EXERCISE FOR PATIENT WITH TYPE 2 DIABETES MELLITUS: 
A LITERATURE REVIEW

Madiha Mukhtar*, Sonia Hadiyanti*, Rifka Pahlevi*
Program Study Master Degree Of Nursing
Nursing Faculty, University Of Airlangga
mukhtar_maha@yahoo.com; sonia_hadiyanti@yahoo.com; rifkapahlevi@gmail.com

ABSTRACT
Introduction: Diabetes Mellitus (DM) is a group of metabolic diseases with characteristic hyperglycemia that occurs due to abnormalities in insulin secretion, insulin action or both. Hyperglycemia in the long term can lead to damage to blood vessels which blood vessels become narrowed causing organ damage such as kidney failure, diabetic retinopathy and diabetic foot as a result of blood vessels and nerve lesion, coronary heart disease, to stroke. One of the Diabetes Mellitus management is exercise. Based on the latest research, exercise had significant effect to type 2 Diabetes Mellitus. The aimed of this study was to examine the literature, journal articles and research related to exercise for type 2 Diabetes Mellitus. Method: This was a literature review from database of national and international journals in google scholar, Pubmed, Science Direct and Plos one with research topics restricted from 2010 to 2015 by using keywords. Result: There were 11 articles were selected that met the criteria. Most of the aerobic exercise based studies showed a beneficial effect in type 2 DM. Resistance exercise also proved to have positive effect on type 2 DM patients. Discussion: Aerobic exercise is more common in clinical practice compared to resistance exercise in managing T2DM.

Keyword: exercise, physical activity, aerobic, resistance, type 2 Diabetes mellitus

INTRODUCTION
Diabetes Mellitus (DM) is a group of metabolic diseases with characteristic hyperglycemia that occurs due to abnormalities in insulin secretion, insulin action or both (American Diabetes Association, 2010). In the conditions of hyperglycemia, glucose transport across the cell membrane is reduced and the formation of glycogen from glucose (gluconeogenesis) is reduced but still there is excess glucose in the blood (Long, 1996). Blood glucose levels in diabetic patient is at a level that exceeds the normal limit is ≥126 mg / dL for fasting blood glucose levels and ≥200 mg / dl for random blood glucose levels (American Diabetes Association, 2011). Hyperglycemia in the long term can lead to damage to blood vessels which blood vessels become narrowed causing organ damage such as kidney failure, diabetic retinopathy and diabetic foot as a result of blood vessels and nerve lesion, coronary heart disease, to stroke (PERKENI, 2011).

According to data from the WHO in 2000 the number of diabetic patients in the world (over age 20) amounted to 150 million people with an estimated in 2025 would be 300 million people. International Diabetic Federation (IDF) in 2007, estimates that the number of Indonesian population aged 20 years and over suffer from DM as many as 5.6 million people in 2001 and the figure will rise to 8.2 million in 2020. The threat of diabetes continues to haunt people’s lives , Approximately 12-20% of the world population is estimated to suffer from this disease and every 10 seconds in the world people have died from complications caused. Complications of diabetes occurs in all organs in the body are fed small and large blood vessels causes 50% mortality from coronary heart disease and 30% due to kidney failure. In addition to death, DM also cause disability. As many as 30% of patients with DM suffered blindness due to retinopathy complications and 10% had to undergo amputation of the legs.

Management of Diabetes Mellitus consists of five main pillars, namely planning diet, physical exercise, medical treatment, education and monitoring of blood sugar (Smeltzer & Bare, 2008). Results of research conducted by Nadimin (2009) showed that high-fiber diet can lower blood glucose levels when (GDS) as much as 107 mg / dl, from 344
mg/dl to 237 mg/dl and at lowering fasting blood glucose 82.8 mg/dl from the initial fasting glucose 225.7 mg/dl to 142.9 mg/dl. Treatment with pioglitazone also significantly reduced fasting blood glucose levels of 11.7 mg/dl and blood glucose 2 hours post prandial decreased by 30.5 mg/dl (DeFronzo, 2010). Other studies have shown that aerobic exercise can lower mean blood glucose levels 235 mg/dl to 223.14 mg/dl (Indriyani, 2007). Based on the results of research conducted Yoga (2011) that diet, exercise and pharmacologic therapy has an effect in lowering blood glucose levels, therefore, the three are inseparable from each other in the management of diabetes.

According Soegondo in Indriyani (2007) physical exercise in patients with DM had a very important role in controlling blood sugar levels, which when doing physical exercise increased glucose utilization by active muscles so that can directly cause a decrease in blood glucose. Physical exercise also can reduce weight, improve cardiovascular function and respiration, lower Low Density Lipoprotein (LDL) and increase High Density Lipoprotein (HDL) so as to prevent coronary heart disease when physical exercise correctly and regularly. Physical exercise is a powerful stimulus to the entry of glucose into skeletal muscle. So far research on the effects of exercise on blood glucose levels have been conducted, but to date model of isometric exercises that can be used as a method of DM therapy to help regulate blood glucose levels can not be explained.

