Nurses Awareness Regarding Hyperbaric Oxygen Therapy among Patients with Diabetic Foot Ulcer

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Abstract

Background: Hyperbaric Oxygen Therapy holds significant importance in the realm of medical treatments. It serves as an adjunctive therapy in conditions such as diabetic foot ulcers. **Aim of the study:** To assess nurses' awareness regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer. **Research design**: A descriptive research design was used in this study. **Setting**: This study was conducted in hyperbaric oxygen therapy unit of Kobry El-kobba hospital. **Sample:** convenience Sample was used in this study in hyperbaric oxygen therapy unit included 70 nurses. **Tools**: Two tools were used: 1st tool was structured Interviewing questionnaire. Consisted of 3parts: Demographic characteristics, knowledge assessment, and nurse's attitude regarding hyperbaric oxygen therapy. 2nd tool was observational checklist regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer. **Results**: 65.7% of nurses had poor level of knowledge 74.3% of nurses had adequate level of practice regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer, 75.7% of nurses had positive attitude regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer, and there was highly statistically significant relationship between nurses total knowledge, total practices and total attitude with (P= 0.000). **Conclusion**: one third of nurses had a good level knowledge regarding Hyperbaric Oxygen Therapy among patients with diabetic foot ulcers, more than quarter of nurses had inadequate level of practice, and less than quarter of nurses had negative attitude. There was highly significant positive correlation between nurses' knowledge, practices, and their attitude. **Recommendation:** Providing training programs for nurses to increase their level of skills regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer.

Keywords: *Diabetic Foot Ulcer, Hyperbaric Oxygen Therapy, Nurses Awareness, Patient.*

Introduction

Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by high blood sugar levels due to inadequate insulin production or impaired insulin function. The International Diabetes Foundation estimates that 40 million people globally are affected by diabetic foot ulcer. One of the most serious complications of diabetes is the development of diabetic foot ulcers (DFUs). Diabetic foot ulcers occur as a result of poor blood circulation and nerve damage in the lower extremities, leading to impaired wound healing. These ulcers can become chronic, non-healing wounds, and if left untreated, Diabetic foot ulcers can lead to severe infection, tissue necrosis, and even amputation *(Akkus & Sert, 2022).*

Hyperbaric Oxygen Therapy (HBOT) has emerged as a promising adjunctive treatment for diabetic foot ulcers. DFUs are challenging wounds to heal due to reduce blood flow, impaire tissue oxygenation, and compromise immune response associated with diabetes. This treatment approach has been found to improve wound healing, reduce the risk of infection, promote tissue regeneration, and potentially prevent the need for amputation in patients with DFUs *(Tao & Yuan, 2023).*

Nurses' awareness regarding the principles, indications, contraindications, and potential complications associated with HBOT is crucial for ensuring patient safety and maximizing treatment outcomes. Nurses need to possess a comprehensive understanding of HBOT protocols, equipment operation, monitoring parameters, and patient assessment

during therapy. Additionally, nurses should be knowledgeable about the potential side effects or adverse events that may arise during HBOT and be prepared to intervene promptly *(Mostafa et al., 2020)*.

Nurses play a pivotal role in the delivery of Hyperbaric Oxygen Therapy (HBOT) among patients with diabetic foot ulcers (DFUs). Nurses are involved in various aspects of HBOT, starting from the initial assessment of patients' suitability for therapy to the ongoing monitoring and evaluation during treatment sessions. Their role includes educating patients about the purpose, benefits, and potential risks of HBOT, as well as providing instructions for safety precautions and proper wound care. Nurses also ensure the accurate documentation of therapy sessions, vital signs, and any observed changes in the patient's condition *(Alemayehu et al., 2020)*.

Significance of the study

Diabetic foot ulcers (DFU) are a common, highly morbid consequence of longstanding and poorly managed diabetes. The latest estimates from the International Diabetes Federation (IDF) indicate that the global prevalence of diabetic foot ulcers (DFUs) continues to rise significantly. In 2021, approximately 537 million people were living with diabetes worldwide, and this number is projected to increase to over 700 million by 2045. It is estimated that up to one-third of people with diabetes will develop a DFU during their lifetime. This marks a significant increase from earlier estimates, highlighting the growing burden of diabetes and its complications on global health. A recent meta-analysis found a 6.3% global prevalence of DFU among adults with diabetes, which equates to approximately 33 million people affected by DFU *(McDermott et al., 2023)*.

