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Physical Exercises for the Elderly with Diabetes Mellitus Type 2

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***Abstract*—Diabetes mellitus type 2 is a common problem that occurs in various developing countries and has increased significantly. The increasing number of elderly also causes an increase in the incidence of this disease due to the decreases in muscle function and insulin sensitivity in elderlies which affect glucose levels in the blood. Physical exercise is one of the pillars in the management of diabetes mellitus type 2. This article will describe various physical exercises in the elderly with diabetes mellitus type 2. The source of data used google scholar, springer exemplar, and science direct. 7 articles that meet the criteria were then analyzed with thematic analysis. The principle of physical exercise in the elderly with diabetes mellitus is by paying attention to the type of exercise, intensity, duration, and frequency of exercise. Furthermore, it is expected that physical exercise in the elderly can be developed with various models as a part of the development of diabetes mellitus management.**

Keywords: diabetes mellitus type 2, elderly, exercises, physical training

I. INTRODUCTION

Diabetes mellitus (DM) is a non-infectious disease whose prevalence continues to increase every year. Data from the World Health Organization (WHO) in 2015 shows that diabetes is the seventh leading cause of death in Indonesia in adult diseases [1]. The results of a study from the International Diabetes Federation in 2017 revealed that there were 425 million people with Diabetes Mellitus worldwide. Indonesia is ranked seventh in the country with the most diabetics, namely 7.6 million people [2]. Type 2 diabetes is the most common type of diabetes, which is about 90% of all people with diabetes and often occurs at the age of 40 years and above [3]. The prevalence of this disease continues to increase mainly due to changes in lifestyle, an increase in the number of calories eaten, a lack of physical exercise and an increasing number of elderly population [4]. Physical activity is recognized as an integral part of primary preventive measures for people at risk of DM and secondary prevention for patients with DM.

Physical activity in which physical exercise is very important in maintaining the physical health of individuals. Physical exercise is associated with obesity and is known to be a third risk factor for non-infectious diseases such as cardiovascular disease, DM type 2, cancer 2. Physical exercise in people with DM has a very important role in controlling blood glucose levels. During physical exercise, the whole body will increase oxygen intake up to 20 times and increase the work of the muscles of the body. This triggers an increase in the breakdown of glycogen, triglycerides and free fatty acids (FFAs) in muscles. Physical exercise in the elderly is health-related fitness that is heart-lung fitness and blood circulation as well as muscle strength and joint flexibility [5].

The elderly are the population group with the largest percentage of DM patients. The results of Riskesdas in 2013 showed the percentage of elderly with DM was 8.3% [6]. Various research results also show an increased risk of DM with age [6]. Increasing age in individuals will cause a decrease in strength, muscle mass, and insulin sensitivity, but this should be prevented by regular physical exercise. The type of physical exercise recommended for DM patients is aerobic exercise. A study by Abe R & Fujinuma H showed that older people did more regular physical exercise than middle adulthood, but the effect on lowering blood glucose levels was lower than in middle adulthood. This needs to be studied in more depth regarding proper physical exercise for the elderly. This article aims to find out the types of physical exercise and its effects on T2DM.

II. METHOD

The design employed was a systematic review. The data was obtained from Google Scholar, Springer Link, Science Direct, Scopus from 2015-2019. The keywords involve "Physical Activity" and Diabetes Mellitus" and "Eldery". Reviews in the articles follow the research criteria. The inclusion criteria as follows: (1) Articles published articles are written in Indonesian and English. (2) The article focuses on physical activity interventions in elderly patients with T2DM. (3) Article of research on open access and full text. Articles searching and summarizing the relevant articles. The consideration of relevance based on the clarity of resources and correlation with the topic. The analysis of results using descriptive thematic analysis.

III. RESULT

From the search results found 1,530 articles, Google Scholar, 227 articles springer links, 11,700 articles on science direct. The article was selected based on the specified criteria. Researchers found 7 articles that match. Researchers analyzed each of these articles. Details of articles are presented in table 1.

