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Effect of Applying Brain Gym Exercises on Balance and Concerns about falls among Patients with Diabetic Neuropathy

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Abstract: Background: Type II diabetes mellitus (DM), which is regarded as a modern pandemic worldwide, is considered a serious public health problem in Egypt that precipitates to diabetic neuropathy on the long run. **Purpose:** The current study's purpose was to determine the effect of applying brain gym exercises on balance and concerns about falls among patients with diabetic neuropathy. **Design:** A quasi-experimental (pre - post test) study research design was utilized to accomplish the purpose of the study. **Sampling:** A purposive sample of 79 patients who visited the diabetic clinic in Shebin El Kom Teaching Hospital during period of data collection were included in the study. **Instruments:** The researchers used five instruments to collect the data as follows: Instrument one: Characteristics of patients interviewing questionnaire, Instrument two: Michigan Neuropathy screening instrument, Instrument three: Mini Mental State Examination Scale, Instrument four: Berg Balance Scale and Instrument five: The Falls Efficacy Scale International (FES-I).**Results:** There was statistical significance improvement of neuropathic symptoms, neurological examination post brain gym exercises implementation than pre brain gym exercises where the p value was 0.000. There was statistical significant improvement in level of total balance post brain gym exercises (20.77±7.70 pre vs 41.15±5.62 post). There is negative correlation between total neuropathy symptoms, total neurological examination, and total balance score. Moreover, positive correlation was found between total neuropathic symptoms, and total falls efficacy. **Conclusion:** Implementing Brain gym exercises for two weeks has significant role is promoting balance, reducing risk of falling and ameliorating the symptoms of diabetic peripheral neuropathy. Moreover, brain gym exercises improved the cognitive functions of patients with diabetes. **Recommendation:** Public awareness about brain gym exercises in all diabetic clinics and hospitals using booklet and mobile applications. Also, future studies about the effect of brain gym exercises in the same and on other neurological problems should be conducted to provide the best hope for improving neurological disorders.

Key words: *Balance, Brain gym exercises, Concerns of falls, Diabetic neuropathy, Effect.*

Introduction

Diabetes mellitus (DM), which is known as a worldwide pandemic disease, is considered a serious public health issue in Egypt. It has a rapidly rising incidence and is considered one of the most 10 leading reasons of death all over the world. Also its frequency has reached epidemic proportions. Rising of diabetics' morbidity and mortality is a result of microvascular and macrovascular complications especially due to long-term untreated DM. Statistical data on the prevalence of DM in Egypt are scarce but Egypt is ranked as the tenth country in the world for the incidence of DM, with 8,850,400 adult diabetes patients and a prevalence of 15.2% in early 2020. Egypt is a part of the MENA (Middle East and North Africa) region of the IDF. In the MENA region, there will be 108 million diabetic patients by 2045, which is a double of the current number (Abouzid et al., 2022).

Some researchers estimated that long term diabetes harms central and peripheral nervous system and may cause diabetic neuropathy on long run which is defined as a chronic major complication that affects people with type II diabetes and may be caused by hyperglycemia via the following mechanisms: a) activation of aldose-reductase, intracellular sorbitol accumulation and myoinositol depletion, decreased activity of Na+/K+ATPase and demyelination; b) protein glycation; and c) microangiopathy (Amara et al.,2019).Diagnostic indicators of risk for DPN include metabolic alterations, elevated hypertension, increased urine albumin excretion, elevated levels of triglycerides and total and low density lipoprotein cholesterol, (Kelkar, 2020; Hernandez -Secorun et al., 2021).

There are many different clinical symptoms of diabetic neuropathies. It's critical to identify neuropathy among diabetics as soon as possible and treat it appropriately (American diabetes association a, 2023). It's possible that that asymptomatic diabetic peripheral neuropathy can account for 50% of cases (Holmes &Hastings, 2021). Peripheral neuropathy, which causes loss of sensation in the feet and/or loss of balance, might increase the risk of falling (American diabetes association b, 2023).

Recognizing and treating diabetic neuropathy may help with symptom's reduction, minimize complications, and enhance quality of life. There isn't a specific medication that can reverse the nerve damage yet. However glycemic control can halt the evolution of type I diabetic peripheral neuropathy (DPN) and cardiac autonomic neuropathy (CAN) as well as type II diabetic neuropathy, but it cannot stop the death of neurons. The use of therapeutic methods (pharmacological and nonpharmacological) to treat unpleasant DPN and autonomic neuropathy symptoms also may lessen pain, maintain balance and enhance quality of life (American diabetes association b, 2023).

From the non-pharmacological management of DPN is exercise training. It is a tried and true technique for boosting many aspects of physical

health, such as enhancing body composition and neuromuscular strength. Exercise training has been used experimentally to address a variety of DPN-related deficits, including those related to balance, pain tolerance, and nerve conduction velocity. From these exercises are the brain gym exercises (Holmes &Hastings 2021). These exercise program suggests variety of easy exercises that are meant to enhance how well certain brain functions (as attention span, comprehension and concentration) are integrated with bodily movements (as eye hand coordination and few motor skills. They are predicated on the idea that particular motions, like swaying back and forth or shaking hands, might enhance brain activity. Such physical activities aim to strengthen, develop, and enhance bodily capacities like sight, focused attention, coordination, balance, and communication (Rathod & Biswas, 2023).