In Egypt, diabetes mellitus (DM) is a significant public health concern, and the disease is considered a modern pandemic throughout the world. According to data from The International Diabetes Federation in 2022, Egypt had approximately 9 million adult diabetic patients, with a prevalence rate of 15.2%. Notably, studies conducted in Egypt have reported a prevalence range of diabetic foot ulcers (DFUs) among diabetic patients, varying from 6.1% to 29.3% *(Abouzid et al., 2022)*.

Hyperbaric Oxygen Therapy (HBOT) has a wide range of applications and has shown promising results in various medical conditions. It serves as an adjunctive therapy in conditions such as diabetic foot ulcers (DFUs), non-healing wounds, radiation-induced tissue damage, and gas gangrene, among others. Nurses' awareness and understanding of HBOT are essential for ensuring safe and effective treatment outcomes for patients with DFUs *(Sharma et al., 2021)*. So, the purpose of this study is to assess the level of awareness among nurses regarding HBOT among patients with DFUs.

Aim of the Study

This study aimed to assess nurses awareness regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer through the following objectives:

1. Assessing nurses knowledge regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer.
2. Recognizing nurses attitude toward hyperbaric oxygen therapy among patients with diabetic foot ulcer.
3. Appraising nurses practices regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer.

Research questions

1. What are nurses knowledge regarding hyperbaric oxygen therapy among patients with diabetic foot?
2. What are nurses attitude regarding hyperbaric oxygen therapy among patients with diabetic foot?
3. What are nurses practices regarding hyperbaric oxygen therapy among patients with diabetic foot?
4. What are the relation between nurse's demographic characteristics and their knowledge, attitude and practices regarding hyperbaric oxygen therapy?

Subject and Methods

The subject and methods for this study was portrayed under the four main designs as follows:

I - Technical items   II - Operational items

III - Administrative items   IV - Statistical items

I – Technical items:

The technical item included research design, setting, subject, and tools for data collection.

Research design:

A descriptive research design was utilized in this study.

Setting:

This study will be conducted in hyperbaric oxygen therapy unit of Kobry El-kobba hospital.

Sampling:

A convenience Sample was used in this study in hyperbaric oxygen therapy unit was chosen which represented 70 nurses.

Tools for data collection:

The required data was collected through the following tools:

1ˢᵗ tool: A structural interview questionnaire:

This tool was designed and written in simple Arabic language based on scientific literature review, experts' opinion and personal experience. It was comprised three parts:

Part 1: Demographic characteristics, it included the following (age, sex, marital status, educational level, years of experience, attendance of previous training regarding hyperbaric oxygen therapy).

Part 2: Assessment of nurses knowledge regarding hyperbaric oxygen therapy: As the importance of HBOT for DFU, If burns are routine indication for HBOT, COPD are contraindication for HBOT.......etc.

Scoring system for knowledge:

25 closed ended questions. Each knowledge question was scored by zero for wrong, one for «correct ». The total knowledge scores ranged from 0-25, grade was evaluated as follows:

Total score knowledge

- ➤ Poor less than 60% <15
- ➤ Average from 60%:75% (15-18.7)
- ➤ Good more than 75 % (>18.7-25)

Part 3: Assessment of nurse's attitude regarding hyperbaric oxygen therapy. It is developed by investigator and consisted of 18 items as thinking that diabetic ulcer treatment is more important than ulcer prevention, thinking it is necessary to assess diabetic ulcers regularly, in comparison with other areas of nursing care, diabetic ulcer care is a high priority task for me, getting satisfaction by caring for diabetic ulcers.......etc.

Scoring system for attitude:

18 closed ended questions. Each question was scored by one for a «no», two for a «yes » and the score was ranged from (1-36), and then evaluated as follows:

- ➤ Negative less than 60% (1-21.6)
- ➤ Positive from 60%:100% (21.7-36)

2ⁿᵈ tool: Observational checklist for nurses practice regarding hyperbaric oxygen therapy: I was developed by investigator. It was consisted of 32 items as practices before hyperbaric oxygen therapy as wash hands and prepare equipment, practices during hyperbaric oxygen therapy as connect oxygen mask and adjust flow rate, practices after hyperbaric oxygen therapy as remove gloves and reassure the patient.

Scoring system for practices:

It consists of 32 closed ended questions. Each practice question was scored by two for a «done practice», one for a «not done », the score ranged from 1-64.

