Interdisciplinary Journal of Advanced Research and Innovation
Volume 3 No. 1 2025 E-ISSN 3031-9455
http://www.ijari.ph/index.php/jr/index

ASSESSING THE EFFECT OF HYPERBARIC OXYGEN THERAPY ON HEART RATE AND BLOOD PRESSURE

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Abstract:
Cardiovascular diseases (CVDs) are the leading cause of global mortality, encompassing heart disease, strokes, and related conditions. To combat this public health concern, monitoring vital indicators like heart rate and blood pressure plays a pivotal role in early detection, preventive care, treatment assessment, fitness tracking, and post-surgery care. This study aims to assess the effect of Hyperbaric Oxygen Therapy on heart rate and blood pressure, exploring its potential role as a therapeutic intervention to optimize cardiovascular system health. This study examines the effects of hyperbaric oxygen therapy (HBOT) on heart rate and blood pressure in patients who receive multiple treatments. The research includes 113 participants undergoing HBOT at different frequencies over 2 weeks. This study used specific statistical tests to analyze the effects of Hyperbaric Oxygen Therapy (HBOT) on heart rate and blood pressure. For nonparametric data, the Wilcoxon test will be employed, and for normally distributed data, the Paired T-test will be used. To determine the most influential HBOT frequencies group, the Kruskal- Wallis test will be applied due to the delta heart rate categorized as ordinal. The statistical analysis revealed a significant difference in heart rate before and after HBOT treatment with frequencies of two, three, and five times a week with the details $p = 0.008$, $p < 0.001$, and $p < 0.001$, respectively. As for heart rate alterations, HBOT should be administered at least three or five times a week, which led to notable reductions in heart rate. The correlation values on systole and diastole before and after treatments are .951 and .916 respectively. This data shows that hyperbaric oxygen therapy does improve the blood pressure quality of hypertensive patients. Conclusion: By examining the effect of HBOT on heart rate and blood pressure, this study seeks to contribute valuable insights to the field of cardiovascular system health and provide evidence for the use of HBOT in promoting healing and well-being.

Keywords: *Hyperbaric Oxygen Therapy, Heart Rate, Blood Pressure, Cardiovascular Disease.*

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INTRODUCTION

Hyperbaric oxygen therapy (HBOT) is a method of therapeutical access of patients inside an air-tight, augmented pressurized chamber with the aid of exposure to pure oxygen (O_2) concentration based on atmospheric pressure (Ortega et al., 2021). The medical device itself is called a Hyperbaric chamber. During the therapy process, the pressure inside the hyperbaric chamber is between two and three absolute atmospheres (ATA). At sea level, ambient air typically contains about 21% oxygen, producing an alveolar oxygen pressure (PAO_2) of roughly 100 mmHg. Under these circumstances, with an assumed hemoglobin (Hb) concentration of 12 g/dL, whole blood has a combined oxygen content of approximately 16.2 mL O2/dL. Henry's law states that the combined oxygen content in whole blood grows to 23.0 mL O_2/dL under hyperbaric settings, breathing 100% oxygen at 3 ATA, increasing the alveolar oxygen pressure value to around 2280 mmHg. Nearly all this 42% increase over the baseline is due to increased oxygen dissolved in plasma. HBOT is based on increased arterial oxygen tension and supply (Kahle & Cooper, 2017).

According to the findings of multiple studies, HBOT has been associated with cardiorespiratory alterations, such as an increase in peripheral oxygen saturation and a decrease in heart rate (Martinelli et al., 2019). According to another study, HBOT also affects people's blood pressure. In detail, 72 naval divers with hypertension participated in the test. The participants were randomly split into two groups: the first groups were given 10 mg of amlodipine and 2.5 ATA hyperbaric chambers supplied by 96% oxygen through oxygen hoods. Only 10 mg of amlodipine was given to the second group. Prior to each session and every two weeks for the first year of therapy, the blood pressure of both groups was similar. After at least two months of treatment, the experimental groups' average heart rates were much lower. After three months of treatment, the experimental groups' average systolic blood pressure was noticeably lower; nevertheless, until one year, there was no discernible difference in diastolic blood pressure between the two groups (Karumanchi & Granger, 2016). Today, research regarding the HBOT effect is very limited to published articles. Therefore, understanding the implications of HBOT in several conditions might increase people