In addition, these exercises may assist to increase specific brain functions, allowing the body and mind to work in harmony, enabling pupils to be more balancing and rooting in their physical, mental, and emotional activities. It is defined as a process of reeducating the brain as well as the body that can result in the mastery of any ability. It includes ten exercises as cross crawl, belly breathing, brain buttons, positive points, thinking 'X',lazy eights, energizer,energy yawns, thinking caps and the elephant (Hyatt, 2019). So the aim of the present research is to determine the effect of applying brain gym exercises on balance and concerns about falls among patients with diabetic neuropathy.

Significance of the study:

Approximately one-third of diabetic individual's worldwide experience painful Diabetic Neuropathy (PDN), per international statistics. According to national data in Egypt, 29.3% of diabetic individuals have PDN. It is more widespread in females than males and is more common in TIIDM than TIDM, (Amara et al., 2019). It is the most prevalent long-term microvascular consequence of Diabetes. According to the researcher's clinical experience, many patients admitted to the vascular surgery section had advanced Diabetic Peripheral Neuropathy which is a disease that may be avoided by applying brain gym exercises. Therefore, there is a need to educate diabetic patients these exercises that may help them avoiding or managing this tense complication. As a result, the present research is being conducted to determine the effect of applying brain gym exercises on balance and concerns about falls among patients with diabetic neuropathy.

Operational definitions:

Brain gym exercises:

Exercises which activate the brain, promote neurological repatterning trough variety of simple movements to improve the integration of specific brain function with body movements. These exercises should be applied at least three times a weak for duration of 20 to 30 minutes for two weeks. It

includes: Cross crawl, belly breathing, brain buttons, positive points, thinking 'X', lazy eights, energizer, energy yawn, thinking caps, and the elephant exercises

Balance:

Balance operationally defined as patient's capacity for safe physical steadiness during a series of preset tasks including sitting, standing, unsupported standing, transfers, 360-degree turns and sitting with back unsupported but the feet are supported on the floor.

Concerns about falls:

Concerns about fall operationally defined as the fear of falling when performing various daily living activities such as cleaning the house, getting dressed or undressed, preparing simple meals, taking bath, shopping, and getting out of chair..etc

Purpose:

The current study aim was to determine the effect of applying brain gym exercises on balance and concerns about falls among patients with diabetic neuropathy.

Hypothesis:

- **H1:** Total balance score will be improved among patients with diabetic neuropathy post applying brain gym exercises than before.
- **H2:** Mean risk of falls will be decreased among patients with diabetic neuropathy post applying brain gym exercises than before.

Methods

Research design:

A quasi - experimental research design (pre -post test) was utilized to accomplish the purpose of the study.

Setting:

The present study was implemented at Shebin El kom Teaching hospital, Menoufia Governorate, Egypt. Data collection was performed at Diabetic clinic, which is one of outpatient clinics in the ground floor of the hospital. The building has different rooms for all specialties opened at big wide hall and rest area for the waiting patients.

Sampling technique:

A purposive sample of 79 adult patients with D.M who visited the diabetic clinic in Shebin El Kom Teaching Hospital during period of data collection was included in the study.

The study sample was selected according to the following:

Inclusion criteria:

Diagnosed as diabetic neuropathy as having positive results of Michigan Neuropathy screening instrument scale (MNSI) and patients' scoring of cognitive function is more than 24 on Mini Mental State Examination scale.

Exclusion criteria:

Patients suffering from neurological illnesses such as Parkinson's disease and Alzheimer's disease, patients who have difficulty with balance as a result of previous injuries or patients who

have severe impaired walking or balance. Because all of these conditions could have an impact on the study's findings.

Sample size was calculated based on 6.066 mean difference of BBS scores which was 30.667±8.216 and 36.733±7.478 between pre and post exercises respectively, according to Panse et al., (2018) with at least 80% power at 95% two-sided significance level, so the sample size was determined to be 79 patients

Sample equation:

n = [(Zα/2 + Zβ)2 × {2(ó)2}]/ (μ1 - μ2)2 **n =** sample size **μ1** = mean at pre test

μ2 = mean at post test **μ1-μ2** = Mean difference between pre and post test

ó = standard deviation **Zα/2:** This depends on level of significance, for 5% this is 1.96

Zβ: This depends on power, for 80% this is 0.84

Instruments for data collection:

Five instruments were used by the researchers to collect the data as follows:

Instrument one: Characteristics of patients interviewing questionnaire:

The researchers developed this instrument to collect patients' baseline bio-sociodemographic data. It contains the following two parts:

- **Part one**: Sociodemographic data as to age, gender, occupation, education, marital status, …etc.
- **Part two**: It contains medical characteristics such as duration of diabetes, hemoglobin A1c (HbA1c), and random blood sugar.

Instrument two: Michigan Neuropathy screening instrument (MNSI):

This instrument was developed by University of Michigan, (2000). It is one of the preferred screening instruments for Diabetic Neuropathy. It was divided into two parts,

- **Part 1**: including 15 self-administered questions about neuropathic symptoms such as feeling numbness in legs, burning pain, muscle cramps, etc.
- **Part 2**: involves neurological assessment and examination of the lower extremity such as ulceration appearance of feet, ankle reflexes, vibration perception at great toe and monofilament. Assessing sensitivity, specificity, positive and negative predictive value revealed clinical neuropathy. The chance of having a positive questionnaire or examination in the presence of verified clinical neuropathy is referred to as sensitivity, whereas the probability of having normal (not positive) MNSI tests in the absence of established clinical neuropathy is referred to as specificity. The proportion of subjects with neuropathy among those with positive MNSI questionnaires or examinations has a positive predictive value, but the proportion of patients without neuropathy among those with normal results has a negative predictive value.