Total score reported practices

- ➢ Inadequate less than 60% (1-38.3)
- ➢ Adequate from 60%:100% (38.4-64)

Validity

- - The developed tool was be formulated and submitted to three experts in Community Health Nursing to assess the content validity.
- - The experts were asked to evaluate the individual items on the study tools in relation to its relevance and appropriateness in terms of the construct and if the items adequately measure all dimensions of the questionnaire.

Reliability:

To assess reliability, the study tool was tested by the pilot subjects for calculating Cronbach's Alpha which was 0.80 for knowledge items, 0.85 for practice items and 0. 99 for attitude items.

Ethical considerations:

An official permission to conduct the proposed study was obtained from the Scientific Research Ethics Committee Faculty of Nursing, Helwan University. Participation in the study was voluntary and subjects was given complete full information about the study and their role before signing the informed consent. The ethical considerations were include explaining the purpose and nature of the study, stating the possibility to withdraw at any time, confidentiality of the information where it was not be accessed by any other party without taking permission of the participants. Ethics, values, culture and beliefs was be respected.

II- Operational Items:

Preparatory phase:

It was included reviewing of past, current, national, and international related literature and theoretical knowledge of various aspects of the study using books, articles, internet, periodicals and magazines to develop tools for data collection.

Pilot study:

A pilot study was carried out on 10% (7) of the study sample to ascertain the clarity, applicability of the study tools, and to identify the obstacles and problems that may be encountered. Nurses included in the pilot study was included of the study without any modification.

Field work:

1. A written approval was obtained from the Dean of Faculty of Nursing Helwan University
2. The letter was be directed to manager of Kobry El-kobba hospital in Cairo city for conducting the study
3. The purpose of the study and its procedure was explained to nurses to get their consent and cooperation
4. Interviewing questionnaire was be completed by the investigator from each nurse
5. It took 20-25 minutes, and the data was collected from nurses in Kobry El-kobba hospital from beginning of September to end of November 2023, the period was three months .an average of 2 days a week and 2 cases per day.

III- Administrative Items:

Approval to carry out this study was be obtained from the dean of the Faculty of Nursing and directed to directors of Kobry El-kobba hospital asking for cooperation.

IV-Statistical Items:

The collected data were organized, tabulated, and statistically analyzed using SPSS software (Statistical Package for the Social Sciences, version 25, SPSS Inc. Chicago, IL, USA). For quantitative data, the range, mean and standard deviation were calculated. For qualitative data, which describe a categorical set of data by frequency, percentage, or proportion of each category, using Chi-square test (x^2). Correlation between variables was evaluated using Pearson's correlation coefficient (r). Level of Significance determined as the following was adopted at $p<0.05$ for interpretation of results of tests of significance, $p>0.05$ for interpretation of results of tests of not significance, and $p<0.0001$ for interpretation of results of tests of highly significance.

Results

Table (1): Number and Percentage Distribution of nurse's Demographic Characteristic (n=70).

Nurses demographic characteristics	No	%
Age (years)		
20 - 25	57	**81.4**
25- 31	13	**18.6**
Sex		
Male	40	57.1
Female	30	42.9
Marital status		
Married	25	**35.7**
Single	45	**64.3**
Educational level		
Diploma degree in nursing	70	**100**
Years of experience		
1-≤ 3	57	**81.4**
>3-5	13	18.6
Attendance of previous training regarding hyperbaric oxygen therapy		
Yes	12	17.1
No	58	82.9

Table (1) shows that 81.4% of nurses were aged 20 to 25 years old, while only 18.6% were aged 25 to 31years old. According to marital status 64.3% of nurses were single and 35.7% were married. 100% had diploma degree in nursing. Regarding years of experience the result reveals that 81.4% of nurses had from 1 to 3 years.
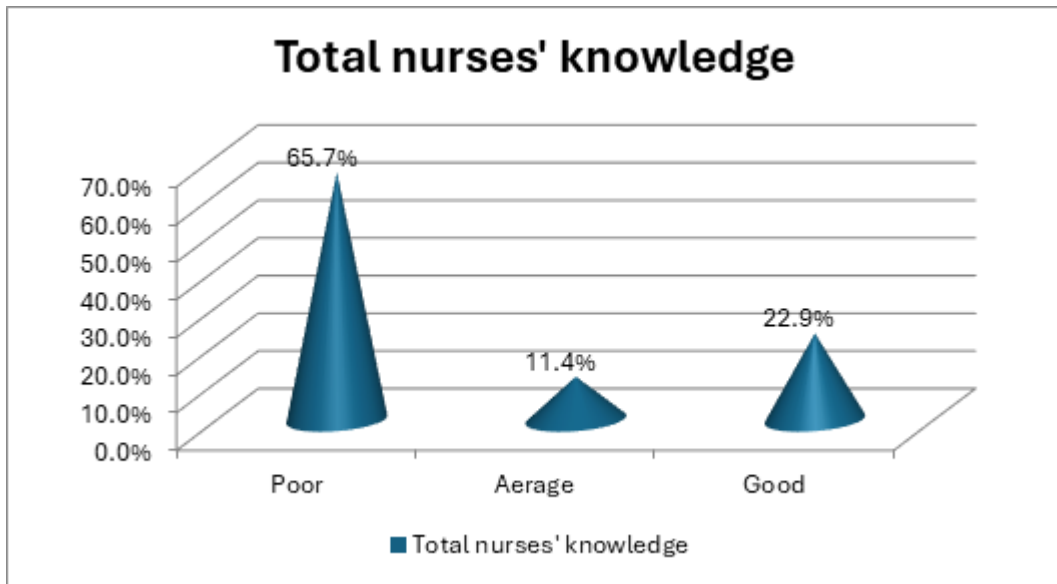
Figure (1): Percentage Distribution of Total Nurses' Knowledge regarding Hyperbaric Oxygen Therapy among Patients with Diabetic Foot Ulcer (n=70)

Figure (1) illustrates that 65.7% of nurses had poor level of total knowledge and 22.9% had good level of knowledge while only 11.4% had average level of total knowledge.
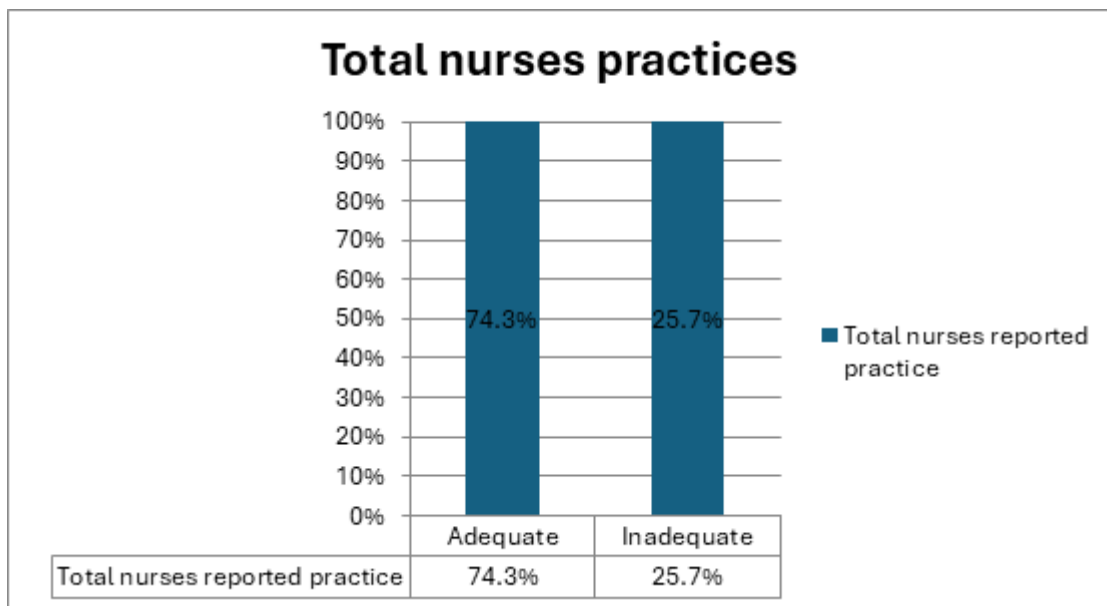

Figure (2): Percentage Distribution of Nurses' Total Practices regarding Hyperbaric Oxygen Therapy among Patients with Diabetic Foot Ulcer (n=70)

