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Physical Activity in the Management of Diabetes Mellitus

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1. Introduction

1.1. Definitions

Physical activity is any bodily movement produced by skeletal muscles that result in energy expenditure beyond resting level. This is a broad definition which involves virtually all types of activity like walking, cycling, dancing, traditional games, pastimes, gardening, housework, sports and others (WHO, 2012, Cavil et al, 2006). Conversely, an individual is termed inactive when there is no marked increase in energy expenditure above resting level. Sedentary lifestyle include some activity, but usually not enough for gaining health effects, while active living is a way of life that integrates at least half an hour of physical activity each day into daily routines (Hagstromer, 2007).

Physical activity can be classified into two main categories. One is 'exercise' that involves structured and repetitive bodily movements. The other is 'non-exercise physical activity', such as standing, commuting to and from school or work, or participating in household chores or occupational work. Thus, sport and exercise are seen as particular types of physical activity: sport usually involve some form of competition, and exercise usually being taken to improve fitness and health. Physical activity is important for health, the levels and patterns of physical activities in a population comprise an important generic indicator in public health

The term health-enhancing physical activity is defined as any form of physical activity that benefits health and functional capacity without undue harm or risk. It emphasizes the connection between health and physical activity (Foster, 2000). Physical activity is important for health and the levels and patterns of physical activity in a population constitute an important generic indicator in public health. Physical inactivity, usually together with unhealthy food habits, is associated with the development of many of the major non-

communicable diseases and conditions in the society, such as cardiovascular disease, some cancers, obesity, diabetes and osteoporosis. It has become increasingly clear that physical inactivity is a global health issue. Physical activity which is beneficial to health must be moderate or vigorous in intensity. Important favorable health effects of physical activity for adults are extensively documented and well accepted by health professionals. Reviewers have identified at least modest positive effects in the population or subsamples of youths on such health outcomes as aerobic fitness, blood lipids, blood pressure, body composition, glucose metabolism, skeletal health, and psychological health. Various levels of physical activity participation are associated with health benefits and/or health risks (Bailey et al, 1999).

2. Classification and types of physical activity

Physical activity is broadly classified using three criteria which are: intensity of activity, energy system utilized during the activity and the effect of the activity on body tissues and systems.

Classification by intensity of activity: Physical activity is classified using intensity as light or low, moderate and vigorous. It is important to provide a clear and comprehensive definition of sedentary behaviour in order to understand what a light physical activity is. Sedentary behavior refers to activities that do not increase energy expenditure substantially above the resting level and include activities such as sleeping, sitting, lying down, and watching television, and other forms of screen-based entertainment. Specifically, sedentary behavior include activities that involve energy expenditure at the level of 1.0-1.5 metabolic equivalent units (METs), where One MET is the energy cost of resting quietly, often defined in terms of oxygen uptake as $3.5\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$). Light physical activity, which often is grouped with sedentary behavior but is in fact a distinct activity construct and involves energy expenditure at the level of 1.6-2.9 METs (Pate et al, 2008). It includes activities such as slow walking, sitting and writing, cooking food, and washing dishes or doing house chores. Moderate exercise generally relates to aerobic forms of exercise. These include: brisk walking, biking on flat ground, or dancing. Moderate intensity activity is exercise that requires 3 to 6 METs of effort. During moderate physical activity, breathing and heart rate become more rapid and the body burns about 3.5 to 7 calories per minute (depending on weight and fitness level). Vigorous intensity activity is intense exercise that requires more than 7 METs of effort. During vigorous physical activity, breathing and heart rate are rapid as the body exerts itself. Vigorous activity burns 8 or more calories per minute (depending on weight and fitness level). Examples of vigorous physical activity are jogging and running, in-line skating, tennis, or calisthenics such as push-ups and jumping jacks performed with intense effort (Pate et al, 2008).

