Chapter 2

2. REVIEW OF LITERATURE

2.1 Diabetes

Diabetes is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Several pathogenic processes are involved in the development of diabetes. These range from autoimmune destruction of the b-cells of the pancreas with consequent insulin deficiency to abnormalities that result in resistance to insulin action.(26)

Deficient insulin action results from inadequate insulin secretion and/or diminished tissue responses to insulin at one or more points in the complex pathways of hormone action. Impairment of insulin secretion and defects in insulin action frequently coexist in the same patient, and it is often unclear which abnormality, if either alone, is the primary cause of the hyperglycemia.(23)

Type I DM (b-cell destruction, usually leading to absolute insulin deficiency) - the cause is an absolute deficiency of insulin secretion. Individuals at increased risk of developing this type of diabetes can often be identified by serological evidence of an autoimmune pathologic process occurring in the pancreatic islets and by genetic markers.(27)

Type II DM (ranging from predominantly insulin resistance with relative insulin deficiency to predominantly an insulin secretory defect with insulin resistance) - the cause is a combination
of resistance to insulin action and an inadequate compensatory insulin secretory response.(3, 26)

2.1.1 Prediabetes

These people were defined as having impaired fasting glucose (IFG) [fasting plasma glucose (FPG) levels 100 mg/dl (5.6 mmol/l) to 125 mg/dl (6.9 mmol/l)], or impaired glucose tolerance (IGT) [2-h values in the oral glucose tolerance test (OGTT) of 140 mg/dl (7.8 mmol/l) to 199 mg/dl (11.0 mmol/l)].

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<th>FPG 100 mg/dl (5.6mmol/l) to 125mg/dl (6.9 mmol/l) [IFG]</th>
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<tr>
<td>2-h PG in the 75-g OGTT 140 mg/dl (7.8 mmol/l) to 199 mg/dl (11.0 mmol/l) [IGT]</td>
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<td>A1C 5.7–6.4%</td>
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Figure 2.1: Categories of increased risk for diabetes (prediabetes)(26)

2.1.2 Diagnosis of Diabetes

A1C ≥6.5%. The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.

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<td>FPG≥126 mg/dl (7.0 mmol/l). Fasting is defined as no caloric intake for at least 8 h.</td>
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<td>2-h plasma glucose≥ 200 mg/dl (11.1mmol/l) during an OGTT. The test should be performed as described by the World Health Organization, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.</td>
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<td>In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥ 200 mg/dl (11.1 mmol/l).</td>
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Figure 2.2: Criteria for the diagnosis of diabetes(26)
2.1.3 Prevention/delay of Type 2 diabetes (28)

Patients with impaired glucose tolerance (IGT), impaired fasting glucose (IFG), or an HbA1C 5.7–6.4 % should be referred to an effective ongoing support program targeting weight loss of 7% of body weight and increasing physical activity to at least 150 min/week of moderate activity such as walking. Follow-up counselling appears to be important for success. Metformin therapy for prevention of type 2 diabetes may be considered in those with IGT, IFG, or an A1C 5.7–6.4%, especially for those with BMI .35 kg/m2, aged, 60 years, and women with prior GDM. At least annual monitoring for the development of diabetes in those with prediabetes is suggested. Screening for and treatment of modifiable risk factors for CVD is suggested.

2.1.4 Medical Nutrition Therapy

General recommendations (28-29)

Individuals who have prediabetes or diabetes should receive individualized medical nutrition therapy (MNT) as needed to achieve treatment goals, preferably provided by a registered dietitian familiar with the components of diabetes MNT. Because MNT can result in cost-savings and improved outcomes, MNT should be adequately covered by insurance and other payers.

Energy balance, overweight, and obesity (28-29)

Weight loss is recommended for all overweight or obese individuals who have or are at risk for diabetes. For weight loss, either low-carbohydrate, low-fat calorie-restricted, or Mediterranean diets may be effective in the short term (up to 2 years). For patients on low-carbohydrate diets, monitoring lipid profiles, renal function, and protein intake (in those with
nephropathy) and adjustment of hypoglycaemic therapy as needed. Physical activity and behavior modification are important components of weight loss programs and are most helpful in maintenance of weight loss.

