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Effect of aromatherapy massage on fatigue and perceived stress of multiple sclerosis patients

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Abstract---Background: Multiple Sclerosis (MS) is an autoimmune, chronic and complex demyelinating disease of the central nervous system, which destroys myelin and damages axons at different levels. Objective: to measure the effect of aromatherapy massage on fatigue and perceived stress of multiple sclerosis patients Methods: quasi-experimental research design with control and study group, The study was conducted at one of the educational hospitals in Cairo. The study was conducted on 35 MS patients as a study group and 35 as a control group. Results: It revealed that almost half of the control group (48.60%) had severe fatigue and 11.40% of them had mild fatigue but 54.80% of the study group had moderate fatigue as well 17.10% of them had severe fatigue post-intervention. Conclusion: This study highlights that aromatherapy massage decreases stress and fatigue levels among multiple sclerosis patients was a highly significant improvement in patients' fatigue and stress levels among the study group compared with the control group. Recommendation: Further trials are justified to enhance the understanding benefits of aromatherapy massage for MS patients. Educational programs about aromatherapy massage for MS caregivers to decrease their burden and improve the quality of life for MS patients.

Keywords---Aromatherapy massage, fatigue, perceived stress, multiple sclerosis.

Introduction

Multiple Sclerosis (MS) is an autoimmune, chronic and complex demyelinating disease of the central nervous system, which destroys myelin and damages axons at different levels.

Demyelinated nerve fibers can produce altered sensations and impairments in bodily functions (Rezaie et al., 2021). As a result, people with MS can experience a range of symptoms including numbness, double vision, cognitive difficulties, bladder problems, paralysis, blindness, fatigue and stress (Karadag & Baglama, 2019).

Fatigue is a common symptom of MS, reported in more than 70% of the population (Ahmady, Rezaei & Khatony, 2019). Fatigue related to MS is often perceived as the most debilitating symptom, which significantly affects activities of daily living, social participation, and quality of life and is associated with changes in employment. Fatigue is a highly complex and multifactorial symptom that may be defined as “a subjective lack of physical and/or mental energy that is perceived by the individual or caregiver to interfere with usual and desired activities” (Power et al., 2021).

The causes of multiple sclerosis are still largely unknown, and there are currently unknown factors that can help prevent the disease. However, genetic and environmental risk factors can contribute to the disease. There has been no definite cure for MS until now (Solari et al., 2020). Treatment mainly consists of immunosuppressive and immune-modulating agents. However, several disease-modifying treatments have been designed to reduce the attack rate and delay disease progress (Heidari, Shahrbanian & Chiu, 2021).

People with MS need to manage both disease-related and daily life-related stresses at every stage of their disease. One of the most significant parts of MS treatment is managing the different associated symptoms. Many multiple sclerosis patients hope that complementary and alternative medicine will improve their quality of life (Candy et al., 2020). Candy et al., 2020 added also that over half of patients with MS use a variety of complementary or alternative therapies. Complementary medicine, a low-risk, cost-effective, and easy therapeutic method, has trivial side effects, with aromatherapy being one of its branches (Armstrong et al., 2019).

Aromatherapy is an effective treatment modality for managing behavioral and psychological symptoms of dementia, which improves cognitive function, increases the quality of life, and enhances independence in daily life activities. Aromatherapy was an effective non-drug therapy for people with dementia, which could have some potential for improving cognitive function, especially in patients with Alzheimer's disease (Kim et al., 2018).

Non-invasive therapeutic approaches such as massage can have benefits to mitigate some of MS symptoms (Arab et al., 2019). As chronic diseases such as multiple sclerosis affects all economic, financial, social and emotional aspects of an individual, family and community and as the use of medication may have

complications, using non-medical methods which can reduce fatigue in this group of patients seems to be rational. Non-pharmacological management can slow down or even inhibit the course of the disease, reduce the number of attacks, and delay its sudden onset (Adibi et al., 2022).

Lately, Various nursing articles refer to massage as a fundamental nursing practice that must be established in the nursing process as it considers an essential part of patient care plans, especially for nursing management of pain, sleeping problems, stress, and fatigue. In nursing field, aromatherapy has been performed historically and worldwide by nurses. It evolved with the development of nursing theories, as about eight nursing theorists apply and support the use of aromatherapy and essential oils in nursing practices (Florence Nightingale, Myra Levine, Hildegard Peplau, Martha Rogers, Callista Roy, Wanda Horta, Jean Watson, and Katharine Kolcaba). Florence Nightingale was the first nurse to practice the essential oil of lavender in caring for wounded soldiers while the first icon pioneer aromatherapist nurse was Marguerite Maury (Gnatta et al 2016).

In the light of the united nation sustainable developmental goals 2017 and Egypt's vision 2030 regarding ensuring a healthy life and promoting well being and quality of life an aromatherapy massage can be applied in nursing practice as one of the instruments that the nurse used to help in providing holistic nursing intervention in an attempt to enrich lives and maintain quality of life as well as the emotional and physical health of the individuals.

Multiple sclerosis is associated with high rates of unemployment in Egypt. the prevalence of MS in Egypt has been shown to be 13.7/100,000 and 25/100,000. Multiple sclerosis-related fatigue may affect up to 80% of People with MS and can be severe in up to 65–70% (Leithead et al., 2020). The prevalence of MS-associated fatigue is greater than other MS symptoms. Aromatherapy massage is one of the non-pharmacological management modalities that have no adequate evidence regarding its effectiveness and efficacy in MS patients if has been provided (Farghaly et al., 2021). As a result, this research was conducted to evaluate the effect of Aromatherapy massage on fatigue and stress of multiple sclerosis patients.

Method

Aim: To **evaluate** the effect of aromatherapy massage on fatigue and perceived stress of multiple sclerosis patients.

Hypothesis:

H¹: Aromatherapy massage reduces the fatigue level of multiple sclerosis patients.
H²: Aromatherapy massage reduces the perceived stress level of multiple sclerosis patients.

Research design

Quasi experimental research design with control and study group

Setting: The study was conducted in the follow-up clinic at one of the educational hospitals in Cairo.

Sample: a convenience sample of 70 MS patients (35 study group and 35 control group). The sample size was calculated based on the statistical power of 90%, level of confidence (1-Alpha Error): 95%, Alpha 0.05, Beta 0.1. Every group determines the sample size, which is set at 30 patients. Considering 15% sample attrition, the final sample size in every group (control and study) is 35 patients in each group

Participants: Patients diagnosed with multiple sclerosis for at least 2 years and visit the outpatient clinic for follow-up regularly. Exclusion criteria were allergy to oils that be used, hand or foot injuries, or skin rash. The participants were randomly distributed equally into the study and control groups.

Tools of data collection:

An Arabic interviewed questionnaire (intended to measure the fatigue level and perceived stress). It included four parts as;

Part I: **Demographic Characteristics of the patient** included age, gender, education level, marital status, residence, and Job. Developed by the researchers and revised by 5 experts in the field of nursing.

Part II: **Medical history** included types of MS, types of treatment, walking performance and duration of disease. Developed by the researchers and revised by 5 experts in the field of nursing.

Part III: **The Revised Piper Fatigue Scale (PFS):** it was adapted from piper et al., 1998 and translated into the Arabic language by the researchers, and reverse translations were done. The version of the PFS consists of 22 items and four subscales: behavioral/severity (6 items), affective meaning (5 items), sensory (5 items), and cognitive/mood (6 items). Each item scored from 1 to 10, a high score means severe fatigue. Total fatigue is categorized as mild fatigue if the score <50%, moderate if the score is 50% to 70%, and severe >70%.

The translated version was tested for the validity of the translation by 5 Experts in the field of nursing sciences.

Part IV: **The Perceived Stress Scale (PSS)** ; is a classic stress assessment instrument, adopted from (Cohen et al., 1994) and translated into the Arabic language by the researchers, and reverse translations were done and tested for face validity. It consists of 10 items. Each item scored as 0 never, 1 almost never, 2 sometimes, 3 fairly often and 4 very often. We determine PSS score by following these directions: reverse scores for questions 4, 5, 7, and 8. On these 4 questions, change the scores like this: 0 = 4, 1 = 3, 2 = 2, 3 = 1, 4 = 0. Individual scores on the PSS can range from 0 to 40 with higher scores indicating higher perceived stress. Scores ranging from 0-13 are considered low stress. Scores ranging from 14-26 are considered moderate stress. Scores ranging from 27-40 are considered high perceived stress.

Pilot study

A pilot study was conducted on a group of 6 patients (10%). It was conducted prior to data collection to assess the feasibility and duration of data collection. No modification was carried out, therefore the participants in the pilot were included in the study.

Validity: A group of five experts in medical surgical nursing ascertained the content's validity; their opinions were elicited regarding the format, layout, consistency, accuracy, and relevancy of the tools.

Reliability: The adapted tools were tested for their reliability by using Cronbach's alpha coefficient test in SPSS program version 24 by a statistician. The Internal consistency reliability (Cronbach's α) for the fatigue scale was excellent (.0.903) and stress was good (.0.840).

Ethical Consideration

Approval was obtained from the Research and Ethics committee of the Faculty of Nursing, Badr University in Cairo. Also, official permission was obtained from the selected setting. As well as the current research was conducted in according to the Helsinki Declaration.

Consent was obtained from each patient before participation. The purpose of the study was explained in written words in the introduction part of the research. In addition, participants who agreed to participate in the study were assured that all information obtained would be kept confidential and there were no personal identifiers in the questionnaire. They were notified that they had the right to withdraw from the study at any time.

Procedure

Aromatherapy massage involves the use of essential oils that are combined with a carrier oil or cream to manipulate the soft tissues of the body. The current study procedure was applied through three phases; preparatory; implementation; and evaluation phase. The preparatory phase began with a consultation with a clinical pharmacist about the essential oils that will be used namely rosemary, sweet orange, and lavender oil in relation to benefits, side effects, carrier oil, and mixing ratio. Also, the researchers consult a physiotherapist regarding the type and technique of massage that will be applied. The aromatherapy formula was mixing the three essential oils rosemary, sweet orange, and lavender oil in a ratio of 2:2:1 and combining them with sunflower oil as a carrier oil. The formula is stored in a glass bottle.

Implementation phase: In the study group along with usual care, using aromatherapy formula, the hands and feet (both feet from sole of the foot to the knee and hands from palm to the elbow) were given a massage for 20 minutes. This duration (performing massage for 20 min) is supported by various studies. On each leg, the simple massage was started from the sole of the foot with the movements of thumbs from the fingers to the heel. Then, applying a deep

pressure by the palm of the hand, the posteriors sides of legs were massaged from the ankle up to the knee and then back down to the foot with gentle pressure. On each hand, the simple massage was started from the palm of the hand with the movements of thumbs from the fingers to the wrist. Then the posterior sides of the hands were massaged by deep pressure applied with the palm of the hand and then back down to the wrist by gentle pressure.

Meanwhile, the control group receives the usual care in the outpatient clinic. Evaluation phase: the immediate effect of aromatherapy on fatigue and stress was assessed by asking the study group to complete a pre-and post-aromatherapy massage session.

Statistical Analysis

The collected data was coded and entered into the statistical package for social sciences (SPSS) (SPSS Inc; version 24; IBM Corp., Armonk, NY, USA). The results were considered statistically significant at $P \leq 0.05$ and highly significant at $P < 0.01^{**}$.

Findings

As shown in table (1), this study is conducted on 35 patients. They are divided into two groups, the study group, and the control group. Regarding their demographic characteristics, the two groups (study and control) were homogenous regarding their Age, Gender, Marital status, and Job with No statistically significant difference ($p > 0.05$) existing with (Chi-square=1.033), (Chi square=1.146), (Chi-square=1.657) and (Chi-square=1.500) respectively.

Table (2) illustrates the studied patients' medical history. Both groups are homogenous regarding all features registered. There is no statistically significant difference ($p > 0.05$) between the two studied groups as regards their Types of MS (Chi-square=1.002), Type of treatment (Chi-square=1.002), and Walking performance (Chi-square=1.002), and Duration of disease (Chi-square=1.352).

Table (3) reveals that the study and control groups were consistent regarding the subtotal and total mean fatigue level scores before application of the aroma therapy as the total mean fatigue level score for the control and study group were 164.81 ± 29.06 , and 167.5 ± 24.57 respectively. While after the application of aroma therapy massage to the study group the total mean fatigue level score of the study group was declined to become 74.88 with a highly significant statistical difference between the study and control group ($t/P = 14.6666 / < 0.01$).

Figure (1) represents the total fatigue of studied patients pre and post-intervention. It reveals that almost half of the control group (48.60%) have severe fatigue and 11.40% of them have mild fatigue pre-intervention, but 54.80% of the study group have moderate fatigue as well 17.10% of them have severe fatigue post-intervention.

Table (4) shows the perceived stress level among the control and study group. Before intervention the control and study groups' mean perceived stress level scores 33.87 ± 8.64 , 32.70 ± 6.38 respectively, were approximately similar. After the

intervention, the mean perceived stress level score of the study group decreased to 16.59 ± 5.60 with a highly statistically significant difference between the study and control group ($t/P=11.076$, $p<0.01^{**}$).

As shown in figure (2), nearly two-thirds of the control group (60.0%) have a high level of total stress, while 11.40% of them have low-level pre-intervention. Additionally, almost half of the study group (48.60%) have a low level of total stress, whilst 20.0% of them have a high-level post-intervention.

Table (5) illustrates highly statistically significant positive correlations between Fatigue level and stress among the study group ($r= 0.702$, $p<0.01^{**}$), and so between Fatigue level and stress among the control group ($r= 0.648$, $p<0.01^{**}$).

Discussion

Over 90% of the patients with MS experience fatigue and 50-60% claim that it is the worst sign of the disease, which affects the level of their activity, daily function and quality of life. One Research showed that fatigue as one of the most common signs of MS reduces the level of patients' daily activities and quality of life (Pfeuffer et al.,2021).

Researchers were keen to select the samples that met the predetermined criteria, and the current results revealed that there was a homogeneity between the study and control group with no significant difference regarding their demographic characteristics as age, gender, job, marital status, types of MS, type of treatment, duration of disease and walking performance ($p >0.05$). Therefore, the two study groups were homogenous.

After analyzing and interpreting the collected data, our results mentioned that there was a highly statistically significant difference ($p<0.01^{**}$) between the two studied groups as regards all domains listed. Concerning the total fatigue level, a highly statistically significant difference exists between the control and study groups (Chi-square=9.30, $p<0.01^{**}$). Also, mentioned improved fatigue levels among the study group than the control group. These results may be due to aromatherapy having been shown to reduce pain and body aches, anxiety, agitation, stress, fatigue, insomnia, and muscular aches.

These results supported with the study conducted by **Atashi, 2014**, in Iran conducted on 62 patients and stated that after the aromatherapy massage, fatigue severity and anxiety scores were significantly different in two groups. Mean scores of fatigue severity were 33.12 and 53.20 for the study and control groups respectively ($p<0.001$). aromatherapy with lavender essential oil improved working memory in women with multiple sclerosis. Also, cohort with **Mohamed et al., 2021** who performed randomized clinical trial included 60 women with MS in Iran and detected that aromatherapy with lavender essential oil improved working memory in women with multiple sclerosis.

Moreover, **Arab et al., 2019** done a clinical trial (11IRCT201611217844N) conducted to evaluate 80 MS patients and stated that massage therapy can be proposed as a non-medical, easy, and low-cost method for reducing fatigue in

patients with multiple sclerosis. Furthermore, **Mohammad pourhodki et al., 2021** conducted a parallel randomized clinical trial study on 105 patients and reported that aromatherapy massages have positive effects on the quality of life of patients. In addition, agreement with **Salarvand et al., 2021** concluded that massage as a complementary and non-pharmacological therapy might have been associated with alleviating fatigue and pain in M.S. patients.

According to stress levels among control and study groups, the current study reveals a highly statistically significant difference between the stress level of the control group and the study group after the application of aromatherapy massage. While nearly two-thirds of the control group had a high level of total stress, in addition almost half of the study group has a low level of total stress after receiving the aroma therapy massage. These results come in agreement with the study by **Atashzadeh Shorideh et al., 2019** who stated that aromatherapy and massage reduced the stress level among patients.

Huang et al., 2021 concluded that Aromatherapy might be an effective complementary therapy for preoperative anxiety. In addition, **Mehrabian et al., 2022** stated that Aromatherapy Massage decreases depression and anxiety levels of Elderly Adults post-intervention. Moreover, **Veiskaramian et al., 2021** revealed that Aromatherapy with Melissa essential oil might temporarily contribute to stress relief. And **Hsu et al., 2019** detected that aromatherapy massage improves anxiety level among patients. Also, **Gong et al., 2020** Aromatherapy may exert short-term benefits in relieving anxiety with temporary effects.

Conclusion

This study highlights that aromatherapy massage decreases stress and fatigue levels among multiple sclerosis patients, and there was a highly significant improvement in patients' fatigue and stress levels among the study group compared with the control group. Based on the current study, massage intervention for MS patients could have possible clinical value for stress and fatigue.

Recommendation

Further studies are justified to enhance the understanding benefits of aromatherapy massage for MS patients.

An educational program is needed about aromatherapy massage for MS caregivers to improve quality of life and decrease the burden of the disease.

Highlighting the importance of aromatherapy massage in the nursing curriculum, might help considering it as a crucial part on the nursing care practice.

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Results

Table (1)

Distribution of studied patients according to their characteristics (n=35)

Items	Control (n=35)		Study (n=35)		Chisquare P value
	n	%	n	%	
Age:					
20 - <30	11	31.4	12	34.8	1.033 >0.05
30 - 40	13	37.1	12	34.8	
>40	10	28.5	11	31.4	
Gender					
Male Female	5 30	14.3 85.7	3 32	8.6 91.4	1.146 >0.05
Educational level:					
Not Read and write	7	20	3	8.6	3.978 <0.05*
Read and write	6	17.1	5	14.3	
Preparatory school	9	25.7	7	20	
Secondary school	8	22.9	10	28.6	
University	5	14.3	10	28.6	
Residence					
Rural	16	45.7	20	57.1	3.041 <0.05*
Urban	19	54.3	15	42.9	
Marital status					
Married	25	71.4	23	65.7	1.657 >0.05
Not married	10	28.6	12	34.3	
Job					
Work	16	45.7	15	42.9	1.500 >0.05
not work	19	54.3	20	57.1	

As shown in table (1), this study is conducted on 35 patients. They are divided into two groups, the study group, and the control group. Regarding their demographic characteristics, the two groups (study and control) were homogenous regarding their Age, Gender, Marital status, and Job with No statistically significant difference ($p>0.05$) existing with (Chi-square=1.033), (Chi square=1.146), (Chi-square=1.657) and (Chi-square=1.500) respectively.

