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Effectiveness Various Physical Exercise to Decrease Glycemic Control in Patient with Diabetes Mellitus : A Systematic Review

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ABSTRACT

Diabetes mellitus is a major global health problem that affect almost 400 million people in the world. Increasing prevalence of T2DM diabetes is followed by some causal factor such as obesity, age and sedentary lifestyle. Physical exercise have been considered as on of 'gold standart intervention' in management of type 2 diabetes. Types of exercise and physical activity that related with T2DM such as aerobic exercise, also resistance (strength) training includes elastic resistance bands. Nevertheless, there is still a low progress and prevalence of exercise in diabetes population.

The aim of our study is to present the effect of various physical exercise such aerobic, resistance exercise also combined aerobic and resistance exercise to decrease Hba1c and blood glucose level.

We search the scientific literature about diabetes and physical exercise in the database such as Scopus, PubMed, ProQuest, Spinger Link and Science Direct for original and full research and then make a systematic review from 1300 articles retrieved, 18 studies include final criteria and obtained using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method.

From the study review combined aerobic physical exercise and resistance exercise improved the glycemic control of T2DM and it was widely used and significant for glycemic control.

This systematic review could be used as evidence when increase combine aerobic and resistance exercise as choice physical exercise interventions for the purpose of glycemic control.

Keywords: Aerobic, Diabetes, HbA1c, Physical Exercise, Resistance Exercise

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BACKGROUND

Diabetes mellitus is a major global health problem that affect almost 300 million people in the world (Yubo Liu & Ye, 2019) According to the latest statistics from the International Diabetes Association, the incidence of diabetes in adults (20–79 years) has risen to 425 million worldwide, and this number is projected to increase to 629 million by 2045. Currently, the largest number of people with diabetes (20–79 years) are in China (114 million), India (73 million), and in the USA (30 million) (IDF, 2017). Increasing prevalence of T2DM diabetes is followed by some causal factor such as obesity, age and sedentary lifestyle. Physical exercise have been considered as on of '*gold standart intervention*' in treatment of type 2 diabetes. Types of exercise and physical activity that suitable with T2DM such as aerobic exercise, activities such as walking, cycling, jogging, and swimming also resistance (strength) training includes elastic resistance bands (Colberg & Sigal, 2016). Nevertheless, there is still a low progress and prevalence of exercise in diabetes population.

Physical activity, especially aerobic exercise (AE) has consistently been reported to decrease the glycemic control, insulin resistance and dyslipidemia in patients with T2DM (Dixit & Maiya, 2017).

Another recommendation of AE, recent findings have a new intervention about the resistance exercise (RE) in efficient management of diabetes. Recommended incorporation from The American College of Sports Medicine (ACSM) about progressive RE to treat T2D (Chodzko-Zajko & Proctor, 2019). The American Diabetes Association (ADA) claimed that both intervention like resistance exercise and aerobic training can improve insulin action, and assist in management of blood glucose, lipids, cardiovascular risk factors, and HbA1c (Colberg & Sigal, 2016). However, recenlty RCT reported that 52-week RE without AE significantly lowers the HbA1c in patients with T2DM (Najafipour & Mobasseri, 2017). A systematic review indicated that both RE and AE, combine RE and AE are effective in manage diabetes glycemic control (decreased glycosylated hemoglobin (HbA1c)), risk factors or safety about newly RE is must be concern in many condition of T2DM patients (Siavoshy & Heidarianpour, 2017) (AminiLari & Fararouei, 2017). Increasing curiousity, functionality and advantages of RE in recent studies could be following with explore further details on the influence of RE, RE variables, RE intensity and how far it can responsible for beneficial effects in controlling T2DM.

On the other hand, aerobic exercise (AE) as a conventional physical exercise for T2DM including jogging, brisk walking, cycling, and swimming recruits a large group of muscles to perform, and usually requires prolonged time to manage T2DM (Ghalavand & Rooholah, 2016) (Gholami & Nikookheslat, 2018). Additionally, no meta-analysis has compared the effects of different AE, RE combine with AE also RE intensities on glycemic control in patients with T2DM.The data collected from all available sources were included into systematic review and examined effective intensity of RE in controlling the HbA1c and blood glucoselevel in patients with T2DM. The aim of the present study was to review the findings from the randomized scientific published literature studies focusing on the T2DM patients used various types of exercise and their effect on glycemic control.

