Effect of Continuous Nursing Model Based on a Smartphone Application on Self-efficacy and Treatment Compliance among Multiple Sclerosis Patients

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Abstract

Background: Multiple sclerosis (MS) is a common neurological disorder that affects people all over the world. Maintaining adherence to disease-modifying therapy is crucial for MS patients to achieve optimal outcomes and improve their quality of life. **Aim**: To evaluate the effect of continuous nursing model based on a smartphone application on self-efficacy and treatment compliance among multiple sclerosis patients. **Methods:** A quasi-experimental study with a pre/posttest design was used for the present study. **Setting:** This study was carried out at multiple sclerosis centers at Fayoum General Hospital. **Sample**: A purposive sample of 60 MS patients. The data were collected using four tools. **Tool I**: Structured interviewing questionnaire to collect information about socio-demographic data and disease-related data, **Tool II:** Multiple Sclerosis Knowledge Questionnaire (MSKQ). **Tool III**: Multiple Sclerosis Treatment Adherence Questionnaire (MS-TAQ) and **Tool IV:** MS Self-Efficacy Scale (MSSS) **Results:** The results demonstrated increase in the total mean knowledge score after one month and after three months following the implementation of Continuous Nursing Model (CNM) compared to pre- implementing the (CNM) also there was improvement in mean score of treatment adherences and self-efficacy after one month and after three months following the implementation of Continuous Nursing Model (CNM) compared to pre- implementing the (CNM) and self-efficacy was increase after one month and after three months following the implementation (CNM) compared to pre- implementing the (CNM) ($p < 0.001$). **Conclusions:** The CNM implementation via a smartphone application resulted in improvements in the MS patients' knowledge, treatment adherence, and self-efficacy. **Recommendation:** Conducting CNM using a smartphone application to be used by nurses to deliver continuous care with other interventions for MS patients.

Keywords: Continuous Nursing Model, Multiple sclerosis, Self-efficacy, Smartphone Application. Treatment Adherence

Introduction

Multiple sclerosis (MS) is an autoimmune disorder that affects the central nervous system (CNS) and can cause a range of symptoms, including pain, mobility limitations, fatigue, and mood changes. Consequently, people with MS encounter numerous physical, emotional, and mental obstacles every day. MS is the second most common disabling condition among people aged 20 to 40 years **(Jakimovski et al., 2024).** The precise etiology of the illness is unknown. Still there are genetic and environmental factors, including a deficiency of vitamin D, infections from the Herpes virus and Epstein-Barr virus, which can trigger T cells and damage protective myelin sheaths **(Ferreira et al., 2020).**

Multiple sclerosis currently affects around 2.5 million people globally, with 700,000 cases reported in Europe **(Baloyannis 2020).** The global prevalence of MS is expanding rapidly, with the estimated number of affected individuals exceeding three million worldwide **(Almuklass et al., 2023).** According to the Ministry of Health and Population in Egypt, MS makes up 1.4% of all neurological nvcytgjjjjjjjhncvb vchfd. The most recent edition of the Atlas of MS estimates that around 2.8 million individuals suffer from MS around the world. According to statistics published in 2020, around 59,670 individuals suffer from MS in Egypt. This translates to one in every 1,500 persons, according to the **Multiple Sclerosis International Federation (MSIF) (2023).**

Patients with MS have persistent disorders that need ongoing monitoring and care, most chronic health condition usually requires long-term treatment strategies that encourage patients, such as Disease-Modifying Therapies (DMTs), managing symptoms, rehabilitation, and supportive care these strategies aim to enhance the therapeutic benefits of MS therapy and decrease the incidence of clinical relapse **(Edan &Le Page,2023).**

Decreased self-efficacy is another challenge encountered by these patients. Self-efficacy is the primary need for changing behavior, particularly in health behaviors. MS can decrease self-efficacy by up to 48%. Because MS is a long-term condition, self-efficacy is a crucial internal component for managing and controlling MS throughout time **(Young et al., 2021).**

The continuous nursing model focuses on providing consistent and ongoing healthcare services to patients, particularly after discharge from a hospital, to address their needs and promote better health outcomes. This model emphasizes establishing a strong and continuous relationship between the patient and the nurse, ensuring ongoing evaluation of needs and facilitating the patient's engagement in their health management **(Kazemi et al., 2022).**

Remote healthcare services offered from a distance improve access for patients with geographical or mobility restrictions. Currently, computer and network technologies make it easier to access health services (**Ahluwalia et al., 2020**). Educational software application generates a participatory platform and delivers essential information, which gives patients the chance to manage their illness and access the information they need when they ask for it. So, it is vital to teach clients via multimedia, as it is an effective strategy to meet the educational needs of MS patients (**Sheikh et al., 2021**).

