, 21]. For those with impaired glucose tolerance, it's recommended to not only limit daily caloric intake but also to have at least 150 minutes per week, of moderate to intense physical activity. A meta-analysis of 27 clinical trials on different exercise protocols (aerobic, anaerobic or a combination of both), showed a significant benefit in diabetics, as evident by decrease in serum levels of HgbA1c. This beneficial effect was comparable with the benefits gained by dieting and medical therapy for diabetes [22].

The best way to control ones weight in the long term, is a combination of diet, exercise and behavioral changes. Exercising alone, without limiting the daily caloric intake and behavioral changes, may lead to loosing up to 1kg at best. The reason for this limited weight loss in obese patients is that they usually have difficulty with adhering to the needed amount of physical activity and also that they tend to compensate for their burned calories by increasing their caloric intake and decreasing their overall physical activity throughout the rest of the day. However, one must note that the weight loss achieved by exertion results in higher insulin sensitivity when compared to the same amount of weight loss achieved by dieting. Also of note that the amount of exertion needed to achieve significant weight loss in the long run is much more than what is needed to control serum glucose levels [18].

The intensity and amount of aerobic exercise needed depends primarily on one's therapeutic goal:

- In order to suppress serum glucose levels, lose weight, and reduce risk of cardiovascular diseases, an exercise protocol consisting of at least 150 minutes per week, with moderate

intensity (corresponding to 40-60% $VO_{2\text{ Max}}$ or 50-70% Max HR) or at least 90 minutes per week of intense aerobic exertion is recommended. This volume of exertion is done best if divided in at least 3 days a week without longer than 2 days of rest in between each session. Minimizing the day to day variance of physical activity in diabetics, eases the regulation of their diet and antiglycemic drug regimen. Thus it is preferred to space the aerobic exercise sessions in as many weekdays as possible. Also for those patients with advanced age and or sedentary lifestyle, one may divide each session of daily exercise into 2 or 3 smaller sub sessions and distribute them evenly throughout the day.

- Performing 4 hours or more of aerobic and or resistive exertion with moderate to severe intensity, reduces incidence of cardiovascular events more, compared with less intense exercise protocols.

- For long term maintenance of significant weight loss (more than 13.5kg), larger volume of exertion, like 7 hours a week of moderate to intense physical activity may be required [18].

Activities like walking, bicycling and swimming are examples of the aerobic exertions that are well accepted among many diabetic patients [12].

Despite the known benefits of aerobic exercise, some practical limitations do exist. Some patients consider these routines redundant and boring [18]. On the other hand, performing such trainings may be difficult for those with sedentary life style and/or obesity. In one study, only 28% of the diabetic population could adhere to these routines and recommendations [23]. Unfortunately, those who may gain the most benefit out of therapeutic exercise routines are those who also have the most difficulties performing them. Realistically, diabetic patients who suffer from obesity, joint diseases and/or other accompanied

complications of diabetes, may have difficulty with even 20-30 minutes of walking. Perhaps, for this group of patients, one may use a host of other physical activities which have same metabolic effects as aerobic exercise [23].

Resistive exercises have been suggested recently, as a safe and effective therapeutic tool in treatment of many chronic diseases like diabetes. As per available data, these types of trainings, same as aerobic routines, are very effective in improving insulin sensitivity [21, 23, 24], increasing daily caloric consumption and improving one's quality of life [23,25,26]. Other than the aforementioned benefits, resistance training potentially improve muscular strength, increase body fat-free mass, improve bone mineral density and decrease symptoms and signs of arthritic diseases, all of which result in rapid improvement of patient's functional capacity. Patients usually find this as an early reward for their hustle which in turn leads to improvement of their self-confidence [12, 18, 23]. Given that daily resistive exercises usually consist of various activities, some patients find them more exciting and easier to adhere to [18].

A clinical study on the effect of resistance training in improving the serum levels of HbA_{1c} in type II diabetics suggests that performing these routines in a gym or recreational centers has higher success compared with performing the same exercises in one's home [27].