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METHODS

Inclusion and Exclusion Criteria

The inclusion and exclusion criteria used for this study have been presented in Table 1.

Table 1. Inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
1.	The study design specifically evaluated the effect of physical exercise on glycemic control such as HbA1c and glucose level	Studies that evaluate the effect of physical exercise on other chronic diseases
2.	This study focused on T2DM patients	Studies that evaluate the effect of physical exercise on children with diaberes or mothers with gestational diabetes
3.	Studies that were published in English	Patient with complications or another disease
4.	The study had one of the following study designs: randomized controlled trial and a before-after trial	

Seacrhing strategy

This study is about systematic review on the effectiveness of various physical exercise for glycemic control for T2DM patients. A comprehensive literature search was conducted using Scopus, PubMed, ProQuest, Spinger Link and Science Direct journal databases. This study began with determining the topic, searching for original articles and matched with the inclusion and exclusion criteria. The keywords that used are *aerobic, diabetes, Hba1c, physical exercise, resistance exercise*. Article selection was done according to the PRISMA guidelines.The comprehensive steps of the selection process and number of articles in each step were presented as a flow diagram in **Figure 1**.

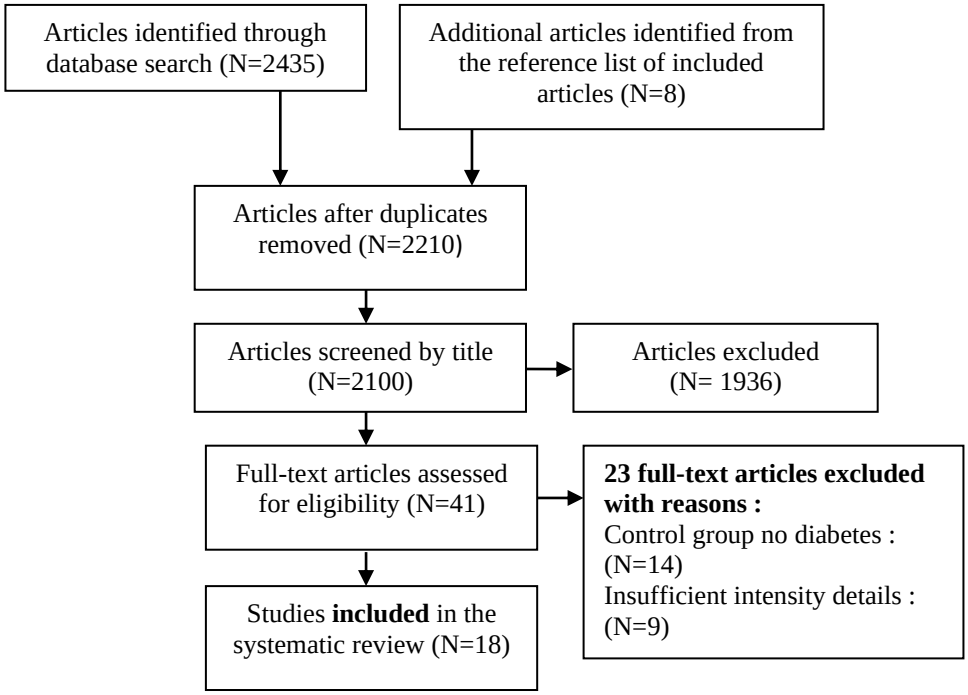

Figure 1. Reporting Items for Systematic Review and Meta-analysis (PRISMA) flow diagram of study selection.

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Data Extraction and quality assesment

The title, abstract and the article were reviewed independently according to inclusion and exclusion criteria. The information that should be considered each study that the full text study consist of authors, date and year of study, population, exercise type, outcome measures, study design, duration of the intervention and its intensity. The quality assessment for each selected study was conducted using the PRISMA method and risk of bias assesment study was conducted using Joanna Briggs Institute (JBI) checklist.

Descriptions of the included articles

This systematic review of 18 study, total 985 patients with T2D were enrolled from smallest particpants are 12 and the largest are 265 participants. The selected studies were including from Iran, Canada, China, Taiwan, Germany, Norway, India, Israel and South Korea. The included trials according to inclusion criteria, were published between 2015 until 2020.

