Effect of Digital Nursing Intervention on Performance of Daily Living Activities and Treatment Adherence among Adult Patients with Multiple Sclerosis

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Abstract

Background: Multiple Sclerosis is a progressive inflammatory neurological disease affecting central nervous system that may lead to long term disability and even death especially among young adults. So, digital nursing intervention is crucial in providing information about disease, identify needs, improve daily activities and treatment adherence among patients with multiple sclerosis **Aim**: to assess the effect of digital nursing intervention on performance of daily living activities and treatment adherence among adult patients with multiple sclerosis.. **Design**: Quasi-experimental (case and control group- pre/ posttest) research design was utilized for the present study. **Setting:** The current study was conducted at Neurological outpatient clinic at University Hospital in Shebin El –Kom, Menofia Governorate, Egypt. **Sample:** A purposive sample of 80 adult patients diagnosed with multiple sclerosis was taken in this study. **Instruments:** Three instruments were used I: Structured interviewing questionnaire to gather socio demographic data, patient's medical data, and Patients' knowledge regarding multiple sclerosis, II: Modified Barthel Index scale, and III: Multiple Sclerosis Treatment Adherence Questionnaire. **Results:** After three and six months of application of digital nursing intervention, total mean score of knowledge among the study group was increased to 14.6 and18.2-compared to 9.1 and 9.8 in the control group respectively. Also, The mean score of performance of Daily Living activity was improved to 15.82±4.24 and 17.07±3.96 in the study group compared to 8.07±3.79 and 8.67±4.28 in the control group respectively. In addition, the study group had a statistical significant improvement in in all item of treatment adherence at post 3 and 6 months of intervention compared to control group ($P<0.001$).. **Conclusion:** Digital nursing intervention ascertained its efficacy in increasing knowledge, enhancing performance of daily living activities and improving treatment adherence of patients with multiple sclerosis. **Recommendation:** Creation of Web site under supervision of medical and nursing to increase information about the disease and facilitate follow up of patients with multiple sclerosis.

Keywords: Daily Living Activities, Digital Nursing Intervention, Multiple Sclerosis, Treatment Adherence

Introduction

Multiple sclerosis (MS) is a chronic destructive and progressive demyelinating disease of the central nervous system. (CNS). Multiple sclerosis is called autoimmune disease because the immune system combats itself leading to various cognitive impairments, long term disability and changes in performance of daily living activities especially among adults **(Alqwaifly et al., 2020)**

The prevalence of multiple sclerosis has been increasing dramatically worldwide. According to the recent epidemiological studies, the prevalence of MS is estimated to be 2–5 million people between the ages of 20 to 50 years suffer from the disease around the world. The disease affects women twice than men **(Abtahi, 2021; Lane et al., 2022)**. In Egypt, the prevalence of multiple sclerosis is about 25/100,000 was recorded from different centers **(Stenager, 2019).**

The underlying causes of MS remain uncertain. It is believed to be attained through complex interactions between genetic factors and the environmental factors such as smoking, inadequate sun exposure, lack of vitamin D, infections as Epstein–Barr and varicella zoster viruses, adolescence obesity, and stress. These variables trigger an aberrant immune response

that activates self-reactive T and B cells, resulting in inflammation and impairment to the myelin sheath in the central nervous system **(Dobson and Giovannoni, 2019)**.

Multiple sclerosis has many types that differ based on deterioration and advancement of disease. These types are relapsing-remitting multiple sclerosis which is common in 85 % of cases, primary progressive MS, secondary progressive MS, radiological isolated syndrome, and clinically isolated syndrome (**Johansson et al., 2021**).

Symptoms of MS are unpredictable because it depends on which part of CNS is influenced by the progress of MS lesions on the brain and the spinal cord. The symptoms of disease include vision problems, numbness, bladder and bowel problems, cognitive variations, depression, and muscle stiffness. Additionally, MS can lead to dizziness, vertigo, sexual problems, emotional changes and difficult in walking, as well as pain and fatigue that interfering with everyday activities **(Johansson et al., 2021; National Multiple Sclerosis Society, 2019).**

Multiple sclerosis has a significant impact on performance of daily living activities, work ability, and quality of life. These effects lead to impairment in physical and psychological functions, increased family conflicts, social isolation, anxiety, depression, decreased working ability, decreased self-esteem, as well as increased financial issues. Therefore, the management of patients with multiple sclerosis needed an individualized treatment plan to control disease and provide a high level of cooperation between patient and their physician to maintain treatment adherence **(Marisa et al., 2021).**

Treatment adherence in MS patients is multifaceted and is influenced by patient-specific factors such as gender, age, cognitive function, socioeconomic status, and accompanying mood disorders; factors specific to the therapy; management-related factors; and those associated with healthcare systems **(Li et al., 2020).** In contrast, the reasons for non-adherence among patients with MS involve lack of efficacy, amnesia, inconvenience with treatment, feeling fatigued or anxious from adverse effects of medications, and inappropriate relationship between the patient and their healthcare team **(Kohler et al., 2021).**

Digital nursing intervention includes the delivery of interventions and data collection using numerous digital tools as smartphones, websites, apps, and wearable devices. Various health interventions have already harnessed the power of digital technology, including mobile apps, digital health, e-health, and internet-based programs, targeting patients, healthcare providers, health system managers, and data services **(Rossen et al., 2020).** This digital revolution is particularly beneficial for individuals with MS, who often face challenges in accessing rehabilitation services and have limited clinical trial opportunities. By embracing digital technology, healthcare providers can now offer remote interventions for both physical and cognitive rehabilitation, as well as improve the overall clinical management of MS patients **(Taylor et al., 2020).**

Nurses play a significant role in the management of multiple sclerosis disease. The primary aims of nursing management are to enhance patients' physical mobility, alleviate fatigue, mitigate pain, prevent injury, and establish bladder and bowel control. Also, the nurses help in improving cognitive abilities, develop coping skills, assist with household management, adapt to sexual challenges, and improving their performance of daily living activities. This can be achieved by using more effective management strategies, which in turn could foster greater independence within the community, decelerate the progression of the disease, improve function after an attack, and prevent new attacks and ensuring treatment adherence. **(Kratz et al., 2019).**

In addition, the nurse can use numerous digital tools to help patients with MS in various ways such as provide information about the disease, its progression, and treatment requirements. The nurse can utilize digital nursing interventions to educate and support patients, assist patients in managing their health, enhance their functional capabilities, implement behavioral interventions and enable them to develop strategies for conserving energy and pacing their daily activities in order to achieve performance and treatment adherence, **(Meehan and Doody, 2020).**

Significance of the study

Multiple sclerosis is an unpredictable disease that affects people differently and it is the second cause of physical disability especially in young people. MS is a silent killer disease not only of the life of patients but also of community development initiatives. This disease strikes people in their prime working years, between the ages of 20 and 40. It impairs rapidly their capacity to perform their job, with dire consequences for their physical, mental, social, and financial well-being (**Saad & Elsayed, 2021).**

The Ministry of Health and Population estimated that 1.4% of all neurological disorders in Egypt are related to MS. The most recent Atlas of MS estimates that 2.8 million people globally are affected by MS. Data from 2020 indicates that, there are more than 59,670 MS patients in Egypt. 1/ 1,500 people have this disease (**Hassan, 2021**). In the Middle East, Egypt has the greatest number of MS patients with high burden due to delayed diagnosis and initiation of treatment, as well as high costs. **(Zakaria et al., 2019; Coyle, 2020).**

Patients who have MS face numerous challenges that have a negative effect on their overall daily living activities and their treatment adherence. So, using digital nursing intervention is important because it has an implication for current care practices, because care setting is shifting from hospital to home that lead to new roles and responsibilities for the health care providers as well as for patients **(Bass et al., 2020)**. Digital nursing intervention can help patients with MS to have more information about disease, determine their needs, enhance their daily activities and their treatment adherence via using of digital devices These apps can produce and share personal health data and can enable the maintenance of health **(Üstündağ, Yeşilbalkan & Kabay, 2024).**

Therefore, this study was done to examine the effect of digital nursing intervention on performance of daily living activities and treatment adherence among adult patients with multiple sclerosis.

Aim of the study

The current study aimed to assess the effect of digital nursing intervention on performance of daily living activities and treatment adherence among adult patients with multiple sclerosis.

Research Hypothesis

H1. Patients with MS who received digital nursing intervention will have increased in total mean knowledge score than control group.

H2. Patients with MS who received digital nursing intervention will have a significant improvement in daily living activities score than control group.

H3. Patients with MS who received digital nursing intervention will have improved in treatment adherence score than control group.

Operational definition

Multiple sclerosis: It is a chronic degenerative disease where immune system combats itself leading to damage of central nervous system and myelin sheaths causing long-standing disability particularly among young adult **(Waubant et al., 2019)**.

Digital nursing intervention refers to a variety of technologies that is used to provide care to patients at home **(Groppo et al., 2019).** It is operationally defined as the use of digital tool to offer nursing intervention at a distance through creating a participatory platform to educate patients with MS through multimedia using a combination of texts, audios, videos, comprehensive activation, reproducibility, and feedback to enhance performance of daily living activities and treatment adherence.

