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CONTRAST BATH SOAKING THERAPY IMPROVES BLOOD CIRCULATION IN DIABETIC FEET

Berkah Afif Udin[a,b], Umi Faridah[a], Muhamad Jauhar[a], Faridha Alfiatur Rohmaniah[a]*
[a]Faculty of Health Sciences, Universitas Muhammadiyah Kudus, Indonesia
[b] PKU Muhammadiyah Hospital Banjarnegara, Indonesia
*Corresponding author: faridha@umkudus.ac.id

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Abstract

Diabetes Mellitus (DM) is the mother of all diseases that can "give birth" to various other diseases. DM patients are at risk of diabetic ulcers due to poor blood circulation in the feet. The prevalence of diabetic neuropathy is high in DM patients. The most important DM management program is to normalize blood glucose levels. The study aims to analyze the effect of contrast bath soaking on blood circulation in diabetic feet. This study uses a quasi-experimental research design using a nonequivalent control group design. The independent variable is contrast bath therapy, and the dependent variable is leg blood circulation. The research was conducted at a private Islamic hospital in Banjarnegara Regency in February 2025. The sample was 18 DM clients for each group, determined using a purposive sampling technique according to certain criteria. The instrument used a GEA stethoscope type SF 411 and a GEA MC 20 sphygmomanometer. The intervention group received contrast bath therapy by soaking their feet for 2 minutes in warm water and 1 minute in cold water. Therapy is given 5 times in 15 minutes and 3 days. The control group received standard intervention through 30-degree leg elevation. Data analysis used the Wilcoxon and Mann-Whitney tests. The results showed that contrast bath soaking therapy increased blood circulation in the legs with a value of p=0.001 (p<0.05). Hospitals need to develop an SOP for contrast bath therapy and apply it to DM clients as an independent nursing intervention that can improve leg blood circulation.

I. INTRODUCTION

Diabetes is now the fourth most common cause of mortality globally. Given that diabetes mellitus is the mother of all ailments, the Ministry of Health has taken notice of this problem. Diabetes can give birth to a number of different diseases, much like a mother giving birth to many children (KEMENKES RI, 2023). Diabetes will be the direct cause of 4.8 million deaths in 2021. Non-communicable diseases like diabetes mellitus are expected to cause 52 million deaths annually in 2030. Additionally, risk factors are expected to rise as a result of changes in lifestyle, mental and emotional disorders, environmental changes, and the emergence of a more modern world. (Profil Kesehatan Indonesia, 2022). The International Diabetes Federation estimates that 5.5% of individuals worldwide between the ages of 20 and 79 have diabetes, or 537 million people. In 2021, there were 360.0 million more diabetics living in cities than in rural regions (176.6 million). An estimated 643 million individuals (11.3% of the population) would have diabetes by 2030 if nothing is done to address the issue. By 2045, the number will have increased to 783 million (12.2%) if this trend continues (International Diabetes Federation, 2021).

With a prevalence of 11.3%, Southeast Asia comes in third. After identifying the ten nations with the largest number of patients, the IDF also projects the number of diabetes patients in various countries across the globe who are between the ages of 20 and 79. With

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116.4 million, 77 million, and 31 million patients, respectively, China, India, and the United States hold the top three spots. With 10.7 million patients, Indonesia is ranked seventh out of the ten nations with the most patients.

Since Indonesia is the only Southeast Asian nation on the list, it is estimated that it contributes significantly to the region's high prevalence of diabetes patients. According to the International Diabetes Federation's (IDF) most recent data from 2021, 19.46 million Indonesians suffer with diabetes. According to the (KEMENKES RI, 2023) the country's diabetes prevalence is predicted to rise by 11.7% by that year. In 2023, there will likely be 15,765 DM patients in Banjarnegara Regency and 618,546 DM patients in the Central Java Province (Portal Data Jawa Tengah, 2023).