RESULTS

The interventions that used were aerobic exercise (AE), resistance exercise (RE) and a combination of both exercises (AE and RE). Three studies used an aerobic exercise (AE) only intervention. Six study used a resistance exercise (RE) only intervention. Six studies used a combination of aerobic and resistance exercises. One used a traning program and one regular exercise. The intensity rate for all of physical exercise ranged from 2 to 3 times a week for 30 to 60 minutes. All of the study intervention primary outcome for reducing HbA1c and blood glucose level. Samples for the pre and post examination of blood sugar and HbA1c were obtained both before exercise and after the administration of the intervention in intervention and control group.

Time for re-examination of the blood glucose levels and HbA1c are varied from 2 weeks and 3 week. All results of the study stated that combined aerobic and resistance studies gave significant results for glycemic control, blood sugar levels and HbA1c. Combined Aerobic exercise (AE) and Resistance exercise (RE) was the most widely used and modest exercise used to maintain glycemic control. The main characteristics of the included studies have been summarized in Table 2.

Table 2. Characteristicsof the trials included in the systematic review.

No	Title	Year, Contry	Sample Size	Type of Exercise	Intensity of Exercise	Finding/ conclusion	Reference
1.	Effects of sprint interval or combined aerobic and resistance training on myokines in overweight women with type 2 diabetes: A randomized controlled trial	2018 Iran	52 participant	Sprint interval training (SIT) or combined aerobic and resistance training (A+R)	Resistance Training: 10 weeks/3 days per week duration2-3 minutes Aerobic Training: 10 weeks/ 3 days per week duration min 15- max30 Sprint interval training (SIT):	There was effect of either exercise fasting glucose (p = 0.03) and HbA1c (p = 0.006) improved significantly and similarly in both exercise groups compared to controls	(Banitalebi , Kazemi, & Faramarzi, 2019)

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No	Title	Year, Contry	Sample Size	Type of Exercise	Intensity of Exercise	Finding/ conclusion	Reference
					10 weeks/ 3 days per week duration 4x 30s		
2.	Effects of exercising before breakfast on the health of T2DM patients—A randomized controlled trial	2019 Germany	30 participant	Training program	8 weeks/3-5 days per weeks	Physical training significantly dercrease glycated hemoglobin (HbA1c) values (absolute change: 0.3%) decreased significantly from pre- to post-training.	(Brinkmann, Weh-Gray, & Brixius, 2019)
3.	The effect of circuit resistance training, empagliflozin or“vegeterranean diet”on physical and metabolic function in older subjects with type 2 diabetes: a study protocol for a randomized control trial (CEV-65 trial)	2019 Israel	120 participant	Circuit resistance training	10 weeks CRT 3 home sessions/week;	Glycemic control FPG and HbA1c significant dercrease (p = 0.006)	(Buch, Eldor, & Kis, 2019)
4.	Efects of Resistance Exercise on Glycated Hemoglobin and Functional Performance in Older Patients with Comorbid Diabetes Mellitus and Knee Osteoarthritis: A Randomized Trial	2020 Taiwan	70 participant	Dynamic Resistance Exercise Group Isometric Resistance Exercise Group	12-week intervention involve 8–15 RM, which must include 5–10 min of warm-up and cool-down	For HbA1c level, the main e ects were not statistically significant over time within groups (p = 0.167) or between groups (p = 0.462). Moreover, no significant time-by-group interaction was noted (p = 0.957)	(Chen, Shen, & Chen, 2020)
5.	Effect of moderate-intensity aerobic exercise on glycosylated haemoglobin among elderly patients with type 2 diabetes & peripheral neuropathy	2017 India	87 patient with T2DM	Aerobic exercise	Eight weeks intervention Intensity 3 times/week, 50 minutes, 8 week	mean values of study and control groups for HbA1c, post-prandial blood sugar (PPBS) and fasting blood sugar (FBS) at baseline and eighth weeks is presented that there was a significant difference in the mean value of HbA 1c at baseline and eighth week between the two groups (P<0.001) The mean value of glycosylated	(Dixit & Maiya, 2017)