Daily Living Activities means activities that are essential to an individual's care as getting into and out of bed and chairs, transferring, stair climbing, dressing, eating, toileting, bathing, and grooming **(Marisa et al., 2021).** It is operationally defined as a person's ability to perform ADLs that is used as a measure of the functional capabilities during disease course. It was measured by using Modified Barthel Index.

Treatment Adherence refers to that a patient is following the recommended course of prescribed treatment and coming for scheduled exams and tests for follow up **(Li et al., 2020).** It is operationally defined as the ability of the

patient to follow all instructions regarding treatment as nutrition, physical activity and prescribed medication. It was measured by using Morisky Medication Adherence Rating Scale, nutritional adherence and physical activity adherence.

Adult refers to the era of life between adolescence and old age, which ranges from 18 to 64 years, based on the stages, ages, and even tasks that are established. (**Erçetin, Açıkalın& Güngör, 2016).**

Subjects and methods:

Research design

Quasi-experimental (case & control group-pre/ posttest) research design was utilized for the present study.

Research setting

The current study was carrying out at Neurological outpatient clinic at University Hospital in Shebin El –Kom, Menofia Governorate, Egypt. Neurological outpatient clinic is located in the first floor and comprised of one room with a bed. This setting was chosen because patients with MS attended in order to receive care, determine their disease progress and followed up.

Sample

A purposive sample of 80 adult patients diagnosed with multiple sclerosis from previously mentioned setting was taken. The patients were divided randomly into two equal groups (40 patients in each group whether study or control group). Study group get digital nursing intervention combined with routine hospital care and control group get routine hospital care only.

Inclusion criteria:
- Adult patients from 18-64 years of age
- Patients have ability to communicate verbally
- Patients able to provide a written informed consent
- Patients read and write
- Patients have smart phone and able to use digital technology
- Patient who not attending any previous training session related to multiple sclerosis

Exclusion criteria:
- Patients with severe complications such as bed redden patient
- Patients with physically, psychologically and socially disorder
- History of psychiatric disorders.
- Patients who can't use digital technology

Calculation of the sample size:

A total of (80) adults diagnosed with multiple sclerosis were selected and calculated at power of 80% and confidence level 95% according to the following formula.

$$n = (Z_{\alpha/2}+Z_{\beta})^2 * (p_1(1-p_1)+p_2(1-p_2)) / (p_1-p_2)^2$$

Where

Zα/2 refers to the critical value of the normal distribution at α/2 and n is sample size, Zβ indicates the critical value of the normal distribution at β, P1 indicates the proportion in group 1, P2 is proportion in group 2, and Z is z score, α is the level of significance, β is false negative result.

In the current study, results were presented using 95% confidence Interval, with 78, which was approximated to 80 participants as sample size.

Instruments of the research

Three instruments were used by the researchers to collect data needed for the current study. It included the following:

Instrument I. Structured Interviewing Questionnaire: -

The researchers constructed this instrument after revising the related studies. It consisted of three parts, as the following: -

Part (1): Patients' Socio demographic data: It included data about patient's age, gender, marital status, educational level, occupation, residence, number of family memeber as well as monthly income.

Part (2): Patients' medical history: It consisted of five questions as type of MS, disease duration, frequency of disease attack in last year, presence of chronic disease, and family history of multiple sclerosis.

Part (3): Patient's knowledge regarding multiple Sclerosis: the researchers constructed this part to identify patients' knowledge about disease. It is consisted of 20 multiple choice questions as: definition,

incidence, risk factors, sign and symptoms, diagnosis …etc.

Scoring system for knowledge: The gained knowledge was compared with a model answer and patients` responses were scored as the correct answer = one point and the incorrect answer = zero point. The total score ranged from 0-20 points and catigorized into two levels as the following :

- Satisfactory level of knowledge ≥ 70% (14-20 points).
- Unsatisfactory level of knowledge <70% (0-13 points) (**Eyas et al., 2021**).

Reliability of the Instrument I:

Reliability of part (3) of the instrument I was tested by the researchers to determine internal consistency. Test-retest method was used by administrating of the instrument to MS patients. Then, after 2 weeks the researchers re-administered the identical instrument to them and compared the results. The instrument was reliable (r = 0.89).

Instrument II: Modified Barthel Index (MBI) scale:

Modified Barthel Index scale was adapted from **Tomoko et al. (2017)** to assess ability of patient with functional disabilities in performing activities of daily living. It is used by the researchers to determine functional status of patients with MS through evaluating dependency level in performing daily living activities. This scale is consisted of ten categories as feeding, dressing, personal hygiene, bathing, chair/ bed transfer, mobility, using stairs, toilet use, bowel and bladder. It was used in 3times as pre intervention, post 3 and six months of digital nursing intervention.

Scoring system:

The scoring system of adult patients' dependency level regarding performance of DLAs was computed as (0) point indicated dependent level , (1) point indicated need help in performance and (2) points indicated independent level. The total score of the scale ranged from 0-20 and classified as follows: (0-6 points) allocated for completely dependent, (7-13 points) allocated for partially dependent, and (14-20 points) allocated for independent. The higher scores reflect the higher performance of DLAs **(Dehghani, Mahsa, and Shahsavari , 2019).**

Reliability of instrument II

Reliability of MBI scale was done to identify to what extent the items of the scale were linked to each other. Cronbach's co-efficiency Alpha was used to test the internal consistency. The instrument was tested by **Dehghani, Mahsa, and Shahsavari , (2019**) and ascertained to be strongly reliable (r = 0.96)

Instrument (III): Multiple Sclerosis Treatment Adherence Questionnaire (MSTAQ)

This instrument was developed by **Wicks et al., (2011**). It is a self-reported tool for identifying patient's ability to adhere to treatment. It is consisted of 29 items that divided into three parts as dietary adherence (15 items), physical activity adherence (6 items), and medication adherence (8 items) as the following:

Part (1): Dietary adherence questionaire: This questionnaire adapted from **(Salime, Elzeheri &Ibrahim, 2022)** to assess dietary adherence among MS patients**.** it included 15 self-reported questions about adherence to health diet as : eat healthy food free from fats, eats vegetables and fruits, eats foods rich in vitamin B, drink 2 liters of water daily, use plants oil, Avoids cola, café, …etc.

This part was valued on a three-point rating scale "always" =three points, "sometimes" =two points, and "rarely" = one point. The total score of the questionnaire ranged from 0-45 and categorized as follows: Higher dietary adherence >80% with scores ranged from 37-45 points, moderate dietary adherence 60 - 80% with scores ranged from 27-36 points, and mild dietary adherence < 60% with score ranged from 1-26 points. **(Panagiotis et al., 2022**).

Part (2): Physical activity adherence questionaire: this questionnaire was used to assess physical activity adherence among MS patients. It is adapted from (**Alkahtani et al., 2023).** it included 6 self-reported questions as perform exercises at least 30 minutes daily, perform exercises that strengthen the muscles, avoid violent sport,……etc.

This part was assessed on a three-point rating scale "always" = three points, "sometimes" = two points, and "rarely" = one point. The total score the questionnaire ranged from 0-18 and classified as following: Higher adherence >80% with scores ranged from 15-18 points, moderate adherence 60 - 80% with scores ranged from 11-14 points, and mild adherence < 60% with score ranged from 1-10 points. **(Alkahtani et al., 2023**).

Part (3): Morisky Medication Adherence Rating Scale (MMARS). This scale adapted from Morisky (2008). It is composed of self-reported 8 questions to address medication adherence concerns among MS patients such as forgetting to take medication , discontinuing medication without guidance, feeling hassled about adherence to treatment plan….etc

The response of the first seven items is Yes / No. Each Yes response = Zero point and No response = one point. The total score ranged from 0- 8, with scores 8 reflect high adherence, while 7 or 6 reflect medium adherence and <6 reflect low adherence.

Scoring system of Multiple sclerosis treatment Adherence questionnaire

The total score of three parts (dietary adherence, physical activity adherence, and medication adherence) were 71 points. The higher scores indicated higher treatment adherence. They were categorized as:

- Higher adherence >80% with scores ranged from 57-71 points.
- Moderate adherence 60 - 80% with scores ranged from 43-57 points.
- Mild adherence < 60% with score ranged from 1-42 points. **(Kazemi et al., 2022**).

Reliability of instrument III

Reliability of instrument III was done to identify relation between the items of scale. Cronbach's co-efficiency Alpha was used to check internal consistency. The instrument was tested by **Wicks et al., (2011**) and showed to be reliable (r = 0.90).

Validity of the instruments

After developing the instruments of this study and before data collection. All Instruments were tested for content validity by five experts (three experts from community health nursing and two experts from medical surgical nursing) to determine accuracy and completeness of instruments to be implemented. The needed modifications and suggestions were integrated into the instruments.

Ethical considerations and the human rights:

Necessary approval to accomplish the research was taken from ethical committee at the Faculty of Nursing, Menoufia University conducted on **June 21, 2023, with registered number (N:985)**. The written consent of patients who agreed to participate was gotten after giving simple explanation of study aim and its importance. The patients were assured the confidentiality of the gained information. In addition, they informed that participation in the current study was completely optional, and they can withdraw from the study at any time. Coding of data was done to confirm its anonymity and confidentiality.