Diabetes mellitus (DM) needs to be managed and treated as soon as possible. Although it cannot be cured, it can be controlled and managed. Complications may arise from untreated type 2 diabetes. Risk factor management is necessary to prevent complications in people with diabetes mellitus. (Decroli, 2019). The most important program for managing diabetes mellitus is to normalize blood glucose levels so that blood circulation runs smoothly. Blood circulation can be detected by measuring the ankle-brachial index (ABI). ABI is a measurement of the ratio of systolic pressure in the arm to systolic pressure in the lower leg (Asir et al., 2020). Diabetes mellitus management because it promotes healthy blood circulation. The Ankle-Brachial Index (ABI), which calculates the ratio of the systolic pressure in the arm to the systolic pressure in the lower leg, can be used to identify blood circulation (Yuliartini, 2024) .

Diabetes mellitus management can be grouped into five pillars: education, physical activity, diet, self-monitoring of blood sugar, and taking anti-diabetic medication. These steps aim to ensure that people with diabetes can live longer and have a better quality of life. (Husna, Jafar, Hidayanti, Dachlan, & Salam, 2022). Meanwhile, active lower range of motion, warm water soaking hydrotherapy, and foot exercises are particular management to increase blood circulation in diabetic patients' feet. When compared to the prior value, this therapy is highly effective in raising ABI by up to 0.08 points (Nabila et al., 2024). Based on this therapy, researchers are interested in hydrotherapy but using contrast baths because there has not been any updated research regarding the effectiveness of contrast-bath hydrotherapy.

One treatment for maintaining healthy blood circulation in the extremities is a contrast bath. Soaking the feet up to the calves in alternating warm water (36.6 to 43.3 degrees Celsius) and cold water (10 to 20 degrees Celsius) is known as contrast bath therapy (Anggreini & Amelia, 2021). This therapy can increase blood circulation because it causes intermittent vasoconstriction and vasodilation in the blood circulation when a contrast bath is administered. This causes a vascular pumping effect, which increases tissue blood flow and oxygenation of soft tissue extensibility. This makes it easier for hemoglobin to release oxygen into the tissue, which increases muscle perfusion at the site of the therapy (Versey et al., 2023).

Based on research conducted by (Anggreini & Amelia, 2021) at Harapan Raya Community Health Center regarding the effectiveness of contrast baths, the results showed that the legs of patients who had decreased blood circulation experienced positive changes after being given contrast bath therapy, with a t-test result of 0.000. Contrast baths considerably enhanced blood circulation, according to research by (Umah, 2023), with a p-value of 0.003. Using incidental sampling approaches, both studies investigated how well contrast baths affected blood circulation in individuals with congestive heart failure. Meanwhile, researchers will use purposive sampling approaches to study samples of people with type 2 diabetes. Analyzing the impact of soaking in a contrast bath on blood circulation in diabetic patients' legs is the aim of this study.

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II. METHOD

This study is a quantitative study with a quasi-experimental research design using a nonequivalent control group design. The independent variable is contrast bath soaking therapy, and the dependent variable is blood circulation in the legs of DM clients. This study was conducted at a private Islamic hospital in Banjarnegara Regency in February 2025. The research sample of 18 DM clients for each intervention and control group was determined through a purposive sampling technique. The inclusion criteria were patients diagnosed with DM by a doctor or health worker, blood sugar levels of 130-500 mg/dL, and an ABI value of more than 0.4. The exclusion criteria were patients with deep vein thrombosis (DVT), unconsciousness, severe leg pain, and amputation.

The research instruments were an ABI observation sheet, SOP contrast bath, handscone, GEA Type SF 411 stethoscope, GEA MC 20(50) sphygmomanometer, mobile phone stopwatch, and GEA water thermometer. The intervention group received contrast bath soaking therapy for 15 minutes with a duration of 2 minutes of warm water and 1 minute of cold water, repeated 5 times and given for 3 days. Contrast bath soaking therapy for diabetes patients uses warm water at 38-40 degrees Celsius for 10-15 minutes to improve circulation and relaxation. The soaking area covers the feet up to the ankles. The tools used are a container or basin (foot bathtub), which is a simple container large enough to soak both feet up to the ankles in. Then a soft towel to dry the feet slowly, especially between the toes.