's willingness to propose this research to provide scientific and empirical results explanation to medical instructors and doctors as a therapeutic option on the effectiveness of conducting HBOT on patients (Monteiro et al., 2023). The object of heart rate assessment was healthy people, whereas the blood pressure was for people who suffer from hypertension. The main reason for this data selection is to consider the importance of hyperbaric therapy to immediately apply as a widely applied therapeutic method (Bennett et al., 2015).

METHOD

1. Heart Rate Assessment

This study included a sample of patients who were undergoing HBOT treatment at a clinic in Asyifa Rempoa, South Tangerang, Indonesia. The study investigated the changes in heart rate among patients undergoing different HBOT treatment frequencies. Employing a pre-post intervention design, measurements were collected before and after a two-week HBOT treatment period. The independent variable will be the frequency of HBOT sessions, encompassing four levels (once, twice, three times, and five times per week) of HBOT treatments. At the same time, post-HBOT (initial) heart rate will serve as a dependent variable. Additionally, the study considered pre-HBOT (final) heart rate as a control variable.

The sample size for this study was determined using the Taro Yamane formula (Equation 1), which was used to calculate the appropriate number of samples needed. Where the total sample size (n) for this study was determined using the Taro Yamane formula, which takes into account the total population (N) of the Asyifa Rempoa HBOT Clinic, which is 200 population, a constant number of 1, and the desired margin of error (e2). With a margin of error set at 0.08, the calculated sample size required for the study was 87.719 ≈ 88.

$$n = \frac{N}{(1 + N(e^2)}$$

Utilizing the Taro Yamane formula (OLONITE, 2022), it was determined that a minimum of 88 respondents were required to conduct this study. This sample size ensures a 92% confidence level, with a margin of error of ±8% to accurately represent the actual value. In total, 93 participants, consisting of 49 males and 44 females, met the inclusion criteria for this survey. These criteria specified that the participants should be patients at the Asyifa Rempoa HBOT Clinic, aged between 18 and 73 years, with a mean age of 46.

A sample of 93 hyperbaric patients was analyzed, and demographic data were collected. The participants' gender distribution was almost equal, with an average age of 45.6 ± 139 years. Body mass and height had mean values of 66.0 ± 11.9 kg and 1.6 ± 0.1 meters, respectively, resulting in an average BMI of 24.6 ± 3.6 kg/m2, indicating a normal weight range. The resting heart rate was measured at 74.8 ± 9.0 beats per minute, and resting blood pressure values were recorded as 130.5 ± 20.5 mmHg (systolic), 78.4 ± 13.9 mmHg (diastolic), and 95.8 ± 14.1 mmHg (mean). The average body temperature was 35.7 ± 0.4 degrees Celsius. These comprehensive demographic data are crucial for analyzing the effects of HBOT treatment on heart rate. Table 1 concludes the demographic data of HBOT patients.

Table 1. Demographic Data of HBOT Patients on Heart Rate Measurements

Characteristics	Mean ± SD
Age [years]	45.6 ± 139
Body mass [kg]	66.0 ± 11.9
Body height [m]	1.6 ± 0.1
Body Mass Index [kg/m^2]	24.6 ± 3.6
Heart Rate at rest [*n*/min]	74.8 ± 9.0
sBP at rest [mmHg]	130.5 ± 20.5
dBP at rest [mmHg]	78.4 ± 13.9
mBP at rest [mmHg]	95.8 ± 14.1
Temperature [˚C]	35.7 ± 0.4