Figure (2) demonstrates that 74.3% of nurses had adequate level of total practices regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer and while only 25.7% of nurses had inadequate level of total practices.
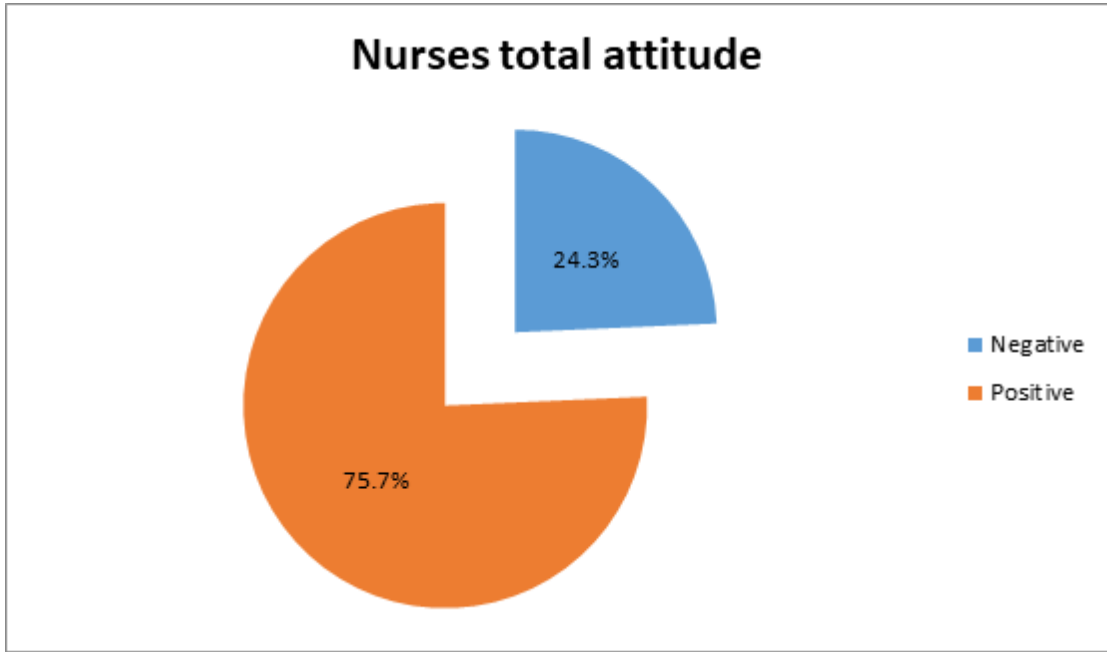
Figure (3): Percentage Distribution of Nurses' Total Attitude regarding Hyperbaric Oxygen Therapy among Patients with Diabetic Foot Ulcer (n=70)

Figure (3) demonstrates that 75.7% of nurses had positive total attitude regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer, while only 24.3% had negative total attitude.

Table (2): Relation between Total Nurses Knowledge and their Demographic Characteristics (n=70).

Demographic characteristics	Total knowledge level among the studied sample						x^2	P-value
	Poor level (n=46)		Average level (n=8)		Good level (n=16)			
	NO	%	NO	%	NO	%		
Age (years)								
20 - <25	39	68.4	8	14	10	17.5	5.95	0.04*
25- 31	7	53.8	0	0	6	46.2		
Sex								
Male	29	72.5	6	15	5	12.5	6.07	0.048
Female	17	56.7	2	6.7	11	36.7		
Marital status								
Married	34	75.6	8	17.8	3	6.7	20.75	0.000**
Single	12	48	0	0	13	52		

Educational level								
Diploma degree in nursing	46	65.7	8	11.4	16	22.9	A	---
Years of experience								
1-≤ 3	39	68.4	8	14	10	17.5	5.95	0.04*
>3-5	7	53.8	0	0	6	46.2		
Attendance of previous training regarding hyperbaric oxygen therapy								
Yes	0	0	0	0	12	100	48.87	0.000**
No	46	79.3	8	13.8	4	6.9		

*Statistically significant.

**Highly statistically significant

Table (2) clarifies that, there was highly statistically significant relation between nurses marital status, attendance of previous training regarding hyperbaric oxygen therapy and their level of knowledge with (P = 0.000). And statistically significant relation between knowledge and demographic characteristics as age, and years of experience

Table (3): Relation between Nurses' Attitude and their Demographic Characteristics (n=70)**.**

Demographic characteristics	Nurses' attitude				x^2	P-value
	Negative (17)		Positive (53)			
	n	%	n	%		
Age (years)						
20 - < 25	13	22.8	44	77.2	0.365	0.546
25- 31	4	30.8	9	69.2		
Sex						
Male	12	30	28	70	1.65	0.198
Female	5	16.7	25	83.3		
Marital status						
Married	13	28.9	32	71.1	1.45	0.228
Single	4	16	21	84		
Educational level						
Diploma degree in nursing	17	24.3	53	75.7	A	----
Years of experience						
1-≤ 3	13	22.8	44	77.2	0.365	.054

	n	%	n	%		
>3-5	4	30.8	9	69.2		
Attendance of previous Training regarding hyperbaric oxygen therapy						
Yes	0	0	12	100	4.64	0.031 *
No	17	29.3	41	70.7		

* Statistically significant

Table (3) demonstrates that, there was no statistically significant relationship between nurses' attitude and their demographic characteristics, except attendance of previous training regarding hyperbaric oxygen therapy.