The control group received standard intervention in the form of 30-degree leg elevation. Researchers measured blood circulation based on ABI values before and after the intervention. The legs are raised approximately 30 degrees above the bed surface or higher than heart level (30° leg elevation). Sessions last 15 to 30 minutes and are often performed while the patient rests or before bed. Data analysis used Wilcoxon to analyze differences in ABI values before and after the intervention in each intervention and control group and Mann-Whitney to analyze the effect of contrast bath soaking therapy on ABI values. This study has been declared to have passed the ethical review of the Health Research Ethics Commission of the Muhammadiyah University of Kudus, number 152 / Z-7 / KEPK / UMKU / II / 2025, on February 2, 2025.

III. RESULTS AND DISCUSSION

A. Table

1. Age

Table 1. Frequency distribution of DM patient by age (n=36)

Age	N	Mean	SD	Median	Min-Max
Intervention	18	46.94	2,461	46.50	43-51
Control	18	47.17	3,698	47.00	41-54

Table 1 explains that the average age of clients was 46.94 years with SD 2.461 in the intervention group and 47.17 years with SD 3.698 in the control group.

2. Gender, Education, Occupation, Income, and DM History

Table 2. Frequency distribution of DM clients based on gender, education, occupation, income, and history of DM (N=36)

Characteristics	Intervention Group		Control Group	
	f	%	f	%
Gender				
Male	7	38.9	8	44.4
Female	11	61.1	10	55.6
Education				
Junior high school	5	27.8	6	33.3
Senior high school	9	50	10	55.6
Collage	4	22.2	2	11.1
Occupation				
Farmer	8	44.4	9	50
Private Employee	7	38.9	7	38.9
Civil Servant	3	16.7	2	11.1
Income				
< RMW (IDR 2,170,475)*	4	22.2	5	27.8
≥ RMW (IDR 2,170,475)*	14	77.8	13	72.2
DM History				
< 5 years	6	33.3	6	33.3
≥ 5 years	12	66.7	12	66.7
Total	18	100	18	100

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*) Banjarnegara Regency Minimum Wage in 2025

Table 2 explains that the majority of clients were female, both in the intervention group (11 clients (61.1%)) and the control group (10 clients (55.6%)). Half of the clients had a high school education background (9 clients (50%) in the intervention group and 10 clients (55.6%) in the control group). Half of the clients worked as farmers (8 clients (44.4%) in the intervention group and 9 clients (50%) in the control group). The majority of clients had incomes above the 2025 Banjarnegara Regency Minimum Wage (Rp. 2,170,476), namely 14 clients (77.8%) in the intervention group and 13 clients (72.2%) in the control group. The majority of clients had a history of diabetes mellitus for more than 5 years, namely 12 clients (66.7%) in both the intervention and control groups.

B. Blood Circulation in the Feet of DM Clients

Table 3. Blood circulation in the legs (ABI value) of DM clients before and after intervention in the intervention and control groups (N=36)

circulation in the legs (ABI values)	Before		After	
	Median	Min-Max	Median	Min-Max
Intervention	0,88	0.79-0.94	0,96	0.85-1
Control	0,86	0.71-0,93	0,86	0.71–0.97

Table 3 states that the median ABI value in the intervention group before the intervention was 0.88 with a minimum value of 0.79 and a maximum value of 0.94, while after the intervention it was 0.96 with a minimum value of 0.85 and a maximum value of 1. The median ABI value in the control group before the intervention was 0.86 with a minimum value of 0.71 and a maximum value of 0.93, while after the intervention it was 0.86 with a minimum value of 0.71 and a maximum value of 0.97.