Pilot study

The research instruments was applied on 10% (eight adult patients diagnosed with MS) of the total sample size to evaluate feasibility, clarity, applicability and objectivity, and to determine needed time to response to all the questionnaire. According to pilot study results, no modifications were required to be made in the study instruments. Pilot sample was excluded from total sample to confirm the strength of study results.

Procedure of data collection

- The Official permission that required to enter the selected setting and collected data related to the current study was gotten from the director of University Hospital at Menoufia governorate, Egypt. After that, the researchers gave a simple explanation about the permission taken and the purpose of the present study to physicians and nurses worked in neurological outpatient clinic to gain their cooperation.
- Data collection took about one year from 1st June 2022 to 1st June 2023.
- The researchers performed an exploratory visit to neurological outpatient clinic in the selected setting to identify numbers of patients with MS and determine the suitable time to collect research data. The researchers visited the clinic in University Hospital from 9:11 Am, 2 days/week (Sunday and Wednesday) as the neurological outpatient clinics specifies these

days for patients with neurological problems as MS and for follow up them continuously until improvement. The researchers met about seven to eight patients a week from selected setting (3-4 patients per visit) for data collection.

- At neurological outpatient clinics, the researchers identified the patients who fulfilled inclusion criteria and requested to join in the study. Once a trusting relationship was built, study's aim was clarified. The patients with MS were randomly allocated into two equal groups: the study group coded with odds number and their data was collected on all Sunday while the control group coded with even numbers and their data was collected on all Wednesday.
- The researchers presented themselves to the patients, obtained their written informed consent, provided simple summary about the present study, its purpose, acquired benefits from participation, then interviewed each patient individually using data collection questionnaire, the interview took about 30-35 minutes to fill baseline data (pretest).
- After that, the study group's, phone numbers were taken, recorded and then added to a Whats App group to enable communication during the period of the study. Each patient in the study group was requested to download Zoom mobile application and then, the timetable was putted with the patient for joining Zoom sessions.
- The collection of baseline assessment (pretest) took about three months.
- **For study group**, Zoom video sessions were undertaken and healthy instructional messages were sent to them via WhatsApp group to motivate the adherence to the provided nursing intervention.
- The patients in the study group received digital nursing intervention regarding MS. The researchers used various teaching methods in implementation of the intervention; these methods comprised video educational sessions regarding MS with PowerPoint presentation and group discussion.
- The digital nursing intervention consisted of virtual conversation using digital tools that comprised four video and audio educational sessions via zoom mobile application. Zoom mobile application was chosen to be used in the current study because it is compatible with IOS and Android mobiles, free, easy to be used, common as well as it facilitated audio and video calls.
- In addition, digital nursing intervention included online support intervention educational booklet regarding MS disease, causes, and management ….etc. It was designed by the researchers after evaluating the evidence- based research and inclusive literature. Designed booklet was evaluated by experts in both medical-surgical and community health nursing. The booklet was written in simple Arabic language included illustrative pictures regarding MS disease. It was applied in this study in order to support the patients to have more knowledge on management of disease and promote self-practice about the disease and its management.
- Before starting the sessions, the researchers divided the study group into five groups (8 patients in each group) according to the patient available time to facilitate understanding, and re- demonstration of sessions.
- The researchers conducted digital nursing intervention with each of five groups through four sessions that provided for four consecutive weeks as the following:
  - **1st session**: This session included information about MS as definition, causes, manifestations, treatment,….etc. These instructions were supplemented by presentation, and sound.
  - **2nd session:** In this session, the researchers used video and presentation through smart phone to demonstrate how to conserve energy and allow them to able to do activities of daily living as possible such as install grab bars in the bathroom. Beds, chairs, and toilet seats should be easier to rise from if they are high. Raising a desk or table is important to enhance sitting posture and also provide a surface in order to stabilize arms to improve the coordination and reduce tremor…..etc.
  - **3rd session:** This session included knowledge about nutrition as certain types of food described to manage disease progression and minimize the MS symptoms that affect quality of life**.** Instructed patient's to eat all fresh fruits and vegetables, diet rich with Omega 3, provided guidelines on avoided food. ……..etc .In addition, the researchers gave knowledge about allowed exercise as walking, avoided exercise, exercise to strength bone ….etc.

- **4th session**: this session included demonstrate how to use the prescribed medication (action, side effect, precaution, and contraindication,….etc) and importance of adherence. It supplemented by an illustrative guidance using video and presentation.

- Each session took about 25-35 minutes according to patients, level of understanding. Following each session, complete summary of the given knowledge, the comments, the feedback and the clarifications of missed items were provided. Also, the patients were tested for acquisition of knowledge and practice.
- Before beginning the following session, group discussion and redemonstration was done with the patients regarding the previous session to identify their understanding as regard to the provided instructions; any ambiguous items were re-explained by the researchers.
- After concluding the sessions, the researchers clarified the importance of following the nursing intervention to improve performance of daily living activities and adherence to MS treatment. Then, a copy of the online support intervention educational booklet was sent via a link on WhatsApp to the study group to serve as a guide for them.
- The researchers monitored each patient in study group via one telephone call per month and also followed up through WhatsApp group to check their adherence to nursing instructions that given via the Zoom sessions and determine their improvement. Also, the researchers assured on the significance of follow-up and scheduled a follow-up visit for study groups at the neurological outpatient clinic at Menoufia university hospital after three months and six months post intervention.
- **For control group**: after interviewing at neurological outpatient clinic, patients were motivated to follow up at the hospital to receive routine care. They were not received any intervention by the researchers. Their phone numbers were taken and then added to a WhatsApp group to be reached every week in order to maintain contact.
- **Posttest session:** After 3 months & 6 months post intervention, the researchers used whatsApp groups to organize with the study and control patients the time of following up at neurological outpatient clinic to determine their progress and filling posttest. Posttest included instruments; I (part 3), II, & III that was used in the pre intervention to assess the effect of digital nursing intervention and compare the results. Filling the questionnaire took about 25-30 minutes to be fulfilled. Then a copy of the developed booklet was sent to the patients in the control group via WhatsApp group to serve as guidance for them.

Statistical Methods:

SPSS program version 22 was used for numerical data that were collected, coded and computerized. Number and percentage expressed qualitative data while means ± SD expressed quantitative data. An independent T-test was used to compare mean changes in data between study and control groups' pre intervention, 3 months and 6 months' post intervention. Correlation between study variables was calculated using Pearson's correlation coefficient (r). Excel program was used to do Graphics. Significance level was stable at p value ≤ 0.05 for all significant tests.

Results

Table (1) clarifies that the mean age for the study group was 34.52 ±6.41, while for the control group was of 34.15±5.6. Regarding to sex, 65 % of the study group compared to 67.5 % of the control group were females. In relation to educational level, 50% and 55% of the study group and control group respectively had secondary education. Concerning to marital status, 55% of study group and 60 % of control group were married. In relation to residence, 75% and 70% of study and control groups respectively were from rural areas. Regarding to occupation, 67.5% and 62.5% of the study and control group respectively were employed. As regard to the monthly income, 60% of study group and 52.5 % of control group had not enough monthly income. Regarding number of family members, 72.5% of the study group and 77.5% of the control group had 4-7 members, The results reveals that there was no significant differences between study group and control group regarding all socio demographic data ($p > 0.05$).

Table (2) reveals that 77.5% and 72.5% of study group and control group had relapsing–remitting type of multiple sclerosis respectively. The mean of disease duration in study group was 2.92 ± 1.47 and in control group was 2.85±1.23. Also, the table presents that the mean of disease attack frequency in last year was 1.82 ± 0.675 in study group while in control group was 1.92 ± 0.708. Regarding to presence of chronic disease, it

shows that 77.5% of study group and 72.5% of control group had not chronic disease. In addition, 90 % and 85% of study group and control group respectively had family history of multiple sclerosis. The result indicates that there was no significant differences between both study and control group regarding all items of medical data ($p > 0.05$).

Figure (1) shows that, the total mean score of knowledge pre digital nursing intervention in the study group was 9.3 that improved to 14.6 post 3 months and to 18.2 post 6 months from implementation of digital nursing intervention. While in control group, total mean score of knowledge pre intervention was 8.6 that slightly increase to 9.1 post 3 months and to 9.8 post 6 months from implementation of intervention. This reveals that there was no statistical significance difference between both groups at pre-intervention. Moreover, a statistical significant difference was observed between study and control groups at posttest of knowledge about multiple sclerosis.

Table (3) displays a highly statistical significant differences among study group than that of control group at all items of DLAs pre, post 3 months, and post 6 months from implementation of digital nursing intervention ($p<0.001$). It shows that, the highest percentages of (independent) among study group were observed (67.5% and 65%) and (77.5% and 75%) in relation to bathing and bowel control post 3 months and post 6 months from implementation of digital nursing intervention respectively.

Figure (2) shows that, the independent level pre digital nursing intervention in the study group was 12.5% that improved to 57.5% post 3 months and to 67.5% post 6 months from implementation of digital nursing intervention. While in control group, independent level pre intervention was 10% that increase slightly to 15% post 3 months and to 22.5% post 6 months from implementation of intervention. This reveals that no statistical significance difference between both groups at pre-intervention. Moreover, a statistical significant difference was occurred between study and control groups at dependency level in performance of daily living activities post intervention.

Table (4) presents that, the total mean score of dependency level pre digital nursing intervention in the study group was 6.42±3.18 that improved to 15.82±4.24 post 3 months and to 17.07±3.96 post 6 months from implementation of digital nursing intervention. While in control group, total mean score of dependency level pre- intervention was 6.25±2.95 that slightly increase to 8.07±3.79 post 3 months and to 8.67±4.28 post 6 months from implementation of intervention. There was a highly statistical significant improvement among study group than that of control group at the total mean scores of dependency level at (post 3 months and post 6 months) from implementation of digital nursing intervention ($P<0.001$).

Table (5) illuminates that, there was a highly statistical significant improvement among study group than that of control group at the total mean scores of main items of treatment adherence at (post 3 months and post 6 months) from implementation of digital nursing intervention ($P<0.001$). The highest mean score was in nutrition dimension followed by physical activity adherence, and then medication adherence. Also, the table shows that, the total mean score of treatment adherence pre digital nursing intervention in the study group was 41.52±5.00 that improved to 54.67±6.17 post 3 months and to 57.47±6.51 post 6 months from implementation of digital nursing intervention. While in control group, total mean score of treatment adherence pre- intervention was 40.87±4.91 that slightly increase to 42.87±5.12 post 3 months and to 43.15±5.50 post 6 months from implementation of intervention. This indicates that, a highly statistical significance difference was found among study group than in control group at the total mean scores of treatment adherence at post 3 months and post 6 months from implementation of digital nursing intervention ($P<0.001$).

Figure (3) shows that, the high treatment adherence pre digital nursing intervention in the study group was 2.5% that improved to 60% post 3 months and to 75% post 6 months from implementation of digital nursing intervention. While in control group, high treatment adherence at pre intervention was 2.5% that slightly increase to 7.5% post 3 months and stilled at 7.5% post 6 months from implementation of intervention. This reveals that there were no statistical significance differences between both groups at pre intervention. Moreover, statistical significant differences were found between both groups in treatment adherence post intervention.

Table (6) represents correlation between knowledge of the studied groups and dependency level of DLAs and treatment adherence (pre, post 3 months and post 6 months). It indicates that, a

statistical positive correlation was found between studied patients' knowledge level and their total dependency level of DLAs ($p < 0.05$). Also, it illustrates that , a statistical positive correlation was occurred between studied patients' knowledge level and their total treatment adherence at pre, post 3 months, and post 6 months from implementation of digital nursing intervention ($p<0.05$).

Table (1): Distribution of the studied patients (study and control groups) according to their socio-demographic characteristics (n=80).

Socio-demographic data	The study sample (n=80)					
	Study group (n=40)		Control group (n=40)		Test of sig. t/χ^2	P-value
	n	%	n	%		
Age (years)						
18-	6	15.0	7	17.5		
30-	25	62.5	23	57.5	0.213	0.899
40-50	9	22.5	10	25.0		
Min. – Max	20-47		21-46		0.277	0.783
Mean ± SD.	34.52 ± 6.41		34.15±5.67			
Sex						
Male	14	35	13	32.5	0.056	0.813
Female	26	65	27	67.5		
Educational level						
Basic education	8	20.0	7	17.5	0.205	0.902
Secondary education	20	50.5	22	50.5		
University education & more	12	30.0	11	27.5		
Marital status						
Single	6	15.0	7	17.5		
Married	22	55.0	24	60.0	0.608	0.895
Divorced	7	17.5	5	12.5		
Widowed	5	12.5	4	10.0		
Residence						
Urban	10	25.0	12	30.0	0.251	0.617
Rural	30	75.0	28	70.0		
Occupation						
Employed	27	67.5	25	62.5	0.220	0.639
Un employed	13	32.5	15	37.5		
Monthly income						
Not enough	24	60.0	21	52.5	0.640	0.726
Enough	12	30.0	13	32.5		
Enough & save	4	10.0	6	15.0		
No. of family members:						
< 4	8	20.0	7	17.5	0.333	0.846
4-7	29	72.5	31	77.5		
>7	3	7.5	2	5.0		

Table (2): Frequency distribution of medical data of the studied patients (study and control groups) (n=80).

Medical data	The study sample (n=80)					
	Study group (n=40)		Control group (n=40)		Test of sig. t/χ^2	P-value
	n	%	n	%		
Type of multiple sclerosis						
Relapsing remitting	31	77.5	29	72.5		
Secondary progressive	7	17.5	8	20.0	0.333	0.846
Primary progressive	2	5.0	3	7.5		
Disease duration (years)						
< 1 years	10	25.0	7	17.5	0.744	0.689
1-5 years	27	67.5	29	72.5		
5-10 years	3	7.5	4	10.0		
Min. – Max	1-6		1-5		0.247	0.806
Mean ± SD.	2.92 ± 1.47		2.85±1.23			
Frequency of disease attack in last year						
None	12	30.0	10	25.0		
1-2 times	24	60.0	26	65.0	0.795	0.851
3-4 times	3	7.5	2	5.0		
5 times & more	1	2.5	2	5.0		
Min. – Max	0-5		0-5		0.485	0.629
Mean ± SD.	1.82 ± 0.675		1.92 ± 0.708			
Presence of chronic disease						
Yes	9	22.5	11	27.5	0.267	0.606
No	31	77.5	29	72.5		
Family history of multiple sclerosis						
Yes	36	90.0	34	85.0	0.457	0.499
No	4	4.0	6	15.0		

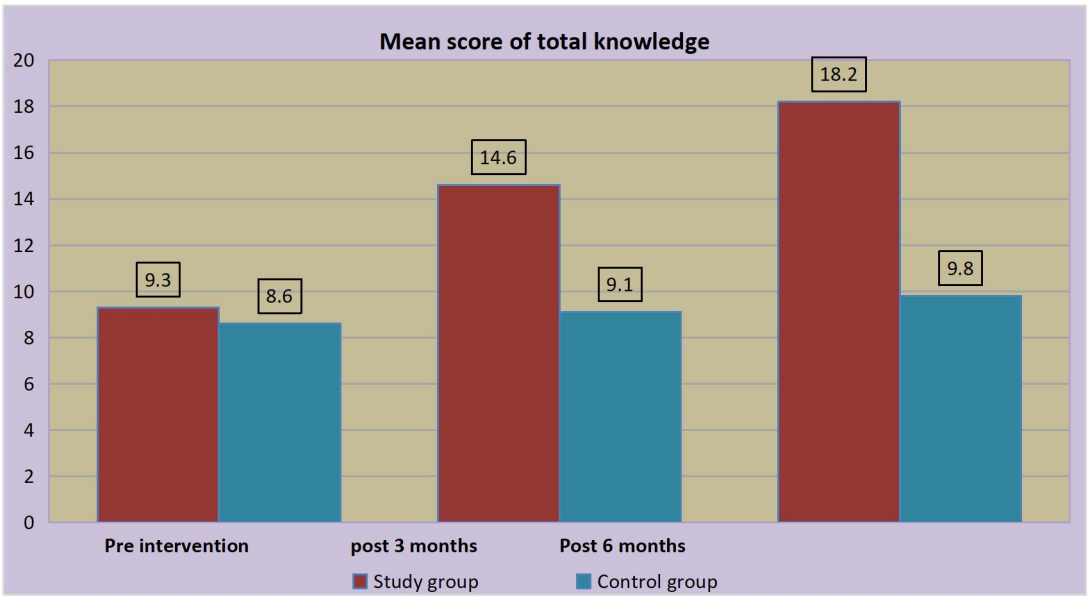

Figure (1): Effect of digital nursing intervention (pre, post 3 months and post 6 months) on total mean score of knowledge regarding multiple sclerosis among the study and control groups (n=80).

