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The effect of diabetes exercise on the quality of life of type 2 diabetes mellitus patients

Nur Rachmawati Maulida [1], Jongky Hendro Prajitno [2]*, Nuniek Nugraheni Sulistiawaty [3]

[1] Undergraduate School of Medicine, Airlangga University Faculty of Medicine, Jl. Mayjen Prof. Dr. Moestopo No.47, Pacar Kembang, Tambaksari, Surabaya, Jawa Timur 60132, Indonesia
[2] Division of Endocrinology, Diabetes, and Metabolism, Department of Internal Medicine, Dr. Soetomo Teaching Hospital, Airlangga University Faculty of Medicine, Jl. Mayjen Prof. Dr. Moestopo No.6-8, Airlangga, Gubeng, Surabaya, Jawa Timur 60132, Indonesia
[3] Department of Physical Medicine and Rehabilitation, Dr. Soetomo Teaching Hospital, Airlangga University Faculty of Medicine, Jl. Mayjen Prof. Dr. Moestopo No.6-8, Airlangga, Gubeng, Surabaya, Jawa Timur 60132, Indonesia
* Corresponding Author. E-mail: jongky-h-p@fk.unair.ac.id

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Abstract: Physical inactivity and obesity are some of the main risk factors for diabetes mellitus (DM). The presence of DM might result in impaired quality of life (QoL). Our study aimed to firstly determine the association between diabetes exercise status and the QoL in type 2 Diabetes Mellitus (T2DM) patients and secondly to explore other factors associated with QoL among T2DM patients. This was an observational study with cross-sectional design of T2DM patients in dr. Trimurti primary health care (PHC) from January – December 2019. The subjects were recruited consecutively then categorized into treatment group (who performed diabetes exercise program) and control group (who did not perform diabetes exercise program). then observed as in the exercise group (who performed diabetes exercise program) and in the non-exercise group (who did not perform diabetes exercise program). The dependent variable was the QoL and was collected through a modified questionnaire made from 30 questions. The maximum score for QoL was 120 (all 4 on the Likert scale) and the score results were categorized as poor if the score was < 96.5 and good if the score was > 96.5. Meanwhile, other data (comorbidities, exercise status, glycaemic status) were obtained through medical records. A total of 60 adult T2DM patients were recruited, consisting of 30 subjects each in the non-exercise and exercise groups. Male subjects, aged > 65 years, had bachelor's degrees, retired, married, had very high income, had no comorbidities, and exercised independently every week tended to have good QoL. In the exercise group, the majority of subjects (60%) performed diabetes exercise every two weeks and the majority (90%) had random blood glucose levels < 200 mg/dL. The chi-square test revealed a significant associaton between participation in diabetes exercise and QoL in T2DM subjects. Participation in diabetes exercise is associated with good QoL and better glycemic control in T2DM patients.

Keywords: type 2 diabetes, diabetes exercise, physical activity, quality of life

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INTRODUCTION

Diabetes Mellitus (DM) is a metabolic disorder caused by a lack of insulin production by the pancreas or ineffective insulin usage. Diabetes Mellitus is divided into two main categories, namely type 1 DM, which is characterized by lack of insulin production, and type 2 DM, which is caused by ineffective insulin usage (KEMENKES RI, 2014). Type 2 DM patients have two to four times higher risk of developing heart and blood vessel disease compared to normal people. Abnormalities in blood vessels could occur before the patient is diagnosed with DM because insulin resistance has already existed (Decroli, 2019). The International Diabetes Federation reported that in 2019, there were 1.2 million deaths attributed to diabetes in Southeast Asia. It makes the Southeast Asian region the second

region with the highest mortality because of DM among other regions. Indonesia is ranked 7th for the most DM patients in the world in 2019 (International Diabetes Federation, 2019).

Lack of physical activity, unhealthy and unbalanced diet, obesity, hypertension, smoking, hypercholesterolemia, and alcohol consumption are the main risk factors for DM. Diabetes mellitus can be controlled through prevention and overcoming of these risk factors (DEPKES RI, 2008). Treatment modalities in DM patients must include both pharmacologically and non-pharmacologically measures. All guidelines regarding diabetes consider physical activity and exercise as part of lifestyle modification for improved outcomes. Some guidelines specified physical activity such as walking at least 150 minutes per week at intervals of no more than 48 hours. Strength exercises such as weightlifting or yoga could also help patients to lose weight (International Diabetes Federation, 2017). The intensity of physical exercise could be reduced for patients who have already developed complications.