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No	Title	Year, Contry	Sample Size	Type of Exercise	Intensity of Exercise	Finding/ conclusion	Reference
						haemoglobin showed a mean reduction of 0.79 per cent in the study group whereas PPBS and FBS of the two groups had no significant difference	
6.	Morning (Fasting) vs Afternoon Resistance Exercise in Individuals With Type 1 Diabetes: A Randomized Crossover Study	2019 Canada	12 participant	Afternoon Resistance Exercise	7 am and 5 pm per day until 10 weeks. Performed 40 minutes of RE (three sets of eight repetitions, seven exercises, at the individual's predetermined eight repetition maximum)	Blood glucose rose with afternoon exercise (8.262.5 to 7.46 2.6 mmol/L;P50.031 for time-by-treatment interaction). Mean blood glucose level after morning exercise was 10.4 63.0 mmol/L compared with 7.4 62.6 mmol/L (P50.019) upon completion of afternoon exercise.	(Toghi-Eshghi & Reza, 2019)
7.	Effects of aerobic training on FBS, HbA1C,Fructosamine and plasma lipid profile in male with type 2 diabetes	2016 Iran	20 participant	Aerobic Training	8 weeks , one day per weeks duration from first meet : 10 minutes and final meet 30 minutes duration per weeks.	Eight weeks of aerobic training resulted in a significant decrease in fasting blood glucose (P=0.017), HbA1C (P=0.045),Fructosamine (P= 0.012) and LDL(P=0.048) and a significant increase in HDL(P=0.012) of exercise group .There were no significantly changes in all variables of control group(P>0.05)	(Ghalavand & Rooholah, 2016)
8.	Effect of aerobic training on nerve conduction in men with type 2 diabetes and peripheral neuropathy: A randomized controlled trial	2018 Iran	31 patient	Aerobic training	12 weeks Then, they underwent aerobic exercise program for three months (walking, jogging or running on treadmill, three sessions a week, 50—70% of heart rate reserve, 20—	Comparing pre-test versus post-test values, fasting glucose levels in the exercise group significantly decreased from 11.22±3.8 mmol/L to 8.58±2.7 mmol/L representing 23% improvement following exercise	(Gholami & Nikookhes lat, 2018)

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No	Title	Year, Contry	Sample Size	Type of Exercise	Intensity of Exercise	Finding/ conclusion	Reference
					45 min). They were required to record 3-day (2 weekdays and 1 weekend)	program (P= 0.020). 2hpp glucose level also decreased significantly from 15.76±2.5 mmol/L to 14.21±2.5 mmol/L indicating 9% reduction in the mean value (P= 0.009). In the exercise group, HbA1c significantly decreased from 8.3%±1.4% at week (0) to 7.7%±1.5% at week (12) and statistical significance was reached for the time×group interaction (F= 7.097, P= 0.014).	
9.	The impact on glycemic control through progressive resistance training with bioDensity™ in Chinese elderly patients with type 2 diabetes The PReTTy2 (Progressive Resistance Training in Type 2Diabetes) Trial	2019 China	265 patients	Progressive Resistance exercise	12 weeks The participants performed one training session per week. Participants accomplished every session within 5–10 min weekly during the study and were supervised by qualified trainers.	At the end of the study period there was no statistically significant difference in the HbA1c between all patients inthe control and PRT groups. All patients in the control groupat the 3-month interval for HbA1c [6.73 ± 0.94 (50 mmol/mol ± 10.3 mmol/mol)] vs. all patients in the PRT group 6.63 ± 0.98 (49 mmol/mol ± 10.7 mmol/mol) p = 0.427] P= 0.554	(Hangping & Xiaona, 2019)
10.	Effects of Three Type Exercise Training Programs onFBS and HbA1C of Elderly Men with Type 2 Diabetes	2017 Iran	52 T2DM	Training Combine Aerobik and Resistance Exercise	10 weeks Three times per week for the ATG and RTG groups and intermittent a sessions for the SAG group, Each session lasted approximately 90 minutes.	The mean (± standard deviation) age of participantswas 53.24 (±1.05) years old. FBS decreased significantly in all studied groups (P-value<0.05); and HbA1c decreased significantly in RTG and SAG groups (P-value<0.05), but, there were no significant	(Siavoshy & Heidarianpour, 2017)