Table (3): Frequency distribution of the studied patients (study and control group) regarding their performance of daily living activities pre, post 3 months , and post 6 months from implementation of digital nursing intervention (n=80)

Activities of daily living	Dependency level	Pre intervention				X^2 P-value	3 months post intervention				X^2 P-value	3 Monthspost intervention				X^2 P-value (1)
		Study group (40)		Control group (40)			Study group (40)		Control group (40)			Study group (40)		Control group (40)		
		No	%	No	%		No	%	No	%		No	%	No	%	
Feeding	-Dependent	22	55	21	52.5	0.268 (0.875)	2	5	20	50	12.907 (0.002**)	0	0	19	47.5	22.228 (0.000**)
	-Partially dependent	12	30	14	35		20	50	13	32.5		15	37.5	13	32.5	
	-Independent.	6	15	5	12.5		18	45	7	17.5		25	62.5	8	20	
Dressing	-Dependent	20	50	22	55	0.950 (0.622)	4	10	21	52.5	18.019 (0.000**)	1	2.5	22	55	24.122 (0.000**)
	- Partially dependent	13	32.5	14	35		12	30	13	32.5		13	32.5	12	30	
	-Independent	7	17.5	4	10		24	60	6	15		26	65	6	15	
Personal hygiene	-Dependent	20	50	20	50	0.125 (0.939)	5	12.5	18	45	15.249 (0.000**)	3	7.5	16	40	17.767 (0.000**)
	-Partially dependent	15	37.5	14	35		13	32.5	15	37.5		11	27.5	15	37.5	
	-Independent.	5	12.5	6	15		22	55	7	17.5		26	65	9	22.5	
Bathing	-Dependent	17	42.5	16	40	0.222 (0.895)	5	12.5	14	35	13.130 (0.001*)	2	5	13	32.5	17.764 (0.000**)
	-Partially dependent	15	37.5	17	42.5		8	20	15	37.5		7	17.5	14	35	
	-Independent.	8	20	7	17.5		27	67.5	11	27.5		31	77.5	13	32.5	
Chair/ bed Transfer	-Dependent	21	52.5	21	52.5	0.175 (0.916)	8	20	20	50	18.214 (0.000**)	5	12.5	19	47.5	23.661 (0.000**)
	-Partially dependent	16	40	15	37.5		9	22.5	15	37.5		8	20	15	37.5	
	-Independent	3	7.5	4	10		23	57.5	5	12.5		27	67.5	6	15	
Mobility	-Dependent	17	42.5	19	47.5	0.251 (0.885)	6	15	17	42.5	11.653 (0.003*)	3	7.5	14	35	13.554 (0.001**)
	-Partially dependent	18	45	17	42.5		14	35	16	40		10	25	14	35	
	-Independent	5	12.5	4	10		20	50	7	17.5		27	67.5	12	30	
Using stairs	Dependent	20	50	20	50	0.115 (0.944)	5	12.5	17	42.5	14.137 (0.001**)	4	10	15	37.5	16.010 (0.000**)
	-Partially dependent	15	37.5	14	35		12	30	15	37.5		10	25	16	40	
	-Independent	5	12.5	6	15		23	57.5	8	20		26	65	9	22.5	
Toilet use	-Dependent	17	42.5	18	45	0.061 (0.970)	5	12.5	16	40	13.591 (0.001**)	3	7.5	14	35	16.313 (0.000**)
	-Partially dependent	16	40	15	37.5		12	30	16	40		10	25	16	40	
	-Independent.	7	17.5	7	17.5		23	57.5	8	20		27	67.5	10	25	
Bowels control	-Unable to control	17	42.5	17	42.5	0.065 (0.968)	4	10	14	32.5	13.729 (0.001**)	2	5	13	32.5	17.911 (0.000**)
	-Occasional	15	37.5	14	35		9	22.5	15	45		8	20	15	42.5	
	-Control bowel	8	20	9	22.5		27	67.5	11	22.5		30	75	12	25	
Bladdercontrol	- Unable to control	14	35	13	32.5	0.214 (0.899)	4	10	13	32.5	10.923 (0.004**)	3	7.5	11	27.5	14.814 (0.001**)
	- Occasional	14	35	16	40		10	25	15	37.5		7	17.5	16	40	
	-Continent	12	30	11	27.5		26	65	12	30		30	75	13	32.5	

** Highly statistically significant difference ($p<0.001$)

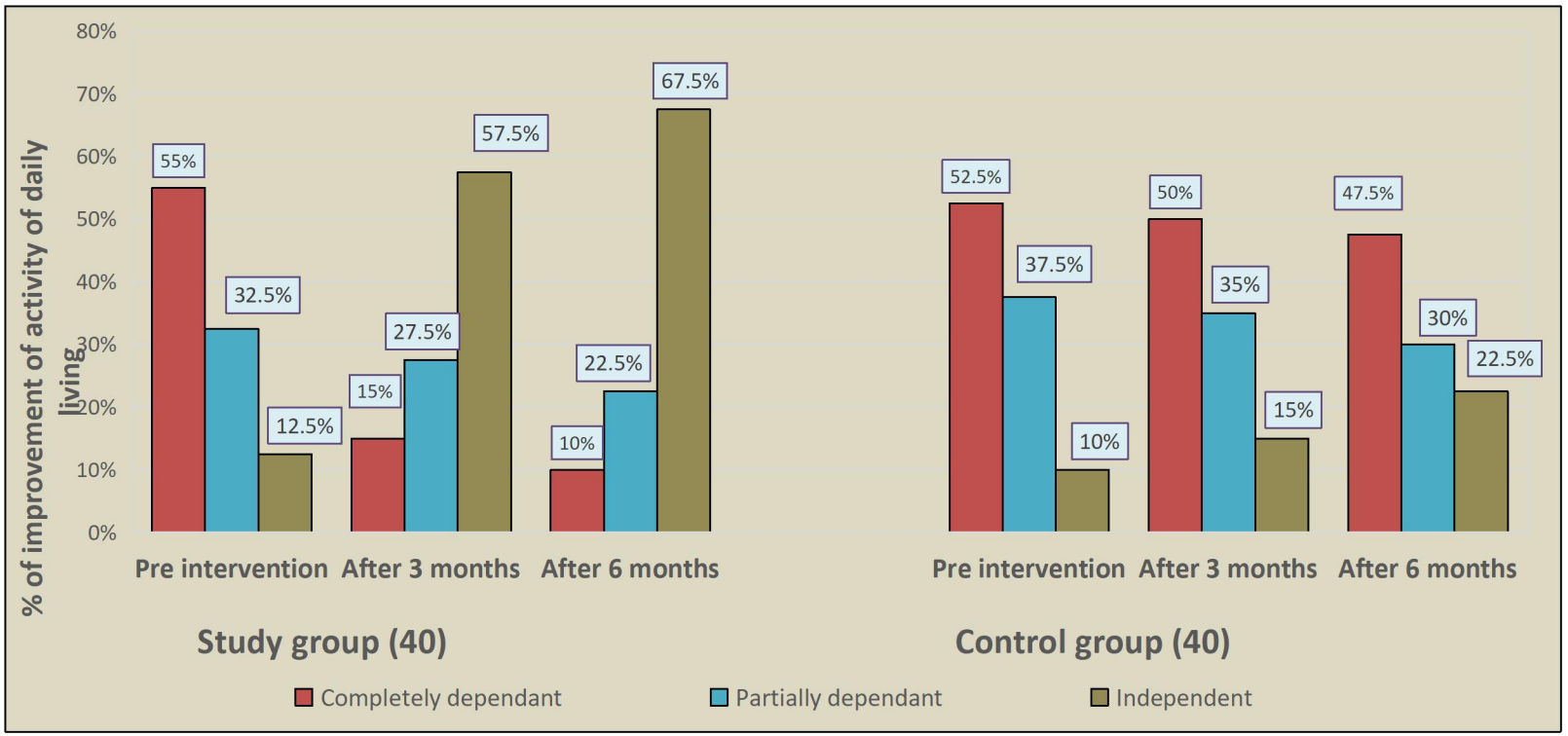

Figure (2): Percentage distribution of the studied patients (study and control group) in relation to their total dependency level in performance of daily living activities pre, post 3 months , and post 6 months from implementation of digital nursing intervention (n=80)

Table (4): Effect of digital nursing intervention (pre, post 3 months and post 6 months) on total mean score of dependency level of daily living activities among the study and control groups (n=80).

Variables	Pre intervention		t-test	P-value	3 months post intervention		t-test	P-value	6 Months post intervention		t-test	P-value
	Study group (40)	Control group (40)			Study group (40)	Control group (40)			Study group (40)	Control group (40)		
	Mean± SD	Mean± SD			Mean± SD	Mean± SD			Mean± SD	Mean± SD		
Total mean scores of dependency level of daily living activities	6.42 ±3.18	6.25±2.95	0.255	0.80	15.82±4.24	8.07±3.79	8.608	0.000*	17.07±3.96	8.67±4.28	9.099	0.000*

**Highly statistically significant difference (p<0.001)

Table (5): Effect of digital nursing intervention (pre, post 3 months and post 6 months) on total mean score of treatment adherence among the study and control groups (n=80).

Variables	Pre intervention		t-test	P-value	3 months post intervention		t-test	P-value	6 Months post intervention		t-test	P-value
	Study group (40)	Control group (40)			Study group (40)	Control group (40)			Study group (40)	Control group (40)		
	Mean± SD	Mean± SD			Mean± SD	Mean± SD			Mean± SD	Mean± SD		
Nutritional adherence	30.30±4.52	30.17±4.45	0.125	0.901	36.77±4.70	30.90±4.67	5.601	0.000*	38.40±4.91	30.72±4.89	6.996	0.000*
Physical activity adherence	6.82±2.15	6.45±1.55	0.892	0.375	11.10±2.85	7.57±2.58	5.794	0.000*	11.97±2.91	7.95±2.63	6.485	0.000*
Medication adherence	4.40±2.25	4.25±2.09	0.305	0.759	6.80±1.45	4.40±2.36	5.473	0.000*	7.10±1.51	4.47±2.43	5.782	0.000*
Total mean scores of Treatment adherence	41.52±5.00	40.87±4.91	0.586	0.559	54.67±6.17	42.87±5.12	9.308	0.000*	57.47±6.51	43.15±5.50	10.619	0.000*

**Highly statistically significant difference (p<0.001)

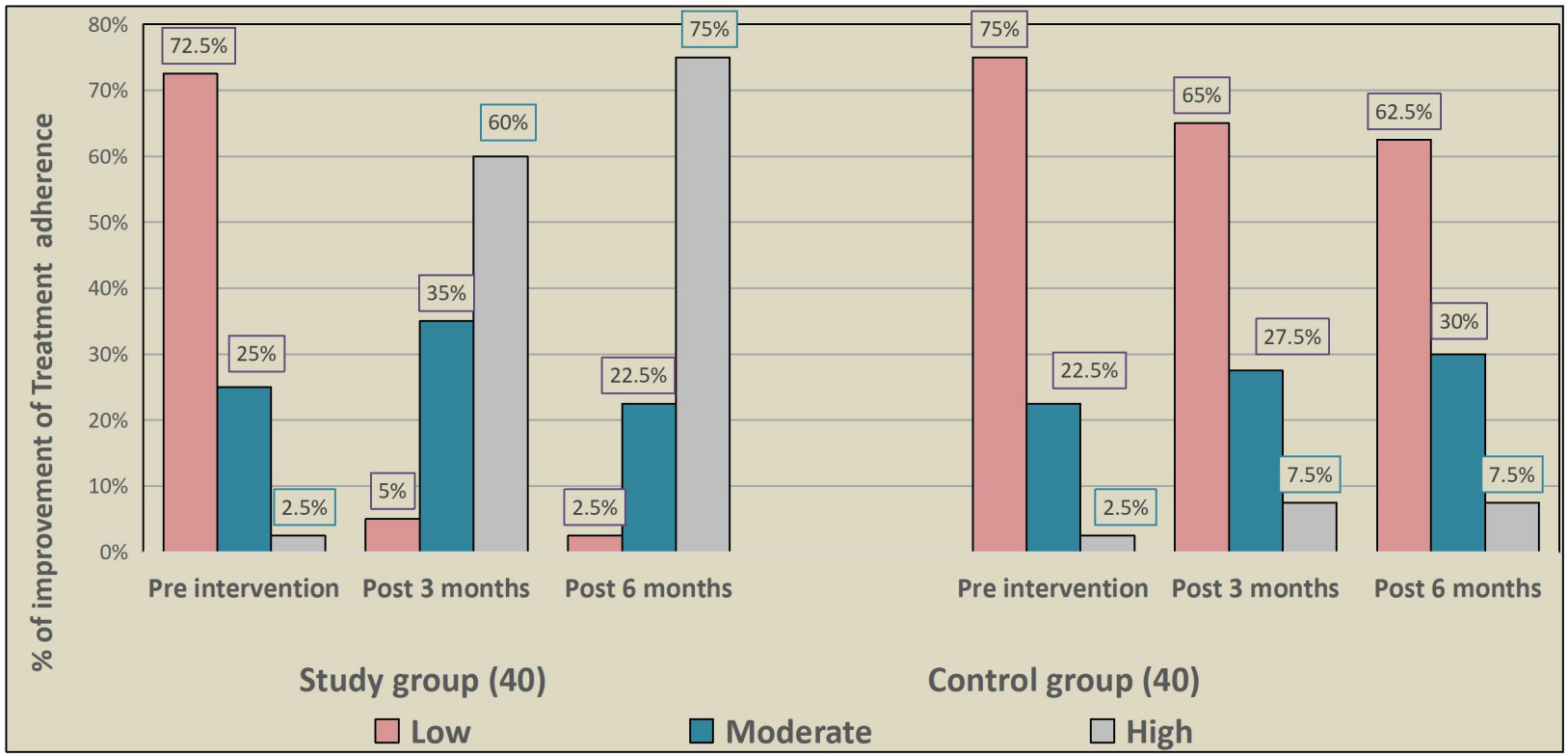

Figure (3): Percentage distribution of the studied patients (study and control group) regarding their total treatment adherence pre, post 3 months , and post 6 months from implementation of digital nursing intervention (n=80)

Table (6): Correlation between knowledge of the studied groups and total dependency level of daily living activities and treatment adherence (pre, post 3 months and post 6 months) (n=80)

Variables	Knowledge about multiple sclerosis (n=80)					
	Pre intervention (n=80)		3 months post intervention (n=80)		6 Months post intervention(n=80)	
	r	P	r	P	r	P
Dependency level in daily living activities	0. 228	0.04*	0.345	0.002*	0.497	0.000*
Treatment adherence	0.351	0.001*	0.572	0.000*	0.606	0.000*

***Significant & (p<0.05)**

Discussion

Multiple sclerosis is a disabling progressive neurological disease that affecting individual's brain and spinal cord. Multiple sclerosis has a great effect on patient's performance of daily living activities, quality of life, and general health status. However, adherence to treatments improves recovery from MS attacks, modify disease progress and manage its symptoms. (**Kimberlyn et al., 2023.)**. The MS patients have little knowledge about disease and its treatment. So, Digital nursing intervention is effective in maintaining and promoting health of patients with MS through the use of digital tool as smartphone program in order to increases patient's knowledge regarding disease which reduce adverse outcomes, enhance their adherence to treatment, and improve performance of daily living activities. (**Üstündağ, Yeşilbalkan , & Kabay., 2024**).

According to study hypothesis No (1) :Patients with MS who received digital nursing intervention will have increased in total mean knowledge score than control group

Focusing on the effect of digital nursing intervention on total mean score of knowledge regarding multiple sclerosis, the current study indicated that, total mean score of knowledge in the study group was 9.3 pre intervention that increased to 14.6 after 3 months and to 18.2 after 6 months post intervention. While in control group, total mean score of knowledge pre intervention was 8.6 that slightly increase to 9.1 post 3 months and to 9.8 post 6 months from implementation of intervention (figure 1). This findings was consistent with **Abozeid et al., (2023)** who stated that total mean score of knowledge regarding MS was 20.16 ± 7.95 pre implementation of intervention which increased to 39.55 ± 6.11 post intervention. Also, This finding was congruent with **Tkáčová, (2020),** who showed that, after the intervention, total mean score of knowledge about MS was higher in the study group than in the control group. This similarity might related to the simplicity of language used during educational sessions facilitates the understanding by the study sample which leads to improve in their knowledge regarding MS.

The current study stated that there was a statistical significant difference was found between study and control groups at posttest knowledge about multiple sclerosis. This finding was similar with **Abd Elsalam & Ali., (2022);** who indicated that a statistically significant improvement regarding MS related knoweldge among the patients at post1 & post2 after carrying out of self-management guidelines**.** Also, this finding was consistent with **Salime, Elzeheri &Ibrahim, (2022)**; they reported that, After implementation of nursing intervention, a highly statistically significant improvements were found in mean scores in all items of knowledge among the MS patients. In addition, this result agreed with **Saad & Elsayed, (2021);** who revealed that a statistically significant improvement in knowledge about MS among studied sample at post program implementation than preprogram implementation**.** This consistency could be related to that digital nursing intervention using educational sessions was effective in improving knowledge of patients with multiple sclerosis.

According to study hypothesis No (2): Patients with MS who received digital nursing intervention will have a significant improvement in daily living activities score than control group

Concerning to the effect of digital nursing intervention on performance of daily living activities. This study clarified that a highly statistical significant differences was observed among study group than control group at all items of daily living activities pre, post 3 months, and post 6 months from carrying out of digital nursing intervention ($p<0.001$). The independent percentages was high in relation to bathing and bowel control post 3 and post 6 months from implementation of digital nursing intervention (Table 3). The study was in the same line with **Kimberlyn et al., (2023).** They reported that a statistical significant improvement in ADLs was occurred among study sample post home- based program implementation than pre implementation ($p<0.001$). Also, this finding was in similarity with **Mohammadzadeh, Haghgoo, & Biglarian., (2020).** They revealed that no significant difference was found among study and control group regarding ADLs at pre intervention, while at post intervention of physical and mental practices, mean score of total items of ADLs was improved among study group than control group ($p<0.001$). In addition, the study finding was congruent with **Abozeid et al ., (2023)** who states that a significant improvement was observed in all domains of patients' self-management practices especially bladder & bowel control . This similarity could be owed to increase awareness and educational session concerning MS can help the study sample to follow instructions and thus improve their performance of ADLs.

In concern to total dependency level in performance of daily living activities .the current study indicated that the independent level among the study group was improved post 3 and 6 months from implementation of digital nursing intervention. While in control group, independent level pre intervention was increase slightly post 3 and 6 months from implementation of intervention. This revealed that no statistical significance differences between both groups at pre- intervention. Moreover, a statistical significant difference was found between study and control groups at dependency level in performance of daily living activities post intervention (Figure 2). This study agreed with **Farnoosh et al., (2016**). They revealed that an improvement in independent level was observed among study sample after application of nursing process based on theory of goal attainment than pre application of intervention. This agreement in results might be due to that the studied sample were interested in applying nursing guidelines regarding DLAs which lead to improvement of their dependency level.