A previous study that examined the correlation between diabetes exercise and blood pressure of T2DM patients showed that DM exercise could reduce the systolic and diastolic blood pressure of T2DM patients (Afifah & Rifa'i, 2017). Diabetes exercise was also considered effective in controlling blood glucose levels in people with DM (Rahayuningrum & Yenni, 2018). In addition, a previous study indicated that there was a significant effect of diabetic foot exercise on the QoL of DM patients (Prihastini, 2017). It is undeniable that lifestyle modification with physical activity could have a clinically significant impact on T2DM patients. To our knowledge, there are still few studies that directly examine the association between diabetes exercise and the QoL in T2DM patients, especially in Surabaya, East Java. Therefore, our present study aimed to determine the association between physical activity therapies such as diabetes exercise with the QoL of T2DM patients and several factors that might be associated.

METHOD

This study was an observational analytic study with a cross-sectional design. The population of this study was T2DM patients at dr. Trimurti Primary Health Care (PHC), Surabaya. The sample size was calculated from the following formula: $n = \frac{Z^2_{1-\alpha/2}P(1-P)N}{d^2(N-1)+Z^2_{1-\alpha/2}P(1-P)}$ which significance level ($Z_{1-\alpha/2}$) value was 1.96, absolute precision value of 0.05, the proportion (p) was 21%, and known population size (N) was 30; therefore, a minimum of 27 subjects was needed for each non-exercise and exercise group. Type 2 DM patients aged > 30 years, had a well-documented medical record, and agreed to participate in this study were included. Meanwhile, subjects diagnosed with dementia, currently being admitted, who had a physical disability in daily living, or handicapped were excluded. The subjects were recruited consecutively then then observed as in the exercise group (who performed diabetes exercise program) and in the non-exercise group (who did not perform diabetes exercise program).

The diabetes exercise in this study was defined as a low impact and rhythmic aerobic exercise performed in 60 minutes (10 minutes for warming up and cooling down, and 40 minutes for core exercise). Diabetes exercise was performed in a group, guided by a gymnastics instructor, and supervised by medical personnel. All cases included in this study were subjected to diabetes QoL evaluation using a questionnaire developed by Thiagarajan in 1998 which had been modified and tested for validity and reliability by Tyas (2008) with a validity value of r > 0.316 and a reliability value (r Alpha value) of 0.958 (Tyas, 2008). The questionnaire consisted of 30 questions that represented several aspects of a T2DM patient daily life, including their perspectives of the diseases and their social activities (Supplementary table S1). Each question was calculated using Likert scale, with scores ranging from 1 to 4. A full 4 score on all questions will result in a total score of 120. Meanwhile, the score results were categorized as poor QoL if the score was < 96.5 and good QoL if the score was > 96.5.

The questionnaire was delivered to the subjects as a Google Forms™ and was sent via the WhatsApp™ application. Data regarding the intensity of exercise were obtained through medical records and attendance lists of the patients. The data analysis used descriptive statistics, bivariate analysis with Chi-square test to investigate the association between two categorical data. All data were processed using Microsoft Excel™ software. This study was carried out after approval from Airlangga

University ethical committee (29/EC/KEPK/FKUA/2021) and informed consent from the subjects obtained.

RESULT AND DISCUSSION

A total of 60 adult T2DM patients were recruited from October 2020 – March 2021, consisting of 30 subjects each in the non-exercise and exercise groups. In general, there were more subjects with good QoL than poor QoL (58 vs 42%). Overall, there were more subjects with good QoL in the exercise group compared to the non-exercise group. Regarding gender, the proportion of subjects with good QoL was higher in males compared to females. Older subjects (aged > 65 years) had a higher proportion of subjects with good QoL compared to younger subjects. Based on education level, the group with diploma/undergraduate level had the highest percentage of samples with good QoL, followed by junior high school, senior high school, and elementary school level. Regarding employment status, the retired group had the highest percentage of subjects with good QoL and the unemployed group had the highest proportion of subjects with poor QoL. The married group had a higher proportion of subjects with good QoL. The order of groups with the highest percentage of subjects with good QoL was as follows: very high income (> Rp. 3,500,000/month), low income (< Rp. 1,500,000/month), high income (Rp. 2,500,000 – Rp. 3,500,000/month), and medium income (Rp. 1,500,000 – 2,500,000/month). The complete socio-demographic characteristics of the subjects are described in table 1.

Table 1. Socio-demographic Characteristics of the Subjects

Characteristics		Group	Quality of Life		*p*
			Good n (%)	Poor n (%)	
Sex	Male	Treatment	13 (81%)	3(19%)	0.362
		Control	5 (62%)	3 (38%)	
	Female	Treatment	11(79%)	3 (21%)	0.003
		Control	6 (27%)	16 (73%)	
Age	30 -65 years	Treatment	17 (74%)	6 (26%)	0.017
		Control	8 (38%)	13 (62%)	
	> 65 years	Treatment	7 (100%)	0 (0%)	0.011
		Control	3 (33%)	6 (67%)	
Education level	Elementary School	Treatment	3 (75%)	1 (25%)	0.272
		Control	6 (35%)	11 (65%)	
	Junior High School	Treatment	7 (78%)	2 (22%)	0.136
		Control	2 (33%)	4 (67%)	
	Senior High School	Treatment	5 (83%)	1 (17%)	0.242
		Control	2 (33%)	4 (67%)	
	Diploma/Undergraduate	Treatment	9 (82%)	2 (18%)	1.000
		Control	1 (100%)	0 (0%)	
Employment status	Employed	Treatment	7 (78%)	2 (22%)	0.136
		Control	2 (33%)	4 (67%)	
	Retired	Treatment	8 (73%)	3 (27%)	0.332
		Control	3 (43%)	4 (57%)	
	Unemployed	Treatment	9 (90%)	1 (10%)	0.014
		Control	6 (35%)	11 (65%)	
Marital status	Married	Treatment	22 (81%)	5 (19%)	0.019
		Control	11 (50%)	11 (50%)	
	Widowed/Divorced	Treatment	2 (67%)	1 (33%)	0.055
		Control	0 (0%)	8 (100%)	
Income	< 1,500,000	Treatment	8 (100%)	0 (0%)	0.007
		Control	6 (40%)	9 (60%)	
	1,500,000 – 2,500,000	Treatment	3 (75%)	1 (25%)	0.217
		Control	2 (22%)	7 (78%)	
	2,500,000 – 3.500.000	Treatment	4 (67%)	2 (33%)	0.429
		Control	0 (0%)	1 (100%)	
	> 3,500,000	Treatment	9 (75%)	3 (25%)	0.600
		Control	3 (60%)	2 (40%)	

This present study indicated that 53% of the T2DM patients had comorbidities or had already developed complications from DM. In those subjects, the exercise group had a higher proportion of subjects (60%) with good QoL compared to the non-exercise group (32%). Overall, the group without complications/comorbidities had a higher proportion of individuals with good QoL. Subjects in the exercise group also had a higher proportion of individuals with good QoL, regardless of the intensity of independent exercise performed. However, the group who performed independent exercise 1-2 times a week had the highest proportion of subjects with good QoL. The clinical characteristics of the subjects in this study are presented in table 2.

Table 2. Clinical Characteristics of the Subjects

Characteristics		Group	Quality of Life	
			Good n (%)	Poor n (%)
Presence of comorbidities/ complication	Present	Exercise	6 (60%)	4 (40%)
		Non-exercise	7 (32%)	15 (68%)
	Absent	Exercise	18 (90%)	2 (10%)
		Non-exercise	4 (50%)	4 (50%)
Independent Exercise Intensity	1–2 times/week	Exercise	13 (100%)	0 (0%)
		Non-exercise	7 (64%)	4 (36%)
	1–2 times/2 weeks	Exercise	3 (100%)	0 (0%)
		Non-exercise	1 (33%)	2 (67%)
	1–2 times/month	Exercise	2 (25%)	6 (75%)
		Non-exercise	0 (0%)	7 (100%)
	None	Exercise	6 (100%)	0 (0%)
		Non-exercise	3 (33%)	6 (67%)

Within the exercise group, subjects who performed diabetes exercise once per two weeks and once per month had better QoL compared to subjects who only performed diabetes exercise once per two months. Regarding glycemic control, it was found that subjects with blood glucose levels of < 200 mg/dL had better QoL compared to subjects who had blood glucose levels of > 200 mg/dL. The intensity of diabetes exercise and glycemic control of the subjects in the exercise group are described in table 3.

Table 3. Intensity of Diabetes Exercise and Glycemic Control in the Exercise Group

Characteristics		Quality of Life	
		Good n (%)	Poor n (%)
Diabetes exercise intensity	Once/2 weeks	16 (89%)	2 (11%)
	Once/month	8 (89%)	1 (11%)
	Once/2 months	0 (0%)	3 (100%)
Random blood glucose	< 200 mg/dl	23 (85%)	4 (15%)
	> 200 mg/dl	1 (33%)	2 (67%)

Considering the independent (diabetes exercise program) and dependent (QoL) variables were categorical data in origin, the association was calculated using the chi-square test with the Yates correction formula. The Chi-square count was 11.59, while the Chi-square table was 3.84 therefore, the null hypothesis (H_0) was rejected. There was a significant association between the diabetes exercise program performed and the QoL in patients with T2DM. Table 4 described the distribution of QoL between the exercise and non-exercise groups.

Table 4. Distribution of Quality of Life between the Exercise and Non-exercise Groups

Groups	Quality of Life	
	Good n (%)	Poor n (%)
Exercise	24 (80%)	6 (20%)
Non-exercise	11 (37%)	19 (63%)
Total	35 (58%)	25 (42%)

The main result of our study was a significant association between the diabetes exercise program performed and the QoL in patients with T2DM. This result was in accordance with the study by Noorratri (2019) who reported that physical therapy treatment had a significant effect on improving the QoL of patients with DM (Noorratri, 2019). Other study by Martin et al. (2009) also concluded that exercise in sedentary and obese subjects would improve their physical and mental QoL (Martin et al., 2009). The study by Prihastini (2017) in T2DM patients also revealed improvement in QoL after the subjects were asked to perform foot exercise therapy (Prihastini, 2017). Physical exercise significantly enhances insulin sensitivity, especially in the muscle tissue (Pedersen & Saltin, 2015). Active or contracting muscles will increase insulin receptor sensitivity, therefore reducing the need for exogenous insulin (Imawati & Kushartanti, 2014; Suryanto, 2009).

Increased energy requirements during physical exercise are met from glycogen and triglycerides breakdown, free fatty acids from adipose tissue, and glucose release from liver. In T2DM patients with obesity, physical exercise could promote weight loss (Tjokroprawiro & Murtiwi, 2014). There is an inverse correlation between physical activity level and obesity, metabolic syndrome, non-alcoholic fatty liver disease (NAFLD), and T2DM. It is recommended to increase physical activity to improve metabolic health and help prevent these interrelated conditions (Davies et al., 2019). However, exercise-induced QoL improvements are independent of weight loss, and the magnitude of change in QoL was similar among those who did and did not lose weight (Martin et al., 2009).

Our present study found that male subjects tended to have a good QoL compared to female subjects. This result is in accordance with the study by Wahyuni et al. (2014) which also found that the QoL score of female subjects tended to be lower. This finding was related to their type of work. As many as 43.8% of female subjects in the study were housewives, which was associated with financial issues, difficulty to access treatment, and impaired physical strength due to clinical manifestations of DM, which further affect their daily housewife activities (Wahyuni et al., 2014). The age group of > 65 years had the highest percentage of samples with good quality of life (63%) compared to the 30 – 65 years group (54%) in our study. This result was also in accordance with Wahyuni et al. which reported that the largest percentage of subjects who had high QoL scores belonged to the elderly (> 60 years) group (65.9%). The elderly already experienced periods of changes in their lives therefore they tended to evaluate their lives more positively and resulting in higher QoL scores (Wahyuni et al., 2014).

In this present study, the group whose education background was elementary level had more subjects with poor QoL compared to the group whose education background was diploma/undergraduate level. These results were in accordance with a study from Retnowati and Satyabakti (2015), which reported that 86.7% of respondents with tertiary education background reported satisfaction in their QoL, while in respondents with elementary education background only 50% (Retnowati & Satyabakti, 2015). According to Nauli (2014), a person with a higher education level would be more mature in processing changes in themselves and would be open to various information about health. These factors helped T2DM patients to implement T2DM treatment management, which further improved their QoL (Nauli, 2014).

Our study found that the unemployed subjects tended to had poor QoL. This result was in accordance with Javanbakht et al. (2012) who stated that people with DM who were unemployed had lower QoL score than people with DM who were employed (Javanbakht et al., 2012). Another study by Syatriani (2019) stated that there was a strong correlation between work and stress with an inverse correlation, meaning that the better the patients' work, the less stressed they would be (Syatriani, 2019). The group that was more susceptible to stress was the unemployed group. Unemployment could lead T2DM patients to think about their or their family's cost of living, including the costs of their healthcare and treatment. These thought burden could further lead the patients to experience stress and affect their QoL.

In this study, the married group had more subjects with good QoL compared to the divorced/widowed group. This result was in accordance with the study by Kodriati who stated that T2DM patients who are married have higher self-esteem and adequate coping mechanism through their partners, which leads the development of adaptive coping mechanisms against stressors (Sulistyoningrum, 2010). According to Utami (2014), the presence of a partner could make the patient feels more optimistic in living their life, thus resulting in better QoL (Utami, 2014). Meanwhile, regarding economic status, the order of groups with the highest percentage of subjects who had good

QoL in this study was as follows: very high income, low income, high income, and medium income. This finding was different from the study by Kosim et al. (2015) which stated that the higher the family income, the higher the QoL will be (Kosim et al., 2015). However, after the results of this study were tested using Fisher's Exact test, it was found that there was no significant correlation between income/economic status and the QoL of T2DM patients at dr. Trimurti PHC. Different perceptions for individual needs could affect the QoL of each individual, thus might explain this insignificancy (Diamanta et al., 2020).

The group with no complications/comorbidities had more subjects with good QoL with 22 samples (79%). This result was in accordance with the study by Retnowati and Satyabakti (2015) where the group without complications had a higher proportion of subjects with better QoL compared to the group with complications (88.9 and 44.4%) (Retnowati & Satyabakti, 2015). Diabetes mellitus patients with complications could experience declining physical abilities, therefore they will experience difficulties in implementing intensive diabetes care management (Donald et al., 2013). The group who performed independent exercise 1-2 times per week had the most samples with good QoL with 20 samples (83%). To achieve the metabolic effect, core exercises should be conducted for approximately 30-40 minutes with warm-up and cool-down for 5-10 minutes, for 3 to 5 times a week (Suryanto, 2009). Physical exercise could also reduce stress, anxiety symptoms, depression, and reduce physiological disorders associated with psychosocial stress (Pedersen & Saltin, 2015). The majority of previous studies stated that the higher the level of physical activity, the higher the QoL score (Martin et al., 2009).

Our study revealed that the group which performed diabetes exercise once in two weeks and once in a month tended to have good QoL compared to the group which performed diabetes exercise once in two months. The diabetes exercise program held at dr. Trimurti PHC aims to increase physical activity in patients suffering from T2DM to improve their health and prevent complications (Lestari, 2019). Fiatarone et al. (2009) stated that higher physical fitness and participation in an aerobic exercise program were associated with reduced clinical depression or anxiety risk (Fiatarone et al., 2009). Other studies have also stated that physical therapy treatment also has significant effects on improving QoL in DM patients (Noorratri, 2019). These findings were in line with our study, where the majority of subjects who routinely followed the diabetes exercise program had good QoL scores.

In this study, subjects with good glycemic status (blood glucose levels < 200 mg/dl) had better QoL than those with poor glycemic status. This finding was in accordance with the study by Nissa (2013) regarding fasting and post-prandial blood glucose levels with T2DM patients' QoL, where a negative correlation was found between fasting and post-prandial blood glucose levels with physical and mental QoL (Nissa, 2013). Patients with T2DM must be able to adapt to changes in their diabetes care management. Controlling perceptions about health and illness has an important role in preventing an increase in anxiety and depression that could affect mental QoL (Zhao et al., 2006).

