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Analysis Of The Effect Of Hyperbarics On Reducing Blood Sugar And Wound Healing Phase In DM Patients : Systematic Review

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ABSTRACT

Diabetes Mellitus (DM) ranks fifth as a cause of death, Diabetes Mellitus (DM) is a deadly disease after coronary disease, stroke, cardiovascular contamination disease, and respiratory disease. Diabetes Mellitus is an infectious disease that proliferates continuously, usually the side effects are not distinguished because the side effects appear mild such as weakness, wounds that do not heal, and polyuria. The purpose of this study was to determine the effect of hyperbaric on blood sugar reduction and wound healing phase of DM patients. The method used in this study is systematic review with systematic review (PRISMA) using several journal databases from Google Scholar, Science Direct, and Pubmed from 2019-2024 with the keywords "Diabetes Mellitus", "Hyperbaric", "Decrease in blood sugar levels ", "wound healing phase of DM patients". 10 articles were ready to be reviewed 10 articles were obtained with PRISMA. The results of the systematic review study showed that there was an effect of hyperbaric administration on reducing blood sugar levels and the wound healing phase of patients with DM. It is hoped that hyperbaric therapy will prevent complications from DM disease.

Keywords: Diabetes Mellitus, Hyperbaric, Decrease In Blood Sugar Levels, Wound Healing Phase.

INTRODUCTION

Diabetes mellitus (DM) is a metabolic problem described by hyperglycemia or increased blood glucose levels that occur due to problems with insulin release. Diabetes Mellitus (DM) is the world's most significant and insidious developing medical condition, known infection because of its sustainable nature and in the long term it usually won't heal like in the past and will usually get worse more often. There are five pillars in Diabetes Mellitus (DM) consisting of education, diet, actual activities, training, and checking glucose levels (Arif, 2019).

Diabetes Mellitus (DM) ranks fifth as a cause of death, Diabetes Mellitus (DM) is a deadly disease after coronary disease, stroke, cardiovascular and respiratory contamination diseases. Diabetes Mellitus is an infectious disease that reproduces continuously, usually the side effects are not differentiated because the side effects appear mild such as weakness, wounds that do not heal, and polyuria. If Diabetes Mellitus (DM) has arrived If there are complications, it will have an impact on the body like kidneys, eyes, mind, nerves, heart, and blood vessels. So you must immediately seek treatment, if it is not treated or treated it will quickly spread and cause death (Review et al., 2021).

Diabetes Mellitus (DM) is a chronic disease that is a public health problem in the world with a very high prevalence and is the main cause of death in adults throughout the world. This disease was reported in approximately 422 million adults and resulted in a significant 1.5 million deaths in 2019

(WHO, 2021). In the United States, around 10% of the incidence of this disease is reported (Rariden, 2019). Asia is ranked 2nd with the prevalence of diabetes in people aged 20-79 years, namely 11.4%, while Indonesia is ranked 7th in Southeast Asia out of 10 countries with a total of 10.7 million sufferers (Ministry of Health, 2020). Therefore, the increasing number of DM cases that are not treated properly can increase the death rate.

In fact, around 50% of diabetes mellitus sufferers in Indonesia are aware that they have diabetes mellitus and 30% of sufferers undergo routine and regular check-ups. Therefore, controlling blood sugar levels for diabetes mellitus sufferers is very important. Determining appropriate medical treatment can reduce the risk of serious complications and help sufferers adjust their diet, physical activity and insulin level needs. to improve daily blood sugar levels (Putri & Kurniawati, 2021).