Recommendations for primary prevention of type 2 diabetes (28, 30)

Among individuals at high risk for developing type 2 diabetes, structured programs that emphasize lifestyle changes that include moderate weight loss (7% body weight) and regular physical activity (150 min/week), with dietary strategies including reduced calories and reduced intake of dietary fat, can reduce the risk for developing diabetes and are therefore recommended. Individuals at risk for type 2 diabetes should be encouraged to achieve the U.S. Department of Agriculture (USDA) recommendation for dietary fiber (14 g fiber/1,000 kcal) and foods containing whole grains (one-half of grain intake). Individuals at risk for type 2 diabetes should be encouraged to limit their intake of sugar-sweetened beverages (SSBs).

2.1.5 Macronutrients in Diabetes Management

The mix of carbohydrate, protein, and fat may be adjusted to meet the metabolic goals and individual preferences of the person with diabetes. Monitoring carbohydrate, whether by carbohydrate counting, choices, or experience-based estimation, remain a key strategy in achieving glycemic control. Saturated fat intake should be, 7% of total calories. Reducing intake of trans fat lowers LDL cholesterol and increases HDL cholesterol; therefore, intake of trans fat should be minimized.(22, 28, 31)

2.1.6 Other Nutrition Recommendations

If adults with diabetes choose to use alcohol, they should limit intake to a moderate amount (one drink per day or less for adult women and two drinks per day or less for adult men) and
should take extra precautions to prevent hypoglycemia. Routine supplementation with antioxidants, such as vitamins E and C and carotene, is not advised because of lack of evidence of efficacy and concern related to long-term safety. It is recommended that individualized meal planning include optimization of food choices to meet recommended dietary allowance (RDA)/dietary reference intake (DRI) for all micronutrients. (23, 28)

2.1.7 Diabetes Self-Management Education and Support

People with diabetes should receive DSME and diabetes self-management support (DSMS) according to National Standards for Diabetes Self-Management Education and Support when their diabetes is diagnosed and as needed thereafter. Effective self-management and quality of life are the key outcomes of DSME and DSMS and should be measured and monitored as part of care. DSME and DSMS should address psychosocial issues, since emotional well-being is associated with positive diabetes outcomes. DSME and DSMS programs are appropriate venues for people with prediabetes to receive education and support to develop and maintain behaviours that can prevent or delay the onset of diabetes. Because DSME and DSMS can result in cost-savings and improved outcomes, DSME and DSMS should be adequately reimbursed by third-party payers. (23, 28)

2.1.8 Physical Activity

Adults with diabetes should be advised to perform at least 150 min/week of moderate intensity aerobic physical activity (50–70% of maximum heart rate), spread over at least 3 days/week with no more than 2 consecutive days without exercise. In the absence of contraindications, adults with type 2 diabetes should be encouraged to perform resistance training at least twice per week.
2.1.9 Psychosocial Assessment and Care

It is reasonable to include assessment of the patient’s psychological and social situation as an ongoing part of the medical management of diabetes. Psychosocial screening and follow-up may include, but are not limited to, attitudes about the illness, expectations for medical management and outcomes, affect/mood, general and diabetes-related quality of life, resources (financial, social, and emotional), and psychiatric history. Screen for psychosocial problems such as depression and diabetes-related distress, anxiety, eating disorders, and cognitive impairment when self management is poor. (23, 30)

2.2.0 Physical Activity and Fitness Terminology

Physical activity and exercise are often used interchangeably, but these terms are not synonymous. Physical activity is defined as any bodily movement produced by the contraction of skeletal muscles that result in a substantial increase over resting energy expenditure (5,36). Exercise is a type of physical activity consisting of planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness (5). Physical fitness has typically been defined as a set of attributes or characteristics that people have or achieve that relates to the ability to perform physical activity (5). These characteristics are usually separated into either health-related or skill-related components.