Our study has several limitations. First, the presence of recall error might affect the validity of the data collected through the questionnaire. Second, the questionnaire regarding QoL used in this study was made in 2008, which might affect the relevancy. Lastly, the diabetes exercise program in dr. Trimurti PHC was only held once in two weeks, which was less than the specified recommendation from the existing diabetes exercise guideline.

CONCLUSION

Participation in diabetes exercise program is associated with good QoL and better glycemic control in T2DM patients. Male subjects, aged > 65 years, had bachelor's degrees, retired, married, had very high income, had no comorbidities, and exercised independently every week tended to have good QoL. Majority of subjects who performed diabetes exercise program had random blood glucose levels < 200 mg/dL.

REFERENCES

Afifah, A. N., & Rifa'i, A. (2017). Pengaruh Senam Diabetes Melitus (DM) Terhadap Perubahan Tekanan Darah Pada Pasien DM TIPE 2 Di Persadia Unit RSUD Dr. Moewardi Di Surakarta Tahun 2015. *(JKG) Jurnal Keperawatan Global*, *2*(2), 70–78.

Davies, K. A. B., Sprung, V. S., Norman, J. A., Thompson, A., Mitchell, K. L., Harrold, J. A., Finlayson, G., Gibbons, C., Wilding, J. P. H., & Kemp, G. J. (2019). Physical activity and sedentary time: association with metabolic health and liver fat. *Medicine and Science in Sports and Exercise*, *51*(6), 1169.

Decroli, E. (2019). *Diabetes Mellitus Tipe 2* (1st ed.). Pusat Penerbitan Bagian Ilmu Penyakit Dalam Fakultas Kedokteran Universitas Andalas.

DEPKES RI. (2008). *Pedoman Pengendalian Diabetes Mellitus dan Penyakit Metabolik*. Departemen Kesehatan RI.

Diamanta, A. D. ., D, M. A. E., & Buntoro, I. F. (2020). Hubungan Tingkat Stres Dan Tingkat Pendapatan Dengan Kualitas Hidup Penderita Tuberkulosis Paru Di Kota Kupang. *Cendana Medical Journal*, *8*(2), 44–50.

Donald, M., Dower, J., Coll, J. R., Baker, P., Mukandi, B., & Doi, S. A. (2013). Mental Health Issues Decrease Diabetes-Specific Quality of Life Independent of Glycaemic Control and Complications: Findings from Australia's Living With Diabetes Cohort Study. *Health and Quality of Life Outcomes*, *11*(1). https://doi.org/http://doi.org/10.1186/1477-7525-11-170

Fiatarone, C.-Z. W. J. P. D. N., CR, S. M. A. M. C. T. N., Salem, G. J., & Skinner, J. S. (2009). Exercise and physical activity for older adults: American College of Sports Medicine position stand. *Medicine and Science in Sports and Exercise*, *41*, 1510–1530.

Imawati, I., & Kushartanti, B. M. W. (2014). Pengaruh Diayogarobik dan KGD awal terhadap kapasitas fisik dan kimiawi darah penderita DM Tipe 2. *Jurnal Keolahragaan*, *2*(2), 182–193.

International Diabetes Federation. (2017). *Recommendations For Managing Type 2 Diabetes In Primary Care*. International Diabetes Federation. http://www.idf.org/managing-type2-diabetes

International Diabetes Federation. (2019). *IDF Diabetes Atlas* (9th ed.). International Diabetes Federation. https://www.diabetesatlas.org/upload/resources/2019/IDF_Atlas_9th_Edition_2019.pdf

Javanbakht, M., Abolhasani, F., Mashayekhi, A., Baradaran, H. R., & Noudeh, Y. J. (2012). Health Related Quality of Life in Patients with Type 2 Diabetes Mellitus in Iran: A National Survey. *PLoS ONE*, *7*(8).

KEMENKES RI. (2014). Situasi dan analisis diabetes. *Pusat Data Dan Informasi Kementerian Kesehatan RI*, 2. https://www.kemkes.go.id/download.php?file=download/pusdatin/infodatin/infodatin-diabetes.pdf

Kosim, N., Istiyani, N., & Komariyah, S. (2015). Faktor Yang Mempengaruhi Kualitas Hidup Penduduk Di Desa Sentul Kecamatan Sumbersuko Kabupaten Lumajang. *Artikel Ilmiah Mahasiswa*.