In patients with diabetes mellitus insulin resistance or insulin deficiency caused by destruction of pancreatic β cells. Insulin deficiency can lead to little or no binding to the receptor so that the process of translocation of glucose transporter (GLUT-4) to the cell membrane becomes blocked. GLUT-4 facilitates the entry of glucose into the cells. When GLUT-4 translocation process will lead to impaired glucose uptake in the blood is impaired, resulting in the accumulation of glucose in the extracellular which will lead to increased blood glucose or also called hyperglycemia (Ganong, 2008). Physical exercise will increase the transport of glucose by stimulating the translocation of GLUT-4 to the surface of muscle cells. At the time of contraction increased energy consumption resulting in decreased Adenosine triphosphate (ATP). ATP will be broken down into cyclic adenosine monophosphate (cAMP) by the enzyme Adenosine Monophosphate Kinase (AMPK), this causes metabolic changes, including glucose transport (Sigal, 2004). Muscle contraction in isometric exercise will result in an increase of calcium (Ca2+) in the cytosol that will activate the enzyme Calmodulin Dependent Protein Kinase (MKNR II). MKNR II and AMPK enzyme will stimulate the translocation of GLUT-4 to the surface of the cell membrane which in turn will bring the glucose into the cells and decreased blood glucose (Rose, 2005).

METHODS

This was a literature review from database of national and international journals in google schoolar, Pubmed, Science Direct and Plos One with research topics restricted from 2010 to 2015 by using keywords “exercise”, “physical activity”, “aerobic”, “resistance”, “type 2 diabetes mellitus”. There were 11 articles were selected that met the criteria. The criteria inclusion for this literature review are adult with type 2 Diabetes Mellitus and all types of exercise for type 2 Diabetes Mellitus.

RESULTS

Total of 11 studies were eligible for literature review. Majorities of them were designed RCT and other study designed such as cohort study 1, pre-post design 2, and quasi experimental 1. Majorities of exercise training programs were aerobic exercise, and the others were resistance programs and one of them is endurance exercise.

Most researches wich reviewed using the intervention and the control group to know the effect of exercise on T2DM expecially the metabolic profile and fitness. Some of them using aerobic exercise as ntervention group, and resistance exercise as control group and vice versa. There is a research that makes a combination of both as the intervention group.

Activities in aerobic exercise are: treadmill, elliptical and stationary bicycle exercise cycle. Activity in resistance exercises using a combination of machines and free weights: quadriceps (seated leg press machine and straight leg raises), hamstrings (hamstring curls machine), biceps, triceps, anterior and middle deltoids (using free weights), hip abductors and extensors (gluteal machine).
Activities in combination of both did the aerobic exercise and resistance training programs. After a warm-up stage, they worked for 20-30 minutes on a treadmill or bicycle. Qualified exercise physiologist led all exercise sessions. Period of research used in this article varies, ranging from 8 weeks to 1 year. The length of time an average exercise time 20-60 minutes weekly.

All outcome measures were taken by an independent assessor who was blinded to group allocation. Research parameters to know the effect of exercise in T2DM are: metabolic profile (HbA1c, blood glucose, lipid profile: total, high- and low-density cholesterol and triglycerides) and fitness (anthropometric: weight, body mass index, body fat, waist circumference, waist: hip ratio, and cardiovascular: blood pressure, and peak oxygen consumption).

The results showed that the treatment in the form of aerobic exercise, resistance progressive and a combination of both showed significant changes in almost parameters (metabolic profile (HbA1c, blood glucose, lipid profile: total, high- and low-density cholesterol and triglycerides) and fitness (anthropometric: weight, body mass index, body fat, waist circumference, waist: hip ratio, and cardiovascular: blood pressure, and peak oxygen consumption)). No significant differences between each type of exercises.

There were 6 study using parameters HbA1c and blood glucose level, to know the effect of exercise (aerobic and resistance program) in T2DM. And the result showed that resistance exercise alone reduced HbA1c and blood glucose level was not significantly different when compared to aerobic exercise (the different -0.1% and -0.1 mmol/L). Only one study showed aerobic exercise reduce blood glucose level to a greater extent than resistance exercise and both have higher risk of exercise induces hypoglycemia (E. Bacchi, 2012). 3 of 6 study above using blood lipid level as parameter. It showed both of them can reduce blood lipid level and no significant different.

Increase of peak oxygen consumption (VO2 peak) was greater in the aerobic, but fitness and strength (weight, body mass index, body fat, blood pressure) was greater in the resistance exercise. In the study conducted by Bacchi et al (2012), there were some parameters of insulin sensitivity and β-cell function. In the aerobic and resistance exercise showed increased insulin sensitivity, but β-cell function is no significant changes. In the study conducted by Yavari (2012) combination of two forms of exercise training led to an additional improvement in some of the parameters such as HbA1c and triglycerides compared with aerobic or resistance training alone.