Table (2)
Distribution of studied patients according to their medical history (n=35)

Items	Control (n=35)		Study (n=35)		Chisquare P value
	n	%	n	%	
Types of MS:					
Relapse remitting MS	17	48.6	16	45.8	1.002 >0.05
Secondary progressive MS	7	20	7	20	
Primary progressive MS	5	14.3	6	17.1	
Unknown	6	17.1	6	17.1	
Type of treatment:					
Interferons	15	42.9	16	45.8	1.002 >0.05
Glatiramer acetate	5	14.3	4	11.4	
Natalizumab	4	11.4	6	17.1	
Oral drugs	6	17.1	5	14.3	
None	5	14.3	4	11.4	
Walking performance:					
Normal	11	31.4	10	28.5	1.002 >0.05
Walk without assistant up to 1.000 m	11	31.4	13	37.1	
Require unilateral or bilateral assistant	8	22.9	8	22.8	
Restricted to wheelchair	5	14.3	4	11.4	
Duration of disease:					
< 5 years	7	20	6	17.1	1.352 >0.05
5 – 10 years	10	28.6	10	28.5	
>10 years	18	51.4	19	54.4	

Table (2) illustrates the studied patients' medical history. Both groups are **consistent regarding** all features registered. There is no statistically significant difference ($p>0.05$) between the two studied groups as regards their Types of MS (Chi-square=1.002), Type of treatment (Chi-square=1.002), and Walking performance (Chi-square=1.002), and Duration of disease (Chi-square=1.352).

Table (3)

Distribution of studied patients according to their fatigue level among control and study group (n=35)

	Pre Study (n=35)		Control (n=35)		Post Study (n=35)		X ² 1 P value	X ² 2 P value
	n	%	n	%	n	%		
Behavioral/severity								
Mild	4	11.4	4	11.4	11	31.4	8.021	1.367
Moderate	17	48.6	16	45.7	17	48.6	<0.01**	>0.05
Severe	14	40	15	42.9	7	20		
Mean (SD)	42.45±5.08		43.13±6.3		20.74 ± 3.21		T test 10.767 <0.01**	T test 2.007 >0.05
Affective meaning								
Mild	6	17.1	5	14.3	12	34.3	9.554	2.004
Moderate	12	34.3	13	37.1	17	48.6	<0.01**	>0.05
Severe	17	48.6	17	48.6	6	17.1		
Mean (SD)	40.26±4.10		41.30±5.6		18.76 ± 2.86		12.088 <0.01**	1.865 >0.05
Sensory								
Mild	5	14.2	5	14.2	13	37.1	7.432	1.555
Moderate	14	40	15	42.9	14	40	<0.01**	>0.05
Severe	16	45.8	15	42.9	8	22.9		
Mean (SD)	41.77±3.99		40.41±5.9		18.04 ± 3.13		13.771 <0.01**	2.111 >0.05
Cognitive/mood								
Mild	4	11.4	6	17.1	14	40	8.556	1.912
Moderate	16	45.7	15	42.9	16	45.7	<0.01**	>0.05
Severe	15	42.9	14	40	5	14.3		
Mean (SD)	43.02±6.22		41.98 ±5.78		17.34 ± 2.87		10.008 <0.01**	1.708 >0.05
Total								
Mild	5	14.3	4	11.4	13	37.1	9.30	1.641
Moderate	16	45.7	14	40	16	45.8	<0.01**	>0.05
Severe	14	40	17	48.6	6	17.1		
Mean (SD)	167.5 ± 24.57		164.81 ± 29.06		74.88 ± 12.08		14.666 <0.01**	3.782 >0.05

X² 1 control vs post study

X² 2 pre study vs control

Slight significant <0.05* **high significant if p value <0.01**

Table (3) reveals that the study and control groups were consistent regarding the subtotal and total mean fatigue level scores before intervention as the total mean fatigue level score for the control and study group were 164.81 ± 29.06 , 167.5 ± 24.57 respectively. While after the intervention the total mean fatigue level score of the study group was declined to become 74.88 with a highly significant statistical difference between the study and control group ($T/P = 14.6666 / <0.01$)

