Aggarwal (1962) has said, “The literature in any field forms the foundation upon which all future work will be built”.

A study of relevant literature is an essential step to get a good comprehension of what has been done with regard to the problem under study. Accordingly, the researcher has gone through available journals, books, magazines, articles, research papers and literature which is relevant to the study are presented in this chapter. The reviews of the literature have been classified under the following headings and arranged as per chronological order.

1. Studies on effect of walking on diabetes mellitus patients
2. Studies on effect of physical exercises on diabetes mellitus patients
3. Studies on effect of yogic training on diabetes mellitus patients
4. Summary of the literature.

2.1 STUDIES ON DIABETES AND WALKING

Yeater (1990) and others made a research on coronary risk factors in Type 2 diabetes: Response to low-intensity aerobic exercise. Patients with non-insulin-dependent diabetes are at greatly increased risk for coronary artery disease. Although exercise training has been shown to decrease risk factors, the presence of obesity, old age, and a sedentary lifestyle makes a high-intensity exercise program an unrealistic choice of therapy. Therefore, we examined the effect of a low-to-moderate-intensity (mean 69 per cent of maximal heart rate) walking program on lipids, glucose, insulin, glycosylated haemoglobin and cardiovascular fitness. Nine women and seven men, mean age 56, were randomly assigned to a control or an exercise group which exercised three times per week for two months. Supervised
exercise sessions consisted of 40-45 minutes of walking and/or slow jogging. Subjects continued on their usual diets. The trained group showed a significant improvement in VO2max from 1.65 to 1.95 L/min. Resting systolic blood pressure decreased from 141 to 130 mm Hg after training, and resting heart rate decreased from 88 to 81. Glycosylated haemoglobin decreased in the exercise group in seven or eight subjects and in only two of eight controls. Triglycerides decreased in the exercise group from 285 to 223 mg/dl. Body weight, total and HDL cholesterol, glucose, and insulin did not change in either group. These data indicate that a low-to-moderate level of aerobic training, independent of dietary changes, is an effective and feasible method of improving cardiovascular risk factors considering physical fitness, systolic blood pressure, plasma triglycerides, and glycemic control in non-insulin-dependent diabetic subjects.

Yamanouchi (2002) and others the effect of walking before and after breakfast on blood Glucose levels in patients with type1 diabetes treated with intensive insulin therapy. They examined the effect of walking at different timing on carbohydrate metabolism in patients with type1 diabetes. Subjects included six non-obese patients treated with intensive insulin therapy. The blood glucose profile was determined with and without walking for 30 min. before (ExAM) or after (ExAM) breakfast results: Mean blood glucose values at 07.00 h in the control, ExBM, and ExAM were 9.0, 8.0, 8.8 mM, respectively. Glucose levels gradually increased after meals up to 13.6, 15.0, and 15.3 mM respectively, at 9.00 h (0.5 h after meals). At 09.30 h, glucose levels significantly fell to 11.0 mM during walking in the ExAM (P=0.039 vs 9.00h values). The area under blood glucose response curve was significantly lower only in the ExAM when compared with that in the control (P=0.043) (11.8, 17.8, and 3.8 mM in the control, ExBM and ExAM, respectively) Concluded that These results might suggest that walking after meals improves glycemic control in patients with type1 diabetes being treated with intensive insulin therapy consisting of the basal-Bolus (NPH-human regular) insulin regimen.
Streja and Mymin (1979) designed a study on moderate exercise and high-density lipoprotein-cholesterol. Observations were made during a cardiac rehabilitation program. The effects of a 13-week moderate exercise program on fasting plasma insulin, lipids, and lipoprotein cholesterol concentrations were studied in 32 sedentary, middle-aged men with coronary artery disease. The preponderant component of the exercise program was walking or slow jogging. There was no significant change in the systolic blood pressure and pulse rate product response to a standard exercise load. The high-density lipoprotein-cholesterol (HDL-C) level increased and the fasting plasma insulin concentration decreased. There were no significant changes in plasma triglycerides or low-density lipoprotein cholesterol levels. In sedentary subjects with coronary artery disease, a moderate increase in activity can result in an increase in the HDL-C level and a decrease in the plasma insulin concentration. These changes occurred in the absence of variations in diet, smoking habits, adiposity, or plasma glyceride concentrations and did not require a cardiovascular training effect.