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No	Title	Year, Contry	Sample Size	Type of Exercise	Intensity of Exercise	Finding/ conclusion	Reference
						differences in HbA1c between groups	
11.	Effect of regular exercise training on changes in HbA1c, BMI and VO_2 max among patients with type 2 diabetes mellitus: an 8-year trial	2017 Iran	65 patients with T2DM	Regular exercise training	52 weeks : three sessions per week (with duration of 15–40 min).	Our long-term exercise training program had a significant effect on HbA1C, BMI and VO_2 max ($P<0.05$). Compared with patients in the control group, HbA1c was significantly reduced and BMI and VO_2 max were significantly improved among the experiment group	(Najafipour & Mobasseri, 2017)
12.	The Effect of 12 Weeks Aerobic, Resistance, and Combined Exercises on Omentin-1 Levels and Insulin Resistance among Type 2 Diabetic Middle-Aged Women	2017 Canada	52 participants (control group 15, AE group 12, RE group 12, and CE group 13)	Aerobic exercise Resistance exercise Combine Aerobic and Resistance exercise	10 weeks AE group : 20 minutes streching & jogging 25 minutes main exercise. RE group: three session per weeks consist three sets and eight repetitions per sets	Glucose, mg/dL Control group (P value 0.06) RE group (P value 0.005) AE group (P value 0.001) Combination (P value 0.001) AE group and Combination (AE and RE) was significantly reduced glucose.	(AminiLari & Fararouei, 2017)
13.	Effects of Exercise in the Fasted and Postprandial State on Interstitial Glucose in Hyperglycemic Individuals	2017 Norway	12 participant	Aerobic exercise	5 weeks. The exercise sessions in both ExBr and BrEx consisted of 60 min of treadmill walking at an individually standardized speed at 8% inclination.	Postprandial exercise also decreased the glycemic variability compared to the control day (1.22 ± 0.49 vs. 1.58 ± 0.52 mmol·L-1, p = 0.015)	(Nygaard & Rønnestad, 2017)
14.	Resistance Training Improves Muscle Function and Cardiometabolic Risks But Not Quality of Life in Older People With Type 2 Diabetes Mellitus: A	2016 Taiwan	30 people with T2DM	Resistance Training	Eight RT exercises—the chest press, shoulder press, biceps curl, hip abduction, standing hip flexion, leg press, standing calf raise, and	No significant correlation was noted between the half-recovery time for deoxyhemoglobin levels after peak exercise and HbA1c levels at week 0 or 12 (P > .05).	(Hsieh, Tseng, & Tseng, 2018)

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No	Title	Year, Contry	Sample Size	Type of Exercise	Intensity of Exercise	Finding/ conclusion	Reference
	Randomized Controlled Trial				abdominal crunch—were performed in 3 sets of 8 to 12 repetitions. Between each set, the participants rested for 60 to 90 seconds. RT was performed 3 times per week for 12 weeks.		
15.	Effects of 12 weeks combined aerobic and resistance exercise on heart rate variability in type 2 diabetes mellitus patients	2016 Korea	16 patients T2DM	Combined aerobic and resistance exercise	8 weeks Stretching as a warm-up and cool-down was performed for 10 minutes until 30 minutes. The aerobic exercise consisted of 2 sets of 9 exercise items using weight machines with 8–12 repetitions for 30 minutes at an I-RM of 60–80%.	Significant correlation was noted in Blood glucose ($p<0.001$) and HbA1c ($p<0.001$).	(Kang & Ko, 2016)
16.	Finding the Optimal volume and intensity of Resistance Training Exercise for Type 2 Diabetes: The FORTE Study, a Randomized Trial	2017 Canada	62 participant	Resistance exercise from low intensity until higher intensity.	24 weeks RT1 (Usual Care) Intensity : Low intensity (15-RM) Repetitions : High (15) Sets : 2 RT2 Intensity : High intensity (7-RM) Repetitions : Low (7) Sets : 3 RT3 Intensity : Low intensity Repetitions : High (15) Sets : 2	Fasting glucose was Significantly different between groups (RT1 differed significantly from RT3; RT1–RT3 = 1.07; 95% CI (2.13, 0.2); p< 0.05).	(Yang & Swardfager, 2017)
17.	Effect of 12-Month Resistance Training on Changes in Abdominal Adipose Tissue and	2019 China	93 participant	Resistance Training and Aerobic Training	28 month resistance training 3 days/week with a bungee cord	No significant differences were noted in RT intervention the following parameters:	(Yan & Dai, 2019)