In addition to defining physical activity, exercise, and physical fitness, it is important to clearly define the wide range of intensities associated with physical activity. This has been accomplished using several methods, including percentages of maximal oxygen consumption (VO2max), oxygen consumption reserve (VO2R), heart rate reserve (HRR), maximal heart rate (HRmax), or metabolic equivalents (METs). Each of these methods for describing the
intensity of physical activity has benefits and limitations. Although determining the most appropriate method is left to the exercise professional.(32)

2.2 Yoga

A previous study was conducted by Sahay et al on normal individuals and those with diabetes to assess the role of yogic practices on glycaemic control, insulin kinetics, body composition, exercise tolerance and various co-morbidities like hypertension and dyslipidemia. These studies were both short term and long-term. These studies have confirmed the useful role of yoga in the control of diabetes mellitus. Fasting and postprandial blood glucose levels came down significantly. There was a lowering of drug requirement and the incidence of acute complications like infection and ketosis was significantly reduced. There were significant changes in the insulin kinetics and those of counter-regulatory hormones like cortisol. There was a decrease in free fatty acids. There was an increase in lean body mass and decrease in body fat percentage. The number of insulin receptors was also increased. There was an improvement in insulin sensitivity and decline in insulin resistance. He suggested that yogic practices have a role even in the prevention of diabetes. There is a beneficial effect on the co-morbid conditions like hypertension and dyslipidemia. This study has methodologic limitations as its reporting is not based on CONSORT and sample size calculation is not reported.(33) Another study reported that subjects with T2DM in yoga practice for 40 days resulted in reduced BMI, improved well-being, and reduced anxiety.(34) Bijlani et al suggested that a short lifestyle modification and stress management education program leads to favorable metabolic effects within 9 days only.(35) Both of the studies reported by Bijlani et al are single group pretest-post test designs.
Another study measured the concentration of thiobarbituric acid reactive substances (TBARS) in blood as an indicator of oxidative stress at the beginning and at the end of a comprehensive yoga-based lifestyle modification program (YLMP). The data was collected from 104 subjects (59 male, 45 female), 19-71 years of age (mean +/− SD, 41.2 +/− 14.6 years). The YLMP consisted of a nine-day educational out-patient course on the theory and practice of yoga and included, besides a daily one-hour practice of physical postures (asanas) and breathing exercises (pranayama), lecture and films on yoga, stress management and nutrition, practice of meditation and shavasana (a relaxation technique), and individual counseling. The study concluded that a brief low cost lifestyle intervention based on yoga reduces oxidative stress.(36) Another study reported Yoga-nidra with drug regimen had better control in fluctuating blood glucose and symptoms associated with diabetes, compared to oral hypoglycaemics alone.(37) This study has not evaluated glycemic control as outcome which is important in diabetes study. Benavides reported Ashtanga yoga as a beneficial weight loss strategy in a predominately Hispanic population(38) while Chaya et al reported that long term yoga practice (for 1 year or more) is associated with increased insulin sensitivity and attenuates the negative relationship between body weight or waist circumference and insulin sensitivity.(39) Another study reported restorative yoga as a feasible and acceptable intervention in overweight adults with metabolic syndrome. However author recommended a randomized controlled trial with larger sample size. (40) Another study conducted by Upadhyay et al indicated that regular practice of Nadisudhi increases parasympathetic activity which is a type of yoga exercise.(41)

In summary studies reported on yoga and diabetes have methodologic limitations in past. Most of the studies have not been blinded and randomized. There is no justification for sample size and calculation has not been reported. Some of the studies are single group and there exists no control group. Most of the studies have reported fasting and blood glucose
level as primary outcome which has limited acceptance for glucose control in absence of HbA1c. HbA1c is a better indicator of glycemic control where as lower fasting and post prandial glucose level can be affected by many confounding factors. This study tries to eliminate all these methodologic issues along with gold standard outcomes. (24)

2.3 Music
Korhan et al reported that music can provide an effective method of reducing potentially harmful physiological responses arising from anxiety. He considered physiological signs of anxiety as systolic and diastolic blood pressure, pulse rate, respiratory rate and oxygen saturation in blood measured by pulse oxymetry which showed reductions after music therapy.(42) Hunter et al also recommended Music therapy to treat anxiety associated with weaning from mechanical ventilation. Limitations and suggestions for further research was discussed.(43)
In a review authors briefly reviewed current literature related to music's effect on people with different mental illnesses, and examined several neurobiological theories that may explain its effectiveness or lack thereof in treating psychiatric disorders. Neuroscientific studies have shown music to be an agent capable of influencing complex neurobiological processes in the brain and suggested that it can potentially play an important role in treatment. Clinical studies provide some evidence that music therapy can be used as an alternative therapy in treating depression, autism, schizophrenia, and dementia, as well as problems of agitation, anxiety, sleeplessness, and substance misuse, though whether it can actually replace other modes of treatment remains undetermined.(44) Cochrane review of Bradt etal concluded that Music listening may have a beneficial effect on heart rate, respiratory rate, and anxiety in mechanically ventilated patients. However, the quality of the evidence is not strong. No
studies could be found that examined the effects of music interventions on quality of life, patient satisfaction, post-discharge outcomes, mortality, or cost-effectiveness.(45)

Nilsson investigated if women with high pre-procedural anxiety reported higher degree of relaxation and comfort if listening to music during coronary angiographic procedures. No effect in relaxation was found although.(46) After a review of the experimental and therapeutic literatures exploring music and the ANS, a "Neurovisceral Integration" perspective on the interplay between the central and autonomic nervous systems was introduced, and the associated implications for physiological, emotional, and cognitive health were explored. The construct of heart rate variability was discussed both as an example of this complex interplay and as a useful metric for exploring the sometimes subtle effect of music on autonomic response. Suggestions for future investigations using musical interventions were offered based on this integrative account.(47) Trappe HJ reported that Music may not only improve quality of life but may affect changes in heart rate and heart rate variability. It has been shown that cerebral flow was significantly lower when listening to relaxive music. The greatest benefit on health was visible with classical music and meditation music, whereas heavy metal music or techno were not only ineffective but possibly dangerous and can lead to stress and/or life-threatening arrhythmias. The music of many composers most effectively improves quality of life, will increase health and probably prolong life, particularly music by Bach, Mozart.(48) Chuang CY determined in his study whether or not music therapy affects the sensations of fatigue, comfort, and relaxation in cancer survivors, and affects the activities of the sympathetic and parasympathetic nervous systems as indicated by HRV parameters. This study provided preliminary evidence that music therapy may be clinically useful for promoting relaxation sensation and increasing parasympathetic nervous system activity in treated cancer survivors.37 Singh VP reported that
Music and PMR are effective in reducing anxiety and dyspnoea along with physiologic measures such as SBP, PR and RR in two sessions in COPD patients hospitalized with exacerbation. However, reductions in the music group were greater compared to the PMR group.\(^{(49)}\)

![Diagram showing the process of distraction affecting preconscious and conscious levels in the brain to reduce pain, dyspnea, and anxiety.]

Fig. 2.3: shows music as a distractor which acts on preconscious and conscious levels in brain to reduce pain, dyspnea, and anxiety.

The primary objective in a previous study was to determine the effectiveness of non-pharmacological and non-invasive interventions to relieve breathlessness in participants suffering from the five most common conditions causing breathlessness in advanced disease. Authors concluded that there is a low strength of evidence for music, relaxation, counseling and support, counseling and support with breathing-relaxation training, case management and psychotherapy and further trials are needed.\(^{(50)}\) Lee reported that Music is a non-invasive, simple and inexpensive therapeutic method of improving quality of life in community-dwelling elders.\(^{(51)}\) Another study proposed that music alters mood, is a cue for movement,
and makes physical activity more enjoyable leading to improved health outcomes of weight, blood pressure, blood sugar and cardiovascular risk factor management, and improved quality of life.(52) However most of indexed literature has recommended future research based on blinded randomized trial methodology, adequate sample size and well defined replicable intervention program which had become basis for this proposal. There are many reports regarding positive effect of music therapy on anxiety, depression, quality of life and sympathetic parameters in various disease populations where as its effect on glycemic control has not been evaluated through well designed trial. Now this study will investigate efficacy of music therapy in two ways. One, it will reveal effect of music therapy over glycemic control and co-morbidities and second it will evaluate whether psychosocial morbidities like anxiety, depression are related to glycemic control. Therefore it will enhance our understanding of correlation between glycemic control and psychsocial factors.