Hubinger and Mackinnon (1996) made an attempt to find out the effect of endurance training on lipoprotein levels in middle-aged males. Serum lipoprotein (a) levels were measured before and after a 12-wk program of moderate-intensity endurance training. The training program consisted of walking and/or jogging, at least three sessions/wk-1 of at least 30 min duration, at an intensity producing 60-85% HR max reserve. Twenty-eight previously sedentary middle-aged Caucasian males matched for age, body mass and body mass index (BMI) were randomly allocated to either an exercise (N=17, mean age+/SEM=51.57+/1.25 yr) or a control (N=11, mean age+/SEM=50.0+/1.15 yr) group. Pre- and post-training median Lp(a) levels, measured by immune turbidimetric analysis, were not significantly different in either the exercise (pre 13.0, post 15.0 mg.dl-1) or the control subjects (pre 14.0, post 12.0 mg.dl-1) (P>0.05). Kendall Rank correlation analysis revealed no significant relationship between the level of Lp(a) and any
other variable in either group before and after training. In the exercises, a significant increase (P<0.05) was recorded in the estimated mean VO2 max (pre 33.39 +/- 1.70, post 37.7+1.75 ml.kg-1 min-1). These data indicate that the level of Lp(a) was not influenced by a 12-wk program of moderate-intensity endurance training and are consistent with previous reports suggesting that Lp(a) levels not altered by lifestyle factors.

**Irwin (2003)** and others conducted a study to find out the effect of exercise on total and intra-abdominal body fat in postmenopausal women: a randomized trial. Context: The increasing prevalence of obesity is a major public health concern. Physical activity may promote weight and body fat loss. Objective: To examine the effects of exercise on total and intra-abdominal body fat overall and by level of exercise. Design: Randomized controlled trial conducted from 1997 to 2001. Setting and Participants: A total of 173 sedentary, overweight (body mass index>=24.0 And >33% body fat), postmenopausal women aged 50 to 75 years who were living in the Seattle, Wash, area. Intervention: Participants were randomly assigned to an intervention consisting of exercise facility and home based moderate-intensity exercise (n=87) or a stretching control group (n=86). Main Outcome Measure: Changes in body weight and waist and hip circumferences at 3 and 12 months; total body, intra-abdominal, and subcutaneous abdominal fat at 12 months. Results: Twelve-month data were available for 168 women. Women in the exercise group participated in moderate-intensity sports/recreational activity for a mean (SD) of 3.5 (1.2) d/wk for 176 (91) min/wk. Walking was the most frequently reported activity. Exercisers showed statistically significant differences from controls in baseline to 12-month changes in body weight(-1.4 kg; 95% confidence interval [CI], -2.5 to -0.3 kg), total body fat (-1.0%, 95% CI, -1.6% to -0.4%), intra-abdominal fat (-8.6 g/cm2; 95%CI,-17.8 to 0.9 g/cm2), and subcutaneous abdominal fat (-28.8 g/cm2); 95% CI, -47.5 to -10.0 g/cm2). A significant dose response for greater body fat loss was observed with increasing duration of exercise.
Conclusions: Regular exercise such as brisk walking results in reduced body weight and body fat among overweight and obese postmenopausal women.

Irwin M.L., (2003) examined the increasing prevalence of obesity is a major public health concern. Physical activity may promote weight and body loss. To examine the effects of exercise on total and intra abdominal body fat overall and by level of exercise. Randomized controlled trial conducted from 1997 to 2001. a total of 173 sedentary, overweight (body mass index ≥ 24.0 and >33 body fat), postmenopausal women aged 0 to 7 years who were living in the Seattle, Washington, and participants were randomly assigned to an intervention consisting of exercise facility and home based moderate intensity exercise (n 87) or a stretching control group (8). Changes in body weight and waist and hip circumferences at 3 and 12 months; total body, intra abdominal, and subcutaneous abdominal fat at 12 months. Twelve month data were available for 18 women. Women in the exercise group participated in moderate intensity sports/recreational activity for a mean (SD) of 3. (1.2) d/wk for 17 (91) min/wk. Walking was the most frequently reported activity. Exercises showed statistically significant differences from controls in baseline to 12 month changes in body weight (-1.4 kg; 95 confidence interval [CI], -2. to -0.3 kg), total body fat (-1.0, 95 CI, -1. to -0.4 ) intra abdominal fat (8. g/cm2; 9 CI, -47. to -10.0 g/cm2 ). A significant dose response for greater body fat loss was observed with increasing duration of exercise. Regular exercise such as brisk walking results in reduced body weight and body fat among overweight and obese postmenopausal women.

Doggrell SA, (2002) observed that diabetes mellitus is now occurring in epidemic proportions in many countries. Owing to the limited effectiveness of drug prophylaxis of diabetic complications after diabetic complications after diabetes has developed, it may be more appropriate to investigate ways to prevent the onset of diabetes. A recent trial published about the Diabetes Prevention Programme Research Group investigated whether lifestyle changes or metformin.
were effective in delaying the onset of diabetes in subjects with impaired glucose tolerance. The goals of the intensive intervention were to achieve and maintain a weight reduction of 7 through a low calorie, low fat diet and to engage in physical activity of moderate intensity, such as brisk walking, for at least 150 Min/week. The effectiveness of the intensive lifestyle intervention on body weight was initially quite good but decreased over time. Metformin caused some weight loss but to a lesser extent than the intensive lifestyle intervention. Both therapies decreased the fasting plasma glucose levels to a similar extent initially. The intensive lifestyle intervention decreased plasma glycosylated haemoglobin levels to a greater extent than metformin. Both intensive lifestyle intervention having the greater effect.

**T. Paillard, (2002)** examined the effects of a walking training programme, that were assessed on healthy, active men aged 63-69. Phospho lipids, pulse and blood pressure maximum oxygen consumption (vo2 max) and anthropometrics were measured before and after this programme. There was a significant fall in LDL and diastolic BP. There was also a significant loss of body fat. These position of physiological effects suggest that brisk walking can be considered as a useful activity for improve the fitness and general health in this age-range.

**Y. Shin (1999)** examined exercise is an important strategy for preventing chronic diseases and promoting the health of older age. The purpose of this research was to evaluate the effects of an out door walking exercise program on the cardio respiratory function, the flexibility, and the emotional state of elderly Korean women. An experimental groups, control group, pre- test, post-test design was used to measure the effects of the exercise program. The subjects were 27 females between the ages of 60 and 75 years. The intensity the walking program was 40-60 minutes, targeting heart –rate with a duration of 50-60 min, 3 times [per week at an outdoor track for 8 weeks. The result of the program was assessed by maximal oxygen uptake (VO2 max), resting pulse rate, blood pressure, the ‘Sit and Reach test ‘ for flexibility, and the Profile and Mood test for emotional state. Physical
function and the emotional state of the experimental group improved significantly more than the control group. The Vo2 max and the flexibility of the elder women in the experimental group progressively improved as the duration of the exercise period. The results of this study suggest a practical and easy method of exercise to enhance the health of older women.

Testermann (1985) conducted a study on training and detraining effect on selected physiological fitness in adult black women. Pre, post and detraining post measuring were made on body weight, heart rate blood pressure, sum of skin fold and predicted VO2 max. The study was conducted in 4 stages, 2 training stages and 2 detraining. Training was either by walking, jogging or aerobic dance, 3 times per week, over 11 to 12 weeks. One detraining period was for 10 weeks, a second period for 15 weeks. Data were analyzed by factorial ANOVA, predicted Vo2 max was significantly increase after training and was either maintained or reduced back to pre training levels through detraining. Skinfold thickness were significantly reduced following training and after detraining either systolic and diastolic blood pressure underwent to changes from training through the detraining period.

John (2009) et al conducted a study on effect of 7 days training on insulin sensitivity and responsiveness in type 2 diabetes mellitus. Fourteen obese with type2 diabetes, aged 62-64, underwent a two stage hyper insulminemic euglycemic clamp procedure, together with a glucose infusion, before and after 7 days of exercise. The training consisted of 30 min of cycling and 30 min of treadmill walking at approximately 70% of maximal aerobic capacity daily for 7 days. The result showed that one week of vigorous exercise training can induce significant improvements in insulin action in type II diabetes.

George Cheyne (1994) recommended walking is the most natural and most useful exercise. He also advocated exercises in the open air to promote perspiration and improve circulation. Walking is a moderate intensity exercise. It has been shown to have significant benefits and minimal associated risks. As long as there are no
contradictions, the benefits of walking almost certainly outweigh the risks in the majority of people with diabetes. Before recommending that diabetic patients began an exercise program more vigorous than a brisk walk, the clinician should evaluate patients for potential conditions that may predispose to injury or that require treatment.

Praet et al., (2008) compared the clinical benefits of a twelve month exercise intervention programme consisting of either brisk walking or a medical fitness programme in type II diabetes patients. We randomized 92 type II diabetes patients to either three times a week of 60 min brisk walking or medical fitness programme. Primary outcome was the difference in changes in blood pressure, plasma lipid concentrations, insulin sensitivity, body composition, physical fitness, programme adherence rate and health related quality of life. It was concluded that, equally effective intervention to modulate glycemic control and cardiovascular risk profile in type II baseline examination during 1970-2002 and were followed for hypertension incidence. It was concluded that, physical activity was associated with lower risk of developing hypertension in a graded fashion.

Williams (2008) determined the dose response relationships of fitness to incident hypertension, hypercholesterolemia, and diabetes independent of activity. Self reported physician, diagnosed incident diabetes, hypercholesterolemia, and hypertension were compared to baseline running distance in 29,139 men and 11,985 women followed prospectively for, 7.7 and 7.4 yr, respectively. It was conclude that, higher cardio respiratory fitness reduces the odds for, hypercholesterolemia, and diabetes, independent of physical activity and is an important risk factor separate from physical activity improve insulin resistance and to prevent diabetic complications.

Davenport et.al (2008) developed to document the effectiveness of a structured low intensity walking protocol on capillary glucose control in GDM
women. Ten GDM women followed conventional management of diet and insulin therapy, plus a low intensity walking programme (W) from diagnosis to delivery. Capillary glucose concentrations, insulin requirements and pregnancy outcomes were compared with a matched cohort by body mass index (BMI), age and insulin usage (20 GDM women who followed conventional management alone (C). It was concluded that, an effective role in glucose regulation for this structured walking programme.

Oshida et al. (2006) discussed the exercise therapy for aged diabetic peoples. The purposes of exercise therapy for diabetes are to improve insulin resistance and to prevent diabetic complications. At first, mild exercises (walking, cycling and swimming) which enhances insulin signaling pathway, is recommended after medical checkups. At first, mild aerobic exercise (walking, cycling and swimming), which enhances insulin signaling pathway, is recommended after medical checkups. If aerobic exercise alone is not effective, the combination of aerobic and resistance training could be considered. The resistance training increases skeletal muscle volume and strength. This combination therapy would bring about not only improvement of insulin resistance but also restoration of quality of life for aged diabetic subjects.

Kriska (2003) demonstrated that physical activity plays an important role in type II diabetes prevention. Their activity goals resembled public health recommendations; 150 min weekly of moderate intensity physical activity (brisk walking). The flexibility of this goal will make it easier to adopt by individuals of all ages and backgrounds and has the potential for being maintained overtime.

Albright et al. (2000) discusse exercise an type II diabetes. Physical activity, including appropriate endurance and resistance training, is a major therapeutic modality for type II diabetes. Individuals with type II diabetes should strive to achieve a minimum cumulative total of 1000 calories/week from physical activities. Those
with type II diabetes generally have a lower level of fitness (VO2 max) than non-diabetic individuals. Although walking may be the most convenient low impact mode, some persons, because of peripheral diabetes patients when compared with more individualized medical fitness programmers.

2.2 STUDIES ON DIABETES AND PHYSICAL EXERCISES

Santeusanio (2003) and others made a study on diabetes and exercise. Physical activity has acute and chronic effects on glucose, lipid and protein metabolism. Long-term effects of regular exercise are particularly advantageous for Type 2 diabetic patients. Regular aerobic exercise reduces visceral fat mass and body weight without decreasing lean body mass, ameliorates insulin sensitivity, glucose and BP control, lipid profile and reduces the cardiovascular risk. For these reasons, regular aerobic physical activity must be considered as an essential component of the cure of Type 2 diabetes mellitus. In this regard, individual behavioral strategies have been documented to be effective in motivating sedentary Type 2 diabetic subjects to the adoption and the maintenance of regular physical activity. In Type 1 diabetic subjects, the lack of the physiological inhibition of insulin secretion during exercise results in a potential risk of hypoglycemia. On the other hand, exercise-induced activation of counter-regulatory hormones might trigger an acute metabolic derangement in severe insulin-deficient subjects. Thus, diabetic patients, before starting exercise sessions, must be carefully educated about the consequences of physical activity on their blood glucose and the appropriate modifications of diet and insulin therapy.

Tokmakidis (2004) and others conducted a study to find out the effects of a combined strength and aerobic exercise program on glucose control and insulin action in women with type 2 diabetes. The purpose of the present study was to investigate the short-term effects and long-term effects of a combined strength and aerobic training program on glycemic control, insulin action, exercise capacity
and muscular strength in postmenopausal women with type 2 diabetes. Nine postmenopausal women, aged 55.2 (6.7) years, with type 2 diabetes participated in a supervised training program for four months consisting of two strength training sessions (3 sets of 12 repetitions at 60% one-repetition maximum strength) and two aerobic training sessions (60%-70% of maximum heart rate at the beginning, and 70%-80% of maximum heart rate after two months). Anthropometrical measurements, percentage glycated haemoglobin, a two hour oral glucose tolerance test, exercise stress testing and maximum strength were measured at the beginning, and after 4 and 16 weeks of the exercise program. Significant reductions were observed in both the glucose (8.1 per cent P<0.01) and insulin areas under the curve (20.7%, P<0.05) after 4 weeks of training. These adaptations further improved after 16 weeks (glucose 12.5%, insulin 38%, P<0.001) of exercise training. Glycated haemoglobin was significantly decreased after 4 weeks [7.7(1.7) vs 7.1(1.3) %, P<0.05] and after 16 weeks [7.7(1.7) vs 6.99(1.0)% , P<0.01] of exercise training. Furthermore, exercise time and muscular strength significantly improved after 4 weeks (P<0.01) as well as after 16 weeks (P<0.001) of training. Body mass and body-mass index, however, were not significantly altered throughout the study. The results indicated that a combined training program of strength and aerobic exercise could induce positive adaptations on glucose control, insulin action, muscular strength and exercise tolerance in women with type 2 diabetes.

Mathieu Marie Eve, Brochu, Martin, Beliveau Louise (1999) conducted the changes in physical activity practice, fitness and Metabolic syndrome in type 2 diabetic patients. After 10-week physical activity programme on 39 subjects, measurements was taken for Physical activity level, aerobic capacity, hand grip strength, dynamic balance, anthropometry, resting heart rate blood pressure, fasting blood lipids and glucose, and metabolic syndrome. A significant increase in physical activity practice was observed after 10-week program, significant increases in aerobic capacity, muscular strength and cholesterol were observed post intervention.
After the program, significant reductions in body weight, waist circumference, skin folds thickness, resting heart rate, and systolic blood pressure were reported and concluded that overall a reduction in the prevalence of metabolic syndrome was measured post intervention.

A group of Swedish doctors (2002) released a study that shows diet and exercise can not only prevent diabetes, they can actually reverse it once started. The subjects were given advice on limiting fats and cholesterol in their diets and put on a regular aerobic exercise programme. For the first two years of the study, the men were given blood and fitness tests every six months, then the interval was lengthened to a year for three more years. The results were so encouraging that almost none of the men dropped out of the study. And the benefits lasted the whole five years, as long as they kept exercising and eating right. Over half of the glucose intolerant men regained normal sugar sensitivity and none of them progressed to diabetes.

In another study they found that the most active men (burning at least 3500 calories in activity per week) were half as likely to develop diabetes as the most sedentary (expending less than 500 calories in activity). Those who participated in strenuous sports, such as swimming, running, or tennis had the lowest risk of developing diabetes. And, those people at highest risk for developing diabetes were found to benefit the most from exercise. Women, who exercised vigorously at least once a week, were significantly less likely to develop diabetes. The protective effect of exercise was due only in part of its effects on weight control.

The researchers found an independent beneficial effect of exercise among obese and non-obese women, older and younger women, as well as among those with a family history of diabetes and those without. Keeping your weight down, avoiding high fat and cholesterol in your diet and exercising regularly, may keep you away from developing diabetes. For a diabetic, aerobic exercises are of great benefit. Aerobic is a system of any exercising by means of such rhythmic activities
as walking, swimming, cycling that aim to improve physical fitness through increased oxygen intake. Regular exercising is a boon for an obese diabetic, since energy expenditure during exercises help in weight reduction. Physical activity is another confounder in the assessment of effects of aging on carbohydrate metabolism. fit elderly people have less body fat and less central adiposity. When insulin action was assessed using a glycemic clamp, the degrees of physical fitness and of central obesity (body fat distribution) were the most important predictors of the degree of insulin resistance observed, and age was not an important predictor. Physically active people are also more insulin sensitive. High resistance exercises using weights are acceptable for young persons with diabetes but not for older adults and those with long standing diabetes.

Lyerly et al. (2008) examined the association between exercise ECG responses and mortality in 2854 men with diabetes mellitus (mean age 49.5) who completed a maximal treadmill exercise test during the period from 1974 to 2001 and who were without a previous cardiovascular disease (CVD) event at baseline. Mortality due to all causes, CHD, and CVD were the main outcome measures across categories of exercise ECG responses, with stratification by cardio respiratory fitness, quantified as treadmill test duration. It was concluded that, among men with diabetes mellitus, equivocal and abnormal exercise ECG responses were associated with higher risk of all cause, CVD and CHD mortality.

Williams (2007) examined the relationship between changes in reported vigorous exercise and self reported physician diagnosed diabetes in 25,988 active men. The dose response relationship between changes in reported vigorous exercise (running distance, change in kilometers per week) and self reported physician diagnosed diabetes was followed prospectively for 7.8 +/- 1.8 years (mean +/- SD). It was concluded that, vigorous exercise significantly reduces diabetes incidence, due in part to the prevention of age related weight gain and in part to other exercise effects.
Lazarevic et al. (2006) investigated the effects of regular physical exercise on glycemic control, insulin resistance, cardiovascular risk and oxidative stress defense parameters in overweight and obese type II diabetic patients. It was concluded that, regular physical exercise has beneficial effects on glycemic control, insulin resistance, cardiovascular risk, oxidative stress defense parameters in overweight and obese type II diabetes.

Weinstein et al. (2005) examined the relative contributions and joint association of physical activity and BMI with diabetes. Prospective cohort study of 37878 women free of cardiovascular disease, cancer, and diabetes with 6.9 years of mean follow up. Weight, height and recreational activities were reported at study entry. The result showed that, although BMI and physical inactivity are independent predictors of incident diabetes, the magnitude of the association with BMI was greater than with physical activity in combined analyses.

Sato et al; (2003) analyzed the beneficial effects of physical exercise on the decreased insulin sensitivity caused by detrimental lifestyle were reviewed based on experimental evidences. The major purpose of physical exercise for primary prevention and treatment of lifestyle related diseases is to improve insulin sensitivity. It is known that, during physical exercise, glucose uptake by the working muscles rises 7 to 20 times over the basal level, depending on the intensity of the work performed. It was found that, combined with other forms of therapy, mild exercise training increases insulin action despite no influence on body mass index or maximal oxygen uptake.

Kumagai et al; (2002) investigated the relationships among the resting systolic (SBP) and diastolic blood pressure (DBP) response during exercise with insulin resistance evaluated by a homeostasis model, abdominal fat accumulation (visceral fat area), subcutaneous fat area by computed tomography (CT), and an estimation of the maximal oxygen uptake (VO2 Max) in 63 japanese middle aged
male patients with type II diabetes mellitus (type II DM). The result showed that, insulin resistance was suggested to be independently associated with the resting DBP and SBP response to standardized exercise intensity in type II DM Patients.