Nurses have a vital role in empowering patients to manage chronic illness **(Zahmatkeshan et al., 2021).** They facilitate the management of complex diseases and improve lifestyle behaviors **(Moriyama et al., 2021).** Recent systematic reviews have shown that nurse-led programs, especially those conducted online, can lead to significant improvements in self-management and symptom relief in chronic neurological conditions, including multiple sclerosis. These interventions often include components such as patient education, self-monitoring, lifestyle coaching, and stress management techniques **(Yalçın , Tulek , Kürtüncü, 2025 ;Wendebourg et al., 2024 ; Qomi et al., 2023).**

In addition, the nurse can use numerous digital tools to help patients with MS in various ways, such as providing 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 self-efficacy, and treatment adherence **(Meehan and Doody, 2020).**

Significance:

Multiple sclerosis is an unpredictable medical condition that affects people differently, and it is the second leading cause of physical impairment, especially in young people. MS is a silent killer disease not only of the lives 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 their capacity to perform their job, with dire consequences for their physical, mental, social, and financial well-being **(Saad & Elsayed, 2021).**

Patients with MS experience a variety of difficulties that impair their treatment compliance as well as their overall daily living activities. Therefore, adopting a smartphone app that runs on an Android-based platform is a viable way to provide services for MS patients **(Bass et al., 2020).** The use of digital nursing interventions can assist MS patients in learning more about their condition, identifying their needs, improving their treatment adherence, and managing their daily activities. These apps can facilitate health maintenance and generate and transmit personal health information **(Üstündağ, Yeşilbalkan & Kabay, 2024).** Therefore, the present study aimed to evaluate the effect of a continuous nursing model based on a smartphone application on self-efficacy and treatment compliance among multiple sclerosis patients.

Aim of the study

The present study aimed to evaluate the effect of continuous nursing model based on a smartphone application on self-efficacy and treatment compliance among multiple sclerosis patients.

Research Hypothesis

H1: The continuous nursing model could improve patients' knowledge about multiple sclerosis.

H2: The continuous nursing model could improve adherence to the treatment regimen among patients with multiple sclerosis.

H3: The continuous nursing model could improve self-efficacy among patients with multiple sclerosis.

Subjects and methods:

Operational definitions:

The Continuous nursing model, based on a smartphone application, aims to improve patient outcomes and well-being, especially for those with chronic conditions or who face geographic barriers to care. This model is described as a structured, technology-assisted nursing intervention delivered through a specialized mobile application. Continuous care services, such as personalized health education, medication reminders, symptom tracking, psychological support, and interactive communication with nursing staff, are offered to individuals with multiple sclerosis using this paradigm.

Self-efficacy: The term "self-efficacy" describes a patient's confidence in their capacity to handle the symptoms and requirements of multiple sclerosis treatment. Increased patient satisfaction and better health outcomes can result from increasing self-efficacy. Scores are gathered both before and after the intervention, and it is operationalized using a validated measure like the Multiple Sclerosis Self-Efficacy measure (MSSS) or a comparable tool. The impact of the intervention is shown in changes in both the overall and subscale scores.

Treatment Compliance: is the degree to which patients follow their recommended treatment plans, which may include taking their prescription drugs on time, going to follow-up appointments, and adopting the suggested lifestyle. The Multiple Sclerosis Treatment Adherence Questionnaire (MSTAQ), medicine refill records, self-reported adherence questionnaires, and engagement metrics from the smartphone application are all used to monitor it.

Research design

A quasi-experimental design (pre-posttest) was used to fulfill the aim of the study.

Setting

This study was carried out at the Multiple Sclerosis Center at Fayoum General Hospital, which offers comprehensive and high-quality health care services to individuals with multiple sclerosis. It consists of two parts: The first part has six beds with six monitors for admission, and the second part is for doctors and nurses. It receives patients from all areas of El-Fayoum governorate. The patient may be diagnosed in the MS center or by a doctor referral. After that, both are admitted to the MS center to receive medication and routine care until their vital signs are stable with remission of MS manifestations. According to the stability of his state, unstable cases are referred to the neurological ICU. Follow-ups are according to the remission and exacerbation of disease manifestations. Newly diagnosed cases follow-up appointments are every other week; stable cases follow-up is every 6 months.

Subjects:

A purposive sample composed of 60 adult patients diagnosed with multiple sclerosis, with the following inclusion criteria**:**

- Both sexes (male and female patients)
- Aged 20-60 years.
- Able to communicate.
- Patients have smartphones and can use digital technology.
- Patients read and write.

- A patient who has not attended any previous training sessions related to multiple sclerosis.
- Willing to participate in the study

Exclusion criteria:

- Having severe disability (scored four or more in the Expanded Disability Status Scale, EDSS).
- Having severe disease complications
- Having cognitive impairment.
- Having a psychiatric disorder.
- Having apparent visual or auditory impairment

Sample size calculation:

Based on the sample size equation, 60 multiple sclerosis patients will participate in the study. Where, n=sample size; N= studied total population; d = error percentage (=0.05); P= prevalence or proportion of event of interest for the study; Zα/2 =1.96 (for 5% level of significance).

$$n = \frac{N \times p\,(1-p)}{(N-1)x\left(\frac{d^2}{z^2}\right)+p(1-p)}$$

Tools for data collection:

Four tools were utilized to collect data required for this study. It contained the following:

Tool I: Structured Interview Questionnaire:

The researchers designed this tool following a comprehensive review of relevant literature. It consists of two sections:

The first section covers socio-demographic characteristics of patients such as age, gender, marital status, level of education, occupation, residence, and income.

The second section covers the patient's medical condition, such as duration of the disease, type of multiple sclerosis, frequency of recurrence, and number of hospitalizations.

Tool II: Multiple Sclerosis Knowledge Questionnaire (MSKQ): It was adopted from **Giordano et al. (2009)** to assess knowledge for patients diagnosed with multiple sclerosis. It consists of 25 multiple-choice questions and was modified by the researchers to be 24. Each question receives a score of one grade for the correct response, and a score of zero for an incorrect answer or unknown response. The total score for knowledge was calculated out of forty-five degrees (24). It was transformed into graded and percent as poor knowledge < 50% (< 12 degrees), moderate knowledge 50- < 75% (12- < 18 degrees), and good knowledge ≥ 75% (≥ 18 degrees).

Tool III: **Multiple Sclerosis Treatment Adherence Questionnaire (MSTAQ):** It was adopted from **Wicks et al. (2011)** and was used to assess factors that affect adherence to disease-modifying therapies (DMTs) among patients with multiple sclerosis taking (DMTs). The questionnaire consists of 30 items, organized into three subscales, each with a different response format:

DMT-Barriers: This section assesses the significance of thirteen barriers to adherence and only asks participants who had missed at least one dose during the previous 28 days, using a four-point scale ranging from "not important at all" to "extremely important".

- **DMT-Side Effects:** all participants were asked in this subscale about the frequency of ten common side effects associated with DMTs. The responses are noted on a five-point scale ranging from "never" to "all or nearly all of the time".

- **DMT-Coping Strategies:** This section assesses seven strategies that patients can employ to control side effects (e.g., applying ice to the injection site). All participants respond with a yes or no to whether they typically used each strategy during the past four weeks (28 days).

- The overall score for each section was computed by summing the subscales, and the mean values were used to compare groups.

Tool IV: Multiple Sclerosis Self-Efficacy Scale (MSSS) : It was adopted from

Rigby et al. (2003). It was comprised of fourteen items categorized into four subscales, namely independence and activity (five items), concerns and interests (four items), personal control (three items), and social confidence (two items). Each item is answered based on a Likert scale of six points, with one representing strong disagreement and six representing strong agreement. The overall score ranges from 14 to 84, with greater scores indicating a higher self-efficacy. The overall score is calculated by adding up the scores from all subscales.

Tool validity:

A panel of seven specialists in medical-surgical nursing and neurology assessed the validity of the research instruments in terms of clarity, relevance, comprehension, and practicality for use. According to their viewpoints, the required changes were made.

Test reliability:

In order to determine whether study tools consistently measure the same variable and the items included were conceptually compatible, reliability was assessed. The alpha Cronbach test was used to determine the reliability of the data collection tools. It was 0.83 for the MSKQ, MS-TAQ was 0.78, and 0.88 for the MSSS tool.

Ethical consideration:

Before beginning the study, the Scientific Research Ethics Committee of the Faculty of Nursing at Fayoum University will approve for the suggested research. Participation in the study research is entirely voluntary, and before signing the informed consent, participants will receive comprehensive details about the study. The ethical issues will cover the study's nature and goals, the option to participate or leave at any moment, and ensuring the privacy of data, so that no other party can access it without the participants' permission. Values, culture, beliefs, and ethics will be respected.

Pilot study:

Following the approval to proceed with the proposed study, a pilot study was conducted involving 10% of the sample (six participants) within the same selected study setting. The aims were to estimate the requisite time for data collection, assess feasibility and objectivity, evaluate the tool's efficacy in eliciting the desired information, and examine the appropriateness of content, wording, and sequence. The results of the pilot study confirmed the feasibility of the research. No alterations were necessary; hence, the participants of the pilot study were incorporated into the actual research subjects.

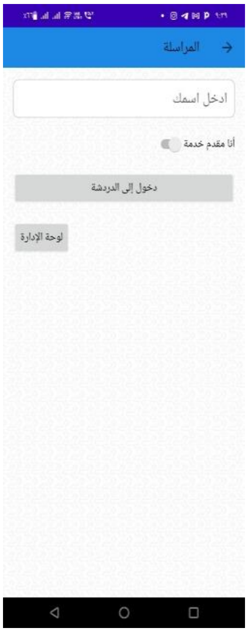
Procedure

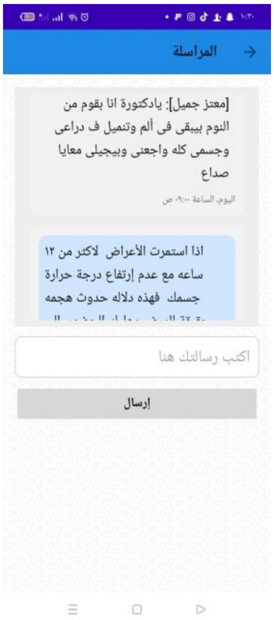
Data collection was conducted in the selected settings from July 2024 to April 2025. The study was conducted in the following phases:

Assessment phase: In this phase, the review of literature and the development of data tools are conducted. Assessing the study's feasibility, accessibility of the sample, and resources of the environment. Educational materials on MS were obtained from credible resources (i.e., textbooks, literature, etc.) and were assessed and refined by five experts in medical-surgical nursing and two neurologists.

Planning phase

The educational content was developed with the overall goal. It included educational materials, digital content, pictures, video, and animations that were designed and created as an offline installable application software using Kotlin for the backend logic and XML for the user interface design. Finally, the developed Android mobile application called the "MS hop Path" was tested and evaluated by an IT expert and an IT specialist in electronic content development. "MS hop Path" was created in Arabic, considering the language. The font size, style, and color were meticulously selected to ensure visibility and readability on the mobile app screen. The application that allows the exchange of messages, documents, and multimedia files through chat rooms also provides a chat room for the patients to contact researchers as needed. The content encompassed various elements addressing multiple facets of the patient's information regarding MS, as well as videos to cover practical part, Home page items were "knowledge about MS which enabling the user to view many pages with clearly and comprehensively presented details, including (MS definition, clinical manifestations, types, risk factors, diagnosis, pharmacologic therapies, nutrition, exercise, and symptoms management), the menu also offers patients with short videos demonstration on (exercise, instructionsabout their medications, relaxation and energy conservation technique. A healthcare professional captured these videos. Below is a summary of the app screens along with several sample displays.