Scoring system:

All questionnaire items were evaluated as 0 for a negative reaction and 1 for a positive response (negative replies on items 7 and 13 were worth 1 point). If there was any abnormality in each foot a score of one was obtained. Also inspection to each foot for ulcers which received a score of one. Then the tendon below the patient's knee was hit with a reflex hammer to elicit the patellar reflex. If the reflex present with reinforcement a score of 0.5 was given. If the reflex is not present with the Jendrassic maneuver, it is marked as absent and is scored as 1. The vibration sensation was rated as present if the researchers sensed the vibration on their finger for 10 seconds greater than the patient feels it in the great toe, decreased if sensed for 10 seconds (scoring as 0.5), and absent if not sensed at all (scored as 1). The maximum attainable score is 8, and a score of 2.5 is considered abnormal according to the established scoring system (Oh et al., 2022).

<u>Instrument three</u>: Mini Mental State Examination scale:

It was originally developed by Folstein et al., (1998) to provide a cognitive impairment quantitatively and record cognitive changes over time. I was used by the researchers to just screen the eligible patients to be subjected in the study, so this instrument did not have results. This scale consists of a group of 11 statements that commonly used to assess for cognitive impairment such as thinking, communication, understanding and or memory problems. It comprises 6 areas of assessing mental characteristics, including:

- Orientation to time and place as; which year, season, date, day and month.
- Registration as naming three objects in which, one second was given to say each. Then ask the subject name all the three objects.
- Attention and calculation as counting backwards from hundreds by seven 93, 86,….and stop after 5 answers.
- Short-term memory (recall) as recalling the three objects repeated above
- Language skills as repeating the phrase; no ifs and/ or buts
- Visuospatial abilities and ability to understand and follow instructions as reading and obeying the following writing sentence.

Scoring:

Each correct answer or command was taken one point. Then all points were summed and the total score ranges from 0-30 score. The score is described as follow:

1) Score of ≥ 27 denotes no impairment
2) Score of 21-26 indicates Mild impairment
3) Score of 11-20 describes Moderate impairment
4) Score of ≤ 10 denotes severe level of impairment.

<u>Instrument four</u>: Berg Balance Scale:

It was developed by Berg et al., (1992) to evaluate a patient's capacity for safe

balance during a series of preset tasks, including sitting and standing, unsupported standing, sitting with the back unsupported but the feet supported on the floor, transfers, and 360-degree turns. It contains a list of 14 items, each of which is rated on a five-points ordinal scale from 0 to 4, with 0 denoting the lowest level of function and 4 denoting the highest level. It was performed in nearly 20 minutes. The assessment of gait was not part of the assessment.

Scoring:

The total score ranges from 0-56. The lower the score, the more the patient is at risk for losing balance. Scores on Berg balance scale are interpreted as follow:

- **41-56:** The subject is considered independent
- **21-40:** The subject is walking with assistance
- **0 to 20:** The subject is wheelchair bound

<u>Instrument five</u>: The Falls Efficacy Scale International (FES-I):

It was developed by Kempen et al., (2008) to measures the fear of falling or, more properly, concerns about falling. It contains 16 items that assess how persons are concerned about falling when performing various daily life activities such as (1) cleaning the house; (2) getting dressed or undressed; (3) preparing simple meals..etc.

Scoring:

All items on the scale were scored on a 4-point Likert scale, ranging from 1 that indicated not at all concerned about falling to 4 which denoted very concerned about falling. The total score ranges from 16 to 64 points in which a higher scoring indicates a greater concern about falling.

Validity and reliability:

A board of five professionals (3 experts specialized in Medical Surgical Nursing and 2 Diabetic specialists) evaluated each instrument for its content validity and for the completeness and relevance of all instruments. All instruments reliability was tested using test -retest method to ascertain their relevance and consistency. The reliability of the instrument 1 was r= 0.78, while for the second instrument was 0.94, and instrument 3 was 0.94. Moreover, the reliability of instrument 4 was 0.81 and instrument 5 was 0.96.

Pilot study:

A pilot study was conducted prior to data collection, on 8 patients (10%) to test the clarity, objectivity, feasibility, and applicability of all instruments. Also, to ascertain any problems to the instruments and estimate the needed time for data collection then all necessary modifications were done so participants of pilot study were omitted from study sample.

Ethical consideration

- Approval of the Menoufia University Faculty of Nursing's Ethical and Research Committee was obtained. The written approval No: 913. (Date 15/6/2022).
- The researchers explained the purpose of the study to all patients. Then a written consent was obtained from each patient including his/her acceptance to participate in the study. Also, they were assured that their information would be kept private and used exclusively. Also the researchers stated to patients that the design of instruments wouldn't cause any physical or emotional harm. Furthermore, the researchers emphasized that participation is entirely optional, and that the participants' confidentiality was ensured by coding all data. Furthermore, all participants were informed that refusing to participate in the study would have no impact on their care.