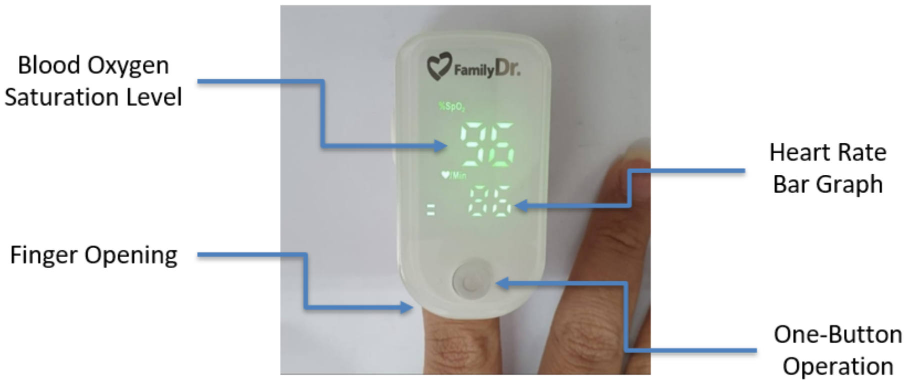

Figure 1. Pulse Oximeter is used to measure Heart Rate (BPM)

A pulse oximeter was used to assess heart rate and oxygen saturation, as shown in Figure 1. This non-invasive device allowed for accurate and reliable measurements. The readings from the pulse oximeter were digitally recorded to ensure precision. Trained staff members collected the data from Asyifa's clinic, who also served as the participants' healthcare companions during the HBOT treatment sessions.

As for data collection of HBOT with blood pressure, there are a total of 20 hypertensive patients who participate in hyperbaric therapy with a range of ages between 31 – 76 years old. The clinical baselines of the patients that participate can be explained as follows: There are equal numbers of patients based on gender (male & female); 10 males make up 50% of the total population, and the other 50% of the population is 10 females. Sleep duration could be classified into 2 parts: short-duration and long-duration. Most participants had a short sleep duration, making up to 80% of the total population. In comparison, the remaining 20% of the population had short-duration sleep. Participants slept for 5 – 7 hours (16 participants), and long-duration sleep participants slept for 8 – 10 hours (4 participants). The majority of participants 14 participants) consume medicine as part of their cure besides therapy, and the rest didn't take medicinal consumption (6 participants). Each of the patients proceeded to conduct their usual daily activities and therapy.

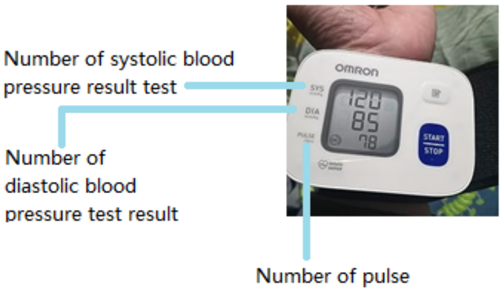

Figure 2. A sphygmomanometer is used to measure blood pressure

A sphygmomanometer was used to assess blood pressure, as shown in Figure 2. This non-invasive device allowed for accurate and reliable measurements. The readings from the sphygmomanometer were digitally recorded to ensure precision. Trained staff members collected the data from Asyifa's clinic, who also served as the participants' healthcare companions during the HBOT treatment sessions.

2. **Blood Pressure Assessment**

There are a total of 20 hypertensive patients who participate in hyperbaric therapy with a range of age between 31 – 76 years old. The clinical baselines of the patient demographic that participates can be explained as follows (Table 2): There is an equal number of patients based on gender (male & female); 10 males make up 50% of the total population, and the other 50% of the population are 10 females. Sleep duration could be classified into 2 parts: short-duration sleep and long-duration sleep. Most participants, up to 80% of the population, had short-term sleep. In comparison, the remaining 20% of the population had short-term sleep. Participants slept for 5 – 7 hours (16 participants), and long-duration sleep participants slept for 8 – 10 hours (4 participants). The majority of participants 14 participants) consume medicine as part of their cure besides therapy, and the rest didn't take medicinal consumption (6 participants). Each of the patients proceeded to conduct their usual daily activities and therapy.

Variables	n
Sex	
Male	10 (50%)
Female	10 (50%)
Age	
31 - 40	2 (10%)
41 - 50	5 (25%)
51 - 60	6 (30%)
61 - 70	6 (30%)
71 - 80	1 (5%)
Medicinal Consumption	
Yes	14 (70%)
No	6 (30%)
Sleep duration	
5 - 7 (hours)	16 (80%)
8 - 10 (hours)	4 (20%)

Table 2. Clinical baselines of hypertensive patients.

Table 3 explains categories or conditions of human blood flow based on blood pressure. The optimal numbers of human blood pressure are 120mmHg in systolic and 80mmHg in diastolic. However, the tolerance range for a person's blood pressure categorized as normal is below 130mmHg and 85mmHg in systole and diastole in sequence. A person can be diagnosed with hypertension when their blood pressure gets 140mmHg and 90mmHg in systole and diastole. However, the maximum tolerance for an old age person diagnosed with hypertension is higher than for younger people. The thickening of capillary walls, specifically fibrosis, increases in the intima layer. A person has urgent hypertension when their SBP and DBP reach 180 mmHg and 110 mmHg. Urgency hypertension is acute, significant blood pressure elevation without any signs of harm to the target organ; however, when it is left untreated, it could cause worse and get into the emergency hypertension stage, linked to symptoms of target organ damage.

Category	SBP (mmHg)	DBP (mmHg)
Optimal	< 120	< 80
Normal	120 - 129	80 - 84
Upper normal	130 - 139	85 - 89
Stage 1 Hypertension	140 - 159	90 - 99
Stage 2 Hypertension	160 - 179	100 - 109
Stage 3 Hypertension	≥ 180	≥ 110
isolated systolic hypertension	≥ 140	< 90

Table 3. Blood pressure category based on systolic and diastolic pressure. SBP is systolic blood pressure, and DBP is diastolic blood pressure.

Patients could do their usual daily activities as well as their therapy without any strict restrictions. Patients will be recorded and maintain their blood pressure levels every time before conducting hyperbaric oxygen therapy. Table 4 shows the average systolic and diastolic blood pressure measurements using a Sphygmomanometer before and after doing therapy. The unit measurements measure blood flow in millimeters of mercury, a manometric unit of pressure. There is a total of 5 measurements were conducted for each patient in total. Every column shows the measurement of systolic and diastolic blood pressure pre and post-therapy for a single patient, with a total of 20 patients measured. The measurements show systolic and diastolic blood pressure increments after conducting hyperbaric oxygen therapy. Some patients have a dramatic increment among the average patients.

Patient number	Avg. SBP (B)	Avg. SBP (A)	Avg. DBP (B)	Avg. DBP (A)
1	133	139	83,167	89,67
2	156,5	161,67	112	110,33
3	146,167	148,33	80	85,67
4	135,33	134,67	82,5	83,33
5	138,167	146,33	73,33	81,167
6	98,67	104,83	61,67	64,167
7	142,33	143,67	78,167	74,167
8	149,67	172,33	97	109,67
9	134,83	144,33	84	88,167
10	139,167	142,67	83,33	84,5
11	163	168,167	99,83	103,33
12	140,83	149,5	77,33	86,83
13	135	140,5	83,33	91,83
14	118,167	119,167	77,5	77,5
15	136,83	134,167	95,83	91,67
16	138,5	142,67	93,83	95
17	155,167	159,167	96,83	97,83
18	144	147,5	110	104,167
19	115,83	120,5	79,33	83,167
20	148,83	157	88	97,167

Table 4. Average of systolic blood pressure (SBP) and diastolic blood pressure (DBP) measurement before (B) and after (A) doing therapy.

Data Analysis

Microsoft Excel 2019 and Statistical Package for Social Sciences Software (SPSS) versions 23.0 and 27.0 were used for the data analysis. Analyzing the heart first involved assessing the normality and homogeneity of heart rate data before and after Hyperbaric Oxygen Therapy (HBOT) treatment, using Kolmogorov-Smirnov's and Levene's tests, respectively. To examine the significant differences among the different treatment frequencies (once a week, twice a week, three times a week, and five times a week) concerning the effect of HBOT on heart rate, Wilcoxon, and paired t-tests were performed with a 92% confidence level and an 8% significance level. As the delta HR and OS were found to be ordinal, the nonparametric Kruskal-Wallis test was used to assess whether there were significant differences in heart rate between the HBOT treatment frequency groups. Furthermore, post hoc tests were conducted to explore further any specific group differences in heart rate after HBOT treatment. These comprehensive analyses allowed for a thorough investigation of the effects of HBOT on heart rate across different treatment frequencies. To analyze hypertension, the firstly involved assessing normality and homogeneity of hypertension data before and after Hyperbaric Oxygen Therapy (HBOT) treatment, using the Shapiro-wilk normality test; if the data are normally distributed, paired sample t-test with a 95% confidence interval is used to examine if the data has a significant level of effect. These comprehensive analyses allowed for a thorough investigation of the effects of HBOT on hypertension across treatment frequencies.

RESULT AND DISCUSSION

1. The Effect of HBOT on Heart Rate

The statistical analysis of the Table 5 was conducted using SPSS. The analysis included assessments of normality, homogeneity, and the comparison of heart rate before and after hyperbaric oxygen therapy (HBOT) treatment using the Wilcoxon signed-rank test and paired t-test. The analysis focused on the intergroup differences among the treatment frequencies (once a week, twice a week, three times a week, and five times a week) regarding the effect of HBOT on heart rate.

The Kolmogorov-Smirnov was applied to determine the normality of the data distribution. The results revealed that for the group, it was once a week and three times a week. This nonparametric test, the Wilcoxon test, is used because the data does not follow the normal distribution (normality p-value<0.08 by Kolmogrov-Smirnov test) or that there is no equal variance between the groups (homogeneity p-value<0.08 by Levine's test). However, for the groups twice a week and Five times a week, the data follows the normal distribution (normality p-value>0.08 by Kolmogrov-Smirnov test), and there is equal variance between the groups (homogeneity p-value>0.08 by Levene's test).

Table 5. Comparison of Heart Rate Changes Before and After HBOT.

Group	N	Mean Value				P-value	
		Wilcoxon		Paired T-test		Wilcoxon	Paired T-test
		Before	After	Before	After		
Once a Week (1x)	2	73.58	73.4	-	-	0.951	
Twice a Week (2x)	4	-	-	72.78	67.65	-	0.008
Three times a Week (3x)	6	-	-	76.08	66.38	-	<0.001
Five times a Week (5x)	10	-	-	76.86	66.14	-	<0.001
Number of Participants				**93**			
Level of Confidence				**92%**			

Paired t-tests were performed to investigate the differences between the groups further, as depicted in Table 5. The results indicated a significant difference in heart rate before and after HBOT treatment for the "Twice a Week (2x)" and "Five times a Week (5x)" groups ($p = 0.008$ and $p < 0.001$, respectively). However, for the Wilcoxon test of "Once a Week (1x)" and "Three times a Week (3x)" groups, no significant difference was found ($p = 0.951$ and $p = 0.001$, respectively).

The result of the statistical analysis shows that there is no significant change in Heart Rate by HBOT in the group once a week (1x) HBOT treatment ($p > 0.08$). However, HBOT gives significant changes in HR in groups twice a week, three times a week, and five times a week ($p > 0.08$).

Overall, the statistical analysis, shown in Table 6, revealed that the administration of HBOT led to significant changes in heart rate within certain treatment frequency groups. Specifically, significant changes were observed for the "Twice a Week (2x)", "Three times a Week (3x," and "Three times a Week (3x)" groups, indicating an effect of HBOT on heart rate in these groups. However, no significant changes in heart rate were observed for the "Once a Week (1x)" group. These findings provide insights into the effects of HBOT on heart rate across different treatment frequencies, supporting the hypothesis that HBOT administration results in a significant change in heart rate.

Group	N	Mean	Std. Deviation	Std. Error
Once a Week (1x)	24	0.17	8.386	1.712
Twice a Week (2x)	23	4.17	9.533	1.988
Three times a Week (3x)	22	9.71	9.341	1.907
Five times a Week (5x)	24	10.73	9.488	2.023
Total of Participants	93	6.12	10.015	1.039
Level of Confidence			92%	
P-value			0.001	

Table 6. Comparison of Heart Rate Alterations Before and After HBOT

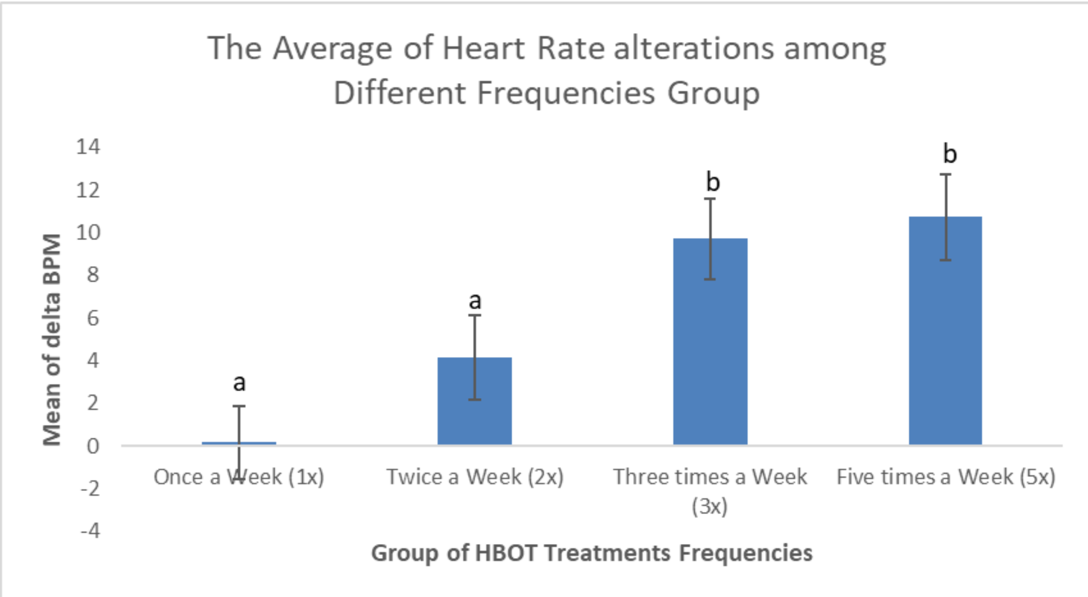

Figure 2. Bar Chart with Error Line of delta Heart Rate (BPM)

The nonparametric test, Kruskal-Wallis test, and followed by post hoc test were performed to assess whether there were significant differences in heart rate between the groups. Post hoc tests can be conducted to analyze the differences between the groups further. Post hoc tests allow for pairwise comparisons between the groups to determine which specific groups differ significantly. After conducting Kruskal-Wallis's test, the following post hoc test, Duncan's t, was performed and illustrated as the bar chart display depicted in Figure 4.

The error bars in the bar chart indicate that groups with the same letter are not significantly different from each other ($p < 0.08$), as determined by the Kruskal-Wallis test followed by LSD and Duncan's test. The error lines represent the range of the mean values, showing the variability in the data.

Based on the findings from the bar chart, it can be inferred that undergoing Hyperbaric Oxygen Therapy (HBOT) at least three times a week is crucial to bringing about a significant change in heart rate under the influence of HBOT.

Upon analyzing the bar chart, it becomes evident that groups with the same letter (e.g., Group 1 and Group 2 labeled as "a") exhibit no significant difference in heart rate. However, Group 3 (Three times a week) and Group 4 (Five times a week), labeled as "b," demonstrate a significant difference from the other groups, indicating the most notable effect of HBOT on heart rate.

2. The Effect of HBOT on blood pressure

Table 6 below shows the results of the correlations on hypertensive patients conducting 5 times hyperbaric oxygen therapy. 20 patients have done hyperbaric therapy. The correlation results were measured based on their average systole and diastole during every therapy during pre-therapy and post-therapy. The correlation values on systole and diastole before and after treatments are .951 and .916 respectively. The closer the correlation value to 1, the more it shows a correlation between hypertensive patients conducting hyperbaric oxygen therapy. This data shows that hyperbaric oxygen therapy does improve the blood pressure quality of hypertensive patients.