C. Differences in blood circulation in the legs (ABI values) before and after intervention

Table 4. Differences in blood circulation in the legs (ABI values) before and after intervention in the intervention and control groups

circulation in the legs (ABI values)	Median	Min-Max	P-Value
Intervention			
Before	0.88	0.79-0.94	0.001
After	0.96	0.85-1	
Control			
Before	0.86	0.71-0.93	0.22
After	0.86	0,71-0.97	1

Table 4 shows a statistically significant difference in ABI values between the intervention group before and after the intervention, with a p value of 0.001 ($p < 0.05$). However, there was no statistically significant difference in ABI values between the control group before and after the intervention, with a p value of 0.221 ($p > 0.05$).

D. The effect of contrast bath soaking therapy on blood circulation in the legs of clients with diabetes

Table 5. The effect of contrast bath soaking therapy on blood circulation in the legs of clients with diabetes

Variable	Median	Min	Max	P value
ABI value difference				
Intervention	0.05	0	0.21	0.
Control	0	0	0.07	001

Table 5 explains that there is a statistically significant effect of contrast bath soaking therapy on blood circulation in the legs of DM clients with a p-value of 0.001 ($p < 0.05$).

DISCUSSION

A. Characteristics of DM Clients

The results of the study showed that both respondents in the intervention and control groups were adults. This is in line with (Damayanti's Theory, 2019) that insulin resistance in diabetes mellitus sufferers tends to increase at the age of 30 years. These results are in line with research conducted by (Suharni et al., 2022), stating that DM patients with diabetes mellitus with diabetic neuropathy complications based on age are 34.6% aged over 45 years. Also supported by research by (Komariah & Rahayau, 2020),

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most of the type 2 diabetes mellitus patients were aged > 45 years, as many as 93 patients (69.4%). The increase in the risk of diabetes with age, especially at ages over 40 years, is due to the beginning of an increase in glucose intolerance. The aging process causes a decrease in the ability of pancreatic β cells to produce insulin. In addition, in older individuals there is a decrease in mitochondrial activity in muscle cells by 35%. This is related to an increase in fat levels in muscles by 30% and triggers insulin resistance (Sari & Faizah, 2020).

The results of the study explain that the majority of respondents were female in both the intervention and control groups. These results on diabetes align with research conducted by Komariah (2022), which stated that the majority of the study participants with diabetes were female (60.4%). This is supported by research by (Suharni et al., 2022), which stated that the majority of the study participants with diabetes were female (69.2%). Women are at higher risk of developing diabetes because physically, women have a greater chance of increasing their Body Mass Index (BMI). In addition, monthly cycle syndromes (premenstrual syndrome) and postmenopause make the distribution of body fat easier to accumulate (Wulandari, 2023).

The study results indicated that the majority of respondents had a high school education in both the intervention and control groups. This is in line with research conducted by Arania (2021) that 27% of DM patients had a high school education. Research by (Haryono et al., 2021) that the majority of DM patients had a high school education (42.4%). This can be linked to the level of knowledge and healthy lifestyles they practice. Better knowledge will encourage a healthier lifestyle (Notoatmodjo, 2019). The study results indicated that the majority of respondents worked as farmers and had incomes above the minimum wage (UMR) in both the intervention and control groups. Based on research conducted by (Wulandari, 2023) it was stated that 41.3% worked and had incomes above the minimum wage (UMR).

The findings of this study contradict the assertion made by (Istianah, 2020) that the majority of DM patients have low economic standing, with incomes below UMR. Stress is linked to low economic position and disrupts the neuroendocrine system, which in turn disrupts endocrine function. Furthermore, socioeconomic circumstances are linked to poor lifestyle choices and restricted access to medical care. Low-income individuals are more likely to have type 2 diabetes because they have less access to wholesome food and/or beverages as well as medical facilities (Damayanti, 2019).

The results of the study explained that the majority of respondents in both the intervention and control groups had a history of DM for more than 5 years. This result is in line with research conducted by (Suharni et al., 2022), which stated that diabetes mellitus patients with diabetic neuropathy complications based on the duration of suffering from DM were mostly ≥ 5 years, as many as 28 people (53.8%). This is also supported by research conducted by (Dharma, 2019), which stated that the majority of respondents showed a history of DM for more than 5 years. This shows that DM is one of the chronic non-communicable diseases because it lasts long-term and requires continuous medical care (Damayanti, 2019).