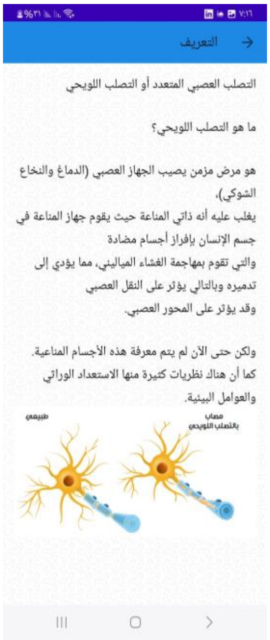




[معتز جميل]: يادكتورة انا بقوم من النوم بيبقى فى ألم وتنميل ف دراعى وجسمى كله واجعنى وبيجيلى معايا صداع

اليوم، الساعة ٠٩:٠٠ ص

اذا استمرت الأعراض لاكثر من ١٢ ساعه مع عدم إرتفاع درجة حرارة جسمك فهذه دلاله حدوث هجمه

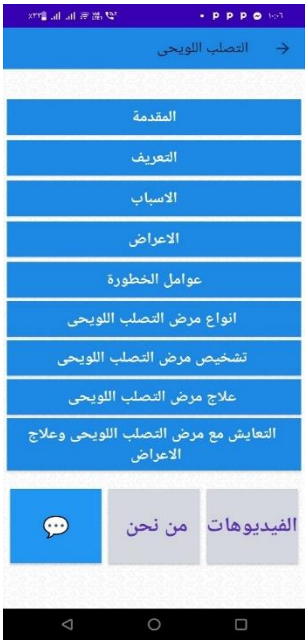


التصلب العصبي المتعدد أو التصلب اللويحي

ما هو التصلب اللويحي؟

هو مرض مزمن يصيب الجهاز العصبي (الدماغ والنخاع الشوكي)، يغلب عليه أنه ذاتي المناعة حيث يقوم جهاز المناعة في جسم الإنسان بإفراز أجسام مضادة والتي تقوم بمهاجمة الغشاء المياليني، مما يؤدي إلى تدميره وبالتالي يؤثر على النقل العصبي وقد يؤثر على المحور العصبي.

ولكن حتى الآن لم يتم معرفة هذه الأجسام المناعية. كما أن هناك نظريات كثيرة منها الاستعداد الوراثي والعوامل البيئية.



Implementation phase: The official permission that was required to enter the selected setting and collect data related to the current study was obtained from the director of EL Fayoum General Hospital, Fayoum 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 who worked in the neurological department (multiple sclerosis units) and the outpatient clinic to gain their cooperation.

The CNM is a nursing care model that was implemented through four stages: orientation, sensitization, control, and evaluation.

The first stage: known as orientation, in this stage, the researcher started to select the study participants from the previously mentioned setting through a face-to-face interview that included explaining the goals, building a relationship with the patients, having all patients ask to sign a consent form, and involving the patients and their families in care. Clarify the essentials of continuous care, ascertain what they expect from each other, and explain the necessity for continued collaboration until the study's end. The collection of demographic and medical data using tool I, MSKQ, using tool II, MS-TAQ, using tool III, and MSSS using tool IV was completed. This stage took about 30-45 minutes for each patient.

The second stage (sensitization) interventions were implemented over six months. Sensitizing the clients to assume accountability for their health focused on assessing their educational requirements. In general, the patients became acquainted with the disease process, its complications, treatment adherence, DMTs, and self-management. This stage held two sessions, each session lasting between 30 - 45 minutes.

After that, the researcher downloaded the "MS hop Path" application on the smartphones of patients and explained to them how to use the application. The researcher repeated the instructions of the application to patients till they mastered the application independently. At this phase, the investigator provided a brochure including instructions related to diet, medication, exercise, symptom management for relieving fatigue, skin problems to prevent pressure ulcers, heat intolerance, constipation, memory deficit, and sleep problems to patients and explained it to each patient individually. This session took approximately 45–60 minutes for each patient.

The patients were given individual instructions on how to use the “MS hop path” application on their smartphone and were also given a training video. Patients were allowed to ask questions by typing or recording their messages on the "MS hop path" application.

The third stage (control) this stage ensures that patients take care of themselves and maintain continuity of care. This was performed through a section of the MS App created specifically for this purpose, continuous care consultations and care needs were monitored on a daily and weekly basis. The researchers' telephone number was also provided to the patients.

The fourth stage (evaluation) involved evaluating the effects of the interventions. The scales were used to measure and compare patients’ knowledge, adherence to treatment, and self-efficacy after one month and again after three months using these tools, MSKQ, MSSS, and MS-TAQ.