DISCUSSION

Effect of aerobic exercise in T2DM

Aerobic exercise comprises of simple training program without using equipment and it showed several positive impact on T2DM (Yokoyama et al. 2004). Aerobic exercise can improves oxygen consumption and increases the functioning of the cardiovascular and respiratory systems. Aerobic exercise is valuable therapeutic strategy for T2DM as it has beneficial effects on physiological parameters and reduces the metabolic risk factors in insulin resistance diabetes mellitus. Several studies have shown the positive effects of aerobic exercise based on different intensities on the improvement of T2DM. Moderate aerobic exercise leads to maintenance of the blood pressure in diabetic neuropathy patients (Mogensen, CE., 2002). However, most of the randomized trial studies showed that high-volume aerobic exercise produced weight loss with significant improvement in insulin sensitivity (Ross R., 2000). As discussed earlier, increase insulin sensitivity normally lasts not more 72 hours, and it can be concluded that regular exercise or physical activity three times/week results in definite and effective management for T2DM patients.

Aerobic exercise improves the physiological parameters, including glycemic control, fasting blood-glucose level and lipid profile. Moreover, it can restore the endothelial function and reduces the arterial stiffness which is the positive denominator for developing cardiovascular complications in T2DM (Yokoyama et al. 2004). Both insulin and exercise increase glucose uptake into skeletal muscle via the glucose transporter (GLUT4) from an intracellular to the cell-surface. In T2DM, there are deficiencies in the insulin receptors which result in impaired glucose uptake and GLUT4 translocation (Garvey WT., 1998). However, exercise
therapy could restore the defects of insulin by providing GLTU4 translocation.

Effect of resistance exercise in T2DM

Resistance exercise leads to develop proper glucose control and less insulin resistance among T2DM. Resistance exercises are exercises that have to be performed against the resistance. Examples of resistance exercises include the weight lifting. Unlike aerobic exercise, resistance exercises are relied on the equipment. High and moderate intensities of resistance exercise range between 50-75% of 1-repetition maximum (1-RM) (Boule NG., 2003). A number of studies have documented the potential effects of aerobic training have been beneficial in the therapeutic regimen in T2DM patients. Similar to the aerobic exercise, resistance exercises are useful therapeutic tools in the management of T2DM. In addition, it is also proven to be safe and efficacious for the elderly insulin resistance diabetic patients. Resistance training has been reported to enhance insulin sensitivity, daily energy expenditure and quality of life (Poehlman ET., 2000). Furthermore, resistance training has the potential for increasing muscle strength, lean muscle mass, and bone mineral density, which could enhance functional status and glycemic control and assist in the prevention of sarcopenia and osteoporosis (Hunter, 2004).

Effect of endurance exercise in T2DM

Endurance exercise involves the use of several large groups of muscles, which depends on the delivery of oxygen to the muscles by the cardiovascular system. Passive exercise needs to include another person or outside force, or produced by voluntary effort of another segment of the patient's own body (Boule NG., 2003). There are paucity of studies on these types of exercise in treating T2DM patients since a wide variety of studies supported the aerobic and resistance training program because of the beneficial effects. Few studies highlighted that endurance-type exercise also reduces postprandial hyperglycemia in T2DM patients. Yet, other uncommon types of exercises are the yoga classes and joba riding. To date, there have been conflicting reports on the yoga classes that have several positive impacts on T2DM. Some studies are successful to report that yoga classes training could improve the glycemic control in diabetic patients (Innes KE., 2007). However, most of the researches could not show the statistical significance over these findings. Similar to that a randomized controlled trial proved that joba riding results in improving insulin sensitivity in T2DM patients (Kubota M., 2007). In future, further studies with significant findings and detailed explanations are warranted to elaborate more on these types of exercise training programs.

CONCLUSION

In general, aerobic exercise and resistance training alone induce positive effects in the prevention or management of glycaemic control and cardiovascular risk factors. Moreover, these effects may be additive in the combination of two types of training. Therefore, both aerobic and resistance exercise training should be considered as useful interventions in the management of T2DM to take advantage of different exercise types for glycaemic control, without clear superiority of either of them.

REFERENCE


Bello AI, Owusu-Boakye E, Adegoke BO, Adjei DN (2011) Effects of aerobic exercise on selected physiological parameters and quality of life in patients
DeFronzo, RA 2010, Pathogenesis of Type 2 Diabetes: Metabolic and Molecular Implications For Identifying Diabetes Genes. Diabetes Review. Page. 177-269.
Rose, AJ & Richter, EA 2005, Skeletal Muscle Glukosa Uptake During Exercise:


