Synthesis
GLOBAL HEALTH JOURNAL
SYNTIFIC Publisher
E-ISSN 2988-3970

Systematic Review

EFFECTIVENESS OF LAND-BASED AND AQUATIC PHYSICAL EXERCISE ON PHYSICAL FITNESS, DEPRESSION STATUS AND QUALITY OF LIFE IN DIABETES MELLITUS TYPE 2

Novita Fajriyah[1)*], Hidayat Arifin[2)], Ulfa Nur Rohmah[3)]
[1)]STIKES Adi Husada, Surabaya, Indonesia
[2)] Taipei Medical University, Taiwan
[3)] STIKES RS Husada, Jakarta, Indonesia
*Corresponding Author, E-mail: novitafajriyah22@gmail.com

ABSTRACT

Background. Type 2 Diabetes Mellitus is a chronic disease that can exacerbate depressive symptoms due to increased symptom burden complications that lead to functional impairment and decreased quality of life. People with T2DM are twice as likely to experience loss of physical function, and decreased physical fitness and strength than people without T2DM. Physical effort is an integral part of programs for disease prevention and management. Physical fitness, depression status, and quality of life have not been specifically evaluated and described after training in these two environments. This article aims to find and review land and water-based physical exercise intervention research as an alternative solution to improve physical fitness, depression status, and quality of life of T2DM patients.
Research Method. Descriptive analysis method. Systematic reviews were evaluated using the PRISMA checklist. Database: Scopus, Science direct, Pubmed, CINAHL, and ProQuest. Article search with the PICOS framework. The Joanna Briggs Institute (JBI) Critical Appraisal as an alternative to assessing the risk of study bias.
Findings. The 25 articles that met the inclusion criteria consisted of 18 (Randomized Control Trials) and 7 (Quasy-experiments). Consisting of land and water-based aerobic classifications that are useful in the physical and psychological aspects of T2DM.
Conclusion. There is an influence of land-based and aquatic physical exercise on physical fitness, depressive status, and quality of life in T2DM patients.

Keywords: Depression, Exercise therapy, Physical fitness, Quality of life, Type 2 diabetes mellitus

BACKGROUND

Unhealthy lifestyles such as lack of physical activity and unhealthy eating habits lead to impaired insulin resistance and can result in an increased risk of developing metabolic diseases such as type 2 diabetes mellitus (hereinafter abbreviated as T2DM). T2DM is a widespread chronic disease and creates a crisis for the health care system and society. [1] T2DM is a group of metabolic diseases characterized by hyperglycemia, which occurs as a result of abnormalities in insulin secretion, insulin action or both, in peripheral tissues such

as skeletal muscle, brain and liver and dysregulation of insulin release from pancreatic beta cells. [2], [3]

The World Health Organization (WHO) reports that the number of people with diabetes has increased from 108 million in 1980 to 422 million in 2014, and diabetes will be the seventh leading cause of death by 2030. [4] T2DM is a major risk factor for coronary artery disease and serious complications, having an adverse effect on mental status and quality of life. [5] The impact of T2DM can cause a person to experience a decrease in physical function. [6] People with T2DM are twice as likely to experience loss of physical function, decreased Physical fitness and strength than people without T2DM. In addition, T2DM patients experience impaired quality of life. [5], and a high incidence of depression. [7] The prevalence of depression is increased in people with T2DM compared with those without diabetes (18% and 10%, respectively). [8] People with T2DM also have a 24% increased risk of developing depression compared to people who don't have diabetes. Diabetes also affects the patient's life, where the presence of diabetes reduces the quality of life. [9]

According to the International Diabetes Federation (IDF), the number of people with diabetes is always increasing every year, the prevalence of diabetes in adults aged 18-99 years was 8.4% in 2017 and is predicted to increase to 9.9% in 2045. [10] In Indonesia, when compared to 2013, the prevalence of T2DM based on a doctor's diagnosis in the population aged ≥ 15 years increased from 2.1% to 2.6%. [11]

DM can exacerbate depressive symptoms due to increased symptom burden complications that cause functional impairment and decreased quality of life. Comorbid depression has been found to interfere with the ability to perform self-care activities necessary to control diabetes by affecting memory, energy levels and executive function. Overall, comorbid depression in individuals with diabetes was associated with a 1.5-fold increased risk of death compared with those without depression.[12] Physical inactivity negatively impacts QoL of diabetic patients.[13] Impaired QoL is related to control. glycemic index, symptom severity, and various medical complications.Complications of cardiovascular disease are the most important causes of morbidity and mortality in T2DM subjects.[14]

Implementation of T2DM treatment reduces the risk of severe complications as well as reducing irreversible organ damage is very important in the long term. Physical effort is an integral part of programs for disease prevention and management .[15] Exercise training is an important component of comprehensive diabetes management. [16] One suggestion in

the management of T2DM in the four pillars is to use physical exercise. [2] Exercise may have psychological benefits for people with T2DM, although the evidence for acute and chronic psychological benefits is limited. In the Look AHEAD trial, participants in an intensive lifestyle intervention attempted to lose more than 7% of their initial weight and increased moderately intense physical activity to more than 175 minutes/week. They experienced improvements in health-related quality of life (QOL) (physical component score SF-36) and depressive symptoms after 12 months mediated by improvements in physical fitness.[17] High levels of physical activity and involvement in a structured physical exercise or sports program are associated with a better quality of life in T2DM patients. [13] Aerobic type activity with sufficient intensity is one of the important points to improve glucose uptake and tolerance as a form of prevention and therapy for T2DM.

An alternative exercise for T2DM patients to land is aquatic exercise, where the physical properties of water can provide low impact forces on the joints of the lower limbs, possibly making them safer in terms of joint damage. Aquatic exercise has profound biological effects, extending across essentially the homeostatic system, and is therapeutically beneficial in the management of patients with musculoskeletal problems, cardiovascular disease, rheumatic diseases, and other conditions. Water-based or aquatic exercise provides the safest and most protective environment for individuals especially the overweight due to the buoyant effect of immersion which reduces the risk of joint injury. This characteristic is especially relevant in cases of diabetes, as it is often associated with obesity, lower strength and functional capacity [18]. Thus, the aquatic environment favors sports practice because of the lower risk of injury and ulceration caused by direct impact absorption by the feet in contact with the ground. In addition, the aquatic environment allows the achievement of training with open kinetic chains, without impact on the bony system of the skull, such as walking in water.

Although several studies have looked at similar metabolic, cardiorespiratory, and functional effects after training in different environments (water or dry land) in T2DM patients [19], the results of Physical fitness, mental health and quality of life have not been specifically evaluated and described after training. in these two environments. Therefore it is necessary to do a comprehensive summary of land- and aquatic-based physical exercise interventions as an alternative solution for physical fitness, depressive status and quality of life of T2DM patients.

RESEARCH METHOD

The data used in this research is secondary data obtained not from direct observation, but obtained from previous studies. Secondary data sources are in the form of reputable journal articles both nationally and internationally with predetermined themes. The literature search in the Systematic review was taken from five data bases that have high and medium reputations such as Scopus, Science Direct, Pubmed, CINAHL, and ProQuest. Search for articles or journals using keywords and Boolean operators (AND, OR NOT or AND NOT) which are used to broaden or specify searches, making it easier to search for articles. The keywords in this systematic review are adapted to the Medical Subject Heading (MeSH) which consists of Type 2 diabetes mellitus, physical fitness, cardiorespiratory fitness, quality of life, depression, exercise therapy, aerobic exercise, and exercise.

Tabel 1. Keywords systematic review Intervention Land-Based Physical Exercise Program and Aquatic on Physical fitness, Depression Status and Quality of Life in Type 2 Diabetes Mellitus : A Systematic Review

Type 2 diabetes mellitus	***Physical effects psychological effects***	**Intervention**
Type 2 diabetes mellitus	*physical fitness*	*Exercise therapy*
	OR	*OR*
	cardiorespiratory fitness	*Aerobic exercise*
	OR	*OR*
	quality of life	*Exercise*
	OR	
	Depression	

Study Selection

The researcher made a checklist sheet obtained from the PRISMA template to randomly check the selected articles and make adjustments according to the guidelines. The researcher then extracted data from the articles that were included according to the inclusion criteria. Based on the results of a literature search through publications in five databases and using keywords that have been adjusted to MeSH, the researchers found 1,535 articles that matched these keywords. The search results that have been obtained are then examined for duplication, found 879 similar articles and the remaining 656 articles. The researcher then screened based on the title adjusted for the systematic review theme, as many as 310 were inappropriate and the remaining 346 articles. Then selection based on abstracts, 300 articles were excluded because they were not suitable and the remaining 46 articles were full-text and eligible to be assessed. The next step is to include articles according to the inclusion criteria, so there are 25 articles that match the inclusion criteria. There were 21 articles that did not fit the inclusion criteria, including 5 articles that did not match the desired population,

8 articles that did not match the desired intervention, 4 articles with inappropriate outcomes, and 4 articles that did not match the type of study. Then the 25 articles were screened again according to the exclusion criteria. After screening, the results showed that there were no articles that match the exclusion criteria. So that the final results of the existing articles were reviewed as many as 25 articles

Eligibility Criteria

The strategy used to search for articles uses the PICOS framework.

Table 2. Details of Intervention PICOS Land and Aquatic Physical Exercise Programs on Physical Fitness, Depression Status and Quality of Life in Type 2 Diabetes Mellitus : A Systematic Review

PICOS framework	Inclusion criteria	Exclusion criteria
Population	1. T2DM patients aged ≥18 years. 2. The patient has been diagnosed by a T2DM doctor for at least 2 years.	Complicated T2DM patients have had a myocardial infarction within 6 months before the start of the investigation, have an unstable chronic medical condition (eg, respiratory disease, heart failure, kidney disease, or liver disease, and diabetes-associated myopathy or neuropathy).
Intervention	Studies that examine land and water-based physical exercise interventions on physical fitness, depression status, and health related quality of life (HRQoL). 1. Water-based (aquatic) intervention programs: • Underwater Treadmill Training (UTT) • Aquatic aerobic training • Water-based Exercise Training 2. Land-based intervention programs • Square aerobic exercise (SAE) • Aerobic, Walking, Rebound, and Treadmil exercise • Combination of aerobic resistance training (resistance exercise)	Studies that do not discuss the effect of giving interventions to respondents
Comparasion	The comparison groups used were other interventions and groups that were observed without intervention	There are no exclusion criteria
Outcome	Studies explaining interventions that affect physical fitness, depression status, and health related quality of life (HRQoL) of T2DM patients	Does not address physical exercise interventions
Study design and publication type	Randomized controlled trials (RCTs), Quasi-Experimental, studi prospective, dan observational study.	Qualitative studies, cross-sectional studies, meta-analyses, literature reviews and systematic reviews.
Publication years	After 2014	Before 2014
Language	English and Indonesian	Languages other than English and Indonesian

Risk of Bias in Studies

The Joanna Briggs Institute (JBI) Critical Appraisal for Several Types of Studies Randomized controlled trials (RCTs) and Quasi-Experimental studies were used to analyze the methodological quality in each study (n = 25). The JBI Critical Appraisal checklist list provided several questions to assess the quality of the study. Assessment criteria are given a value of 'yes', 'no', 'unclear' or 'not applicable', and each criterion with a score of 'yes' is given one point and another value is zero, each study score is then calculated and summed up.

The following is an assessment of articles based on the JBI Critical Appraisal Checklist for Randomized Controlled Trials [20]: 1) Was true randomization used for assignment of participants to treatment groups?, 2) Was allocation to treatment groups concealed?, 3) Were treatment groups similar at the baseline?, 4) Were participants blind to treatment assignment?, 5) Were those delivering treatment blind to treatment assignment?, 6) Were outcomes assessors blind to treatment assignment?, 7) Were treatment groups treated identically other than the intervention of interest?, 8) Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?, 9) Were participants analyzed in the groups to which they were randomized?,10) Were outcomes measured in the same way for treatment groups?, 11) Were outcomes measured in a reliable way?, 12) Was appropriate statistical analysis used?, 13) Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?.

The following is an assessment of articles based on the JBI Critical Appraisal Checklist for Quasi-Experimental Studies (non-randomized experimental studies) [21]: 1) Is it clear in the study what is the ‘cause’ and what is the ‘effect’ (i.e. there is no confusion about which variable comes first)?, 2) Were the participants included in any comparisons similar?, 3) Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention o interest?, 4) Was there a control group?, 5) Were there multiple measurements of the outcome both pre and post the intervention/exposure? , 6) Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?, 7) Were the outcomes of participants included in any comparisons measured in the same way? , 8) Were outcomes measured in a reliable way?, 9) Was appropriate statistical analysis used?

Critical appraisal for assessing the eligibility of studies is carried out by researchers. If the research score is at least 50% it meets the Critical Appraisal criteria with the cut-off point

value. As agreed by the researchers, the study was included in the inclusion criteria. Researchers excluded low-quality studies to avoid bias in validation of results and review recommendations. In the final screening, the title and abstract reviewed by the author are included in the feasibility assessment sheet for the prospective journal being reviewed. The feasibility test of a journal cannot be seen from the abstract alone, but the complete text needs to be seen. Journals entered are based on predetermined inclusion criteria. In addition, the characteristics of the participants were also seen, the sample size used and the strength of the journal. In the final screening, twenty-five articles achieved a score higher than 50% and were ready for data synthesis.

FINDINGS

Study Quality and Risk of Bias

Table 3. The results of the assessment of studies using JBI Critical Appraisal Checklist for Randomized Controlled Trials.

Number.	Citation	Criteria													Result
		1	2	3	4	5	6	7	8	9	10	11	12	13	
1	(Conners, Caputo, Coons, Fuller, & Morgan, 2019) [22]	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	10/13 (76,9%)
2	S. Delevatti et al., 2018 [23]	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	11/13 (84,6%)
3	Scheer et al., 2020 [16]	✓	✓		✓	✓	✓	✓	✓	✓					8/9 (88,9%)
4	R. S. Delevatti et al., 2016 [24]	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	11/13 (84,6%)
5	Gilani & Feizabad, 2019a [25]	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	10/13 (76,9%)
6.	Hwang et al., 2019 [26]	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	10/13 (76,92%)
7.	dos Anjos et al., 2017 [27]	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	10/13 (76,92%)
8.	Tapehsari, Mohammad, Khamseh, Seifouri, & Nojomi, 2020 [28]	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	10/13 (76,92%)
9.	Maharaj & Nuhu, 2015 [29]	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	10/13 (76,92%)
10.	Kour, Kothiwale, & Goudar, 2019 [30]	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	11/13 (84,6%)
11.	Taylor, Fletcher, Mathis, & Cade, 2014b [31]	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	10/13 (76,92%)
12.	Tomas-Carus et al., 2016 [32]	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	10/13 (76,92%)
13.	Dadgostar et al., 2016 [33]	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	10/13 (76,92%)
14.	Sousa, Mendes, Silva, & Oliveira, 2017 [34]	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	10/13 (76,92%)
15.	Kaka & Maharaj, 2018 [35]	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	10/13 (76,92%)
16.	Maharaj & Nuhu, 2019 [36]	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	10/13 (76,92%)
17.	Sardar, *et al.*,, 2014 [37]	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	10/13 (76,92%)

Number.	Citation	Criteria													Result
		1	2	3	4	5	6	7	8	9	10	11	12	13	
18.	Akinci, Yeldan, Satman, Dirican, & Ozdincler, 2018 [38]	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	10/13 (76,92%)

Table 4. The result of the assessment of studies using JBI Critical Appraisal Checklist for Quasi-Experimental Studies (non-randomized experimental studies)

Number	Citation	Criteria									Result
		1	2	3	4	5	6	7	8	9	
1.	Cugusi et al., 2015 [39]	✓	✓		✓	✓	✓	✓	✓	✓	8/9 (90,9%)
2.	Dede et al., 2015 [40]	✓	✓		✓	✓	✓	✓	✓	✓	8/9 (88,9%)
3.	Liu, Yue, Liu, Wu, & Lin, 2017 [41]	✓	✓		✓	✓	✓	✓	✓	✓	8/9 (88,9%)
4.	Youssef, 2019 [12]	✓	✓		✓	✓	✓	✓	✓	✓	8/9 (88,9%)
5.	Tokmakidis et al., 2014 [42]	✓	✓		✓	✓	✓	✓	✓	✓	8/9 (88,9%)
6.	Paul & Mary, 2014 [43]	✓	✓		✓	✓	✓	✓	✓	✓	8/9 (88,9%)
7.	Dincer et al., 2017 [44]	✓	✓		✓	✓	✓	✓	✓	✓	8/9 (88,9%)

The quality of the study of each article that was determined as a source of systematic review was determined based on the analysis of the quality of the JBI Critical Apprational Tool, so that 25 articles were found in accordance with the systematic review. The results of the literature search that have been analyzed and determined in a systematic review are as follows:

Table 5. Summary of 25 articles that met the inclusion criteria

Language Resources	Year	*Database*	N	Research design	
				RCT	**Quasy-Experiment**
English	2014-2020	*Scopus*	14	9	5
		Science Direct	2	2	-
		PubMed	5	4	2
		CINAHL	3	2	1
		ProQuest	1	1	-
Result			25	18	7

Of the 25 articles that met the inclusion criteria (table 5), the results obtained were that 18 studies were randomized control trials, 7 studies used quasy-experiments. Based on these results, after carrying out a critical appraisal using the JBI critical appraisal tools to be given a quality score. Studies using the Randomized Control Trials design were given a total score

ranging from ten to eleven points out of a total of thirteen points on the checklist. The quasy-experiment study in this systematic review was given eight points out of a total of nine points on the checklist.

Based on all the studies summarized, all studies showed significant results from data analysis and testing. The assessment of bias in the study shows that the results of the articles specified in the systematic review are considered to have a low risk of selection bias because most of the determination of the sample is by random selection and probability sampling. Research studies in a systematic review are a type of intervention research where procedures must be carried out according to ethics, and all studies have met ethical requirements in each location or country in the study. Most of the studies included in the systematic review used a questionnaire, so the instrument requires reliability and validity tests.

DISCUSSIONS

A. Land-based physical exercise intervention

1. Aerobic Exercise

Moderate to high levels of aerobic physical activity and higher levels of cardiorespiratory fitness are associated with substantial reductions in morbidity and mortality in men and women and in T2DM with substantial reductions in morbidity and mortality in men and women and in T2DM [45]. Aerobic exercise is a form of physical exercise that uses the aerobic energy-producing system, can increase the capacity and efficiency of this system, and is effective for increasing cardiorespiratory endurance [46], [47]. Aerobic exercise involves repetitive and continuous movement of large muscle groups [47]. Benefits Aerobic training improves mitochondrial density, insulin sensitivity, oxidative enzymes, vascular compliance and reactivity, lung function, immune function, and cardiac output [47], [48].

In individuals with T2DM, regular training reduces HbA1c, triglycerides, blood pressure, and insulin resistance [19]. High-intensity interval training (HIIT) can improve skeletal muscle oxidative capacity, insulin sensitivity, and glycemic control in adults with T2DM [47], [49]. Research showed that at the end of 10 weeks of aerobic training, elderly women with T2DM showed increased functional capacity as indicated by better performance in the Time Up and Go test (TUG), 10MWT, 5-STS and Handgrip strength tests (HGS), which attested to the benefit of the instructed protocol in the intervention of this study [27] .

2. Combination of Aerobic Exercise and Resistance (Resistance Exercise)

T2DM patients have decreased muscle strength based on pre-intervention data, where in this study, patients showed poor initial muscle strength and high levels of fatigue in relation to

normative isokinetic strength values for healthy people (non-T2DM). Combining resistance and aerobic exercise was more effective for increasing fall risk factors than aerobic exercise alone in elderly men. However, apart from that, exercise compared to not exercising is beneficial in increasing the risk factors for falls. These results were obtained from research by [32].

3. Square Aerobic Exercise (SAE)

Square Aerobic Exercise (SAE) is the first and popular form of exercise program in China. Glucose metabolism is also affected by skeletal muscle, and during exercise, about 80% of blood glucose is absorbed by these muscles. Glucose entering cells is mainly mediated by the glucose transporter isoform 4 (GLUT4), which can be triggered by insulin. Through exercise, the translocation of GLUT4 from intracellular sites to the cell membrane is enhanced, thereby increasing glucose disposal. In addition, long-term regular exercise can also upregulate GLUT4, which will increase insulin sensitivity of skeletal muscles [50].

4. Walking Exercise

Any form of aerobic exercise (including brisk walking) that uses large muscle groups and causes a sustained increase in HR is likely to be beneficial [51]. In a study [51], in Cairo, this study was conducted to study the effects of walking and aerobic exercise on physical fitness performance and depression in patients with T2DM. In this study the patients with T2DM were all non-athletic and physically inactive. Given these wide-ranging potential health benefits, it is clear that regular regular exercise such as walking or swimming is one of the best advocates of emotional and physical health that can be recommended [12].

5. Physical Activity Package (PAP)

100 people with T2DM were included and randomized to the intervention and control groups. After starting the study, 5 individuals were excluded during follow-up (three in the intervention and two in the control group). Causes of withdrawal in the intervention group were breast cancer, abnormal uterine bleeding and loss to follow-up. In the control group two individuals were lost during follow-up. Finally, 95 people with T2DM (47 in the intervention and 48 in the control group). The results of this study indicate that PAP has a significant effect on all domains of social relations quality of life [28].

6. Rebound Exercise

Research by [29], which was conducted on outpatient T2DM patients at the Department of Physiotherapy at MMSH. Significant improvement in quality of life occurred in the rebound exercise intervention group with improvements in all domains of quality of life compared to the control group ($p<0.05$). Rebound exercise and treadmill walking can be used to improve

quality of life for T2DM patients and possibly reduce side effects and comorbidities associated with diabetes and diabetes treatment [29].

7. Treadmil Exercise

In outpatient T2DM patients in the Department of Physiotherapy at MMSH. In addition to the rebound exercise intervention group, the results of a significant increase in quality of life also occurred in the treadmill exercise intervention group with improvements in all domains of quality of life compared to the control group ($p<0.05$) [29].

B. Water-based physical exercise intervention

1. Underwater Treadmill Training (UTT)

A new therapy that may help individuals with type 2 diabetes overcome barriers to active living is underwater treadmill training (UTT). A unique training mode that combines aerobic and strength training together, walking on a treadmill placed in water improves cardiovascular health and provides resistance to strengthen the legs, while decreasing vertical ground reaction forces [52]. Using water as a medium also reduces the weight on the feet, thereby reducing the force required to walk and support the body. The study [20] was approved by the university's institutional review board, and participants provided written informed consent. Throughout the study, participants were asked to maintain their current medication use and not engage in structured exercise.

2. Aquatic aerobic training

Improvements in the physical and psychological domains of quality of life (per protocol analysis) and overall quality of life with aquatic training have clinical relevance for people with T2DM because complications and co-morbidities of T2DM such as obesity and functional disability, often preclude them from engaging in walking or running on land [52] . Aquatic training was well tolerated by the participants, with no side effects occurring during the intervention in this group. Aerobic training program conducted in an aquatic environment improves the overall quality of life and in physiological and psychological domains and the sleep quality of patients with T2DM is similar to an aerobic training program on dry land (land), making it an excellent alternative. good for this population [23]**.**

3. Water based exercise training

Research from [16], conducted at a university and research institute in Brazil, showed that the training program was well tolerated by the participants, with no injury or negative response to exercise occurring. Water-based circuit training also results in significant increases in overall and leg strength. Aerobic capacity increases significantly with exercise training [16].

4. Supervised Aquatic-based Exercise program

Research on Supervised Aquatic-Based Exercise (SAEP), by Cugusi, et., al [39], was conducted at a Diabetic Center of University-Hospital, USA. SAEP is focused on increasing aerobic capacity through the use of swimming techniques and strengthening muscle groups through the use of circuit training with and without water sports equipment. During the program, all subjects were monitored continuously while exercising in the water using a Polar FT2 heart rate monitor (Polar Electro Inc, Lake Success, NY). At the start and end of each training session, blood glucose levels were recorded via the FreeStyle Freedom Lite (supplied with test strips from Abbott Diabetes Care Inc, Abbott Park, IL), and minimum and maximum blood pressure values were measured. SAEP was well tolerated by the subjects, and no adverse situations or accidents occurred during the 12 weeks of training.

5. Aerobic training method's in water

Aerobic training programs conducted in aquatic environments may contribute to the treatment of type 2 diabetes similar to aerobic training programs implemented on dry land, being an excellent alternative for this population, due to disease comorbidities. (ie, obesity, functional disability) that often precludes the patient from walking or running on land. This beneficial effect may be explained by the characteristics of the intervention, even with weeks of duration of less than 150 minutes, having adequate weekly frequency (three sessions), variables that are strongly associated with decreased HbA1c levels resulting from aerobic training2 and progression of exercise training doses (intensity and volume) during the intervention [53].

CONCLUSION

There is an effect of land and water physical exercise on physical fitness, depression status, and quality of life in people with type 2 diabetes mellitus. An aerobic exercise program conducted in an aquatic environment can contribute to the treatment of type 2 diabetes similar to an aerobic exercise program carried out on dry land , being an excellent alternative for this population, due to comorbidities i.e. obesity or lower. limb dysfunction often prevents patients from walking or running on land. Land and water-based physical exercise have profound biological effects, extend across homeostatic systems, and are useful therapeutically in the management of patients with musculoskeletal problems, cardiovascular disease, rheumatic diseases, and other conditions.

REFERENCES

[1] A. V. A. Korat, W. C. Willett, F. B. Hu, and F. Hu, "Diet, lifestyle, and genetic risk factors for type 2 diabetes: a review from the Nurses' Health Study, Nurses' Health Study 2, and Health Professionals' Follow-up Study Compliance with Ethics Guidelines Human and Animal Rights and Informed Consent," vol. 3, no. 4, pp. 345–354, 2014, doi: 10.1007/s13668-014-0103-5.

[2] Perkeni *et al.*, *Konsensus Pengelolaan dan Pencegahan Diabetes melitus Tipe 2 di Indonesia2015*, Pertama. Pengurus Besar Perkumpulan Endokrinologi Indonesia (PB PERKENI), 2015.

[3] American Diabetes Association (ADA), "Updates to the Standards of Medical Care in Diabetes-2018," *Diabetes Care*, vol. 41, no. 9, pp. 2045–2047, 2018, doi: 10.2337/dc18-su09.

[4] World Health Organization, "Global Report on Diabetes," *GLOBAL REPORT ON DIABETES*, 2016.

[5] C.-H. Lin *et al.*, "Effects of a 12-week Exercise Training on Insulin Sensitivity, Quality of Life, and Depression Status in Patients with Type 2 Diabetes," *Journal of Medical Sciences*, vol. 37, no. 6, pp. 227–236, 2017, doi: 10.4103/jmedsci.jmedsci_68_17 ORIGINAL.

[6] J. D. Taylor, J. P. Fletcher, R. A. Mathis, and W. T. Cade, "Effects of Moderate- Versus High- Intensity Exercise Training on Physical Fitness and Physical Function in People With Type 2 Diabetes: A Randomized Clinical Trial," *Phys Ther*, vol. 94, no. 12, pp. 1720–1731, 2014.

[7] C. Tovilla-Zárate *et al.*, "Prevalence of anxiety and depression among outpatients with type 2 diabetes in the mexican population," *PLoS One*, vol. 7, no. 5, 2012, doi: 10.1371/journal.pone.0036887.

[8] A. Nouwen *et al.*, "Type 2 diabetes mellitus as a risk factor for the onset of depression: A systematic review and meta-analysis," *Diabetologia*, vol. 53, no. 12, pp. 2480–2486, 2010, doi: 10.1007/s00125-010-1874-x.

[9] A. Trikkalinou, P. AK, and M. A, "Type 2 diabetes and quality of life," *World J Diabetes*, vol. 8, no. 4, pp. 120–129, 2017.

[10] N. H. Cho *et al.*, "IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045," *Diabetes Res Clin Pract*, vol. 138, pp. 271–281, 2018, doi: 10.1016/j.diabres.2018.02.023.

[11] Kementrian Kesehatan RI, "Hasil Utama Riset Kesehatan Dasar Jawa Timur 2018," *Jakarta: Badan Penelitian dan Pengembangan Kesehatan, Kementrian Kesehatan Republik Indonesia*, pp. 1–82, 2018.

[12] M. K. Youssef, "Effect of walking and aerobic exercise on physical performance and depression in cases of type 2 diabetes mellitus," *Egypt J Intern Med*, vol. 31, no. 2, pp. 142–148, 2019, doi: 10.4103/ejim.ejim.

[13] T. K. Çolak *et al.*, "Association between the physical activity level and the quality of life of patients with type 2 diabetes mellitus," *J Phys Ther Sci*, vol. 28, no. 1, pp. 142–147, 2016, doi: 10.1589/jpts.28.142.

[14] E. Hopps, B. Canino, and G. Caimi, "Effects of exercise on inflammation markers in type 2 diabetic subjects," *Acta Diabetol*, vol. 48, pp. 183–189, 2011, doi: 10.1007/s00592-011-0278-9.

[15] K. Ucok *et al.*, "Do patients with newly diagnosed type 2 diabetes have impaired physical fitness, and energy expenditures?," *Netherlands Journal of Medicine*, vol. 73, no. 6, pp. 276–283, 2015.

[16] A. S. Scheer *et al.*, *The Effects of Water-based Exercise Training in People with Type 2 Diabetes*, vol. 52, no. 2. 2020. doi: 10.1249/MSS.0000000000002133.

[17] D. A. Williamson, J. Rejeski, W. Lang, B. Van Dorsten, A. N. Fabricatore, and K. Toledo, "Impact of a weight management program on health-related quality of life in overweight adults with type 2 diabetes," *Arch Intern Med*, vol. 169, no. 2, pp. 163–171, 2009, doi: 10.1001/archinternmed.2008.544.
[18] M. C. Ferreira, J. Tozatti, S. M. Fachin, P. P. De Oliveira, R. F. Dos Santos, and M. E. R. Da Silva, "Reduction of functional mobility and cognitive capacity in type 2 diabetes mellitus," *Arq Bras Endocrinol Metabol*, vol. 58, no. 9, pp. 946–952, 2014, doi: 10.1590/0004-2730000003097.
[19] M. M. P. Van Der Heijden, F. E. P. Van Dooren, V. J. M. Pop, and F. Pouwer, "Effects of exercise training on quality of life, symptoms of depression, symptoms of anxiety and emotional well-being in type 2 diabetes mellitus: A systematic review," *Diabetologia*, vol. 56, no. 6, pp. 1210–1225, 2013, doi: 10.1007/s00125-013-2871-7.
[20] Joanna Briggs institute, *The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews: Checklist for Randomized Controlled Trials*. 2017. [Online]. Available: http://joannabriggs.org/research/critical-appraisal-tools.htmlwww.joannabriggs.org
[21] Joanna Briggs Institute, *The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic ReviewsChecklist for Quasi-Experimental Studies (non-randomized experimental studies)*. 2017. Accessed: Apr. 05, 2023. [Online]. Available: http://joannabriggs.org/research/critical-appraisal-tools.htmlwww.joannabriggs.org
[22] R. T. Conners, J. L. Caputo, J. M. Coons, D. K. Fuller, and D. W. Morgan, "Impact of underwater treadmill training on glycemic control, blood lipids, and health-related fitness in adults with type 2 diabetes," *Clinical Diabetes*, vol. 37, no. 1, pp. 36–43, 2019, doi: 10.2337/cd17-0066.
[23] R. S. Delevatti *et al.*, "Quality of life and sleep quality are similarly improved after aquatic or dry-land aerobic training in patients with type 2 diabetes: A randomized clinical trial," *J Sci Med Sport*, vol. 21, no. 5, pp. 483–488, 2018, doi: 10.1016/j.jsams.2017.08.024.
[24] R. S. Delevatti *et al.*, "Glucose control can be similarly improved after aquatic or dry-land aerobic training in patients with type 2 diabetes: A randomized clinical trial," *J Sci Med Sport*, vol. 19, no. 8, pp. 688–693, 2016, doi: 10.1016/j.jsams.2015.10.008.
[25] S. R. M. Gilani and A. K. Feizabad, "The effects of aerobic exercise training on mental health and self-esteem of type 2 diabetes mellitus patients," *Health Psychol Res*, vol. 7, no. 65786, pp. 10–14, 2019, doi: 10.4081/hpr.2019.6576.
[26] C. L. Hwang *et al.*, "Effect of all-extremity high-intensity interval training vs. moderate-intensity continuous training on aerobic fitness in middle-aged and older adults with type 2 diabetes: A randomized controlled trial," *Exp Gerontol*, vol. 116, no. August 2018, pp. 46–53, 2019, doi: 10.1016/j.exger.2018.12.013.
[27] D. M. da C. dos Anjos, B. de S. Moreira, R. N. Kirkwood, R. C. Dias, D. S. Pereira, and L. S. M. Pereira, "Effects of aerobic exercise on functional capacity, anthropometric measurements and inflammatory markers in diabetic elderly women," *J Bodyw Mov Ther*, vol. 21, no. 3, pp. 509–516, 2017, doi: 10.1016/j.jbmt.2016.07.012.
[28] B. S. Tapehsari, M. A. Mohammad, E. Khamseh, S. Seifouri, and M. Nojomi, "Physical Activity and Quality of Life in People with Type 2 Diabetes Mellitus: A Randomized Controlled Trial Abstract," *Int J Prev Med*, vol. 11, no. 9, pp. 1–6, 2020, doi: 10.4103/ijpvm.IJPVM.
[29] S. S. Maharaj and J. M. Nuhu, "The effect of rebound exercise and treadmill walking on the quality of life for patients with non-insulin-dependent type 2 diabetes," *Int J Diabetes Dev Ctries*, vol. 35, pp. 223–229, 2015, doi: 10.1007/s13410-015-0350-z.

[30] H. Kour, V. A. Kothiwale, and S. S. Goudar, "Effects of the six months of programmed exercise therapy on cardio-respiratory endurance and neurophysiological variables in asymptomatic young adults diagnosed newly with type 2 diabetes mellitus – a randomized controlled trial," *Indian J Physiol Pharmacol*, vol. 63, no. 4, pp. 283–293, 2019.
[31] J. D. Taylor, J. P. Fletcher, R. A. Mathis, and W. T. Cade, "Effects of Moderate- Versus High-Intensity Exercise Training on Physical Fitness and Physical Function in People With Type 2 Diabetes: A Randomized Clinical Trial," *Phys Ther*, vol. 94, no. 12, pp. 1720–1730, 2014, doi: 10.2522/ptj.20140097.
[32] P. Tomas-Carus *et al.*, "A randomized controlled trial on the effects of combined aerobic- resistance exercise on muscle strength and fatigue, glycemic control and health-related quality of life of type 2 diabetes patients Paper," *The Journal of Sports Medicine and Physical Fitness Abstract*, vol. 56, no. 5, pp. 572–578, 2016.
[33] H. Dadgostar, S. Firouzinezhad, M. Ansari, S. Younespour, A. Mahmoudpour, and M. E. Khamseh, "Supervised group-exercise therapy versus home-based exercise therapy: Their effects on Quality of Life and cardiovascular risk factors in women with type 2 diabetes," *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, vol. 10, no. 2, pp. S30–S36, 2016, doi: 10.1016/j.dsx.2016.01.016.
[34] N. Sousa, R. Mendes, A. Silva, and J. Oliveira, "Combined exercise is more effective than aerobic exercise in the improvement of fall risk factors: A randomized controlled trial in community-dwelling older men," *Clin Rehabil*, vol. 31, no. 4, pp. 478–486, 2017, doi: 10.1177/0269215516655857.
[35] B. Kaka and S. S. Maharaj, "Effect of rebound exercises and circuit training on complications associated with type 2 diabetes: Protocol for a randomized controlled trial," *J Med Internet Res*, vol. 20, no. 5, pp. 1–9, 2018, doi: 10.2196/resprot.8827.
[36] S. S. Maharaj and J. M. Nuhu, "Mini-trampoline rebound exercises: A 'self-care' initiative for glycated hemoglobin, body mass index and emotional distress for mildly obese females with non-insulin dependent type 2 diabetes," *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, vol. 13, no. 2, pp. 1569–1573, 2019, doi: 10.1016/j.dsx.2018.11.006.
[37] M. A. Sardar, V. Boghrabadi, M. Sohrabi, R. Aminzadeh, and M. Jalalian, "The effects of aerobic exercise training on psychosocial aspects of men with type 2 diabetes mellitus.," *Glob J Health Sci*, vol. 6, no. 2, pp. 196–202, 2014, doi: 10.5539/gjhs.v6n2p196.
[38] B. Akinci, I. Yeldan, I. Satman, A. Dirican, and A. R. Ozdincler, "The effects of Internet-based exercise compared with supervised group exercise in people with type 2 diabetes: a randomized controlled study," *Clin Rehabil*, vol. 32, no. 6, pp. 799–810, 2018, doi: 10.1177/0269215518757052.
[39] L. Cugusi *et al.*, "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," *PM and R*, vol. 7, no. 2, pp. 141–148, 2015, doi: 10.1016/j.pmrj.2014.09.004.
[40] N. D. Dede *et al.*, "Influence of exercise on leptin, adiponectin and quality of life in type 2 diabetics," *Turkish Journal of Endocrinology and Metabolism*, vol. 19, no. 1, pp. 7–13, 2015, doi: 10.4274/tjem.2564.
[41] S. X. Liu, X. W. Yue, E. P. Liu, Y. Wu, and J. J. Lin, "Effect of square aerobic exercise on cardiovascular risk factors and health-related quality of life in Chinese women with type 2 diabetes," *Int J Diabetes Dev Ctries*, vol. 37, no. 2, pp. 183–189, 2017, doi: 10.1007/s13410-016-0474-9.

[42] S. P. Tokmakidis, A. M. Touvra, H. T. Douda, I. Smilios, K. Kotsa, and K. A. Volaklis, "Training, detraining, and retraining effects on glycemic control and physical fitness in women with type 2 diabetes," *Hormone and Metabolic Research*, vol. 46, no. 13, pp. 974–979, 2014, doi: 10.1055/s-0034-1390483.
[43] J. Paul and M. A. Mary, "A comparative study on the effectiveness of combined aerobic and resistance training to improve quality of life in type II diabetes," *Int J Pharma Bio Sci*, vol. 5, no. 1, 2014.
[44] S. Dincer *et al.*, "Effects Of A Regular Exercise Program On Life Quality Of Patients With Type 2 Diabetes Mellitus," *Turkish Journal of Sports Medicine*, vol. 51, no. 3, pp. 83–93, 2017, doi: 10.5152/tjsm.2016.009.
[45] R. J. Sigal *et al.*, "Physical Activity and Diabetes," *Can J Diabetes*, vol. 37, no. SUPPL.1, pp. S40–S44, 2013, doi: 10.1016/j.jcjd.2013.01.018.
[46] Physical Activity Guidelines Advisory Committee, "Physical Activity Guidelines Advisory Committee Report, 2008," in *Medicine and Science in Sports and Exercise*, Washington, DC, U.S.: Department of Health and Human Services, 2008, p. 683. doi: 10.1097/00005768-200110000-00027.
[47] S. R. Colberg *et al.*, "Physical Activity / Exercise and Diabetes : A Position Statement of the American Diabetes Association," vol. 39, no. November, pp. 2065–2079, 2016, doi: 10.2337/dc16-1728.
[48] C. E. Garber *et al.*, "Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness in Apparently Healthy Adults: Guidance for Prescribing Exercise," *Med Sci Sports Exerc*, vol. 43, no. 7, pp. 1334–1359, 2011, doi: 10.1249/MSS.0b013e318213fefb.
[49] C. Jelleyman *et al.*, "The effects of high-intensity interval training on glucose regulation and insulin resistance: A meta-analysis," *Obesity Reviews*, vol. 16, no. 11, pp. 942–961, 2015, doi: 10.1111/obr.12317.
[50] E. O. Ojuka and V. Goyaram, "Mechanisms in exercise-induced increase in glucose disposal in skeletal muscle," *Diabetes and Physical Activity*, vol. 60, pp. 71–81, 2014, doi: 10.1159/000357337.
[51] S. R. Colberg *et al.*, "Exercise and type 2 diabetes: The American College of Sports Medicine and the American Diabetes Association: Joint position statement," *Diabetes Care*, vol. 33, no. 12, 2010, doi: 10.2337/dc10-9990.
[52] B. K. Pedersen, "Anti-inflammatory effects of exercise: role in diabetes and cardiovascular disease," *Eur J Clin Invest*, vol. 47, no. 8, pp. 600–611, 2017, doi: 10.1111/eci.12781.
[53] R. S. Delevatti *et al.*, "Glucose control can be similarly improved after aquatic or dry-land aerobic training in patients with type 2 diabetes: A randomized clinical trial," *J Sci Med Sport*, vol. 19, no. 8, pp. 688–693, 2016, doi: 10.1016/j.jsams.2015.10.008.