There are 4 important things that need to be done so that diabetes patients can live healthy again which are called the four pillars of diabetes control (Education, arrangement Eat, sport, drug like tablet or insulin). However, in reality the death rate and complications from diabetes mellitus still just tall. Effort What is done is to provide counseling and health education (education) about the care and treatment of disease diabetes mellitus independently. This education includes meal planning (diet), sports activities, drug use orally and insulin appropriately. Monitoring sugar levels in blood and urine and increased motivation for diabetes sufferers mellitus For control in a way regular Which aim remove symptom, prevent acute and chronic complications, reduce existing complications, treating comorbidities, creating and maintaining body health, repair quality life And reduce number death . And diabetic foot requires a long healing time and comprehensive multidisciplinary treatment, starting from controlling blood sugar levels, daily local wound care, antibiotic therapy, and revascularization surgery, but to date none of this has been satisfactory.

With progress technology in field knowledge knowledge medical produce methods new in effort healing disease, including diabetes and accelerating healing of diabetic wounds. One of these technological developments is therapy oxygen hyperbaric. Has Lots study Which done to method treatment therapy hyperbaric in field medical. Hyperbaric therapy oxygen is a therapy where sufferer must is at in something room pressurized tall And breathe with oxygen pure (100%) on air pressure is greater than that of normal atmospheric air, ie 1 ATA (Absolute Atmosphere) is equal to 760 mmHg. Giving oxygen pressure tall For therapy held in chamber or RUBT (Room Air Pressurized Tall).

By theory therapy hyperbaric can increase sensitivity network to insulin and causes hypoglycemia in diabetes mellitus sufferers, where hyperbaric therapy in an absolute atmosphere causes a decrease in blood sugar levels . In hyperbaric therapy, air pressure increases up to 2 times The condition is normal and the patient is breathing using 100% oxygen. Giving 100% oxygen in high pressure, causing pressure that will dissolve oxygen into the blood as well as tissues and other body fluids until it reaches increased concentration 20 times higher than normal. Increased concentration this is known as oxygen consumption maximum (VO 2 max). Oxygen consumption maximum (VO 2 max) can interpreted as ability maximum somebody to consume oxygen during physical activity at equivalent altitudes with surface sea. VO2 max stated as volume total oxygen used per minute (ml/minute). The more muscle mass a person has, the more Lots also oxygen (ml/min) Which used during exercise maximum. Apart from that, the role of hyperbaric therapy is to improve the amount of oxygen delivered to the wound area, both bound to hemoglobin and dissolved in plasma. Thus, the rate of wound healing is directly related to oxygen levels in the tissue. .

The use of hyperbaric therapy has been widely used in clinical, medical and health practice for the treatment of decompression sickness, CO poisoning, and to improve wound healing (Rosyanti et al., 2019). In research conducted by Ekanova et al (2019), the results showed that the change in PEDIS score that occurred between the two measurements appeared to be greater in the TOHB group compared to the control group (2 vs 0, P = 0.001). TOHB (Hyperbaric Oxygen Therapy) accelerates the healing process of UKD (Diabetic foot ulcers) as assessed by a decrease in the PEDIS score. The aim of writing this article is to determine the effect of giving hyperbaric therapy on reducing blood sugar levels and the wound healing phase of DM sufferers with a systematic review.

METHODS

Study Design

This research article uses a *systematic review design* with standard systematic review and Meta Analysis (PRISMA) used to conduct a systematic review.

Eligible Criteria

The criteria used in writing this article use PICO (*Population, Intervention, Comparison, Outcome*) to develop eligibility criteria for inclusion and exclusion criteria from randomized research reviews. Here are some criteria:

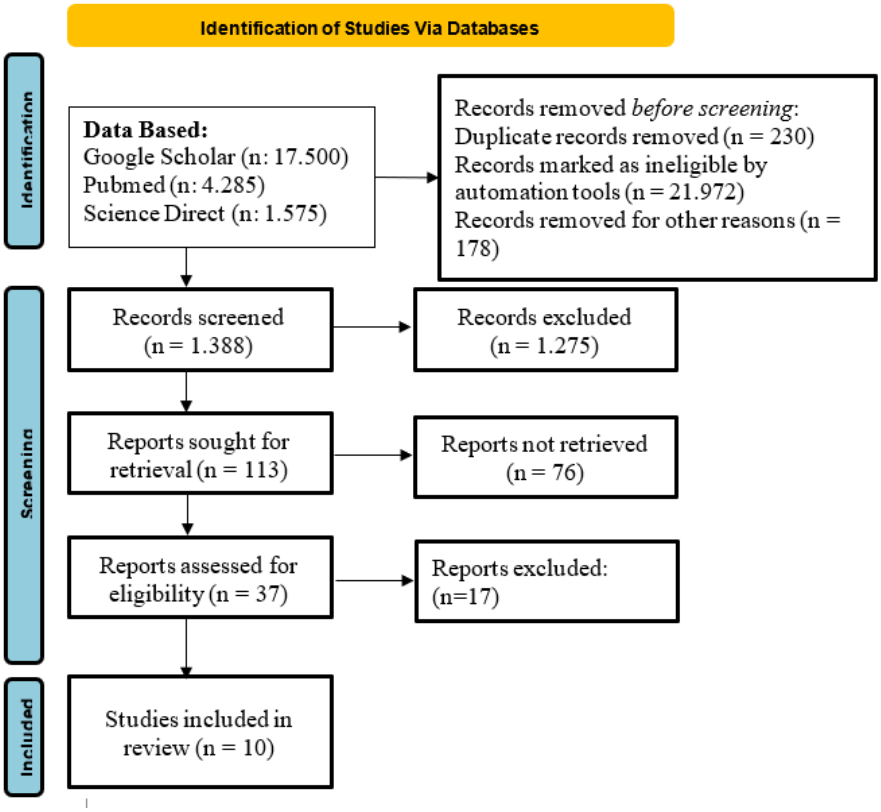
Criteria	Inclusion	Exclusion
Population	Diabetes mellitus patients	Apart from diabetes mellitus patients
Intervention	Hyperbaric therapy	-
Comparison	Do not use comparison factors	-
Outcomes	*Self-efficacy*	-
Study design and type of publication	All research designs	Systematic review
Year of publication	2019-2024	< 2019
Language	English Indonesian	-

Search Strategy

The databases used in writing this systematic review are *Google Scholar*, *Science Direct*, and *Pubmed* . Article searches were carried out systematically from 2019-2024 using several keywords, namely " Diabetes Mellitus ", " Hyperbaric ", " Decreased blood sugar levels ", " Wound healing phase in DM sufferers ". Article searches use English and Indonesian .

Study Selection and Synthesis

The article feasibility study was carried out by reviewing articles with full text. Articles deemed appropriate will be used in this literature, the process and results of article selection are presented in the PRISMA diagram diagram 1. Based on the journal database search results, results were obtained from *Google Scholar* (17,500 articles) , *Pubmed* (4,285 articles), *Science Direct* (1,575 articles), then selected according to the inclusion and exclusion criteria, 10 articles were obtained.



RESULTS

No.	Journal	Method	Results
1.	Hyperbaric oxygen therapy as an adjunct to standard therapy in the treatment of diabetic foot ulcers (Kumar, et al, 2020) Publisher: Journal of Anaesthesiology Clinical Pharmacology	**Design:** Prospective study **Sample:** Population: Patients with diabetic feet Sample: 28 people . Sampling: - **Variables:** Dependent "hyperbaric oxygen therapy" Independent "diabetic foot ulcer treatment" **Instruments:** underwent Trans-cutaneous partial pressure of oxygen (TcPO2) **Analysis:** unpaired t-test and Chi square test.	Diabetic ulcers in 78% of patients in Group H healed completely without surgical intervention while no patient in group S healed without surgical intervention (P = 0.001). Two patients in group H required distal amputation while in group S, three patients underwent proximal amputation.
2.	Use of hyperbaric oxygen therapy (HBOT) in chronic diabetic wounds - Randomized trial (Rahman, et al, 2019) Publisher: Med J Malaysia .	**Design:** Randomized trial **Sample:** Population: Patients with diabetic wounds Sample: 58 people . Sampling: - **Variables:** Dependent "hyperbaric oxygen therapy" Independent "on chronic diabetic wounds" **Instruments:** conventional wound care **Analysis:** ANOVA with Greenhouse-Geisser correction	Repeated Measures ANOVA analysis with Greenhouse-Geisser correction showed that the mean wound size over time (Days 0, 10, 20 and 30) among patients undergoing HBOT was statistically significantly different ($F(1.61) = 30.86$, $p < 0.001$) compared with the conventional therapy group. Multiple logistic regression analysis showed that the HBOT group had almost 44 times higher odds of achieving at least 30% reduction in wound size within the study period (95% CI: 7.18, 268.97, $p<0.001$).
3.	Hyperbaric Oxygen Therapy in Changes in Blood Glucose Levels in Patients with Diabetes	**Design:**Quasi Experiment with a pretest posttest design approach	The results showed that the average blood