Variable	Number of Patients	Correlation	Significant value (1 tailed)
systole before & after treatment	20	.951	.000
Diastole before & after treatment	20	.916	.000

Table 7. Results of correlation effects on patients with hypertension that conducted HBOT using SPSS.

Patients' data were gathered and analyzed using statistical packages for the social science program (SPSS) and choosing paired sample t-tests. The gathered data will be analyzed using a paired sample t-test since it is two continuous variables. The paired sample t-test assumes that both variables are normally distributed; hence, before conducting a paired sample t-test, the study results found that the data are usually distributed by conducting a normality test using Shapiro Wilk (normality test if samples are less than 50). The test was divided into 2: systole before and after treatment and diastole before and after treatment. The P value results for both parameters exceeded P=0,05 (>0,05) 0,114 and 0,548 in sequence, which means it is usually distributed. Table 7 and Table 8 show the test of normality in systole and diastole using SPSS.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Systole_Before_Treatment	.204	20	.028	.923	20	.114
Systole_After_Treatment	.134	20	.200*	.960	20	.548

Table 8. Results of normality test data of systole before and after treatment using SPSS.

Tests of Normality

	Kolmogorov-Smirnov^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Diastole_BeforeTreatment	.191	20	.054	.952	20	.393
Diastole_After_ Treatment	.087	20	.200*	.980	20	.938

Table 9. Results of normality test data of systole before and after treatment using SPSS.

High blood pressure can be a sickness and a significant risk factor for other diseases. An individual's blood pressure varies, making it difficult to characterize from just one or a few measurements. Rising blood pressure (from systolic blood pressures above 120 mmHg) is associated with an increased risk of cardiovascular events like premature mortality, atrial fibrillation, myocardial infarction, heart failure, and stroke (Gabb, 2020).

The production of Endothelin-1 is dramatically boosted during hyperbaric oxygen treatment. Endothelial cells release endothelin-1, an amino acid peptide that acts as a vasoconstrictor stimulant. Vasoconstriction caused by endothelin-1 may thus have a role in this process. Vasoconstriction, characterized by narrowing blood vessels due to muscular contraction on blood vessel walls, raises blood pressure and eventually activates the baroreflex, which may enhance parasympathetic activity. Acetylcholine should be released to reduce heart rate. In the hyperbaric environment, sympathetic activity is primarily responsible for lowering HR; during therapy, sympathetic activity may rise partly due to the patient's fear and the intervention.

DISCUSSION

The statistical analysis results indicate that administering hyperbaric oxygen therapy (HBOT) leads to significant changes in heart rate within certain treatment frequency groups. Specifically, the "Twice a Week (2x)", "Three times a Week (3x)", and "Five times a Week (5x)" groups showed significant differences in heart rate before and after HBOT treatment, as well as the changes of blood pressure visible after conducting more than 5 times therapy. This suggests that HBOT affects heart rate and blood pressure in these groups.

The absence of significant changes in heart rate in the "Once a Week (1x)" group implies that the frequency of one HBOT session per week may not be sufficient to elicit a noticeable effect on heart rate. On the other hand, the "Twice a Week (2x)", "Three times a Week (3x)", and "Five times a Week (5x)" groups, which received more frequent HBOT treatments, demonstrated significant changes in heart rate. This suggests that higher treatment frequencies may be necessary to alter heart rate significantly.

These findings align with the hypothesis that the administration of HBOT will result in a significant change in heart rate and blood pressure. The statistical analysis supports the notion that HBOT can influence heart rate and blood pressure, but the magnitude of the effect may depend on the treatment frequency. It is essential to consider the explanation behind these statistical results.