Wei et al; (2000), evaluated the association of physical activity and cardio respiratory fitness with mortality in men with type II diabetes. 1263 men with type II diabetes who received a thorough medical examination between 1970 and 1993 were selected as subjects. It was concluded that, low cardio respiratory fitness and physical inactivity are independent predictors of all cause mortality in men with type II diabetes. Physicians should encourage patients with type II diabetes to participate regular physical activity and improve cardio respiratory fitness.

Hordern et al ; (2008) , determined the effects of a 4-week exercise training intervention on blood glucose, insulin sensitivity, BMI and cardio respiratory fitness in patients with type II Diabetes, and to identify and establish criteria for patients who are more likely to improve their blood glucose from short term exercise training. BMI, waist circumference, blood pressure, blood lipid profile, blood glucose,insulin, insulin sensitivity and QUICKI, beta –cell function, and VO2max were measured at baseline and at 4 weeks. It was concluded that, apparently healthy patients with type II diabetes, a 4-week exercise intervention improved cardio respiratory fitness. BMI and triacylglycerols. Elevated blood glucose and HbA1c predicted improvements in blood glucose.

Bordenave et al; (2008), quantified the magnitude of changes in insulin sensitivity (S (I0) And glucose effectiveness (S(G) ) in response to acute exercise in type II diabetic (T2D) patients, as previously studied in non –diabetic subjects. Seven T2D patients and seven non-diabetic controls participated in the study. The result indicated that, a single bout of exercise at moderate intensity in type II diabetics did not improve S(G) but markedly improved the low S(I) values found in these patient , indicating that the acute effects of exercise on S(I) are quantitatively
important in the interpretation of training–related S(I) changes and may even be therapeutically useful on their own. Surrogates such as homeostasis model assessment (HOMA) and quantitative insulin sensitivity check index (QUICKI) were not sensitive enough to detect this increase in S(I) and should probably be used with caution in the follow up of exercise protocols in diabetic patients.

**Lima et al; (2008)**, verified the occurrence of post-exercise hypotension (PEH) in type II diabetics (DM (2)) and the effects of exercise intensity on post exercise blood pressure (BP). Eleven men and women with DM (2) of fasting blood glucose and 126 +/- 10/75 +/- 7 mm Hg of resting BP performed an incremental test (IT) for cardiovascular evaluation and anaerobic threshold (AT) determination. Then, participants randomly underwent 2 exercise sessions (90 and 110 AT) and a control session (CON). In all sessions, BP was measured at resting, during 20 min of exercise / control and at each 15 min through 120 min of post–exercise recovery (R15-R120). It was concluded that, both exercise intensities evoked reductions in SBP while DBP and MAP were reduced only after 110. Despite the higher intensity exercise to be more effective in promoting BP reductions, we suggest caution while prescribing exercise for DM type II.

**Gaesser (2007)**, determined the role of exercise as a cornerstone in prevention and treatment of cardiovascular disease (CVD), type II diabetes (T2D), and the metabolic syndrome. Physical activity and cardio respiratory fitness are also associated with reduced mortality rates among persons with CVD, T2D, and metabolic syndrome. Exercise has definite acute effects on a number of risk markers for CVD and T2D, in addition to more substantial benefits with chronic training. It was concluded that, both aerobic and resistance exercise have therapeutic value, largely independent of weight loss, and should be included in exercise programmes.

**Schafer et al; (2007)**, determined lifestyle intervention is effective in the prevention of type II diabetes individuals with impaired glucose tolerance (IGT).
Data from 181 subjects (133 with NGT and at risk for type II diabetes and 48 with IGT) who participated in the Lifestyle Intervention Programme with increase in physical activity and decrease in caloric intake were included into this study. Body fat distribution was quantified by whole body magnetic resonance (MR) tomography and liver fat and intra myocellular fat by (1) H-MR spectroscopy. It was concluded that, moderate weight loss under a lifestyle intervention with reduction in total, visceral and ectopic fat and increase in insulin sensitivity improves glucose tolerance in individuals with IGT but not with NGT. In individuals with NGT, the beneficial effects of a lifestyle intervention on fat distribution and insulin sensitivity possibly prevent future deterioration in glucose tolerance.

Raguso et al; (2007), investigated the impact of lifestyle programmes, including diet and physical training, on the incidence of diabetes, confirming physical exercise as a corner stone in the strategy of the prevention and treatment of type II diabetes. Although public health recommendations regarding regular physical activity are available, however often little is done by governments to implement them. Finally, the general practitioner is pivotal in counseling patients regarding their lifestyle and therefore in affecting a large number of people.

De Feoet et al; (2006) discussed exercise and diabetes. Regular aerobic exercise reduces of visceral fat mass and body weight without decreasing lean body mass ameliorates insulin sensitivity, glucose and blood pressure control, lipid profile and reduce the cardiovascular risk. For these reasons, regular aerobic physical activity must be considered an essential component of the cure of type II diabetes mellitus. In this regard, individual behavioral strategies have been documented to be effective in motivating sedentary type II diabetic subjects to the adoption and the maintenance of regular physical activity.

Bassuk et al; (2005), studied that physically active individuals have a 30-50% lower risk of developing type II diabetes than do sedentary persons and that physical
activity confers a similar risk reduction for coronary heart disease. Protective mechanisms of physical activity include the regulation of body weight, the reduction of insulin resistance, hyper tension, atherogenic dyslipidemia, and inflammation and the enhancement of insulin sensitivity, glycemic control, and fibrinolitic and endothelial function. It was concluded that, moderate increases in physical activity may offer the best balance between efficacy and feasibility to improve cardiovascular health and metabolic condition in largely sedentary populations.

**Stewart K.J. (2004)**, conducted a study on Role of exercise training on cardiovascular disease in persons who have type II diabetes and hypertension. Exercise training is an essential component in the medical management of patients who have type II diabetes and hypertension. Exercise training reduces total and abdominal fat, which mediate improvements in insulin sensitivity and blood pressure, and possibly, endothelial function. Exercise programmes can establish individualized exercise prescriptions and provide an environment that is conductive for “lifestyle change” that underlies long term compliance to exercise and risk factor modification.

**Flemming Dela, et al; (2004)**, studied physical training changes B-cell function in type II diabetic patients. In healthy young subjects, training increases insulin sensitivity but decreases the capacity to secrete insulin. Patients, stratified into moderate and low secretors according to individual C-peptide response to an intravenous glucagons test, were randomly assigned to a training programme (ergometer cycling 30-40 min /day, including at least 20 min at 75% maximum oxygen consumption (VO2 max), 5 days /week for 3 months )or a sedentary schedule. Before and after the intervention (16 hr after last training bout), a sequential hyperglycemic (90 min at 11,18, and 25 min ) clamp was performed. An intravenous bolus of 5 g of arginine was given at the end. Training increased VO2 max17+/−13/ and decreased heart rate during sub maximal exercise (P<0.05). During the 3 months of sedentary lifestyle insulin and C-peptide responses to the
clamp procedures were unchanged in both moderate and low secretors. Likewise, no change in B-cell response was seen after training in the low secretors (n=5). In contrast, moderate secretors (n=9) showed significant increases in B-cell responses to 18 and 25 mm hyperglycemia and to arginine stimulation. Glucagon responses to arginine as well as measures of insulin sensitivity and HbA1c levels were not altered by training. In conclusion, in type II diabetic patients, training may enhance B-cell function if remaining secretary capacity is moderate but not if it is low. The improved B-cell function does not require changes in insulin sensitivity and HbA1c concentration.

Fenicchia, et al; (2004), conducted a study on the effects of acute and chronic resistance training on glucose and insulin responses to women with type II diabetes. Subjects consisted of type II diabetic women (n=7) and age matched control (n=8) with normal glucose tolerance. All subjects participated in 3 oral glucose tolerance tests: pre training, 12 to 24 hours after the first exercise session (acute) and 60 to 72 hours after the final training session (chronic). Exercise training consisted of a whole body resistance exercise programme using weight lifting machines 3 days per week for 6 weeks. Resistance training was effective in increasing strength of all muscle groups in all subjects. Integrated glucose concentration expressed as area under the curve (AUC) was 3,550.0+/- 324.6 nmol/L min pre training, improved significantly (P<.01) after the acute bout of exercise (2,868+/-324.0nmol/L), but was not improved with chronic training (3,206.0+/-337.0nmol/L) in diabetic subjects. A similar pattern of significance was observed with peak glucose concentration (pre : 20.2+/- 1.4 nmol/L. acute 17.2+/- 1.7 nmol/L : chronic : 19.9+/- 1.7nmol/L). There were no significant changes in insulin concentrations after any exercise bout in the diabetic subjects. There were no changes in glucose or insulin levels in control subjects. An acute bout of resistance exercise was effective in improving integrated glucose concentration in women with type II diabetes, but not age matched controls. There was no significant changes
in insulin concentrations for either group. Resistance exercise offers an alternative to aerobic exercise for improving glucose control in diabetic patients. To realize optimal glucose control benefits, individuals must follow a regular schedule that includes daily exercises.

2.3 STUDIES ON DIABETES AND YOGA

Malhotra et al; (2005), were conducted a study,20 patients with type II diabetes were put on a 40 days yoga routine taught by an expert yoga teacher. The postures performed were suryanamaskar (sun salutation), Trikonasana (triangle pose), Tadasana (mountain pose), Sukhasana (easy pose), Padmasana (lotus pose), Bhashrika pranayama (breathing exercise), Paschimothanasana, (posterior stretch), Ardhamatsyendrasana (half spine twist) Pawan muktasana (joint series), Bhujangasana (cobra pose), Vajrasana (thunder pose), Dhanurasana (bow pose) and Shavasana (corpse pose). At the end of the 40 days of performing the asanas, on average the study participants had a decrease in fasting glucose levels, a significant decrease in waist-hip ratio and beneficial change in insulin levels. Practicing and performing yoga postures as part of a regular exercise routine may further help in diabetics to increase insulin sensitivity and attain normal glucose metabolism.

Jothipriya (2001) studied the effect of selected yogic asanas, pranayama and meditation on low back pain and physiological variables of female University students. For this purpose twenty students were randomly assigned to two groups. Group I, Control, Group II: Experimental. Control group was not involved in any specific training. Subjects in each group were trained with respective programmes for a period of eight weeks, six days a week, the training session lasted for 1.30 hours, prior to and at the end of training period all subjects tested were hip flexibility and physiological variables like systolic pressure, diastolic pressure, pulse rate and respiratory rate. The experimental group showed significant improvement on hip flexibility and abdominal strength (Sit and reach and Sit –ups) and range of pain
was significantly decreased. Experimental group showed significant improvement on systolic pressure, pulse rate, respiratory rate and but diastolic pressures showed no significant difference in experimental group.

**Manchanda et al., (2000)** evaluated the possible role of lifestyle modification incorporating yoga on retardation of coronary atherosclerotic disease. In this prospective randomized, controlled trial, 42 men with angiographically proven coronary artery disease (CAD) were randomized to control (n = 21) and yoga intervention group (n = 21) and were followed for one year. The active group was treated with user-friendly programme consisting of yoga, control of risk factors, diet control and moderate aerobic exercise. The control group was managed by conventional methods i.e. risk factor control and American Heart Step I diet. After one year, the yoga groups showed significant reduction in number of anginal episodes per week, improve exercise capacity and decrease in body weight Serum total cholesterol, LDL cholesterol and triglyceride levels also showed greater reductions as compared with control group.

**Dengel et al., (1998)** studied effect of Yoga therapy on Obesity and Lipid profile. Twenty five obese individuals were included in thus study, majority of them 21, i.e., 84 were females and four i. e., and 16 were males. The mean age was 41 years. Control group appreciable improvement in blood lipid levels in the study group. Main fall in serum cholesterol was 26.5 mg (12.43.% ) and that in serum triglycerides, it was 22.82 mg % (14.98%). Similarly there was a significant fall in low density lipoproteins (LDL)which was 17.73 % and that in very low density lipoproteins (VLDL) was 12.83 % also a significant fall in fasting blood sugar values was noted in the selected subjects with mean reduction being 38.5 mg % ie.28 %.

**Telleset al., (1997)** conducted a group of healthy who were performing yoga and age matched controls were compared in this study. The examination included
bio-chemical, hematological and ventilatory function tests. At the end of an hour daily for six months both groups showed a significant decrease in blood sugar with increase in plasma protein specially albumin, slowing of pulse rate, corrective improvement in hematological values were noted in this study. Mid expiratory flow rate was found to have appreciable improvement in majority of the patients.

Nayaer M.S (1986) et al, investigated the effects of yogic exercises on human physical efficiency. The studies were conducted on 53 cadets of national defence academy. The parameters of assessment included ventilation, minute volume of respiration, oxygen consumption, pulse rate and blood pressure, mechanical efficiency and maximum oxygen uptake. Four additional assessments were made under resting condition viz, vital capacity (VC), maximum, breathing capacity (MBC) forced expiratory volume (FFVB 10 sec) and breath holding time. All the three groups showed significant decrease in pulse rate during exercises. The yogic group in addition recorded a highly significant increase in breath holding time. The remaining two groups recorded only significant increase in VC, ventilation, minute volume, rate of respiration, blood pressure mechanical efficiency, maximum oxygen uptake capacity and MBC remained unaltered in all the three groups.

Sahay BK, Murthy KJR, Raju PS (1991) et al, studied the effect of yogic practices on the exercise tolerance in diabetes. After three months well designed exercise program, the benefits include a reduction in body weight, normalization of glucose tolerance, an increase in maximal oxygen uptake, reduction in blood pressure, and preservation of the early responsiveness to glucose loading were concluded.

Robin Monroe, Joyce Power, Anil Comer, Nagarthna R, Dan Dona P (2004) conducted a study, the potential of yoga therapy as an aid to the management of non-insulin–dependent diabetes mellitus. The study were conducted 21 patients with NIDDM, 13 were take medication, the remainder were on diet alone. The yoga group was offered five yoga classes per week for twelve weeks. Fasting blood
glucose and glycated haemoglobin (HbAIC) were assayed Before and after 12 weeks of yoga. They concluded that both FPG and HbAIC improved significantly in the yoga group, compared to the controls.

2.4 SUMMARY OF THE LITERATURE

The reviews are presented under three sections such as studies on diabetes and walking, diabetes and physical exercises, diabetes and yoga in chronological order. All the research studies presented in this section proved that walking, physical exercises and yoga programmes contribute significantly for better preventive process of diabetic diseases. The research studies reviewed are from books, journals and available websites such as www. Pubmed. Com, diabetologica website etcetera.