### 2.4 Exercise Prescription

The benefits of regular exercise in patients with type 2 diabetes mellitus include improved glucose tolerance, increased insulin sensitivity, decreased HbA1C, and decreased insulin requirements. Additional exercise benefits for people with type 1 and type 2 diabetes mellitus include improvement in CVD risk factors (i.e., lipid profiles, BP, body weight, and functional capacity) and well being. Regular exercise participation may also prevent type 2 diabetes mellitus in those considered at high risk (i.e., prediabetic) for developing the disease. The general recommendations for exercise prescription apply to people with diabetes mellitus. However, the reasons for participating in an exercise program may differ among those with type 1 and type 2 diabetes mellitus. For example, a primary purpose for a person with type 1 diabetes mellitus to undertake an exercise program is often cardiovascular health/fitness related; whereas for a person with type 2 diabetes mellitus, the primary purposes are often healthy weight loss maintenance and improved glucose disposal.
The aerobic exercise training exercise prescription recommendations for those with diabetes mellitus follows: **Frequency:** 3–7 d·wk⁻¹, **Intensity:** 50%–80% VO₂R or HRR corresponding to a rating of perceived exertion (RPE) of 12 to 16 on a 6 to 20 scale. **Time:** 20–60 min·d⁻¹ continuous or accumulated in bouts of at least 10 minutes to total 150 minutes per week of moderate physical activity with additional benefits of increasing to 300 minutes or more of moderate-intensity physical activity. **Type:** Emphasize activities that use large muscle groups in a rhythmic and continuous fashion. Personal interest and desired goals of the exercise program should be considered.

Resistance training should be encouraged for people with diabetes mellitus in the absence of contraindications, retinopathy, and recent laser treatments. The recommendations for healthy persons generally apply to persons with diabetes mellitus. An optimal resistance training program should include the following components: **Frequency:** 2–3 d·wk⁻¹ with at least 48 hours separating the exercise sessions, **Intensity:** 2 to 3 sets of 8 to 12 repetitions at 60% to 80% 1-RM, **Time:** 8 to 10 multijoint exercises of all major muscle groups in the same session (whole body) or sessions split into selected muscle groups. **Type:** Given that many patients may present with comorbidities, it may be necessary to tailor the resistance-exercise prescription accordingly. Emphasize proper technique, including minimizing sustained gripping, static work, and the Valsalva maneuver to prevent an exacerbated BP response. Those without contraindications for exercise should strive to accumulate a minimum of 1,000 kcal·wk⁻¹ either through 150 min·wk⁻¹ of moderate-intensity (40%–60% VO₂R or 55%–70% age-predicted maximum heart rate [HRmax]) or 90 min·wk⁻¹ of vigorous-intensity (≥60% VO₂R or ≥70% HRmax) exercise, or some combination of moderate- and vigorous-intensity physical activity for health/fitness benefits. Moreover, no more than two
consecutive days of physical inactivity per week should be allowed. A greater emphasis should eventually be placed on vigorous-intensity exercise if cardiovascular fitness is a primary goal. On the other hand, greater amounts of moderate-intensity exercise that result in a caloric energy expenditure of $\geq 2,000$ kcal·wk$^{-1}$, including daily exercise, may be required if weight loss maintenance is the goal, as is the case for most people with type 2 diabetes mellitus. (3, 31-32)