	Mellitus in Lakesla Drs. Med. Rijadi R. Phys Surabaya. (Rachmawati, et al, 2017) Publisher: Proceedings of Hefa 1st. .	one group **Sample:** Population: Patients With Diabetes Mellitus Sample: 19 respondents Sampling: - **Variables:** Independent "hyperbaric oxygen therapy" dependent "changes in blood glucose levels" **Instrument:** questionnaire and blood sugar measurement **Analysis:** Spearman Rho test and one sample paired t test	sugar level before TOHB was 219 mg / dL, and the average blood sugar level after TOHB was 153 mg / dL, the results of statistical tests before and after therapy showed p = 0.01 ($p < 0.05$) meaning there is an effect of TOHB on blood glucose levels. Statistical analysis also shows that there is a significant relationship between meal time factors and blood sugar levels with p = 0.001, there is also a significant relationship between the use of insulin therapy and changes in blood glucose levels with p = 0.01. While the use of oral medication before TOHB also had p = 0.04, the relationship between changes in blood sugar levels and activity before therapy had a relationship with changes in sugar levels with p = 0.01.
4.	Effect of Hyperbaric Oxygen Therapy (TOHB) on Healing of Type 2 DM Foot Ulcers Based on PEDIS Score (Ekanova, et al, 2019) Publisher: Biomedical Journal (JBM)	**Design:** *randomized controlled trial* (RCT) **Sample:** Population: Patients with DM 2 diabetic ulcers Sample:	The results of the study showed that the change in PEDIS scores that occurred between the two measurements appeared to be

		10 respondents Sampling: randomized controlled design **Variables:** Independent “hyperbaric oxygen therapy” Dependent "healing type 2 DM foot ulcers" **Instruments:** PEDIC **Analysis:** t test or Mann-Whitney U	greater in the TOHB group compared to the control group (2 vs 0, *P* = 0.001).
5.	Local Hyperbaric Oxygen Therapy in the Treatment of Diabetic Foot Ulcers (Jaroslaw et al, 2022) Publisher : Int J Environ Res Public Health	**Design:** Randomized control trial **Sample:** Population: Patients with Diabetic Foot Ulcers Sample: 45 patients. **Variables:** Independent “Local hyperbaric oxygen therapy” Dependent “diabetic foot ulcer treatment” **Instruments:** VASE **Analysis:** chi square test	Analysis of the results showed a statistically significant reduction in wound surface area after treatment, from 8.54 ± 3.34 cm to 4.23 ± 3.23 cm² (p = 0.000001). In 5 patients (11.1%), the wounds healed completely. In 25 patients (55.5%), the topical condition of the wound surface was significantly reduced by an average of 50%. There was also a significant reduction in perceived pain on the VAS in all examined patients from 4.64 ± 1.68 points before treatment to 1.51 ± 0.92 points after treatment (p = 0.000001).
6.	Adjuvant Hyperbaric Oxygen Therapy Improves Healing of Non-Ichemic Diabetic Foot Ulcers Compared to Standard Wound Care Alone (Shimaa et al, 2019) Publisher: Int J Low Extreme Wounds.	**Design:** randomized **Sample:** Population: Patients with diabetic wounds Sample: 30 respondents Sampling:*Random sampling*	Ischemic wounds and patients with contraindications to systemic HBOT were excluded. The primary endpoint was complete healing of the target ulcer. Secondary