B. Blood Circulation in the Feet of DM Clients

The results of the study showed that before the study, the average ABI value was 0.87–0.88 in both the intervention and control groups. These results are in line with research conducted by (Maryama et al., 2021) which stated that the average Ankle Brachial Index on the day of the examination at Muhammadyah Hospital Palembang before the Ankle Brachial Index treatment was 0.871. These results are also supported by research conducted by (Nugroho, 2020), which stated that before warm water soaking hydrotherapy, the ABI value of type 2 DM patients was 0.801. This occurs due to blood vessel disorders in the legs so that blood circulation in the legs is not smooth. The study found that the ABI value in the mild

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ischemia range of 0.7–0.9 indicates borderline perfusion/perfusion limit value/mild ischemia. Symptoms are felt in the form of pain in the buttocks or calves when walking due to blood vessel occlusion, which causes blood flow to not meet nutritional needs, especially in the lower extremities.

After soaking feet in warm and cold water (contrast baths), respondents experienced an increase. Blood circulation in the feet after the study in the intervention group, namely, the average respondent with an ABI value of 0.95 and a standard deviation of 0.043, was measured. Meanwhile, in the control group, the average respondent had an ABI value of 0.87. There was a significant increase in the intervention group, but in the control group there was no statistically significant increase. Supported by research conducted by (Maryama et al., 2021), it stated that after the warm water foot soak treatment, the average ankle-brachial index increased significantly with an ABI value of 1.052. Also strengthened by research conducted by (Nugroho, 2020), which stated that after warm water soaks, the ABI value in diabetes sufferers increased, namely to an ABI value of 0.883. Contrast bath therapy, which is the use of alternating cold and hot therapy, can result in drastic changes in muscle perfusion due to the combination of cold/hot effects, called the "pumping effect," so that it can increase peripheral blood circulation with the mechanism of “vasodilation/vasoconstriction," which has benefits for improving peripheral blood circulation (Song Ji-Ah, 2023).

C. Difference in ABI before and after intervention

The results of the study showed that there was a difference in ABI values in the intervention group after the study. While in the control group, there was no difference in ABI values. These results are in line with research conducted by (Umah, 2023), stating that contrast baths have an effect on increasing ABI values with $p < 0.002$. Also supported by research by (Song Ji-Ah, 2023) stating that contrast baths can have an effect on increasing ABI values with $p < 0.000$. Based on the theory of (Versey et al., 2023), the increase in ABI values is caused by the mechanism of "vasodilation vasoconstriction." The mechanism of "vasodilation vasoconstriction" stimulates the endothelium of blood vessels to secrete or release nitric oxide. Endothelial cells are a single layer of specialized epithelial cells that line the lumen of all blood vessels and function to release paracrine vasoactives, which play a role in blood vessel vasodilation, namely NO (nitric oxide). Nitric oxide is produced through the conversion of the amino acid L-arginine to L-citrulline by the enzyme NO-synthase (NOS). Nitric oxide will stimulate soluble guanylate cyclase (sGC), which causes increased synthesis of cyclic GMP from guanosine triphosphate (GTP).

This cyclic increase in GMP causes the smooth muscles of the blood vessels to relax. When smooth muscle cells relax, blood vessels will vasodilate, improving blood flow to the periphery of the feet. In the control group, there was no statistically significant difference in ABI values before and after the study because respondents did not receive foot care intervention during the study. Based on field findings, an increase in ABI values of 0.04 points was found, indicating a very minimal increase. The increase in the control group may be influenced by factors such as the antidiabetic medication consumed, which affects the patient's glucose levels, and also by food consumption, which can affect the patient's glucose status, thus indicating an increase (Anggreini & Amelia, 2021).