It's prudent to realize that resistive exercise routines, as opposed to simple aerobic exertions, may require machines and understanding of the correct techniques used for each move. Thus, in order to incorporate resistive exercises in one's daily schedule, one must search for the more practical and cost-effective measures [23].

If no contraindication is present, type II diabetics must practice resistive exercises for at least 2 sessions a week or up to 3 sessions per week. In each practice session,

one must use drills that involve all groups of large muscles. By definition, the ideal number of repetitions for each move is 10-15 times against a moderate resistance (about 30-50% of 1RM) [12, 23]. Once the person becomes capable of completing 15 repetitions against a given resistance, then one could gradually add to the resistance [12]. Studies have shown that by using higher resistance, the lowering effect on the HgbA_{1c} becomes even more prominent. Thus, for patients with good physical condition, the physician may prescribe heavier resistance and subsequently less repetitions (like reps of 8-10 times) [18, 23]. Perhaps, exercise using resistance machine is preferred over using free weights, given that it's easier and safer [12].

There is some data suggesting that using a combination of aerobic and anaerobic exercises may have a synergistic effect [8, 28]. Recently following a randomized clinical trial involving 251 adults, researchers demonstrated that combining aerobic with resistive exercises improves patients' serum levels of HgbA_{1c} more prominently than using each exercise modality alone [29]. However, these studies do have some limitations that warrant further research to shed some light on the correct answer [23].

Flexibility or stretching exercises, are often recommended to increase the joints range of motion and decrease potential of injuries like muscle strain. Though some of previous studies found that these trainings are ineffective in decreasing the risk of such injuries [30], but one must keep in mind that many of these studies were done on younger populations and thus the results of such studies may not be attributable to other age groups [18]. Altogether, it seems that performing these trainings accurately can result in increasing muscular flexibility and joints range of motion. Since diabetes may be associated with increased limitation of joints range of motion, probably use of

flexibility exercises is beneficial in these patients. It is recommended that during stretching, muscles be gradually extended to the point that patient feels the extension but no pain. Each stretch is better to last for about 30 second [1].

Same as in non-diabetics, exercise for diabetics, must begin with a warm-up, followed by elastic exercises and end with a cool-down period. Warm-up should consist of 5-10 minutes of light aerobics (slow jogging, stationary bicycling, etc) in order to prepare the target muscles and the cardiopulmonary system. Next, the target muscles should be slowly stretched for 5-10 minutes and then to proceed with the main exercise course. At the end of main exercise course, there must be a cool-down period of 5-10 minutes. This cooling period consists of similar activities as in the warm-up phase, and is intended to gradually decrease the heart rate to pre-exercise level [31]. Having said that, for patients who have had a sedentary life style, longer durations of warm-up and cooling must be considered [1].

Exercise in none euglycemic states

➤ **Hyperglycemic state:** American diabetic association recommends caution toward exercise if serum glucose exceeds 300mg/dl. In the presence of ketonemia, serum glucose levels above 250mg/dl preclude participation in exercise routines. Some experts believe that using a cut-off value of 300mg/dl without ketonuria for type II diabetics is too conservative and thus recommend light to moderate intensity exercises to improve serum glucose levels [18]. Accordingly until arrival of newer guidelines, clinicians must adhere to these recommendations for prescribing exercise protocols in diabetics.

➤ **Hypoglycemic state:** Increased physical

activity in patients who take insulin secreting agents like sulfonylurea may lead to hypoglycemia [18]. In general, etiologies of hypoglycemia during the day include inappropriate diet, delay or missed meal, use of alcohol without sufficient carbohydrate intake and physical activity. Physical activity is of particular interest here, given that it is the only factor with the most variation during daily living [32].