Lestari, T. A. (2019). *Faktor-faktor yang Berhubungan dengan Keaktifan Mengikuti Senam Prolanis pada Pasien Hipertensi di Puskesmas Dau Kabupaten Malang*. University of Muhammadiyah Malang.

Martin, C. K., Church, T. S., Thompson, A. M., Earnest, C. P., & Blair, S. N. (2009). Exercise Dose and Quality of Life. *Archives of Internal Medicine*, *169*(3), 269–278. https://doi.org/http://doi.org/10.1001/archinternmed.2008.545

Nauli, F. A. (2014). *Hubungan antara dukungan keluarga dan kualitas hidup pasien diabetes mellitus tipe II di RSUD Arifin Achmad Provinsi Riau*. Riau University.

Nissa, M. K. (2013). *Hubungan Kadar Glukosa Darah dengan Kualitas Hidup Penderita Diabetes Melitus Tipe 2 di Rumah Sakit Umum Daerah (RSUD) Kota Cilegon*.

Noorratri, E. D. (2019). Peningkatan Kualitas Hidup Pasien Diabetes Mellitus Dengan Terapi Fisik. *Jurnal Ilmu Keperawatan Komunitas*, *2*(1), 19–25.

Pedersen, B. K., & Saltin, B. (2015). Exercise as medicine - evidence for prescribing exercise as therapy in 26 different chronic diseases. *Scandinavian Journal of Medicine & Science in Sports*, *25*, 1–72. https://doi.org/http://doi.org/10.1111/sms.12581

Prihastini, T. P. (2017). *Pengaruh Latihan Senam Kaki Diabetes terhadap Perubahan Kualitas Hidup pada Pasien Diabetes Mellitus di Rumah Sakit Daerah dr. Soebandi Jember*. Universitas Muhammadiyah Jember.

Rahayuningrum, D. C., & Yenni, R. (2018). Efektifitas pemberian latihan fisik: senam diabetes terhadap pengendalian kadar gula darah pada penderita diabetes melitusefektifitas pemberian latihan fisik: senam diabetes terhadap pengendalian kadar gula darah pada penderita diabetes melitus. *JIK (Jurnal Ilmu Kesehatan)*, *2*(2), 18–26.

Retnowati, N., & Satyabakti, P. (2015). Hubungan Dukungan Keluarga Dengan Kualitas Hidup Penderita Diabetes Melitus Di Puskesmas Tanah Kalikedinding. *Jurnal Berkala Epidemiologi*, *3*, 57–68.

Sulistyoningrum, E. (2010). Tinjauan Molekular dan Aspek Klinis Resistensi Insulin. *Mandala Of Health*, *4*(2).

Suryanto. (2009). Peran olahraga senam diabetes mellitus Indonesia bagi penderita diabetes mellitus. *Medikora*, *5*(2), 173–184. journal.uny.ac.id/index.php/medikora/article/download/4681/4029

Syatriani, S. (2019). Hubungan Pekerjaan Dan Dukungan Keluarga Dengan Stres Pada Pasien Dm Tipe 2 Di Daerah Pesisir Kota Makassar. *Sinergitas Multidisiplin Ilmu Pengetahuan Dan Teknologi*, *2*, 20–24.

Tjokroprawiro, A., & Murtiwi, S. (2014). Terapi Nonfarmakologi pada Diabetes Mellitus. In *Buku Ajar Ilmu Penyakit Dalam* (6th ed., pp. 2336–2346). Interna Publishing.

Tyas, M. D. C. (2008). Hubungan perawatan diri dan persepsi sakit dengan kualitas hidup pasien DM tipe 2 dalam konteks keperawatan di Kota Blitar. *Skripsi Tidak Dipublikasikan*.

Utami, D. T. (2014). *Faktor-faktor yang mempengaruhi kualitas hidup pasien diabetes mellitus dengan ulkus diabetikum*. Riau University.

Wahyuni, Y., Nursiswati, N., & Anna, A. (2014). Kualitas Hidup Berdasarkan Karakteristik Pasien Diabetes Melitus Tipe 2. *Jurnal Keperawatan Padjadjaran*, *2*(1).

Zhao, W., Chen, Y., Lin, M., & Sigal, R. J. (2006). Association between diabetes and depression: sex and age differences. *Public Health*, *120*(8), 696–704.