The current study asserts that effect of digital nursing intervention on total mean score of dependency level of daily living activities. It revealed that, the total mean score of dependency level was not statistically significant between both groups. While total mean score of dependency level among the study group was improved post 3 and 6 months from implementation of digital nursing intervention than in control group (table 4). This result was agreed with **Firuzeh et al., (2022);** who reported that the total mean score of ADLs was not statistically significant before the intervention between the two groups. While after intervention, a statistically significant difference was perceived between two groups ($P = 0.002$). Improvement was occurred among study group than control group ($P < 0.001$). This agreement might be related to effectiveness of application of digital nursing intervention on improving performance and independency of ADLs.

According to study hypothesis No (3) : Patients with MS who received digital nursing intervention will have improved in treatment adherence score than control group.

Concerning the effect of digital nursing intervention on total mean score of nutritional adherence among the studied sample, the current study revealed that the total mean score of nutritional adherence pre digital nursing intervention was the same in both groups. While the mean score was changed and improved in the study group post 3 months and post 6 months from implementation of intervention. While in control group, total mean score was nearly remain the same post 3 and post 6 months from implementation of intervention. There was a highly statistical significant improvement in nutritional adherence among study group than control group after intervention ($P<0.001$) (table 5). This resultss was congruent with **Metaxouli et al., (2024)** who stated that no statistical significant differences were observed in diet total score between two groups at baseline. While, at the 2nd and 3rd follow-ups, the study group had a significantly higher mean score compared to the

control group (P<0.001). Moreover, no significant changes were found among the control group in the 2nd and 3rd follow-ups of dietary pattern (p > 0.05). Also, a highly statistical significant improvement in nutritional adherence were observed among study group than control group after intervention (P<0.001). This similarity might be owed to that the level of interest and discipline among sample to follow the digital nursing intervention guidelines that affect their eating behaviors and improve nutritional adherence

In relation to the effect of digital nursing intervention on total mean score of physical activity adherence among the studied sample, the current study indicated that no statistical significant differences were observed in physical activity total score between two groups at baseline data. While total mean score was increased in the study group post 3 months and post 6 months from implementation of intervention. While in control group, no significant change was found in physical activity adherence post 3 months and post 6 months from implementation of intervention (table 5). Also, A statistical significant improvement in physical activity adherence was occurred among study group than control group after intervention (P<0.001). This result was similar with **Coulter et al., (2020)**. They demonstrated that; mean score of physical activity adherence was improved post intervention than pre intervention. Also, there was a statistical significant improvement of physical activity adherence was occurred among study sample in post intervention than pre intervention. (P <0.001). This similarity could be associated with that interest of study sample to follow the digital nursing intervention instructions influenced their health behaviors regarding exercise and thus improve physical activity adherence.

Focusing on the effect of digital nursing intervention on total mean score of medication adherence among the studied sample, the current study illustrated that the total mean score of medication adherence was increased among study group post 3&6 months of implementation digital nursing intervention than in control group (table 5). Also, There was a statistical significant improvement in medication adherence among study group than control group after intervention than pre intervention (P<0.001). These findings agreed with **Abd Elsalam & Ali, (2022)** who reported that, improvement in total score MMAS of the studied patients in relation to Post1 & Post2 of implementation of self-management guidelines. Also, they reported that a statistically significant improvement in medication adherence was occurred among studied patients post guidelines than pre guidelines. Also, this results was congruent with **Verdugo et al., (2019)** who stated that most of patients were adherent in medication after intervention. In addition, the results were supported by **Golan et al., (2020).** They clarified that a statistically significant difference in medication adherence was found among study group than control group studied patients post mobile phone application intervention than pre intervention. This similarity might be due to that interesting of patients to follow nursing instructions in order to improve their medication adherence, recover from disease and live normal life as possible

The present study illustrates that effect of digital nursing intervention on total mean score of treatment adherence among the studied groups. It revealed that, a statistical significance improvement in treatment adherence was occurred among study group than in control group at post 3 and post 6 months from implementation of digital nursing intervention (P<0.001) (table 5). This result was in same line with **Kazemi et al., (2022).** They stated that, after application of continuous care using smartphone and at follow up, the total mean score of treatment adherence was higher in intervention group than in control group. Also, this finding was supported by **Verdugo et al., (2019)** who clarified that mean score of treatment adherence was improved in studied patients with MS after intervention than pre intervention (P<0.001).. This agreement returned to that increasing knowledge among patients regarding disease using digital nursing intervention lead to increase their treatment adherence

In relation to distribution of total treatment adherence among studied sample. This study presented that, more than half and three quarters of study group had high treatment adherence post 3&6 months of digital nursing intervention respectively compared to three quarters and more than half of control group had low adherence after post 3&6 months of intervention (Figure 3). This finding was supported by **Kazemi et al., (2022).** They indicated that higher levels of treatment

adherence was occurred among intervention group compared to low adherence in the control group after implementation of intervention using smartphone application and at follow-up. Also, this result was agreed with **Üstündağ, Yeşilbalkan , & Kabay., (2024)**; who indicated that most of the intervention group showed higher treatment adherence than control group after mobile education application. This agreement might returned to that electronic book and educational session through smartphones application could be effective in improving treatment adherence among patients with MS.

The present study indicated that, there was a statistical positive correlation between studied patients' knowledge level and their total dependency level of daily living activities at pre, post 3 months, and post 6 months from implementation of digital nursing intervention ($p<0.05$). This finding was in contract with **Firuzeh et al., (2022**). They reported that a statistical positive correlation was taken placed between patients' knowledge and total dependency level of ADLs at pre and post application of intervention. Also, the results proved that , a statistical positive correlation between studied patients' knowledge level and their total treatment adherence was found at pre, post 3 months, and post 6 months from implementation of digital nursing intervention ($p<0.05$) (Table 6.). This finding was supported by **Üstündağ, Yeşilbalkan , & Kabay., (2024).** They stated that positive correlation between patients' knowledge level and their total treatment adherence was observed at pre, and post implementation of mobile education application. These agreements was associated with increasing knowledge through digital nursing intervention was effective in improving performance of ADLs and treatment adherence.

Conclusion

The study's results demonstrated that after application of digital nursing intervention, the study group had increased in total knowledge score compared to control group. A highly statistical significant improvement in performance of daily living activities was observed among the study group than the control group. Also, a significant improvement in treatment adherence was occurred among study group than in control group. A significant positive correlation was found among knowledge, performance of ADLs and treatment adherence. In addition, digital nursing intervention ascertained its efficacy in increasing knowledge, enhancing performance of daily living activities and improving treatment adherence of patients with multiple sclerosis

Recommendations:

- Dissemination of the educational programs is important to provide information about treatment approach regarding MS to help patients to manage disease effectively.
- Booklet about disease, daily living activities and treatment should be available for patients with multiple sclerosis in all neurological outpatient clinics.
- Creation of Web site under supervision of medical and nursing to increase information about the disease and facilitating follow up of patients with multiple sclerosis
- Future studies with constructed large sample size are necessary to attain generalization of the results.

Reference

Abd Elsalam, Sh & Ali, R. (2022). Self-Management Guidelines: Effect on Knowledge, Fatigue, Self-Efficacy and Medications Adherence among Patients with Multiple Sclerosis .Egyptian Journal of Health Care, 2022 EJHC Vol 13. No.1

Abozeid,A , Abd Elaty, A , Faheem,G, khalifa,A. (2023). Effect of Educational Guideline on Self-Management and Clinical Outcomes for Patients with Multiple Sclerosis Egyptian Journal of Health Care, December, 2023 EJHC Vol. 14. No. 4

Abtahi S, Manavi S, Fereidan M. (2021). Updated systematic review on epidemiology of multiple sclerosis in Iran: central accumulation and possible role for industrial pollution. J Rev Med Sci. ;1(1):16–24.

Alkahtani F, Mohammad F, AlRashid M, Abdulrahman A, Shawg S, Abdulrahman F. Awad A, and Abdulaziz

M.(2023). Physical activity assessment among patients with multiple sclerosis in Saudi Arabia. Neurosciences (Riyadh). 28(4): 243–249.. doi: 10.17712/nsj.2023.4.20230024

Alqwaifly M, Alsuhaibani A., Alharbi, S, Asim Alshowaiman , Omar Alluhayyan , Khaled Almutawwaa.(2020). The quality of life in patients with multiple sclerosis in Qassim; International Journal of Medicine in Developing Countries; 2020. 4(12): 2050–2055. https:// doi. org/ 10. 24911/ IJMDC. 51-1598359967

Bass A, Van B, Mayer L, Mäurer M, Boster A, Mandel M, Singer B. (2020). Effect of multiple sclerosis on daily activities, emotional well-being, and relationships: the global vs MS survey. Int J MS Care 22:158–164.

Coulter E, Bond S , Dalgas U, & Paul P .(2020). The effectiveness of interventions targeting physical activity and/or sedentary behaviour in people with Multiple Sclerosis: a systematic review. Disabil Rehabil J. ;42(5):594-612. doi: 10. 1080/ 09638288. 2018.1503737.

Coyle P. (2020). Introduction to neuroimmunology. In: Clinical neuroimmunology. Cham: Humana; pp. 3–15. ISSN 1559-0585 ISSN 2524-4043 (electronic). Current Clinical Neurology. ISBN 978-3-030-24435-4 ISBN 978-3-030-24436-1 (eBook). https://doi. org/ 10. 1007/ 978- 3-030-24436-1.