Glucose expenditure may increase many folds during intense physical activity and may continue for up to 15 hours post exercise. Thus exercise-induced hypoglycemia may occur with some delay after workout. Occasionally this hypoglycemia may occur as late as the next morning of an afternoon session of exercise [32]. Exercise-induced hypoglycemia is most likely to occur 6-14 hours post exertion [31]. However, this is a minimum risk in the type II diabetics, who are not on insulin or insulin secreting agents. For type II diabetics, who are on insulin or insulin secreting agent, it is recommend taking some carbohydrate prior to exercise, if their serum glucose level is less than 100mg/dl. Perhaps, this precautionary measure is not needed for those diabetics who are on metformin, alpha-glucosidase inhibitors or thiazolidinediones and not using insulin or insulin secreting agents. Same applies to those diabetics how control their diabetes only with a diabetic diet. Anyhow, it is advisable to have some carbohydrate supplements available prior to exertion [12, 18].

Few points to remember for exercise in diabetics

➤ **Appropriate footwear:** Perhaps shoes are the most important exercise equipment used in diabetics. Appropriate shoes protect the skin and may decrease the recurrence of diabetic foot ulcers [33]. It's prudent that physicians observe patients habits and behaviors toward their footwear. Physician must also recommend appropriate footwear for exercise along with proper modes of exercise for diabetics with diabetic foot

neuropathy [34]. Many of the aerobic exercises like walking and jogging require appropriate shoes. Shoes, if inappropriate, may result in impaired blood perfusion to the foot and inflammation resulting from recurrent focal pressure. The combination of aforementioned mechanisms may even lead to foot ulceration. If patient fails to recognize and treat diabetic foot ulcer, it may easily become infected and deepen further [35].

Diabetics with neuropathy must wear shoes with thick bottom layer. They may also frequently examine the internal surfaces of their shoes and look for foreign bodies. Walking barefooted on hot sidewalks, around the pool or inside hot showers may be dangerous as it may lead to severe burns on their soles.

For aerobic exertions, the American diabetic association recommends use of silica gel or air orthoses in the mid sole part of shoes in order to minimize foot injuries. Also recommend is use of polyester or cotton blend stockings, which helps to keep foot dry and prevent it from blistering. One must always wear clean and dry stockings when exercising and then exchange the sweaty stockings and dry up his feet after each session. The moist stockings are hazardous given that it may become infected with fungi.

Impaired blood perfusion to the feet as a result of stiff footwear is a common etiology for foot injuries. Many times, when shopping for shoes, diabetics with neuropathy may assume that the shoe they are trying is too tight and thus request a smaller size shoe. Tight footwear is dangerous given that it may easily lead to ischemic pressure ulceration. These patients need to wear shoes with enough space around the toes to prevent friction and blistering in the toes. In general, leather is preferred to plastic given that it molds to the foot and allows air exchange between the foot and the surrounding air. New footwear must be initially worn for short periods until they soften and then foot must be evaluated for any pressure points. One

must discard any worn out footwear.

Diabetic patients may choose shoes appropriate for the type of their intended exercise. In regard, the surface on which patient is to exercise should be considered when choosing the footwear [35]. A good time to ensure if patient has obtained appropriate footwear at the time of physical exam prior to beginning the exercise routine [36].

➤ **Adequate hydration:** It is prudent to adequately hydrate diabetics during exercise. Dehydration may lead to various detrimental effects in a diabetic. First, blood glucose concentration will increase as the body dehydrates during exertion. Second, diabetics with autonomic neuropathy are prone to hypotension following exertion if dehydrated. Also given that most of the type II diabetics are obese and obesity is a precursor for dehydration and heat exhaustion, thus it is essential to pay close attention to maintain adequate hydration during exercise. Adequate rehydration may be achieved by drinking 500 ml of fluids about 2 hours prior to the activity. During the exercise as well, one must drink fluids frequently with short intervals, enough to compensate for the amount of fluid lost with perspiration. Caution is advised with exertion in the cold or warm climate [37]. Diabetics must avoid exercising in the hot and under direct sun light [5].

Exercise precautions in diabetics affected by diabetes complications

Since there are limited studies about the pros and cons of exercise in patients who suffer from complications of diabetes, thus, most of recommendations in this field are based on expert opinion [18]. Diabetic complications do not contraindicate exercising as the benefits of light to moderate intensity exercise outweigh its potential hazards [5]. Here we will review the potential complications associated with

exercise.