		Variables: Independent "adjuvant hyperbaric oxygen therapy" dependent "non-icemic diabetic ulcer healing" **Instruments:** **Ulcer Assessment** **Analysis:** t test	endpoints included the following: ulcer healing rate at the end of the treatment period and at 4 and 8 weeks thereafter and amputation rate. A significantly greater percentage of wounds treated with HBOT (33.3%, 5/15) achieved complete closure than wounds treated with conventional therapy (0%, 0/15; P = .014) at the end of treatment. This significant difference was maintained during 8 weeks of follow-up
7.	*Relationship between hyperbaric oxygen therapy and quality of life in participants with chronic diabetic foot ulcers: data from a randomized controlled trial* (Li, G *et al*, 2017, Springer-Verlag, Italy)	**Design:** correlation study **Sample:** Population: Patients with diabetic foot wounds Sample: 103 (49 in therapy group oxygen hyperbaric and 54 in the control group) **Variables:** *hyperbaric oxygen therapy and quality of life in participants with chronic diabetic foot ulcers* **Instruments:** HRQoL questionnaire with EQ-5D3L instrument, Short Form 36 (SF-36) and Diabetic Foot Ulcers Scale-Short Form (DFS-SF) **Analysis:** analysis regression linear for continuous variables and logistic regression analysis for categorical variables, respectively)	There is no significant difference in mark EQ-5D index was found between hyperbaric oxygen therapy and control groups. Hyperbaric oxygen therapy was found to be associated with fewer participants reporting problems in mobility and pain or discomfort compared to the group control. No no significant differences in SF-36 or DFS-SF were observed.

8.	of Hyperbaric Oxygen (HBO) Regarding Peripheral Perfusion of Gangrene Wounds in DM Patients at RSAL Dr. Ramelan Surabaya (Huda, N 2010, FIK UI, Jakarta) .	**Design:** Study *quasy Experimental* with a *non-equivalent control group design pre-post test* approach **Sample:** Population: DM patient with gangrene Sample: 40 respondents **Variables:** Hyperbaric Oxygen (HBO) Regarding Peripheral Perfusion of Gangrene Wounds in **Instrumental Patients:** Respondent characteristics data , data physique, observation sheet, *pulse oximetry device* A: T-test **Analysis:** T-test	The results of research on 40 respondents taken randomly *consecutive sampling*, showed there were significant differences between peripheral perfusion groups intervention before and after being given HBO. It was concluded that hyperbaric oxygen affects the perfusion of gangrene wounds in diabetes sufferers mellitus Which assessed from acral, CRT and oxygen saturation.
9.	Effect of hyperbaric oxygen treatment on diabetes foot ulcers: A meta-analysis. (Imam, Mohamed S., et al, 2023). Publisher: Wiley IWJ. .	**Design:** *Literature review : meta analysis* **Sample:** Population:957 articles Sample:17 articles **Variables:** Hyperbaric oxygen treatment on diabetic foot ulcers **Instruments:** OVID, PubMed, the Cochrane Library, the Cochrane Central Register of Controlled Trials, Embase and Google Scholar. **Analysis:** *Literature review*	The 17 tests published between 1992 and 2022 are included in the meta-analysis after evaluation of 957 tests were applicable because they met the inclusion criteria. Table 2 summarizes the findings this investigation. 7219 people with diabetic foot ulcers were at the starting point of the study used, 1328 of them using hyperbaric oxygen treatment, and 5891 people using standard care. The sample size is 18 to 5466 people.