Classification by energy system utilized: Three energy systems are involved in activities performed by every individual; ATP PCr system, lactic acid system and aerobic system. Activities utilizing these systems could be aerobic or anaerobic activities. There are three separate energy systems through which ATP can be produced for activity. A number of

factors determine which of these energy systems is chosen, such as exercise intensity and duration.

2.1. The ATP-PCr system

ATP and creatine phosphate (also called phosphocreatine or PCr for short) make up the ATP-PCr system. PCr is broken down releasing a phosphate and energy, which is then used to rebuild ATP. ATP is rebuilt by adding a phosphate to ADP in a process called phosphorylation by an enzyme that controls the breakdown of PCr called creatine kinase (Macardle et al, 2000).

The ATP-PCr energy system can operate with or without oxygen but because it does not rely on the presence of oxygen it is said to be anaerobic. During the first 5 seconds of exercise, energy system utilized is the ATP-PCr system. ATP concentrations last only a few seconds with PCr buffering the drop in ATP for another 5-8 seconds. Combined, the ATP-PCr system can sustain all-out exercise for 3-15 seconds, so ATP- PCr system takes care of activities of short duration and high intensity (Macardle et al, 2000). If activity continues beyond this immediate period, the body must rely on another energy system to produce ATP.

2.2. The glycolytic system

Glycolysis literally means the breakdown of glucose and consists of a series of enzymatic reactions. The carbohydrates we eat supply the body with glucose, which can be stored as glycogen in the muscles or liver for later use. The end product of glycolysis is pyruvic acid. Pyruvic acid can then be either funnelled through a process called the Krebs cycle or converted into lactic acid. It is anaerobic glycolysis if the final product is lactic acid and aerobic glycolysis if the final product is pyruvic acid. Alternative terms that are often used are fast glycolysis if the final product is lactic acid and slow glycolysis for the process that leads to pyruvate being funnelled through the Krebs cycle. As its name suggest, the fast glycolytic system can produce energy at a greater rate than slow glycolysis. However, because the end product of fast glycolysis is lactic acid, it can quickly accumulate and is thought to lead to muscular fatigue. The contribution of the fast glycolytic system increases rapidly after the initial 10 seconds of exercise. This also coincides with a drop in maximal power output as the immediately available phosphogens, ATP and PCr, begin to run out. By about 30 seconds of sustained activity, the majority of energy comes from fast glycolysis. At 45 seconds of sustained activity, there is a second decline in power output (the first decline being after about 10 seconds). Activity beyond this point corresponds with a growing reliance on the oxidative system (Macardle et al, 2000).

The oxidative system consists of four processes to produce ATP: slow glycolysis (aerobic glycolysis), Krebs cycle (citric acid cycle or tricarboxylic acid cycle), electron transport chain and beta oxidation. Slow glycolysis is exactly the same series of reactions as fast glycolysis that metabolise glucose to form two ATPs. The difference, however, is that the end product pyruvic acid is converted into a substance called acetyl coenzyme A rather than lactic acid. Following glycolysis, further ATP can be produced by funnelling acetyl coenzyme A

through the Krebs cycle. The Krebs cycle is a complex series of chemical reactions that continues the oxidization of glucose that was started during glycolysis. Acetyl coenzyme A enters the Krebs cycle and is broken down into carbon dioxide and hydrogen allowing more two more ATPs to be formed. However, the hydrogen produced in the Krebs cycle plus the hydrogen produced during glycolysis, left unchecked would cause cells to become too acidic, therefore hydrogen combines with two coenzymes called NAD and FAD and is transported to the electron transport chain. Hydrogen is carried to the electron transport chain, another series of chemical reactions, and here it combines with oxygen to form water thus preventing acidification. This chain, which requires the presence of oxygen, results in 34 ATPs being formed. Beta oxidation, unlike glycolysis, the Krebs cycle and electron transport chain can metabolise fat as well as carbohydrate to produce ATP. Lipolysis is the term used to describe the breakdown of fat (triglycerides) into the more basic units of glycerol and free fatty acids. Before these free fatty acids can enter the Krebs cycle they must undergo a process of beta oxidation-a series of reactions to further reduce free fatty acids to acetyl coenzyme A and hydrogen. Acetyl coenzyme A can now enter the Krebs cycle and from this point on, fat metabolism follows the same path as carbohydrate metabolism (Macardle et al, 2000).

2.3. Energy systems & training

Each of the three energy systems can generate power to different capacities and varies within individuals. Best estimates suggest that the ATP-PCR system can generate energy at a rate of roughly 36 kcal per minute. Glycolysis can generate energy only half as quickly at about 16 kcal per minute. The oxidative system has the lowest rate of power output at about 10 kcal per minute. The capacity to generate power by each of the three energy systems can vary with training. The ATP-PCr and glycolytic pathways may change by only 10-20% with training. The oxidative system seems to be far more trainable although genetics play a limiting role here too. VO₂max, or aerobic power can be increased by as much as 50% but this is usually in untrained, sedentary individuals (Macardle et al, 2000).

2.3.1. Energy systems and physical activity

The three energy systems do not work independently of one another. From very short, very intense exercise, to very light, prolonged activity, all the three energy systems make a contribution however, one or two usually predominate.

3. Classification by effect on the body tissues and system

This type of physical activity includes muscle-strengthening, bone strengthening, and stretching. Exercises or activities that have a great impact on muscular strength involve weights, bands or body weight and work the muscles to maintain a specific movement. These activities are also referred to as resistance training exercises and include pushups and sit-ups, biceps curls, lifting weights, climbing stairs, and digging in the garden and calisthenics. The muscle is metabolically active tissue and this means that it utilizes calories

to work, repair, and refuel itself. However, as one grows older, there is gradual loss of muscle cell as part of the natural aging process which means that the amount of calories needed each day starts to decrease, and it becomes easier to gain weight. Therefore, engaging in regular strength training exercise could decrease this loss of lean muscle tissue and even replace some that has been lost already (Macardle et al, 2000).

Strength training increases lean body mass, decrease fat mass, and increase resting metabolic rate in younger and older adults. While strength training on its own typically does not lead to weight loss, its beneficial effects on body composition may make it easier to manage one's weight and ultimately reduce the risk of disease, by slowing the gain of fat especially abdominal fat. Another beneficial effect of resistance training pertains to bone health. In addition to weight bearing, cardiovascular exercise, weight training has been shown to help fight osteoporosis. For example, a study in postmenopausal women examined whether regular strength training and high-impact aerobics sessions would help prevent osteoporosis. In some studies, researchers found that the women who participated in at least two sessions a week for three years were able to preserve bone mineral density at the spine and hip; over the same time period, a sedentary control group showed bone mineral density losses of 2 to 8 percent (Engelke et al, 2006; Katzmarzyk and Craig, 2002; Gale et al, 2007). Bone-strengthening activities strengthen the bones. This includes running, walking, jumping rope, and lifting weight. These activities make the feet, legs, or arms support the body's weight, thereby making the muscle push against the bone. Muscle-strengthening and bone-strengthening activities can also be aerobic. Whether they are depends on whether they make the heart and lungs work harder than usual. For example, running is an aerobic activity and a bone-strengthening activity. Stretching helps improve the flexibility and ability to fully move your joints. Examples of stretching is touching the toes, doing side stretches, and doing yoga exercises (NHLBI, 2011).

4. Benefits of physical activity

Regular physical activity is recognized as a key determinant of health and wellness. Strong evidence indicates that low levels of physical activity are linked with morbidity and mortality in adults, particularly the risk of chronic diseases such as type II diabetes, heart disease, osteoporosis and certain types of cancer and the risk of overweight and obesity in adults. Surveillance and monitoring are fundamental to developing evidence based programs and initiatives to combat obesity and reduce the risk for chronic disease (Chronic disease prevention Alliance of Canada,2005).

Routine physical activity has been shown to improve body composition e.g., through reduced abdominal adiposity and improved weight control; (Warburton et al, 2001, Mariona et al 2003), enhance lipid lipoprotein profiles (e.g., through reduced triglyceride levels, increased high-density lipoprotein [HDL] cholesterol levels and decreased low-density lipoprotein [LDL]-to-HDL ratios, improve glucose homeostasis and insulin sensitivity, reduce blood pressure, improve autonomic tone, reduce systemic inflammation (Adamopoulos, 2001), decrease blood coagulation, improve coronary blood flow, augment cardiac function and enhance endothelial function (Hambrecht, 2000, Warburton et al, 2000).

Chronic inflammation, as indicated by elevated circulating levels of inflammatory mediators such as C-reactive protein, has been shown to be strongly associated with most of the chronic diseases whose prevention has benefited from exercise. Recent RCTs have shown that exercise training may cause marked reductions in C-reactive protein levels. Each of these factors may explain directly or indirectly the reduced incidence of chronic disease and premature death among people who engage in routine physical activity (Nicklas et al, 2005).

Routine physical activity is also associated with improved psychological well-being (e.g., through reduced stress, anxiety and depression). Psychological well-being is particularly important for the prevention and management of cardiovascular disease, but it also has important implications for the prevention and management of other chronic diseases such as diabetes, osteoporosis, hypertension, obesity, cancer and depression (Dunn et al, 2001, Warburton et al, 2011). Regular aerobic activity has been found to improve vascular function in adults independent of changes in other risk factors and has been said to result in a shear-stress-mediated improvement in endothelial function, which confers a health benefit to a number of disease states (Laughlin et al, 2004).

A study conducted by WHO European region reviewed the evidence for the health effects/benefits of physical activity and reported that it improved fitness, strength, flexibility and coordination, improved general health and assists in weight management, development of a wide range of motor skills, healthy growth and development of the cardiovascular system as well as the bones and muscles of the children. It further reported on the establishment of healthy behaviors that young people could carry throughout their lives such as better eating habits and decreased likelihood of smoking (Government of Western Australia, 2005).

Exercise has been shown to have impact on social benefits in children such as development of communication, interpersonal, leadership and co-operation skills, creation of lasting friendships, increased interest in accepting responsibility, teaches them how to deal with winning and losing, provides a vehicle for responsible risk taking, helps build social skills among children and may deter anti-social behaviours and helps young people develop self-discipline and leadership skill (Government of Western Australia, 2002).

Mental health benefits of physical activity among children includes improved self esteem and confidence, reduction in stress, anxiety and depression, improved mood and sense of wellbeing, improved concentration, enhanced memory and learning, and better performance at school, reduced feelings of fatigue and depression, and improved psychological wellbeing and mental awareness (Government Western Australia, 2005).

5. Health implications of sedentary living

Physical inactivity is a modifiable risk factor for cardiovascular disease and a widening variety of other chronic diseases, including diabetes mellitus, cancer (colon and breast), obesity, hypertension, bone and joint diseases (osteoporosis and osteoarthritis), and

depression. Physical inactivity, usually together with unhealthy food habits, is associated with the development of many of the major non-communicable diseases and conditions in the society, such as cardiovascular disease, some cancers, obesity, diabetes and osteoporosis. It has become increasingly clear that physical inactivity is a global health issue among young and old (Halal et al 2012, Odunaiya et al, 2010), this is because of the technology advancement as children becomes progressively inactive as they spend more time indoor with school assignment, computer games, television and being carried to school either by bus or personal car (Sjostrom et al, 2003).

According to the World Health Organization, inactivity is responsible for a multitude of diseases, disabilities and even deaths (WHO, 2010). A dose–response relationship has been observed between time spent in sedentary behaviors (e.g., TV viewing time, sitting in a car, overall sitting time and all-cause and cardiovascular disease mortality (Katzmarzyk et al, 2009, Dunstan et al, 2010, Warren et al, 2010) This growing epidemiological evidence links sedentary behavior to health outcomes, including anxiety, diabetes mellitus, colon cancer, osteoporosis, high blood pressure, deep vein thrombosis, obesity, kidney stone, depression and cardiovascular diseases. This is shown in the epidemiological reviews of physical inactivity and it was concluded that sitting for a very long time in some particular jobs, using elevator, sitting in a car, TV viewing time and other encompassing factor is associated with some sedentary behavior).

The prevalence of childhood obesity and related health problems is increasing in many Western countries and is anticipated to continue to increase (Zaninto et al, 2010). Evidence of an association between physical activity and weight gain remains sparse (Wareham et al, 2005). However, three main benefits arising from adequate childhood physical activity have been postulated. The first is direct improvements in childhood health status and evidence is accumulating that more active children generally display healthier cardiovascular profiles, are better learner and develop higher peak bone masses than their less active counterparts. Secondly, there is a biological carryover into adulthood, whereby improved adult health status results from childhood physical activity. In particular, childhood obesity may be a precursor for a range of adverse health effects in adulthood, while higher bone masses in young people reduce the risk of osteoporosis in old age. Finally, there may be a behavioral carryover into adulthood, whereby active children are more likely to become more active (healthy) adults (Epteins, 2005) . Nevertheless, in an effort to halt or reverse trends in obesity, promotion of physical activity in children and adolescents has been identified as a key focus of efforts to promote health (Lobstein et al, 2004). Physical activity among children and adolescents is believed to be insufficient, and low levels of activity seem to persist into adulthood (WHO, 2004). This makes physical inactivity among young people a risk factor for developing cardiovascular disease, cancer, and osteoporosis in later life (Telema et al, 2005). The development and evaluation of interventions to promote physical activity in young people is therefore a priority. Physical activity which is beneficial to health must be moderate or vigorous in intensity (Hangstromer et al, 2007).

6. Measurement of physical activity

6.1. Types of measurement

Physical activity can best be measured by a combination of activity monitors, questionnaires, and analytical technique. The measures for physical activity can be organized into two categories, according to the type of information they provide: Subjective or self-report instruments and objective instruments. No one measure is capable of capturing all of the aspects related to physical activity but each has some advantages and some disadvantages (Sirard and Pate, 2001).

6.2. Objective measurement

Objective measurements are measurements that quantify levels of physical activity, producing data that are not influenced by recall ability, ethnicity, culture or socioeconomic status. Some objective instruments can also measure the duration, intensity and patterning of daily physical activity in children and youths. Objective methods for measuring physical activity make use of equipment like video, movement's counters, accelerometer, heart rate monitoring, blood pressure monitoring, electromyography, anthropometry, fitness, VO₂ metabolic cart or VO₂ portable equipment, respiration chamber and doubly labeled water (DLW). However, they require special equipment and are not very well adapted to a large sample study of children (Sirard and Pate, 2001).

6.3. Subjective measurement

Subjective instruments comprising self-report instruments such as questionnaires are straightforward means for population health researchers to gather information on the physical activity levels of individuals in their communities. These instruments are generally reliable, valid and are relatively simple and inexpensive to administer. These instruments should have good psychometric properties in order to be useful and such psychometric properties include validity, reliability, utility and responsiveness (Eslinger et al, 2005).

7. Effect of exercise on biochemical, metabolic and psychosocial variables in individuals with diabetes mellitus: an overview of systematic reviews, meta analysis and randomized control trial

7.1. Introduction

Physical activity (PA) is a key element in the prevention and management of type-2 diabetes mellitus. It has been observed that many persons with this chronic disease do not become or remain regularly active. High-quality studies establishing the importance of exercise and fitness in diabetes were lacking until recently, but it is now well established that participation in regular PA improves blood glucose control and can prevent or delay type-2 diabetes mellitus along with positively affecting lipids, blood pressure, cardiovascular

events, mortality, and quality of life (Sigal et al, 2006). Structured interventions combining PA and modest weight loss have been shown to lower type-2 diabetes risk by up to 58% in high-risk populations. Most benefits of PA on diabetes management are realized through acute and chronic improvements in insulin action, accomplished with both aerobic and resistance training. Present recommendation includes 150 mins of aerobic exercise per week and resistance exercise 3 times a week. PA-associated blood glucose management, diabetes prevention, gestational diabetes mellitus, and safe and effective practices for PA with diabetes-related complications (Sigal et al, 2006).

In the last few years, a lot of studies have been conducted to assess the effects of exercise on several variables associated with diabetes mellitus. For effective management of individuals with diabetes mellitus using physical activity, it is critical to ensure that the type of exercise, frequency and duration most strongly associated with effectiveness are utilized. The aim of this systematic review of reviews, meta analysis, clinical trials was to identify evidence for the effectiveness/ impact of exercise/ level of evidence, exercise type, frequency and duration on biochemical, metabolic and psychosocial parameters of individuals with type 1 and type 2 diabetes mellitus.

7.2. Methods

Pedro and pubmed were searched for systematic reviews, meta-analysis, and clinical trials of interventions using physical activity in management of individuals with type 1 and type 2 diabetes mellitus from 2006 -2012. The search term used were exercise and diabetes. Literatures that addressed effectiveness to intervention components were extracted, graded for evidence and summarized. Clinical trials were assessed for methodological quality and materials that focused on effectiveness were extracted, graded and summarized. Information on effectiveness was extracted from systematic review and presented in a narrative form showing level of evidence. The RCT could not be pooled together for meta-analysis due to differences in designs and outcomes, consequently the results are presented in a narrative form.

7.3. Results

Three studies were systematic reviews, one of which included a meta analysis and 15 were randomized control trial of which one was duplicated, therefore 14 RCTs were included in the study.

Exercise has positive effect on metabolic, biochemical and psychosocial variables. Combination of aerobic and resistance exercise is more beneficial than either aerobic or resistance exercise. Daily exercise is not more beneficial than every other day exercise. Exercise of 30 mins duration every other day is as effective as 30 min exercise every day. Progressive resistance training is more effective than aerobic training and structured /supervised programme is more effective than advised exercise. Structured exercise, consisting of aerobic training, resistance training, or a combination of aerobic and resistance exercise training for at least 12 weeks, is associated with improved glycaemic control in

type-2 diabetic patients. Structured weekly exercise of more than 150 minutes per week was associated with greater declines in HbA_{1c}. Structured exercise training reduced HbA_{1c} to a larger degree than physical activity advice. Physical activity advice is beneficial only if associated with dietary recommendations. Exercise improves quality of life, mental health and general health status. This is shown in Table 1

study	Author	year	population	Exec type	duration	Frequency	intensity	Impact on selected variables	Impact on psychosocial variable
SR	Umpierre et al	2011	Type 2 dia	Aerobic, resistance	30 min or more	Every day or every other day	Moderate, vigorous	Improve glycaemic control	
SR	Simpson and Singh	2008	Type 2 diab	X	X	X	X	Increase adiponectin	
SR	Thomas et al	2006	Type 2	X	X	X	X	Glucose control, increase insulin response, decrease plasma triglyceride	Reduction in visceral, subcutaneous adiposity
RCT	Sigal et al	2007	Type 2	Aerobic and resistance, aerobic and resistance combined	x	Thrice weekly for 22 weeks	x	Combined aerobic and resistance has greater impact on biochemical variables	
RCT	Bacchi et al		Type 2	Aerobic, resistance compared	x	4 months intervention	x	Increase in peak vo ₂ max greater in aerobic, increase in strength more in resistance group. Insulin sensitivity similar in both groups and no significant difference for beta cell function in both groups	
RCT	Ng et al		Type 2	Aerobic, prog resistance exc compared		8 weeks 50 min aerobic at 65% of age predicted heart rate, 3 sets of 10 repetition at 65% of the assessed repetitive maximum		Both had positive effect on glycaemic control and health status but more significant changes in PRT Group in more domains of SF - 36	