D. The Effect of Contrast Bath Soaking Therapy on Blood Circulation in the Feet of DM Clients

The results of this study indicate that there is an effect of contrast baths on improving blood circulation in the feet of DM clients. Hydrotherapy that combines cold and warm temperatures and extremes is called a contrast bath. These results are in line with research conducted by (Anggreini & Amelia,

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2021) at Harapan Raya Community Health Center regarding the effectiveness of contrast baths, which found that the feet of patients with decreased blood circulation experienced positive changes after being given contrast bath therapy with a t-test result of 0.000. Research conducted by (Umah, 2023) showed that contrast baths had a significant effect on improving blood circulation with a p-value of 0.003. This is because therapy with the use of hot and cold water alternately causes intermittent vasoconstriction and vasodilation that induces a vascular pumping effect, which results in increased tissue blood flow and increased oxygenation of soft tissue extensibility, which causes hemoglobin to release oxygen more easily into the tissue, thereby increasing muscle perfusion at the site of therapy. Therefore, blood circulation can be increased by the "vasodilation-vasoconstriction" mechanism (Versey et al., 2023)

Diabetes mellitus is one of the conditions that disrupts blood viscosity throughout the body, which leads to a significant reduction in tissue perfusion, particularly in the foot or distal region. This syndrome may lead to peripheral circulation abnormalities or disease if it continues for an extended period of time (Sari & Faizah, 2020). According to field observations, mild ischemia or borderline perfusion/perfusion limit value is indicated by an ABI value between 0.7 and 0.9. Additionally, there was a rise in calcification following contrast bath therapy, with an ABI value range of 0.91 to 0.99, suggesting a medical condition manifested as ischemic symptoms brought on by the development of moderate blood circulation abnormalities.

A contrast bath is the process of immersing part or all of a body part in a container filled with cold or warm water at a certain temperature alternately within a certain period of time according to existing procedures or rules (Song Ji-Ah, 2023). The activity or process is carried out to open and then close the vasoconstriction of blood vessels through warm water, which is then continued with cold water to facilitate blood flow through the pumping effect (Petrofsky et al., 2017). A contrast bath describes the repeated soaking of a body part in hot water and then cold water for a certain time, duration, and temperature. The use of hot and cold water alternately causes intermittent vasoconstriction and vasodilation, which induces a vascular pumping effect (Versey et al., 2023). This results in drastic changes in muscle perfusion due to the combination of cold/hot effects, called the pumping effect, thereby increasing blood circulation (Song Ji-Ah, 2023).

The effect of the contrast bath also results in increased tissue blood flow and increased oxygenation of soft tissue extensibility, which causes hemoglobin to release oxygen more easily into the tissue, thereby increasing muscle perfusion at the location of the therapy. Therefore, blood circulation is stimulated by the endothelium of blood vessels secreting or releasing nitric oxide, which causes an increase in the synthesis of cyclic GMP from guanosine triphosphate (GTP) so that the smooth muscles of the blood vessels relax and blood circulation becomes smooth and is indicated by an increased ABI value (Umah, 2023) In this study, limitations were found in the form of confounding factors that researchers did not limit in the form of the influence of drugs consumed by respondents in the hospital during treatment and food consumed by respondents.

IV. CONCLUSION

The results of the study indicate that contrast bath soaking therapy can improve blood circulation in the legs of DM clients, indicated by an increase in ABI values. The results of this study serve as a reference in developing independent nursing interventions, especially in the process of caring for DM clients. Contrast bath soaking therapy can be integrated into the learning process as one of the study materials, especially in courses on medical-surgical nursing, family nursing, geriatric nursing, community nursing, community aggregate nursing, etc. Health care facilities, especially hospitals, need to develop SOPs for contrast bath soaking

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therapy as a complementary therapy that can be carried out by nurses in the room, especially while caring for DM clients. Further research can identify other benefits obtained from providing contrast bath soaking therapy or examine other therapies that can be used as complementary therapies that can improve blood circulation in the legs of DM clients.

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