Dehghani A, Mahsa K, and Shahsavari S. (2019). Challenges in the Daily Living Activities of Patients with Multiple Sclerosis: A Qualitative Content Analysis. Int J Community Based Nurs Midwifery. ; 7(3): 201–210.doi: 10. 30476/ IJCBNM. 2019.44995

Dobson A and Giovannoni S. (2019). Multiple sclerosis - a review. Eur J Neurol Jan; 26 (1):27-40.

Erçetin A, Açıkalın M& Güngör N, (2016). A unique classification on adults: "adult child, adult-adolescence, adult-adult" different perspective on leadership. Journal of Aging Studies. 19 (2): 163– 183. doi:10.1016/j.jaging.2004.05.002.

Eyas K, Dania S, Waggas A, Alkhunani, and Rola A.(2021). Assessment of Multiple Sclerosis Awareness and Knowledge among the Community of Jeddah, Saudi Arabia. J Neurosci Rural Pract. 2021 Oct; 12(4): 733–738.. doi: 10.1055/s-0041-1734009

Farnoosh R, Mitra A, Moshtagh E, Farvid M, and Hamed H. (2016). Improvement in Activity of Daily Living and Fatigue in Multiple Sclerosis Patients: the Impact of Nutrition Education. Nurs Midwifery Stud.5(4):e32862.. doi: 10. 17795/ nmsjourna l32862.

Firuzeh P, Mahnaz K, Alireza S , Masoud G , & Seyed R. (2022). The effect of applying the nursing process based on the Theory of Goal Attainment on activities of daily living and quality of life in persons with multiple sclerosis during COVID-19 pandemic: a clinical trial Ir J Med Sci;192(3):1361–1369. doi: 10. 1007/ s11845- 022-03104-9

Golan D, Sagiv S, Marmor L, &Miller A. (2020). Mobile phone-based e-diary for assessment and enhancement of medications adherence among patients with multiple sclerosis. Mult Scler J Exp Transl Clin.;6(3)

Groppo E, Signori A, Sormani M, Grosso C, Mantia L, Cattaneo D, Rovaris M**. (2019).** Predictors of hospital-based multidisciplinary rehabilitation effects in persons with multiple sclerosis: a large-scale, single-centre study. Multiple Sclerosis J 5:2055217319843673.

Hassan M. (2021). Fatigue in A sample of Egyptian Multiple Sclerosis Patients: A Cross Sectional Study International Journal of Medical Arts; 3 [3] July-September: 1681-1688

Johansson S, Skjerbæk, J, Michael N. (2021). Associations between fatigue impact and lifestyle factors in people with multiple sclerosis – The Danish MS hospitals rehabilitation study, Multiple sclerosis and Related Disorders;,

DOI:https://doi.org/10.1016/j.msard.2021.102799

Kazemi E, Mahnaz R, Mozhgan R and Sadegh A. (2022). The effects of continuous care model using a smartphone application on adherence to treatment and self- efficacy among patients with multiple sclerosis .BMC Medical Informatics and Decision Making: https:// doi. org/ 10. 1186/s12911-022-01785

Kimberlyn B, StephanieK, Amanda H, Alex andra L, Shelby R, Claudia H, Amber A. (2023). The effectiveness of nontraditional or home-based programing on ADL performance of individuals living with multiple sclerosis: A systematic review. Multiple Sclerosis and Related Disorders J. Volume 71, , 104576. https:// doi. org/ 10.1016/ j.msard.2023.104576

Kohler W, Bayer K, Neußer T, Schürks M, and Ziemssen T. (2021). Predictors of Adherence among Patients with Multiple Sclerosis Using the BETACONNECT® Autoinjector: A Prospective Observational Cohort Study. Front. Neurol.; 12:643126. doi: 10.3389/fneur.2021.643126.

Kratz A, Fritz N, Braley T, Scott E, Foxen E and Murphy S. (2019). Daily temporal associations between physical activity and symptoms in multiple sclerosis. Ann Behav Med 53:98–108.

Lane J, Poyser C, Lucas R, Tremlett H (2022). "Multiple sclerosis incidence: A systematic review of change over time by geographical region". Mult Scler Relat Disord. 63: 103932. doi:10.1016/j.msard.2022.103932.

Li P, Ladage V, Berger J,Chahin S, Jhaveri M, Geremakis C and Doshi J. (2020). Disease-Modifying Therapy Adherence and Associated Factors in a National Sample of Medicare Patients with Multiple Sclerosis. Value Health. **23**:328–334. doi: 10.1016/j.jval.2019.10.011.

Marisa P, McGinley, Carolyn H, Goldschmidt A, and Alexander D. (2021). Diagnosis and Treatment of Multiple Sclerosis: A Review JAMA. Feb 23;325(8):765-779.

Meehan M and Doody O. (2020). The role of the clinical nurse specialist multiple sclerosis, the patients' and families' and carers' perspective: An integrative review Mult Scler Relat Disord. Jan 3:39:101918.

Metaxouli K, Tsiou C, Dokoutsidou E and Nikoletta M. (2024). Nutritional Intervention in Patients with Multiple Sclerosis, Correlation with Quality of Life and Disability—A Prospective and Quasi-Experimental Study *NeuroSci* , *6*(1), 4; https://doi.org/10.3390/neurosci6010004

Mohammadzadeh M, Haghgoo H, Biglarian A. (2022). Effects of Combined Mental and Physical Practices on Walking and Daily Living Activities in Individuals With Multiple Sclerosis. Iranian Rehabilitation Journal; 18 (4) :455-464

Morisky D, Ang A, Krousel M, and Ward H. (2008) Predictive Validity of a Medication Adherence Measure for Hypertension Control. The Journal of Clinical Hypertension, 10, 348-354. http:// dx.doi. org/ 10.1111/j.1751-7176. 2008. 07572.x

National Multiple Sclerosis Society. (2019). Multiple sclerosis symptoms and diagnosis. Available at: https:// www. Nationalms society.org/.

Panagiotis S , Evangelia K , Christos B, ,Styliani A, Natalia K , Marina B , & Nikolaos G. (2022)., The Role of Diet and Interventions on Multiple Sclerosis. Nutrients J: A Review.;14(6):1150. doi: 10.3390/nu14061150

Rossen S, Kayser L, Vibe-Petersen J, Christensen J, and Ried M. (2020). Cancer Survivors' Receptiveness to Digital Technolo-gy-Supported Physical Rehabilitation and the Implications for Design: Qualitative Study. J. Med. Int. Res. ;22:e15335

Saad A, & Elsayed E. (2021). Self management program to adapt with multiple sclerosis problems and enhance quality of life. Assiut Scientific Nursing Journal, 9(26), 34-54.

Salime R, Elzeheri D& Ibrahim R. (2022). Effect of Nursing Intervention on Fatigue for Multiple Sclerosis Patients. Tanta Scientific Nursing Journal . Vol. 24 No. 1.

Stenager, E. (2019).A global perspective on the burden of multiple sclerosis. Lancet Neurol. **18**(3), 227–228. https://doi.org/10.1016/S1474-4422(18)30498-8

Taylor C, Ruzek J,Fitzsimmons E, Sadeh S, Topooco N, Weissman R., Eisenberg D, Mohr D, Graham A and Jacobi C. (2020). Using Digital Technology to Reduce the Prevalence of Mental Health Disorders in Populations: Time for a New Approach. J. Med. Internet Res. ;22:e17493. doi: 10.2196/17493

Tkáčová, Ľ. (2020). Influence of self-care on quality of life in patients with multiple sclerosis. CER Comparative European Research 2020.

Tomoko O, Kimitaka H, Yoshie N & Takeo N.(2017). Validity and reliability of a performance evaluation tool based on the modified Barthel Index for stroke patients.BMC Medical Research Methodology volume 17, Article number: 131

Üstündağ S, Yeşilbalkan Y, & Kabay S. (2024). The effect of a mobile education application (MobilMS) developed for multiple sclerosis patients in Turkey on symptom management and quality of life: A randomized controlled study. Mult Scler Relat Disord. :81:105342. DOI: 10.1016/j.msard.2023.105342

Verdugo M, Herráiz E, Olmo, R, Bonet M, and García M. (2019). Adherence to disease-modifying treatments in patients with multiple sclerosis in Spain Patient Preference and Adherence, Patient Prefer Adherence J. 13;13:261–272. doi: 10.2147/PPA.S187983

Waubant E, Lucas R, Mowry E, Graves J, Olsson T, Alfredsson L, and Langer-Gould A (2019). Environmental and genetic risk factors for MS: an integrated review. Ann Clin Transl Neurol 6:1905–1922.

Wicks P, Massagli M, Kulkarni A,& Dastani H.(2011). Use of an online community to develop patient-reported outcome instruments: the Multiple Sclerosis Treatment Adherence Questionnaire (MS-TAQ). J Med Internet Res.13(1):e12.

Zakaria M, Sharawy M, Raed M, &Anan I (2019). Economic burden of multiple sclerosis in Egypt − a societal perspective (P4. 2-089). J Neurol 92:P4.2-089; available at https://n. neurology. org/ content/ 92/15_Supplement/P4.2-089