study	Author	year	population	Exec type	duration	Frequency	intensity	Impact on selected variables	Impact on psycho-social variable
RCT	Gorden et al	2008	Type 2	Yoga, exercise				Decrease oxidative stress and improve anti oxidant status	
RCT	Van Dijk et al		Type 2			Daily or every other day		No difference in optimization of glycaemic control in daily or every other day hroup	
RCT	Swift et al	2012	Type 2	exer				Did not reduce C reactive protein	
RCT	Shvandi et al	2010	Type 2					Improved mental health, quality of life, and metabolic variables	
RCT	Lopez et al		Type 1	Exercise in conjunction with diet and medication				Positive influence on long term glycaemic control	
RCT	Lincoln et al		Type 2	Resistance exercise training				Improves mental health	
RCT	Adeniyi et al	2010	Type 2	Therapeutic exercise			12 week	Reduce pain, improves dermalotological foot grade, disorders of ranges of movement but relapse when exercise was withdrawn	
RCT	Slentz et al	2009	Type 2	exercise		Moderate, vigorous		Larger significant increase with moderate exercise compared to Vigorous	
RCT	Taylor et al	2009	Type 2	Exercise and counseling directed by PT compared				No significant difference between both	

study	Author	year	population	Exec type	duration	Frequency	intensity	Impact on selected variables	Impact on psycho-social variable
				to supervised training					
RCT	Praet et al	2008	Type 2 diabetes	Brisk walking, individualized medical fitness program		3 times a week of 60 mins brisk walk, 3 sessions a week of supervised exercise using bicycle ergometer for 1 year		Improves biochemical variables and blood pressure in type 2 diabetes patients	
RCT	Winnick et al	2008	Type 2	Short term aerobic training				Improves whole body insulin sensitivity	

Table 1.

7.4. Discussion

All systematic reviews and clinical trial reviewed showed that exercise is effective in the management of both type 1 and type 2 of diabetes mellitus .Our review shows that there is limited study on the effect of exercise in the management of type 1 diabetes mellitus although exercise improves glycaemic control in conjunction with drugs and diet in type 1 diabetes mellitus. Both aerobic and resistance exercise are effective in the management of diabetes especially type-2 diabetes in improving glycaemic control However, for best management aerobic and resistance exercise should be combined as in current recommendation and moderate intensity should be preferred to vigorous intensity since vigorous exercise has no added advantage. Review shows that exercise frequency of greater than 150 mins per week is more effective than less than 150 mins per week in improving glycaemic control. However, exercise does not necessarily have to be daily as there is no significant difference in daily exercise and every other day exercise in improving glycaemic control. This is level 1 evidence.

Our review also shows that exercise improves quality of life, mental health and general health status of type-2 diabetic patients. This is level 2 evidence. Exercise also improves metabolic variables of type-2 diabetic patients with level 2 evidence. However, exercise withdrawal results in loss of all the benefits associated with exercise. It is important to note that therapeutic exercises are very effective and should be directed by experts. It is not sufficient to prescribe aerobic, resistance or both exercises for patients with type-2 diabetes but there is a need to involve exercise experts in the clinics such as physiotherapists/ exercise physiologists for therapeutic exercise especially in deconditioned and elderly patients.

7.5. Comment

For effective management of patients with diabetes mellitus, physicians should refer patients to exercise experts to enhance utilization of exercise and adherence to exercise in the management as many patients with diabetes mellitus do not participate in exercise regularly.

7.6. Limitations

Many studies were not clear on how they progress their training programmes and volumes of exercise used in many studies for comparison of aerobic and resistance exercise were not comparable. Many exercise programmes were not clear on intensity of aerobic exercise and duration per session as this could affect result by creating bias. We also recommend further studies on the effect of exercise in the management of type 1 diabetes.

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