Table (4): Relation between Nurses' Practices and their Demographic Characteristics (n=70).

Demographic characteristics	Nurses' practices				x^2	P-value
	Inadequate (18)		Adequate (52)			
	n	%	n	%		
Age (years)						
20 - < 25 (years)	18	31.6	39	68.4	5.52	0.019*
25- 31(years)	0	0	13	100		
Sex						
Male	12	30	28	70	0.897	0.343
Female	6	20	24	80		
Marital status						
Married	6	13.3	39	86.7	10.11	0.001**
Single	12	48	13	52		
educational level						
Diploma degree in nursing	18	25.7	52	74.3	a	---
Years of experience						
1-≤ 3	18	31.6	39	68.4	5.52	0.019*
>3-5	0	0	13	100		
Attendance of previous training regarding hyperbaric oxygen therapy						
Yes	0	0	12	100	5.01	0.025*
No	18	31	40	69		

*Statistically significant

**Highly statistically significant

Table (4): shows that, there was highly statistically significant relation between nurses marital status, **s**ex, years of experience, education level, and their level of practices**.**

Table (5): Correlation between total Knowledge, Practices, and Attitude of nurses (N=70).

Variables	knowledge		practices		Attitude	
	r	p-value	r	P-value	R	p-value
Knowledge	1	----	0.862	0.000**	0.946	0.000**
Practices	0.862	0.000**	1	-----	0.894	0.000**
Attitude	0.946	0.000**	0.894	0.000**	1	---

**Highly statistically significant .

Table (5): Illustrate that, there was highly statistically significant positive correlation between nurses total knowledge, total practices and total attitude (P= 0.000).

Discussion

Nurse's demographic characteristic.

The present study showed that majority of the studied nurses their age ranged between 20 to less than 25 years and more than half of them were female; moreover, nearly two thirds of them were single. All of them had diploma degree in nursing education, and majority had 1-≤ 3 years of experience, less than quarter attend of previous Training regarding hyperbaric oxygen therapy (table1).

This finding goes in the same line with **Das, 2021** who study "Perception and Practices of Nurses about Diabetic Foot Care in Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders, Dhaka " (207) and **Mustafa**, **2023** who study "Effect of an Educational Program on Nurses' Knowledge and Practice of Oxygen Therapy", (160) nurses whom reported that the respondents were predominantly female (80%). Approximately 80% of the respondents had diploma (basic nursing degree) degree alone, 14.5% obtained graduate (BSc Nursing) degree as well.

Also, **Bilal etal 2018,** who study "Knowledge, Attitudes, and Practices among Nurses in Pakistan towards Diabetic Foot" (2520 nurses) and reported that approximately 53% of the nurses were older than 30 years of age, not even 1% of the sample population had received formal wound care training

Moreover, agree with **Adeniyi et al 2021** who study "Assessment of knowledge and practice of oxygen therapy among doctors and nurses: a survey from Ondo State, Southwest Nigeria " (176) who reported that Formal training of healthcare workers on oxygen therapy was poor as 79% of our respondents had not received additional training on administration of oxygen therapy.

From investigator point of view this is an important gap as lack of training and education of medical and nursing staff have been identified as a factor that affects the effective administration of oxygen therapy adversely, resulting in poor patient outcomes.

Regarding total knowledge (figure1).

The present study reported that more than half had poor level of knowledge, less than quarter, had good level, while less than quarter had average level with mean and SD 12.80±5.47 regarding Hyperbaric oxygen therapy.

These results **agree with Hassanzad et al 2022 who study "**Nurses' Knowledge Regarding Oxygen Therapy; a Cross-Sectional Study**"** Masih Daneshvari Hospital, Tehran, Iran, (70 nurses) who reported that the mean score obtained by nurses from the questionnaire to determine the level of knowledge of oxygen therapy was 8.89± 2.79 , Given that the maximum score is 16, it can be said that most nurses had a poor knowledge level of properly using oxygen. The obtained results were consistent with similar studies in other parts of the world. For example, **in Zeleke and Kefale's 2021** who study "Nurses' Supplemental Oxygen Therapy Knowledge and Practice in Debre Tabor General Hospital: A Cross-Sectional Study" and reported that only one-third of the nurses had relevant practical knowledge of the proper use of oxygen. **In Demirel and Kazan's 2021** who study "Nurses' Supplemental Oxygen Therapy Knowledge and Practice in

Debre Tabor General Hospital: A Cross-Sectional Study" and recorded that, the nurses' knowledge of oxygen therapy was much lower than expected. In addition, the results of the present study, along with other studies, indicate that nurses do not receive adequate training on how to properly work with oxygen.