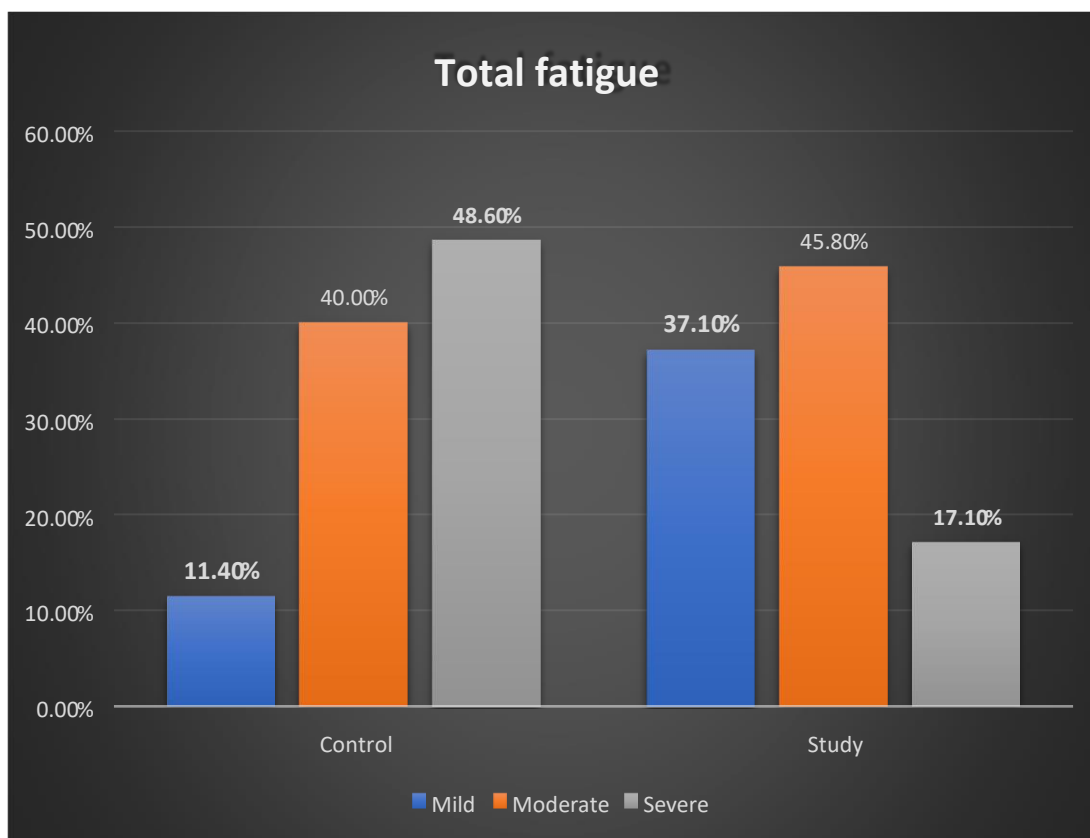


Figure (1) *Distribution of studied patients according to their total fatigue pre and post intervention (n=110)*

Figure (1) represents the total fatigue of studied patients pre and post-intervention. It reveals that almost half of the control group (48.60%) have severe fatigue and 11.40% of them have mild fatigue pre-intervention, but 45.80% of the study group have moderate fatigue as well 17.10% of them have to severe fatigue post-intervention.