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No	Title	Year, Contry	Sample Size	Type of Exercise	Intensity of Exercise	Finding/ conclusion	Reference
	Metabolic Variables in Patients with Prediabetes: A Randomized Controlled Trial				The resistance training sessions took approximately 50 minutes to complete The aerobic training program required participants to exercise 3 days/week for 60 minutes/session (including 5-10 minutes of warm-up and 5-10 minutes offlexibility exercises).	Hba1c (group-by-time interaction P=0.573) In withingroup analyses, decreases in HbA1c were only observed in AT (group-by-time interaction P=0.033)	
18.	Effects of combined aerobic and resistance training on the glycolipid metabolism and inflammation levels in type 2 diabetes mellitus	2015 China	42 diabetes patients	Combined aerobic and resistance training	12 weeks Aerobic exercise was conducted for a total of 40–60 minutes per session, 3 sessions per week.	In the CT group, FBG, PBG, PIN, and HbA1c decreased significantly after treatment ($p<0.05$, <0.01)	(Yuan Liu, Liu, & Cai, 2015)

DISCUSSION

Regular physical exercise is highly recommended in the management of type 2 diabetes mellitus (T2DM). Physical activity includes all movement that increases energy use, whereas exercise is planned and structured physical activity. The previous study pointed that there were 3 types of physical exercise; aerobic exercise, resistance exercise and flexibility and balance exercise. These can be done by the T2DM patients as an intervention for glycemic control (Colberg & Sigal, 2016).Exercise improves blood glucose controlin type 2 diabetes, reduces cardiovascular risk factors, contributes to weight loss,and improves well-being (Xie, Li, Wang, Li, & Chen, 2015) (Lin & Zhang, 2015). It can decrease the levels of inflammatory factors such as TNF-α, IL-6, CRP and leptin while increasing the levels of anti-inflammatory factors such as IL-4, IL-10, and adiponectin in diabetes patients. Exercise also reduces the inflammation level and improves IR by enhancing anti-stress and anti-oxidative effects (Kurniawati & Kusumawati, 2020). Exercise therapy is an effective method for treating diabetes mellitus. Many studies show aerobic exercise including home-based exercise decreases blood glucose, lipid, and HbA1c levels as well as improves insulin sensitivity, blood pressure, in T2DM patient (Ghalavand & Rooholah, 2016) (Gholami & Nikookheslat, 2018) (Nygaard & Rønnestad, 2017).

This systematic review, the authors reviewed 18 research articles about various physical exercise (aerobics, resistance exercie, and a combination of aerobics and resistance exercise) related to glycemic control (blood sugar and Hba1c).

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Aerobic Exercise

The American College of Sports Medicine (ACSM) defines aerobic exercise as any activity that uses large muscle groups, can be maintained continuously and is rhythmic in nature (Chodzko-Zajko & Proctor, 2019).As the name implies, muscle groups activated by this type of exercise rely on aerobic metabolism to extract energy in the form of adenosine triphosphate (ATP) from amino acids, carbohydrates and fatty acids. In this systematic review, the study's result show that one intervention aerobic exercise has a significant for reducing HbA1c and blood glucose according to study from (Ghalavand & Rooholah, 2016) that 8 weeks with duration 10 -30 minutes duration per weeks make significant decrease in fasting blood glucose (P=0.017) and HbA1C (P=0.045). Then, study from (Gholami & Nikookheslat, 2018) 12 weeks aerobic exercise(AE), fasting glucose levels in the exercise group significantly decreased from 11.22±3.8 mmol/L to 8.58±2.7 mmol/L. 2hpp glucose level also decreased significantly from 15.76±2.5 mmol/L to14.21±2.5 mmol/L indicating 9% reduction in the mean value (P= 0.009). In the exercise group, HbA1c significantly decreased from 8.3%±1.4% at week to 7.7%±1.5% at week.

Thrid study from (Nygaard & Rønnestad, 2017) 5 weeks aerobic exercise postprandial exercise decreased the mean of the 10 highest glucose values measured in each individual (8.6 ± 1.9 mmol·L-1) over 22 hours compared to both the control day (9.3 ± 2.1 mmol.L-1). From all the study, average duration 8 weeks and 20-40 minutes intensity of aerobic exercise can decrease level of HbA1c and blood sugar. During aerobic exercise, muscle contraction stimulates an increase in AMPK activity (AMP-activated protein kinase). This activation then stimulates GLUT4 translocation into the cell membrane, thereby increasing the glucose uptake (Bird & Hawley, 2017). In T2DM, there are deficiencies in the insulin receptors which results in impaired glucose uptake and GLUT4 translocation. However, exercise therapy could restore the defects of insulin by providing GLTU4 translocation (Bird & Hawley, 2017).