			Hyperbaric oxygen treatment significantly ulcer healing was higher (OR, 14.39; 95% CI, 4.02-51.52, p < 0.001) with high heterogeneity (I2 = 80%), higher side effects (OR, 2.14; 95% CI, 1.11-4.11, p = 0.02) without heterogeneity (I2 = 0%), lower mortality (OR, 0.22; 95% CI, 0.07-0.71, p = 0.01) with low heterogeneity (I2 = 34%) and higher ulcer area reduction (MD, 23.39; 95% CI, 11.79-34.99, p < 0.001) with high heterogeneity (I2 = 76%) compared with standard treatment in patients .
10.	The Effect of Hyperbaric Oxygen Therapy on Hemoglobin Sugar Levels in Diabetes Patients (Ismawatie, Emma., et al, 2023)	**Design:** *Quasi experimental with one-group pre-test - post-test.* **Sample:** Population: Diabetes mellitus patients. Sample: 23 people **Variables:** Hyperbaric Oxygen Therapy on Hemoglobin Sugar Levels in Diabetes Patients **Instrument:** hematology analyzer with the principle of flow cytometry **Analysis:** Shapiro-Wilk test and Levene's test	The results of the study showed that the average hemoglobin level of Diabetes mellitus patients before hyperbaric therapy was 10.3 g/dl, on the 5th day it was 11 g/dl, and on the 10th day it was 10.8 g/dl. The results of data analysis showed that there was no significant effect of hyperbaric oxygen therapy on hemoglobin levels in diabetes mellitus patients.

DISCUSSION

Hyperbaric oxygen therapy is therapy using 100% pure oxygen with a pressure of more than 1 ATA in a hyperbaric chamber (Lestarining et al., 2017). Hyperbaric therapy uses pressure of 1.5 to 2.5 Atm for 30 to 90 minutes and can be used repeatedly. The aim of hyperbaric therapy itself is to treat and treat several diseases, for example, intravascular embolism, decompression sickness, anaerobic infections, and CO poisoning (Rosyanti et al., 2019). TOHB is usually performed in a hyperbaric chamber. There are 2 types of chambers, namely chambers that can only be entered by one patient (monoplaced chamber) and chambers that can be entered by several patients with the same pressure (multiplaced chamber) (Kirby et al., 2019) .

In research conducted by Ekanova et al (2019), the results showed that the change in PEDIS score that occurred between the two measurements appeared to be greater in the TOHB group compared to the control group (2 vs 0, P = 0.001). TOHB (Hyperbaric Oxygen Therapy) accelerates the healing process of UKD (Diabetic foot ulcers) as assessed by a decrease in the PEDIS score.

In other research, it is stated that TOHB (Hyperbaric Oxygen Therapy) can also increase insulin sensitivity by reducing beta cell apoptosis through the Bcl-2/caspase-3/PARP pancreatic apoptosis pathway in mice which can then reduce blood sugar levels. Another study also states that TOHB can reduce blood sugar levels by increasing aerobic metabolism and reducing HbA1c levels which can control blood sugar levels in patients with type 2 diabetes mellitus (Zhang et al. , 2022) .

Hyperbaric oxygen therapy can be used as diabetic foot therapy along with other therapies such as wound debridement, wound care, reducing pressure on the feet, good sugar control, nutritional intake, and use of antibiotics. It is hoped that providing hyperbaric therapy can minimize the level of complications in diabetes mellitus sufferers . Apart from that, it is important to provide support from family and community during treatment. They need to be empowered to address psychological well-being to improve coping mechanisms and reduce stress or depression during treatment. A supportive environment facilitates diabetes mellitus patients .

CONCLUSION

Systematic review is a method used to identify, evaluate and interpret research evidence in order to answer certain research problems. Based on a systematic review study that has been carried out, it can be concluded that hyperbaric therapy can reduce blood sugar levels and the wound healing phase in DM sufferers.

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