2.4.1 Special Considerations

Hypoglycemia is the most common problem for people with diabetes mellitus who exercise and is usually only a concern in individuals taking insulin or oral hypoglycemic agents. Hypoglycemia, defined as blood glucose level $<70$ mg·dL$^{-1}$ ($<3.89$ mmol·L$^{-1}$), is relative. Rapid drops in blood glucose may occur with exercise and render patients symptomatic even in elevated glycemic states. Common symptoms associated with hypoglycemia include shakiness, weakness, abnormal sweating, nervousness, anxiety, tingling of the mouth and fingers, and hunger. Neuroglycopenic symptoms may include headache, visual disturbances, mental dullness, confusion, amnesia, seizures, and coma.

Blood glucose monitoring before and following exercise, especially when beginning or modifying the exercise program, is prudent. The timing of exercise should be considered in individuals taking insulin or hypoglycemic agents. Exercise is not recommended during peak insulin action because hypoglycemia may result. Moreover, given the risk of a delayed postexercise hypoglycemia, exercise before bed is not recommended.

However, if exercising late in the evening is necessary, an increased consumption of carbohydrates may be required to minimize the risk of nocturnal hypoglycemia. When
possible, scheduling similar timing of exercise into the daily routine may be beneficial to minimize potential hypoglycemic events.

Adjust carbohydrate intake and/or medications before and after exercise based on blood glucose levels and exercise intensity to prevent hypoglycemia associated with exercise. If pre- or postexercise blood glucose is <100 mg·dL⁻¹ (<5.55 mmol·L⁻¹), 20 to 30 g of additional carbohydrates should be ingested. Avoid injecting insulin into exercising limbs. Use an abdominal injection site instead to lower the risk of hypoglycemia associated with exercise.

Exercise with a partner or under supervision to reduce the risk of problems associated with hypoglycemic events. Hyperglycemia with or without ketosis is a concern for people with type 1 diabetes mellitus who are not in glycemic control. Common symptoms associated with hyperglycemia include polyuria, fatigue, weakness, increased thirst, and acetone breath. Patients who present with hyperglycemia, provided they feel well and have no ketone bodies present in either the blood or urine, may exercise, but they should refrain from vigorous-intensity exercise.

Dehydration resulting from polyuria, a common occurrence of hyperglycemia, may contribute to a compromised thermoregulatory response. Thus, a patient with hyperglycemia should be treated as having an elevated risk for heat illness requiring more frequent monitoring of signs and symptoms.

Patients with diabetes mellitus and retinopathy are at risk for retinal detachment and vitreous
hemorrhage associated with vigorous-intensity exercise. However, risk may be minimized by avoiding activities that dramatically elevate BP. Thus, for those with severe nonproliferative and proliferative diabetic retinopathy, vigorous-intensity aerobic and resistance exercise should be avoided. During exercise, autonomic neuropathy may cause chronotropic incompetence, a blunted systolic blood pressure (SBP) response, attenuated VO$_2$ kinetics, and anhydrosis.(23, 32)

In this situation, the following should be considered: Monitor the signs and symptoms of hypoglycemia because of the inability of the patient to recognize them. Also, monitor the signs and symptoms of silent ischemia because of the inability to perceive angina. Monitor BP following exercise to manage hypotension and hypertension associated with vigorous-intensity exercise. The HR and BP responses to exercise may be blunted. Rating of perceived exertion (RPE) should also be used to assess exercise intensity.

For the patient with peripheral neuropathy, take proper care of the feet to prevent foot ulcers. Special precautions should be taken to prevent blisters on the feet. Feet should be kept dry and the use of silica gel or air midsoles as well as polyester or blend socks should be used. Consider non–weight-bearing activities such as cycling because they may be better tolerated and aid healing. For the patient with nephropathy, although protein excretion acutely increases postexercise, there is no evidence that vigorous-intensity exercise accelerates the rate of progression of kidney disease. Although there are no current exercise intensity restrictions for patients with diabetic nephropathy, it is prudent to encourage sustainable exercise programming, which more likely includes tolerable moderate intensities.(26, 32)