Table (4)

Distribution of studied patients according to their perceived stress level among control and study groups (n=35)

	Pre Study (n=35)		Control (n=35)		Post Study (n=35)		X² 1 P value	X² 2 P value
	n	%	n	%	n	%		
Low	5	14.3	4	11.4	17	48.6	10.244 <0.01**	2.008 >0.05
Moderate	10	28.6	10	28.6	11	31.4		
High	20	57.1	21	60	7	20		
Mean	32.70 ±6.38		33.87 ±7.64		16.59 ± 5.60		T test 11.076 <0.01**	T test 1.966 >0.05

X² 1 control vs post study

X² 2 pre study vs control

Slight significant <0.05* **high significant if p value <0.01**

Table (4) shows the perceived stress level among the control and study group. Before intervention the control and study groups' mean perceived stress level scores 33.87±8.64, 32.70±6.38 respectively, were approximately similar. After the intervention, the mean perceived stress level score of the study group decreased to 16.59±5.60 with a highly statistically significant difference between study and control group (T/P=11.076, p<0.01**).

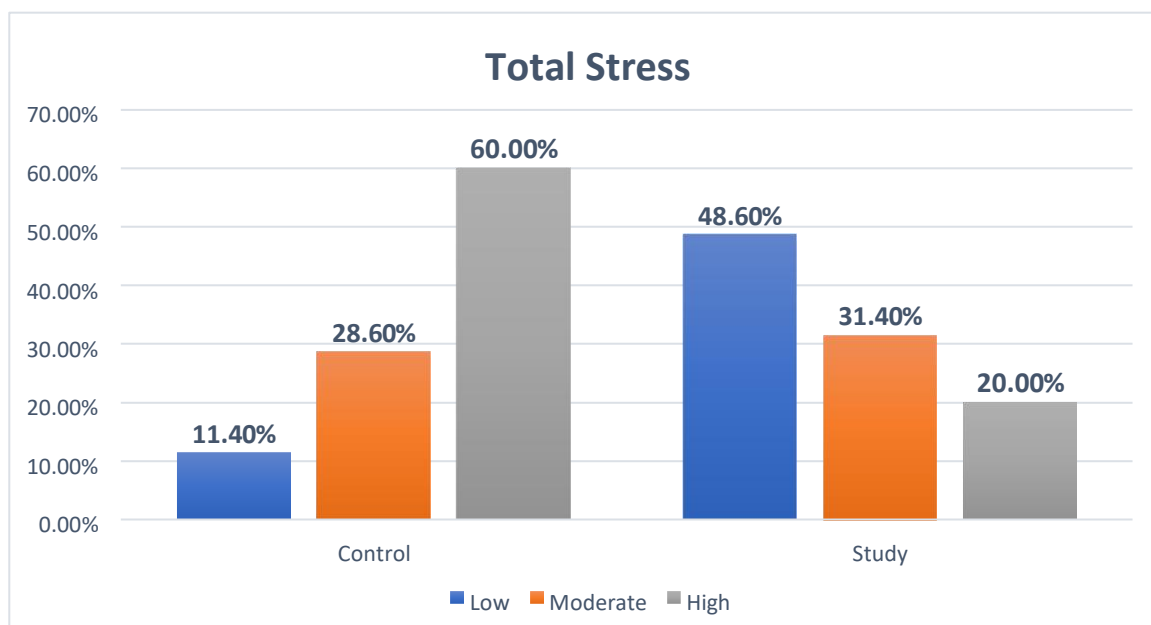


Figure (2) *Distribution of studied patients according to their total stress pre and post intervention (n=110)*

As shown in figure (2), nearly two thirds of the control group (60.0%) has high level of total stress, while 11.40% of them have low level pre intervention. Additionally, almost half of the study group (48.60%) has low level of total stress, whilst 20.0% of them have high level post intervention.

Table (5)
Correlations between studied variables.

	r.	p. value
Fatigue level and stress among study group	0.702	<0.01**
Fatigue level and stress among control group	0.648	<0.01**

Slight significant <0.05 **high significant if p value <0.01**

Table (5) illustrates highly statistically significant positive correlations between Fatigue level and stress among study group ($r= 0.702$, $p<0.01^{**}$), and so between Fatigue level and stress among control group ($r= 0.648$, $p<0.01^{**}$).