TABLE I. THE SUMMARY OF THE ARTICLE ON EXERCISE TRAINING OF ELDERLY WITH DIABETES MELLITUS

No	Authors	Title	Year	Design	Method	Findings
1	Gian Pietro Emerenziani, Maria Chiara Gallotta, MarcoMeucci, Luigi Di Luigi, Silvia Migliaccio, Lorenzo Maria Donini, Felice Strollo, and Laura Guidetti [7]	Effects of Aerobic Exercise Based upon Heart Rate at Aerobic Threshold in Obese Elderly Subjects with Type 2 Diabetes	2015	Experimental design with randomize sampling	30 elderly (age 66.8 + 6.3 y. 15 subjects intervention and 15 subjects control Test were performesd at baseline and after 3 months in both group	After training, patinets enrolled in Intervention had significantly hiher (P<0.001) VO2 peak, MET peak, WR peak and WR aet Tgd significantly lower (p<0.005) weight, BMI, %FM and waist circumference than before intervention period. But no significant differences were found for all the between pre and posttraining and between groups
2	Joan Kelly, Katrina Edney, Chris Moran, Velandai Srikanth, and Michele Callisaya[8]	Gender Differences in Physical Activity Levels of Older People With Type 2 Diabetes Mellitus	2016	Cohort Study	2 groups obtained 293 participants with T2DM and 336 without T2DM	In women, T2DM wa associated with fewer mean steps per day; not meeting Phisical Activity guidelines.
3	Lucia Cugusi, PhD, Christian Cadeddu, MD, PhD, Silvio Nocco, MD, PhD, Fabio Orru`, MD, Stefano Bandino, MD, Martino Deidda, MD, Alessandra Caria, MSc, Pier Paolo Bassareo, MD, PhD, Alessandra Piras, MD, PhD, Sergio Cabras, MD, Giuseppe Mercuro, MD[9]	Effects of an Aquatic-Based Exercise Program to Improve Cardiometabolic Profile, Quality of Life, and Physical Activity Levels in Men With Type 2 Diabetes Mellitus	2015	Observational study, community pre-post aquatic-based exercise program, primary care inter vention	Eighteen men diagnosed with 2DM Main Outcome Measurements: Cardiometabolic profile, quality of life, and physical activity levels were assessed before and after 12 weeks of an aquatic-based exercise program	The results show a significant improvement of cardiometabolic assessments (maximum oxygen consumption 24.1 versus 21.1 mL/kg/min, P < .05; blood pressure: 125.4/77 versus 130.7/82.5 mm Hg, P < .05; fasting blood glucose: 119.6 versus 132.5 mg/dL, P < .05; body mass index: 29.9 versus 31.1 kg/m², P < .005; low-density lipoprotein cholesterol: 95.2 versus 104.9 mg/dL, P < .05; and diastolic function: E/E′ 9.1 versus 10.1, P < .005) and an increase in quality of life and physical activity and energy expenditure in general physical activity (physical activity: 3888.7 versus 1239.5 kcal/wk, P < .05).
4	Kishan Bakrania, Charlotte L. Edwardson, Kamlesh Khunti, Joseph Henson, Emmanuel Stamatakis, Mark Hamer, Melanie J. Davies, Thomas Yates[10]	Associations of objectively measured moderate-to-vigorous-intensity physical activity and sedentary time with all-cause mortality in a population of adults at high risk of type 2 diabetes mellitus	2017	Experimental	At baseline, participants were randomised to usual care or the three-hour Walking Away structured education programme with ongoing annual support Participants were followed up at 12, 24 and 36 months. Over the 36 months, levels of physical activity or sedentary behaviour between the two arms	findings demonstrate that the risk of death was reduced by 5% for every 10% increase in MVPA time in adults at high risk of T2DM