Regarding total practices about Hyperbaric Oxygen Therapy

The present study showed that more than two third of nurses had adequate level of practice regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer and while more than a quarter of nurses had inadequate level of practice with mean score 50.41±7.41. (figure2)

that is consider higher level than study done by **Getahuna et al 2022**, who reported that, based on the practice of supplemental oxygen administration, 47% of the nurses had a good practice.

On the other hand, the study done by **Zeleke and Kefale's 2021** who reported that the practice level of nurses on oxygen administration showed only 33% of the nurses had good practice level.

Also, with **Ghebremichael el al 2020,** who study Assessment of nurses' knowledge, attitude and practice about oxygen therapy in emergency and ICU departments of Orotta National Referral Hospital, and reported the mean practice score was 2.37±1.76. Based on the observed practice of supplemental oxygen administration, only 33% of the nurses had good practice and the majority (67%) of nurses had poor practice of supplemental oxygen administration. Only 21.9% and 27.9% of the nurses assessed oxygen saturation and vital signs during supplemental oxygen administration, respectively.

Adeniyi et al 2021 who study "Assessment of knowledge and practice of oxygen therapy among doctors and nurses: a survey from Ondo State and Cairo, Egypt" who reported that only 33 (20.00%) had good practice level of oxygen therapy.

Magdalena et al 2023 who study "Factors associated with knowledge and practices regarding oxygen administration among nurses: A cross-sectional study at Muhimbili National Hospital, Dar el Salaam – Tanzania" and reported that Only 78 (37.5%) nurses had poor practice. Items with the highest practice score were ensuring pulse oximetry to monitor response to oxygen therapy was available before administration of oxygen and removing gloves after administration of oxygen with both scores being 195 (93.8%). Items with the lowest practice score were discarding used equipment after administration (137; 65.9%) and verifying physician prescriptions before administration (122; 58.7%).

Concerning nurses' total attitude regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer

Answered research question: What is nurses attitude regarding hyperbaric oxygen therapy among patients with diabetic foot?

More than two third of nurses had positive attitude regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer while only less than a quarter had negative attitude with mean score 28.87±4.13. (figure3)

Agree with **Basazinew et al 2022** who study **"Knowledge, attitude, and practice of health professionals for oxygen therapy working in South Gondar zone hospitals, 2021: multicenter cross-sectional study** and reported that 54.6, 54.6, and 65.1% of participants have a good level of knowledge, positive attitude, and good level of practice towards oxygen therapy respectively. This implies around half of the participants had significant knowledge, attitude, and practice gap for oxygen therapy.

These results agree with **Kumarasinghe el al., 2018, who study** Nurses' knowledge on diabetic foot ulcer disease and their attitudes towards patients affected: a cross-sectional institution-based study, and **Das, 2021,** whom reported that nearly three quarter had positive attitude about oxygen therapy.

Relation between total nurses'' knowledge and their demographic characteristics

Present study illustrated that there was statistically significant relationship between nurses demographic characteristic and their level of knowledge with (P = < 0.05) except educational level (table2)

These results compatible with *Magdalena et al., (2023)* who reported shorter work experience and receiving in-service training on oxygen administration were significantly associated with good knowledge on oxygen administration

In contrast with *Ponnappa, (2017)* that study "knowledge, attitudes, and practices for the prevention of Diabetic foot in rural tertiary care teaching hospital" and found none of the investigated factors have proven to be statistically

significant in influencing the level of knowledge of the nurses. Thus, all demographic data are deemed to be important confounders of knowledge of nurses. Some studies show that working experience does strongly influence the level of knowledge.

On the same direction the current study in contrast with *Hussein and KamarulZaman (2018)*, there was no correlation found between the years of working experience and the level of knowledge.

in contrast with **Hassanzad et al., (2022)** who study "Nurses' Knowledge Regarding Oxygen Therapy; a Cross-Sectional Study" Masih Daneshvari Hospital, Tehran, Iran, (70 nurses) and reported that There was no statistically significant relationship between age ($p = 0.57$), gender ($p = 0.09$), employment status ($p = 0.68$), workplace ($p = 0.86$), current position ($p = 0.11$), degree ($p = 0.27$), and graduation time of nurses ($p = 0.58$) and their knowledge of using oxygen properly. Besides, there was no statistically significant relationship between nurses' work experience in Masih Daneshvari Hospital and the history of oxygen therapy training courses with their knowledge of properly using oxygen ($p = 0.15$).