Methods

- After sending a letter from the Dean of Menoufia Nursing Faculty to the responsible authorities outlining the purpose of the study, the competent authorities (director and head nurse) of the diabetic clinic provided approval.
- After reviewing the literature extensively (Panse et al.,2018, Hung et al.,2019, and Tatikola et al.,2022), the first instrument was developed by the researchers, the second was developed by University of Michigan (2000), while the third was developed by Folstein et al., (1998), the fourth was developed by Berg et al., (1992) and the fifth was developed by Kempen et al.(2008).

Data collection procedure:

- Collection of data was over a period of 7 months from August 2022 to the end of February 2023.
- All eligible patients were assessed for the presence of Diabetic Neuropathy using Michigan Neuropathy screening instrument (instrument two). Examination was done by the researchers by inspecting both foot for dry skin, calluses, deformities infections, and fissures. The ankle reflexes were also elicited. If the reflex was done, the patient was asked to clench the teeth, flex both sets of fingers into a hook-like form, and interlock those sets of fingers together. A tuning fork was also used to examine the existence of vibrating sensation in the big toe. It was used to select patients of the study.
- After screening and fulfilling the inclusion criteria, each patient was assessed individually by the researchers for biosociodemographic data using instrument one.
- Each eligible patient was screened by the researchers for cognitive impairments using instrument three to decide if patient would be or not in the study.
- The researchers assessed each patient for balance and concerns about fall using instrument four and five respectively.

- The researchers developed an instructional Arabic booklet guided by pictures that aimed to improve patient's condition based on the obtained data baseline, assessment need and related recent literature (Panse et al.,2018,Azmy et al., 2022 and Cai etal., 2022).
- Three educational sessions were performed (one theoretical and two practical); each session took about 30 to 60 minutes through face to face interview with each patient alone to assist in improving their performance and enforcing the learned knowledge. These sessions were performed two days a week between 11.00 and 12.00 AM as preferred by all study patients.
  - **First session (theoretical session)**: each patient was provided with knowledge about diabetes neuropathy (definition, causes, clinical manifestations, diagnostic methods and management). At the session end, the researchers allowed all patients to ask for clarification for any unclear information.
  - **Second session (practical session)**: This session began with revision of the previously provided knowledge then the researchers explained for each patient the importance of brain gym exercises and demonstrated five exercises. Each exercise was explained to all patients as regards its aim and way of practicing it. Firstly, Cross crawl exercise is used to enhance left- and right-hemisphere brain coordination. The patient was instructed to alternatively move one arm and the opposing leg and the other arm with the opposing leg for three minutes. While Belly breathing (diaphragmatic) exercise was used to improve the nervous system by lying on back, slightly bend knees and maintain a flat foot then inhale deeply and slowly through nose to fill the abdomen with air. It should be repeated three times daily.

Moreover, Brain buttons exercise enhances bodily balance, eases shoulder, neck, and eye strain, and improves electromagnetic energy flow. Patient was instructed to press a flat hand against umbilical area while the opposite hand is tucked beneath the left and right collar bones to induce multiple place-based movements with the hands. Simultaneously moves eyes left and right for 20 to 30 seconds each, repeat the exercise five to ten times daily for a period of two weeks. Positive **points exercise** increases learning, reading, and academic skills as well as long-term memory. The patient was told to close eyes and muses over something that stresses him/her to allow for feeling the tension then releasing it.

Finally Thinking 'X' exercise improves brain-to-body coordination, which facilitates thought, speech, and performance. The patient was instructed to close eyes, imagine the letter X then observe that the body is symmetrically arranged in an X-like manner. The researchers asked all patients to redemonstrate all

learnt exercises, then allowed them a clarification for any unclear information.

- **Third session (practical session):** it focused on redemonstration of the previously learned exercises then the researchers demonstrated the rest of brain gym exercises as **lazy eights** exercise that enhances coordination and balance by integrating visual fields. Ask patient to extend arms to shoulder level, point thumb upward, and trace the outline of the figure 8 gently while keeping eyes fixed on the thumb.

  Energizer exercise stimulates patients to be active. Ask patient to lead head forward, keep shoulder relaxed, and breathe deeply while making tiny circles with his/her head turned to the side and shoulders relaxed. Also, **Energy yawn** exercise is used to improve oxygenation and keep patient's alert. Patient places each hand's index and middle fingers on the jaw joint then open the mouth and begin circularly massaging the joints. Repeated this five times with shutting mouth and a five-minute massage.

  Thinking caps exercise; this exercise effectively boosts mood, attention span, and memory. Ask patient to take a seat and put thumb and index finger on their ears, massage the outer portion of the ear then gradually descend to the whole ear. Repeat this fifteen times, for four times a day. The elephant exercise enhances attention, recognition, sight, memory, speech, reasoning, and perceive depth. The patient places left ear on the left shoulder, extends the left arm like an elephant trunk and draws an infinity sign in front of the extended arm. After 4-5 full marks, change arms.

- The aim of each exercise was demonstrated by the researchers then asked all patients to redemonstrate the newly learnt exercises and they were allowed to ask for any unclear information. The researchers encouraged the study's patients to redemonstrate the brain gym exercises at least three times a weak for duration of 20 to 30 minutes.
- Each patient was assessed twice at pre brain gym exercises implementation as baseline data and post brain gym exercises application by two weeks using instrument two, four, and five to examine the effect of applying brain gym exercises on balance and concerns about fall among those patients. While instruments two and three were used only before applying brain gym exercises to screen for Diabetic Neuropathy and evaluate eligible patients for their cognitive impairment
- Comparison between pre and post brain gym exercises application was done to examine the effect of the brain gym exercises on balance and risk of fall.

Statistical analysis

To statistically analyze data, Microsoft Excel software and the Statistical Package for Social Science (SPSS) version 25 were used. Descriptive statistics were used to provide data in the form of frequencies and percentages for categorical data, and the mean (x) and standard deviation (SD) for quantitative data. The chi square test (X2) was used to compare the qualitative variables, the Paired T test (t) was used to compare quantitative variable means, and the Pearson correlation test (R- test) was used to determine the correlation between the research variables. Degrees of significance of results were considered as follows:

- P-value > 0.05 Not significant (NS)
- P-value ≤ 0.05 Significant (S)
- P-value ≤ 0.01 Highly Significant (HS).

Results

Table (1): Shows distribution of studied patients according to their sociodemographic data. It's evident from the table that more than one third of the studied patients (39.2%) were between fifty and less than sixty years old with mean age of 50.08 ± 7.49 years. The dominant gender in the studied patients was female representing 65.8%. Furthermore, the majority of the studied patients were married and educated (91.1 % and 77.2% respectively). Moreover, more than half of the studied patients (55.7%)had manual work. About two thirds of studied patients (66%) had medium distance between work and home.

Table (2): Illustrates distribution of the studied patients according to their medical data. This table shows that more than half of the studied patients (55.7%) complained from diabetes from 10 to 15 years and 53.2% of them had Hb A1c between 6 to less than 8%. Furthermore, the random blood sugar level was between 170 to less than 185 in more than one third of them (40.5%).

Table (3): Clarifies distribution of the studied patients according to subtotal peripheral neuropathy level pre and post brain gym exercises implementation. This table presents that all studied patients (100. %) had abnormal neuropathic symptoms and neurological examination pre implementing brain gym exercises that were highly significantly decreased to 16.5% and 17.7% respectively post brain gym exercises. For this reason, there were very highly statistical significance between levels of peripheral neuropathy among patients pre and post brain gym exercises.

Table (4): Shows mean total balance level among studied patients pre and post brain gym exercises. It reveals that the mean total balance level was 20.77± 7.70 pre brain gym exercises implementation that was highly significantly increased to 41.15 ± 5.62 post brain gym exercises implementation. A highly statistical significance between levels of balance pre and post brain gym exercises.

Figure (1): this figure clarifies percentage distribution of studied patients according to their total balance

level pre and post brain gym exercises implementation. It shows that about half of the studied patients (50.6%)walked with assistance pre brain gym exercises implementation that highly significantly decreased to 17.7% post application of brain gym exercises. Also a highly significant increase of patients who were independent from 0.0% pre brain gym exercises to 79.8% post exercises implementation with highly statistical significance difference where the p value (0.000).

Table (5): Clarifies distribution of studied patients according to their subtotal falls efficacy level pre and post brain gym exercise implementation: This table shows that there were highly statistical significant improvements between pre and post brain gym exercises implementation regarding all items of fall efficacy.

Figure (2): Indicates total mean score of falls efficacy among studied patients pre and post brain gym exercises implementation. This figure reveals that total mean score of fall efficacy among studied subjects was 47.12 ± 5.38 pre brain gym exercises implementation that was highly significantly decreased to 23.28 ±5.73 post brain gym exercises.

Table (6): Clarifies correlation between total neuropathic symptoms, total neurological examination, total balance and total falls efficacy levels among the studied patients pre and post brain gym exercises implementation. This table shows that there were highly statistical significant negative correlations between total neuropathic symptoms and total neurological examination with total balance on pre and post brain gym exercises. Moreover, there are highly significant positive correlation between total neuropathic symptoms and total neurological examination pre and post brain gym exercises. Also there are highly significant negative correlations between total balance with total fall efficacy pre and post brain gym exercises implementation.

Table (1): Distribution of the studied patients according to their sociodemographic data (n=79).

Sociodemographic data	No.	%
Age (Year)		
30-<40	7	8.9
40-<50	29	36.7
50-<60	31	39.2
60-65	12	15.2
X ±SD	**50.08 ± 7.49**	
	37-60	
Gender		
Female	52	65.8
Male	27	34.2
Marital Status		
Single	1	1.3
Married	72	91.1
Widowed	0	0.0
Divorced	6	7.6
Educational level		
Illiterate	18	22.8
Read and write	18	22.8
Basic education	3	3.8
Secondary education	15	19.0
High education	23	29.1
Postgraduate studies	2	2.5
Occupation		
Housewife	28	35.4
Manual work	44	55.7
Administrative work	4	5.1
Retired / not working	1	1.3
commercial works	2	2.5
The distance between work and home (n=50)		
Short (100m - 1km)	10	20.0
Medium (1 km - 5 km)	33	66.0
Long > 5 km	7	14.0

Table (2): Distribution of the studied patients according to their medical data (n=79).

Medical data	No.	%
Duration of Diabetes		
1-< 5 years	8	10.1
5-<10 years	27	34.2
10-15 years	44	55.7
X±SD	**9.11 ± 3.36**	
Hemoglobin A1C (Hb A1C) level		
6-< 8 %	42	53.2
8-< 10%	27	34.2
≥ 10%	10	12.6
X±SD	**8.14 ± 1.24**	
Random blood sugar level		
155 -< 170	23	29.1
170 -< 185	32	40.5
185 -< 200	12	15.2
≥ 200	12	15.2
X±SD	**178.5 ± 14.6**	

Table (3): Distribution of the studied patients according to subtotal peripheral neuropathy level pre and post brain gym exercises implementation (n=79).

Subtotal neuropathy level		Pre brain gym exercises		Post brain gym exercises		X2	P-value
		No.	%	No.	%		
Neuropathic symptoms	Normal	0	0.0	66	83.5	14.16	0.000**
	Abnormal	79	100.0	13	16.5		
Neurological examination	Normal	0	0.0	65	82.3	110.43	0.000**
	Abnormal	79	100.0	14	17.7		

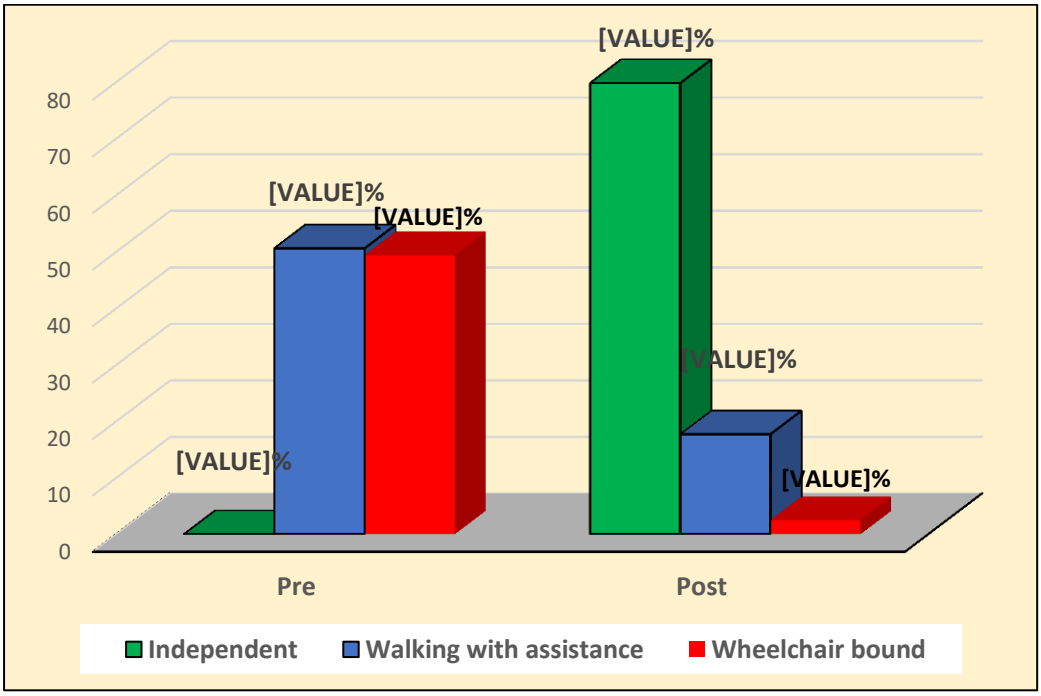
t= Paired t. test. X^2: Chi-square test. **highly significant at p ‹ 0.01.

Table (4): Mean total balance level among studied patients pre and post brain gym exercises implementation (n=79).

Mean total balance level	Pre brain gym exercises	Post brain gym exercises	t test	p-value
X ±S. D	20.77 ± 7.70	41.15 ± 5.62	41.27	0.000**

**highly significant at p ‹ 0.01.

Figure (1): Percentage distribution of studied patients according to their total balance level pre and post brain gym exercises implementation (n=79).



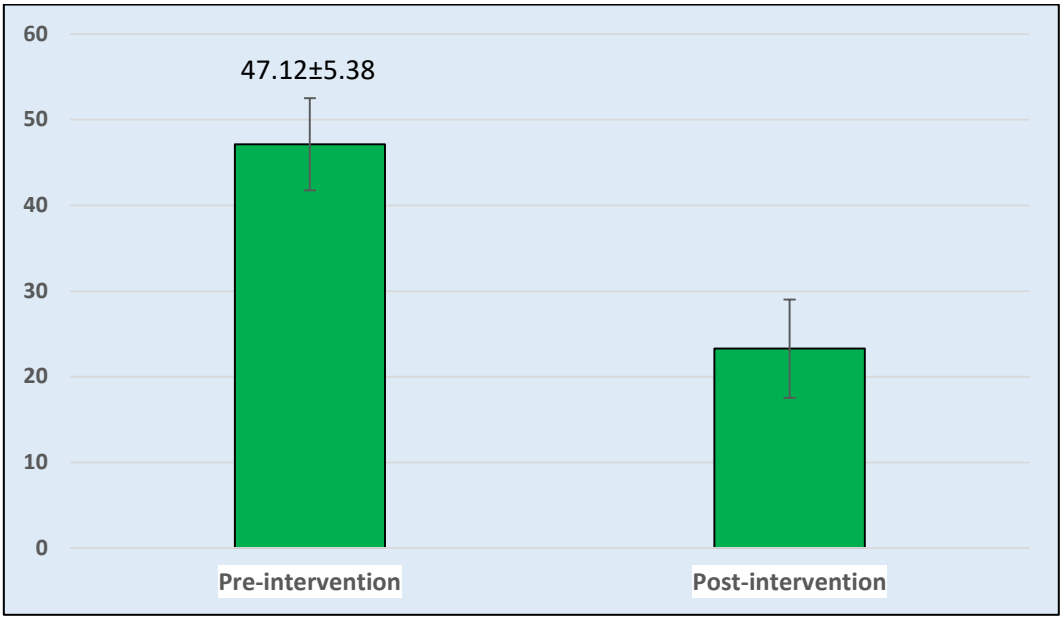
X^2 = 108.90 P: 0.000**.