5	M. Mogharnasi, A. TajiTabas, M. Tashakorizadeh, S.H. Nayebifar[11]	The Effects of Resistance and Endurance Training on Levels of Nesfatin-1, HSP70, Insulin Resistance and Body Composition in Women with Type 2 Diabetes Mellitus	2019	experimental	26 women with type 2 diabetes were selected using purposive sampling and were randomly divided into three groups. 10 subjects participated in the resistance training group (3 sessions per week, exercising with 30–80% of one repetition maximum (1RM)), 8 subjects participated in the endurance training group (3 sessions per week, exercising with 40–80% of maximum heart rate (HR max), for 20–45 minutes), and 8 subjects were placed in the control group who did not engage in any physical exercise during the study period.	There was a significant increase in nesfatin-1 levels and a significant decrease inHSP70 levels of the resistance training group, (P < 0.05), whereas no significant changes were observed in nesfatin-1 and HSP70 levels of the endurance training group (P > 0.05). Glucose levels, insulin resistance (HOMA1-IR) and body composition indices (except for WHR) significantly decreased in both training groups (P < 0.05). However, there were no significant changes in insulin levels of the training groups (P > 0.05). Moreover, comparing the pre- and post-test levels of glucose changes, a significant difference was observed in the resistance and endurance training groups but not in the control group (P < 0.05).
6	Fernanda Maria Martinsa , Aletéia de Paula Souzaa , Paulo Ricardo Prado Nunesa , Márcia Antoniazi Michelinc , Eddie Fernando Candido Murtac , Elisabete Aparecida Mantovani Rodrigues Resendec , Erick Prado de Oliveirad , Fábio Lera Orsatti[12]	High-intensity bodyweight training is comparable to combined training in changes in muscle mass, physical performance, inflammatory markers and metabolic health in postmenopausal women at high risk for type 2 diabetes mellitus:	2018	A randomized controlled clinical trial	16 PW at high risk of TDM2 was randomly allocated into two groups: HIBWT (n=8) and COMT (n=8). The HIBWT group performed a training protocol (length time ~28 min) consisting of ten sets of 60 s of high-intensity exercise interspersed by a recovery period of 60 s of low -intensity exercise. The COMT group performed a training protocol (length time ~60 min) consisting of a 30 min walk of the moderate-intensity following by five resistance exercises. All training sessions were performed in the university gym facility three days a week (no consecutive days) for 12 weeks.	Both groups increased (P < 0.05) muscle mass index (MMI), 6MWT, and interleukin 1 receptor antagonist and decreased fasting glucose, glycated hemoglobin, Insulin, HOMA-IR, and monocyte chemoattractant protein-1 (trend, P=0.056). HIBWT effects were indistinguishable (P > 0.05) from the effects of COMT. There was a significant (P < 0.05) interaction of time by the group in muscle strength, indicating that only the COMT increased muscle strength
7	L.C. Cruz, A.A. Teixeira-Araujoa,, K.T.P. Andrade, T.C.O.G. Rocha, S.R. Moreira[13]	Low-intensity resistance exercise attenuates the relationship between glucose and autonomic nervous system indicators during 24 hours in women with type 2 diabetes	2018	randomized block design	20 postmenopausal women with T2D between 48 and60 years old took part in the study.	a single RE session attenuates the correlation between glucose and RRi values. Besides, low-intensity RE session provides the extinction of the correlation between glucose and autonomic nervous system indicators in postmenopausal women with T2D.