From a researcher's perspective, this may suggest that additional nursing education on HBOT knowledge could improve nurse's knowledge. Also it may be related to HBOT considered an evidence based practice and recently used.

Relation between nurses' attitude and their demographic characteristics

There was no highly statistically significant relationship between nurses' attitude and their demographic characteristics except attendance of previous training regarding hyperbaric oxygen therapy and these results contrasting with *Aloushan et al., (2022)* who study "Assessment of knowledge, attitude and practice regarding oxygen therapy at emergency departments in Riyadh in 2019: a cross-sectional study ", reported that age was found to be a factor which influenced the attitude of nurses. Younger nurses demonstrated more positive attitudes than older nurses. However, no correlation was observed between nurses' knowledge and attitudes.

Disagree with *Basazinew et al., (2022)* who study **"Knowledge, attitude, and practice of health professionals for oxygen therapy working in South Gondar zone hospitals, 2021: multicenter cross-sectional study**" and reported based on the multivariable logistic regression, knowledge level, educational status, work experience, and oxygen therapy training were significantly associated with the attitude of health professionals towards oxygen therapy. According to the analysis, the likely hood of having a positive attitude towards oxygen therapy was higher among health professionals having poor knowledge, being 1st degree /below, having ≤4 years of work experience and taking training about oxygen therapy.

Relation between nurses' practices and their demographic characteristics

There was highly relation between nurses marital status, sex, years of experience, educational level and their level of practices with ($P = 0.001$).

In contrast with *Magdalena et al., (2023)*, **who indicated that** None of the sociodemographic and organizational factors were associated with practices on oxygen administration **also *Adeniyi et al., (2021)*** who study "Assessment of knowledge and practice of oxygen therapy among doctors and nurses: a survey from Ondo State, Southwest Nigeria" and reported that no significant relation observed between participant demographic characteristics and practices.

For instance, like in our study, nurses' practices of administering oxygen therapy had no significant association with the age of the study participants in Egypt by **Mayhob, 2019.** However, like in our study, a higher level of professional education, and lack of training, predicted good practice, poor practice, and managing supplemental oxygen administration respectively, in Ethiopia and Denmark by *Jamie, (2021)* who study Knowledge and practice of nurses towards oxygen therapy in the Public Hospitals of Harari Region, Ethiopia, also *Mustafa, (2023)* who study "Effect of an Educational Program on Nurses' Knowledge and Practice of Oxygen Therapy" and accounted that respondents' sociodemographic characteristics and methodological approaches may account for the differences observed.

Regarding correlation between knowledge, practices, and attitude

There was highly statistically significant relationship between nurses total knowledge, total practices and their total attitude with ($P= 0.000$), (table 5).

these results was contradictory with **Wui et al 2020** who Shows that good or poor knowledge does not correspond to having an equally good or poor attitude for treating diabetic foot ulcers. A chi-square test performed yielded a p-value of 0.63 affirming the previous statement. A regression analysis was conducted (binary logistic regression) with both the outcomes of knowledge and attitude (done separately). A binary logistic regression was conducted after the assumptions proved favorable. There was no statistical significance on the demographic characteristics with the knowledge and attitude of nurses. All demographic variables were deemed to be confounders with the knowledge and attitude of nurses towards diabetic foot ulcer care.

Conclusion

In the light of the present study findings, it can be concluded that: less than two third of nurses had poor total knowledge regarding hyperbaric oxygen therapy among patients with diabetic foot ulcers ,nearly three quarters of nurses had adequate level of total practices, and more than three quarters of nurses had positive total attitude. There was highly significant correlation between nurses' knowledge, practices and attitude of nurses regarding hyperbaric oxygen therapy.

Recommendations

Based on the findings of the present study, the following suggestions were recommended:

➢ Implementation of educational program initiatives to improve nurses' knowledge regarding hyperbaric oxygen therapy in the management of diabetic foot ulcers.
➢ Continuous professional development opportunities should be provided to keep nurses updated with the latest evidence-based practices.
➢ Providing training programs for nurses to increase their level of skills regarding hyperbaric oxygen therapy among patients with diabetic foot ulcer.

For Future research

➢ Future research is required in other hospitals and on larger sample.

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