Table (5): Distribution of studied patients according to their subtotal falls efficacy level pre and post brain gym exercise implementation (n=79).

Items	Pre brain gym exercise								Post brain gym exercise								X^2	P-value
	Not at all concerned		Somewhat concerned		Fairly concerned		Very concerned		Not at all concerned		Somewhat concerned		Fairly concerned		Very concerned			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
Cleaning the house	37	46.8	40	50.7	2	2.5	0	0.0	0	0.0	23	29.1	56	70.9	0	0.0	91.86	0.000**
Getting dressed or undressed	12	15.2	65	82.3	2	2.5	0	0.0	0	0.0	8	10.1	48	60.8	23	29.1	121.82	0.000**
Preparing simple meals	27	34.2	48	60.7	3	3.8	1	1.3	0	0.0	5	6.3	26	32.9	48	60.8	125.21	0.000**
Taking a bath or shower	27	34.2	49	62.0	3	3.8	0	0.0	1	1.3	1	1.3	73	92.4	4	5.0	138.69	0.000**
Going to the shop	71	89.9	8	10.1	0	0.0	0	0.0	1	1.3	31	39.2	24	30.4	23	29.1	128.62	0.000**
Getting in or out of a chair	38	48.1	41	51.9	0	0.0	0	0.0	1	1.3	23	29.1	51	64.6	4	5.0	95.16	0.000**
Going up or down stairs	52	65.8	27	34.2	0	0.0	0	0.0	2	2.5	28	35.5	49	62.0	0	0.0	95.31	0.000**
Walking around in the neighborhood	51	64.5	27	34.2	1	1.3	0	0.0	2	2.5	7	8.9	68	86.1	2	2.5	124.12	0.000**
Reaching for something above the head or on the ground	50	63.3	29	36.7	0	0.0	0	0.0	2	2.5	27	34.2	49	62.0	1	1.3	94.37	0.000**
Going to answer the telephone before it stops ringing	49	62.0	29	36.7	1	1.3	0	0.0	7	8.9	6	7.6	22	27.8	44	55.7	109.78	0.000**
Walking on a slippery surface	53	67.1	25	31.6	1	1.3	0	0.0	1	1.3	12	15.2	66	83.5	0	0.0	117.70	0.000**
Visiting a friend or relative	51	64.5	27	34.2	1	1.3	0	0.0	1	1.3	6	7.6	72	91.1	0	0.0	105.13	0.000**
Walking in a place with crowds	53	67.1	25	31.6	1	1.3	0	0.0	2	2.5	7	8.9	70	88.6	0	0.0	124.47	0.000**
Walking on an uneven surface	54	68.4	25	31.6	0	0.0	0	0.0	4	5.1	52	65.8	23	29.1	0	0.0	75.57	0.000**
Walking up or down a slope	52	65.8	27	34.2	0	0.0	0	0.0	10	12.7	49	62.0	20	25.3	0	0.0	54.82	0.000**
Going out to a social event	34	43.0	44	55.7	1	1.3	0	0.0	0	0.0	1	1.3	0	0.0	78	98.7	150.14	0.000**

X^2: Chi-square. ****highly significant at p ‹ 0.01**

Figure (2): Total mean score of falls efficacy among studied subjects pre and post brain gym exercises implementation (n=79).



Paired t. test=29.47. p ‹ 0.000

Table (6): Correlation between total neuropathic symptoms, total neurological examination, total balance and total falls efficacy levels among the studied patients pre and post brain gym exercises implementation (n=79).

Variables		Total neuropathic symptoms		Total neurological examination		Total balance	
		Pre brain gym exercises	Post brain gym exercises	Pre brain gym exercises	Post brain gym exercises	Pre brain gym exercises	Post brain gym exercises
Total neuropathy symptoms	r p						
Total neurological examination	r p	0.501 0.000**	0.240 0.033*				
Total balance	r p	-0.239- 0.034*	-0.414- 0.000**	-0.791- 0.000**	-0.728- 0.000**		
Total falls efficacy	r p	0.016 0.888	0.109 0.347	0.143 0.216	0.300 0.008**	-0.451- 0.000**	-0.358- 0.001**

r= Pearson correlation coefficient test. (-) negative correlation. *Correlation is significant at the 0.05 level (2-tailed). **highly correlation is significant at the 0.01 level (2-tailed)

Discussion:

Diabetic peripheral neuropathy (DPN) affects autonomic somatic sensory, and motor nerve and is the most frequent microvascular consequences of diabetes (Tatikola et al.,2022). After ruling out other potential reasons, it can be inferred that diabetes has precipitated peripheral nerve damage (American diabetes Association b ,2023).