A. Physical Exercises

Physical exercise is often associated with the development of DMT2 complications. Elderly with DM if able to do regular exercise, especially strength training, the weight, and blood glucose levels can be controlled better.

Physical exercise is known to increase insulin sensitivity to receptors in muscles and tissues, besides that the risk of cardiovascular complications such as hyperlipidemia and hypertension can be reduced with regular and proper physical exercise [4,14]. Physical exercise in the elderly with DM has a risk, however physical exercise can trigger angina execration or ischemia in patients with cardiovascular disorders [4].

The presence of peripheral neuropathy causes the risk of injury to an increase in the elderly with DM. Symptoms of hypoglycemia can also occur in the elderly with oral medication. The American Diabetes Association recommends elderly people who want to do more than just walk to assess the risk of cardiovascular disease and other diseases [4].

The purpose of physical exercise for people with DM include (1)To get a good metabolism; (2) To reduce weight; (3) To increase physical capacity; (4) To improve the quality of life; (5) To improve cardiovascular function and dyslipidemia; (6) Improve sleep quality, improve digestive function [1,15].

Specific analysis of appropriate physical exercise based on an evidence base needs to be carried out to obtain guidance on an appropriate and safe program. In table 1, we will present some of the results of research related to physical exercise in the elderly.

Type of exercise. Helping the elderly in choosing the right and comfortable physical exercise is important in the success of physical exercise activities. An appropriate physical training program must include strength, flexibility and balance training [15]. Physical activity in the elderly must pay attention to FITT (frequency, intensity, time, type). This type of physical exercise is also suggested to have a social aspect as well as an impact on elderly emotions. Exercises suitable for the elderly with T2DM include [16-18].

Aerobic Exercise. This includes rhythmic activities, repetition and continuous movement in large muscle groups for at least 10 minutes. These exercises tend to be safe for the elderly, for example walking, jogging, swimming, cycling and aerobic exercises [16,17].

For older people over the age of 65, it is recommended to do sports that do not overload bones, and start from the low intensity and gradually increase in behavior based on tolerance to physical exercise [18].

Muscle-strengthening / endurance exercises. Exercises that use muscle strength to move or lift weights, endurance exercises are chosen for each muscle group [16]. Physical exercises for strengthening muscles are activities that strengthen and support the muscles and connective tissue. Exercises are designed so that the muscles are capable of strength to move or hold weights such as standing movements from a chair, held for several seconds repeatedly, training with elastic straps. Muscle-strengthening exercises done at least 2 days a week with rest between sessions [18].

Muscle-strengthening training for 2.5 x / mgg for> 8 mg in adults has been shown to reduce HbA1C levels even though there is no significant change in body mass index [16].

Flexibility Exercises. Flexibility or stretching exercises aim to increase the range of motion of the muscles and help reduce the risk of injury. Flexibility exercises are designed to involve every major joint (hip, back, shoulder, knee, and neck). Flexibility training is recommended to be done in conjunction with aerobic and muscle-strengthening exercises, 2-3 x / week, examples of flexibility exercises are ROM and yoga. Balance training also needs to be done to prevent the elderly from falling, at least 3 days a week, this exercise is done in low intensity.

1) Exercise protocol: Standard protocol in physical exercise for people with DM includes 4 stages

- Stage 1: warming up for 5-10 minutes aerobic with low-intensity level
- Stage 2: Muscular stretching for 5-10 min
- Stage 3: core training
- Stage 4: cooling for 5-10 min which will help HR return to before training.

Physical training programs for the elderly are arranged in stages. For example, starting with a low intensity of 40-50% resting pulse for 10-20 min is increased according to the ability to adapt to each individual's training gradually.

Monitor blood sugar and hypoglycemic signs need to be considered during physical exercise. Effects of Physical Exercise on Metabolism. Physical exercise helps the absorption of the hormone insulin into cells to form energy. Muscles use glucose better than fat4. The mechanisms that occur in glucose control include improvements in insulin sensitivity and effects on Glucose Transporters (GLUT4), the muscle contracting simultaneously with the transfer of GLUT4 into the plasma membrane directly. During 5-10 minutes of exercise, glycogen becomes the main source of energy, with glycogen training in the muscles will be depleted and glucose will be replaced by glucose from the liver and the results of neogluconeogenesis. If the exercise continues for several hours this will contribute to reducing glucose and FFAs which are the main fuel [17]. The effect of exercise on insulin does not exceed 72 hours, so it is recommended no more than two days the distance between exercises. Moderate-intensity exercise for 30 min / hr is the most ideal, but those who are unable to do it every day should be able to reach 150 min / week at least 3 days / week [16,17,19,20].

Marwick et al's research state that exercise stimulates metabolic improvement, influences HbA1c blood glucose and insulin sensitivity6. There is an improvement in the average HbA1c value of -0.38% to - 0.97% at practice [19].

III. CONCLUSION

The purpose of physical exercise for people with DM include (1)To get a good metabolism; (2) To reduce weight; (3)

To increase physical capacity; (4) To improve the quality of life; (5) To improve cardiovascular function and dyslipidemia; (6) Improve sleep quality, improve digestive function [1,15].

There some good physical exercise as the results of research related to elderly with DM : Aerobic Exercise, Muscle-strengthening / endurance exercises, Flexibility Exercise.

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