➤ **Diabetic retinopathy:** Exercise and physical activity have no known detrimental effect on vision or progression of the non-proliferative retinopathy and macular edema. This applies to both aerobic and resistive exercises [18]. In severe non-proliferative retinopathy and also the proliferative type, any exercise activity requiring to hold one's breath for long duration or those leading to increased systolic blood pressure over 160 mmHg are prohibited. These patients must also avoid exercises like gymnastics which positions patient's head below the trunk [5].

➤ **Peripheral neuropathy:** Patients affected with peripheral neuropathy must avoid exercises like long distance walking which may inflict injury to the foot. Also routines that require excessive balance are not appropriate for this group of diabetics. Sports that require less weight bearing like swimming and cycling are more appropriate for these patients [18]. However, some diabetics with neuropathy actually do prefer exercise modes which have more weight bearing. Researchers have shown that increasing weight bearing activities are not associated with increased risk of diabetic ulceration recurrence. Finally more studies are needed to ascertain the most appropriate exercises in this patient population [38].

➤ **Sports and diabetic foot:** Weight bearing exercise modalities like long distance walking, slow jogging, and running on the treadmill are not recommended for those who suffer from diabetic foot. For those with active ulceration who intend to exercise during their recovery, we do recommend activities involving upper extremities like using an arm ergometry, etc. This group of patients must also avoid water sports until the diabetic ulceration has fully healed [35]. Identifying high risk patients with diabetic foot ulceration is an important step to

reduce the exercise risk in diabetics. Daily surveillance of the foot and appropriate management of the minute foot injuries, (like, aberrations, erosions, blisters and long lasting ulcers) and, also, foot infections like fungus infections, will reduce the potential for formation of diabetic foot ulcerations in patients with peripheral neuropathy [39].

➤ **Autonomic neuropathy:** Autonomic neuropathy may lead to reduced cardiac response to exertion, orthostatic hypotension, gasteroparesis, impaired thermoregulation, reduced night vision and impaired thirst sensation. These will all increase risk of exercise induced derangements in diabetics [18]. In order to adjust the level of physical activity, the affected patients must use the RPE measure rather than the heart rate. Heart rate in these patients may not correlate well with the intensity of exercise. It is best to start the aerobic routines of such patients with only 50% of their potential and then gradually increase it as tolerated [12]. These patients as mentioned earlier are prone to dehydration and hypothermia, as a result of impaired thirst and temperature regulation [5]. Given that these patients may have difficulty in sensing symptoms of hypoglycemia, thirst and hypotension, close monitoring during physical activities is highly recommended [6].

➤ **Diabetic nephropathy:** These patients must adhere to light exertions and avoid any physical activity like weight lifting which requires one to hold his/her breath and also may lead to elevation of their systolic blood pressure [5].

➤ **Hypertension:** It's recommended to lower patient's blood pressure prior to exercise, if systolic pressure exceeds 160 mmHg or for diastolic blood pressure more than 100 mmHg [12]. This group of diabetics should avoid heavy and strenuous physical activities and instead adhere to more dynamic activities which involve

large groups of muscles with light to moderate intensity (like bicycling, biking, etc). Recommendations for hypertensive patients must also be followed.

CONCLUSION

Exercise is an important measure of primary and secondary prophylaxis in type II diabetes and it also helps regulate blood sugar in these patients. Other than regulation of glucose metabolism, regular exercise harbors many somatic, mental and social benefits in diabetics.

While nowadays, even those diabetics who suffer from diabetes complications are not

prohibited from physical activity, but as a rule of thumb, physician must always evaluate this group, prior to any change in the level of daily activities and modify the prescribed exercise routine as needed.

For the physicians, using simple phrases, like “walk somewhat more”, are not beneficial. Patients must be adequately educated in this regard. The prescribing physician must tailor an exercise routine which fits patient’s physical condition and also is compatible with her/his psychological and social situations. This will improve patient’s motivation and compliance with the prescribed exercise routine.

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