It is linked to muscular dysfunction, discomfort and paresthesia of limbs, loss of sensory nerves and atrophy of the muscle with fat infiltration. Exercises training is an effective approach for enhancing all aspects of being physically fit, such as improving neuromuscular strength and body composition. It has been used experimentally to address a variety of DPN-related deficits, including those related to balance, pain tolerance, and nerve conduction velocity (Holmes & Hasting,2021). Hence, this study aimed at applying brain gym exercises to determine its effect on balance and concerns about falls among patients with diabetic neuropathy.

Concerning age, the findings of the current study showed that the mean age of the studied patients was 50.08 ±7.49 years. Hamdani, et al.'s (2017) researched on the "correlation between walking tests and psychological factors after brain gym exercise in diabetic individuals" validated this result and noted that the study group's mean age was 50.73±5.05 years. This explains why diabetic peripheral neuropathy is more common as people age.

It was observed that, the dominant gender in the patients of the current study was female. This result is supported by Hung et al., (2019), who conducted a study entitled "effects of interactive video game-based exercise on balance in diabetic patients with peripheral neuropathy "and stated that the dominant gender in their study was female. This result can be viewed as female is at higher risk of diabetes than male because of high body fat mass so developing early diabetic consequences as diabetic nephropathy.

The current study results stated that, most of the studied patients were married and educated. These findings are in line with Bai et al., (2021), who conducted a study entitled "effects of physical activity on cognitive function among patients with diabetes in China" and found that majority of studied patients married and educated. This may be explained by; the marital status is in harmony with the subject's age.

The current study showed that, more than half of the studied patients complained from diabetes for 10 to 15 years and their Hb A1c was between 6 to less than 8 %. These findings coincide with a study titled "Effect of mild exercise on glycemic and bodyweight control in Japanese type II diabetes patients" that was conducted by Nakanishi et al., (2019) and found that study patients with diabetic history of 14 years and HbA1c between 6 to 8%.

As regards peripheral neuropathy level pre and post brain gym exercises implementation, the present study

showed that there was statistical significance improvement in neuropathic symptoms and neurological examination post brain gym exercises implementation than before. These findings were supported by Tatikola et al., (2022) who studied " effect of various exercise protocols on neuropathic pain in individuals with type II diabetes with peripheral neuropathy "and Sohrabzadeh et al., (2022), who studied " The immediate effect of a single whole-body vibration session on balance, skin sensation, and pain in patients with type 2 diabetic neuropathy "and mentioned that peripheral diabetic neuropathy symptoms improved in the studied patients post exercise program implementation than before. This can stress the effect of implementing the brain gym exercises which ameliorates the neuropathy features.

Concerning mean total balance level pre and post brain gym exercises implementation, the current study results observed that there was highly significant improvement of mean total balance level among studied patients post implementing brain gym exercises than before .This results is in agreement with Sohrabzadeh et al., (2022) and Akbari & Naimi (2022)who studied "the effect of exercise therapy on balance in patients with diabetic peripheral neuropathy" and found in their studies that exercise therapy improved balance among patients with diabetic peripheral neuropathy. Additionally, this finding is consistent with Du Plessis et al's., (2023) findings. Who conducted a study about the "effects of isometric exercise training program on muscular strength, ankle mobility and balance in patients with diabetic peripheral neuropathy in lower legs in South Africa," which demonstrated that after completing the program, patients with diabetic peripheral neuropathy had improved levels of muscular strength, ankle mobility, and overall balance. According to the researcher's view, this may be connected to a reduction in neuropathic pain following the application of the brain gym activities and a subsequent improvement in balance. These results support the first study hypothesis.

As regards total falls efficacy pre and post exercises implementation, the current study revealed that the mean total fall efficacy level was highly significantly decreased and improved post brain gym exercise implementation than before. This result is supported by Akbari& Naimi (2022), and Gialanella et al., (2023) who conducted a study about " effects of motor rehabilitation on balance and functional activities in elderly patients with peripheral neuropathy and recurrent falls" and showed that traditional exercise rehabilitation improved balance and recurrent fall. According to the researcher's view, this may be related to improving balance and cognitive functions as a result of brain gym exercises implementation that which result in improving fall efficacy as well. These results support the second study hypothesis.

Concerning correlation between total neuropathic symptoms, total neurological examination with total balance level, the current research

found that there were highly substantial negative associations between total neuropathy symptoms and total neurological examination with total balance level among the studied patients pre and post applying brain gym workouts. This could be connected to how better balance is affected by reducing neuropathic symptoms. A study conducted by Riandini et al., (2020) who studied "fall risk and balance confidence in patients with diabetic peripheral neuropathy " supported the findings of present study and reported that there was negative correlation between total fall efficacy and total balance level. This can be explained as, the studied subjects who practice brain gym exercises had reduced risk of fall as result of increasing balance.

Conclusion:

Implementing Brain gym exercises has significant role in promoting balance, reducing risk of fall and ameliorate the symptoms of diabetic peripheral neuropathy.

Recommendation:

- Establishing Diabetic patient's awareness about brain gym exercises and its effect on peripheral neuropathy using the designed illustrative booklet and mobile applications.
- Continuous training programs about diabetes and brain gym exercises should be provided in all Diabetic Clinics and Medical Departments of all hospitals to patients with diabetes.
- Future studies should be done about the effect of Brain Gym exercises in the same and other neurological problems may provide the best hope for improving neurological disorders and permit for generalization of results.
- Replication of the study on a larger sample is required to allow for greater generalizability of the results.

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