Resistance Exercise

Resistance training benefits for individuals with type 2 diabetes include improvements in glycemic control, insulinresistance, fat mass, blood pressure, strength, and lean body mass (Colberg, 2016). Resistance training-induced physiological stimuli and/or specific molecular signaling cascades can facilitate a number of physiological adaptations in individuals, and mitigate the diabetes complications (Shaw, Sicree, & Zimmet, 2010). For instance, RE induces beneficial changes in insulin sensitivity through increased
skeletal muscle mass, glucose storage, enhanced glucose clearance from circulation, and improved
mitochondrial oxidative capacity (Pesta & Goncalves, 2017). Improved insulin sensitivity in T2D was associated with RE-induced (~67% 1RM) loss of abdominal fat and increased muscle density(Yubo Liu & Ye, 2019).

Our study review that decreased blood glucose and HbA1c with resistance exercise (RE) as single intervention have significant and no significant result. First, study from (Buch et al., 2019) 10 weeks Circuit Resistance Training (CRT) 3 home sessions per week has significant dercrease glycemic control Fasting Plasma Glucose (FPG) and HbA1c (p = 0.006). Second, study from (Toghi-Eshghi & Reza, 2019) during 10 weeks performed 40 minutes RE and te result is Blood glucose decrease in treatment group exercise from 8.262.5 to 7.46 2.6 mmol/L. Third study, from (Yang & Swardfager, 2017)

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in 62 participant during 24 weeks with RE from low intensity until higher intensity has result for fasting glucose was significantly different between groups (RT1 different significantly from RT3; RT1–RT3 =1.07; 95% CI (2.13, 0.2); p< 0.05). Similar to aerobic exercise, resistance exercises are useful therapeutic tools in the management of T2DM. In addition, it was also proven to be safe and efficacious for the elderly insulin resistant diabetic patients. Resistance exercise has been reported to enhance insulin sensitivity, daily energy expenditure and quality of life(Bird & Hawley, 2017). Furthermore, resistance training has the potential to increase muscle strength, lean muscle mass and bone mineral density, which could enhance both functional status and glycemic control (Patel & Alkhawam, 2017).

Nevertheless, many study showed significant result in the other hand there are no statistically significant for decrease HbA1c level in T2DM patients with RE intervention in study from(Chen et al., 2020) (Hangping & Xiaona, 2019) (Hsieh et al., 2018) between intervention group and control group.

Kombinasi AE dan RE

In the present study, T2DM patients performed combination of aerobic exercises and resistance training for 10 to 12 weeks. The study's result before was related to the results of the current study in combination of aerobic and resistance exercise were the most common types of physical exercise used for maintaining glycemic control respectively. Compared with supervised aerobic or supervised resistance exercise alone, combined exercise showed there to be more of an improvement in HbA1c levels and blood sugar.

First study from study (Siavoshy & Heidarianpour, 2017) 52 T2DM patient in Iran during 10 weeks combine (AE and RE) the result is FBS decreased significantly in all studied groups (P-value<0.05) and HbA1c decreased significantly in RTG and SAG groups (P-value<0.05). Second study from (AminiLari & Fararouei, 2017) 52 participants in Canada doing combine AE and RE at 8 weeks and the result is AE group and Combination (AE and RE) was significantly reduced glucose with (P value 0.001). Third study from (Kang & Ko, 2016) in South Korea with 16 participant doing combine Ae and RE during 10 weeks and the result is significant correlation was noted in Blood glucose (p<0.001) and HbA1c (p<0.001). Fourth study from (Yuan Liu, 2015) in China with 42 T2DM pastient doing combine AE and RE during 12 weeks and the result is FBG, PBG and HbA1c decreased significantly after treatment (p<0.05, <0.01) .The limitation of this study was the variation of the intervention's duration in many studies . Two studies had an intervention duration that was less than standart 8 days. The other studies were done over more than 12 week.

CONCLUSION

The present systematic review showed the effectiveness of various physical exercise on glycemic control (HbA1c and blood glucose T2DM patinet. From the published data, it can be concluded that exercise-based research on a schedule of minimum 2 or 3 times a week for 30 to 60 minutes per session over 2 months was widely used and significant at reducing blood glucose and hemoglobin A1c (HbA1c). This systematic review could be used as evidence when carrying out combined aerobic and resistance exercise as good choice physical exercise interventions for the purpose of glycemic control on patient with diabetes type 2

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