Hyperbaric oxygen therapy (HBOT) has been observed to influence heart rate and blood pressure. During HBOT sessions, heart rate tends to decrease gradually while blood pressure tends to increase in a controlled manner (Goyal et al., 2018). This decrease can be attributed to increased oxygen availability, vasodilation, modulation of the autonomic nervous system, and the induction of the

hyperbaric reflex bradycardia (Shaffer et al., 2020). The increase in blood pressure is a response from the central nervous system to conduct vasoconstriction in the blood vessel vessel walls (Raghuveer et al., 2020). HBOT enhances oxygen supply to tissues, including the heart, reducing its workload and resulting in a lower heart rate (Tian et al., 2019). Vasodilation promotes better blood flow and decreases demand on the heart. The autonomic nervous system, specifically the parasympathetic activity, lowers heart rate during HBOT (Goyal et al., 2018).
Additionally, the hyperbaric reflex bradycardia, stimulated by HBOT, contributes to the observed decrease in heart rate (Chaudhry et al., 2022). It is important to note that the decrease in heart rate during HBOT falls within normal physiological ranges and poses no significant concerns. These findings align with the hypothesis that HBOT leads to a significant change in heart rate. HBOT is a safe and well-tolerated therapy with expected physiological responses.

Regarding heart rate, the results indicate that undergoing HBOT at least three times a week (Three times a week and Five times a week groups) significantly changes heart rate. This aligns with previous research suggesting that higher treatment frequencies potentially produce more significant changes in heart rate. The mechanisms underlying these changes can be attributed to the physiological effects of HBOT. HBOT enhances oxygen availability, promotes vasodilation, and influences the autonomic nervous system, resulting in a decrease in heart rate (Goyal et al., 2018).

The induction of the hyperbaric reflex bradycardia, stimulated by HBOT, reduces heart rate (Tian et al., 2019). These explanations support the statistical findings indicating significant differences in heart rate between the Three-times-a-week and Five-times-a-week groups compared to other groups.

CONCLUSION

In conclusion, the statistical analysis of hyperbaric oxygen therapy (HBOT) on heart rate indicates that certain treatment frequency groups, namely "Twice a Week (2x)", "Three times a Week (3x)", and "Five times a Week (5x)", exhibited significant changes in heart rate after undergoing HBOT. This suggests that HBOT has a notable effect on heart rate within these groups. However, the "Once a Week (1x)" group did not show significant changes in heart rate, implying that a single HBOT session per week may not be sufficient to produce a noticeable effect on heart rate. The findings support the hypothesis that HBOT influences heart rate, with the magnitude of the effect potentially dependent on the treatment frequency (Zhang et al., 2023). The underlying physiological mechanisms, such as increased oxygen availability, vasodilation, modulation of the autonomic nervous system, and the induction of the hyperbaric reflex bradycardia, contribute to the observed changes in heart rate during HBOT (Ablin et al., 2023). Overall, undergoing HBOT at least three times a week appears essential for achieving a significant change in heart rate, as indicated by both statistical analysis and physiological explanations. These results provide valuable insights for optimizing HBOT treatment protocols and may have implications for improving cardiovascular health outcomes.

Hypertension can potentially affect everyone. The source that causes someone to suffer hypertension is various, whether caused by hereditary, old age, or lousy lifestyle (Schinko et al., 2017). Hypertension medicine temporarily lowers blood pressure, needs to be maintained in routine, and has withdrawal of rawal effects if they suddenly stop (Tobin et al., 2020). Hyperbaric therapy does affect patients who suffer from hypertension; It helps lower blood pressure gradually (Farley, 2023). Based on the effects of high pressure on the blood and cardiovascular system, inhaled air comes from an external elevation.

Hyperbaric therapy gradually reduces blood pressure, primarily attributed to its impact on the cardiovascular system. The effects of high pressure on blood are harnessed through pressurized air with an elevated oxygen pressure (PO2) externally administered. By subjecting individuals to pressurized air at 2 or 3 atmospheres absolute (ATA) with 100% oxygen concentration, a positive trend emerges, facilitating increased oxygen intake. Consequently, a more excellent oxygen supply is made accessible to various tissues, ensuring continued oxygen provision even in obstructions. This efficacy is attributed to the diminished size of oxygen molecules under heightened pressure conditions.

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