Statistical Methods:

The SPSS 25 program was used to process the data at the significance level of $p < 0.05$. To evaluate the normality of the variables related to knowledge, treatment adherence, and self-efficacy, the Kolmogorov–Smirnov test was conducted, confirming that the data followed a normal distribution ($p > 0.05$). Based on these results, both descriptive and inferential statistical methods were applied. Descriptive statistics included the calculation of means and standard deviations (SD). For inferential analysis, including chi-square, Fisher’s exact test to examine relationships between categorical variables, Repeated measures ANOVA to assess changes over time within groups, and Tukey’s post hoc test for multiple comparisons following significant ANOVA findings.

Results:

Table (1) shows that,43.3% of the studied patients their age ranged between 30-< 40 with the mean age 32.16±7.85 years, and 68.3 % were females, regarding their marital status, 66.7% were married, 60.0% of them having a university degree, 61.7 % were urban patients, 50.0% were not working and housewives, 60.0% of them stated that their monthly income was insufficient. Meanwhile, 100.0% of the studied patients live with their family.

Table (2) shows that relapsing–remitting MS was the most prevalent form of the disease, accounting for 55.0% of the studied patients. The mean duration of MS was 5.03±3.18. Also, 8.3% indicated that they were smokers. Concerning the hospital admission number per year due to MS, 43.3% of patients reported that they were hospitalized once per year, and 50.0% of the studied patients had previous relapses, two times in the past year. Moreover, 66.7 %, 55.0% and 51.7 % of the studied patients suffered from fatigue, pain, and urological problems, respectively.

Table 4: Shows that only 3.3% had good knowledge regarding MS in pre-intervention evaluation, compared to 96.7% and 93.3% had good knowledge after one month and after three months, respectively, with a statistically significant difference at $p < 0.001$.

Table (5) shows that there was a significant improvement in all mean adherence dimensions, such as disease-modifying treatment barriers, disease-modifying treatment disease-modifying treatment side effects, and disease-modifying treatment coping strategies after one month and after three months of implementing the intervention, compared to the pre-intervention phase with statistically significant difference as well as overall treatment adherence mean score with statistically significant difference at $p <0.001$.

Table (6) Shows that there was a significant improvement in all mean self-efficacy dimensions, such as independence and activity, personal control, concerns, and social confidence after one month and after three months of implementing the intervention compared to the pre-intervention phase as well as overall self-efficacy mean score with statistically significant difference at p <0.001.

Table (7) shows that there was a significant positive correlation between knowledge and self-efficacy in all intervention phases at p < <0.001. There was a significant negative correlation between knowledge and treatment adherence after one month and after three months of intervention at p <0.001. Also, there was a significant negative correlation between self-efficacy and treatment adherence pre-, after one month, and after three months of intervention at p < 0.001.

Table (1): Distribution of MS patients according to their demographic characteristics (No= 60).

Demographic Characteristics	No	%
Age (Years)		
20 -<30	21	35.0
30- < 40	26	43.3
40 <50	13	21.7
Mean ±SD	32.16±7.85	
Sex		
Male	19	31.7
Female	41	68.3
Marital status		
Single	16	26.7
Married	40	66.7
Widow	3	5.0
Divorced	1	1.7
Level of education		
Primary school	4	6.7
Secondary school	20	33.3
University	36	60.0
Residence:		
Urban	37	61.7
Rural	23	38.3
Occupation:		
Employee	20	33.3
Manual work	10	16.7
Not working/ Housewife	30	50.0
Monthly income		
Sufficient	24	40.0
Insufficient	36	60.0
Living status		
Alone	0	0.0
With family	60	100.0

Table (2): The distribution of MS patients according to disease-related characteristics (No= 60).

Disease-related characteristics	**No**	**%**
Type of MS:		
Relapsing remitting	33	55.0
Progressives relapsing	2	3.3
Secondary progressive	16	26.7
Primary progressive	9	15.0
Duration of disease		
1-3 years	21	35.0
4-6years	24	40.0
7-9 years	9	15.0
≥10 years	6	10.0
Mean± SD	5.03±3.18	
Family history		
Positive	1	1.7
Negative	59	98.3
Smoking		
Yes	5	8.3
No	55	91.7
Hospital admission in the past year		
None	8	13.3
One	26	43.3
Two	16	26.7
More than two	10	16.7
Number of relapses in the past year		
None	10	16.7
Two	30	50.0
More than two	20	33.3
MS current manifestation		
Fatigue	40	66.7
Pain	33	55.0
Visual problems	26	43.3
Speech problems	6	10.0
Motor problems	31	51.7
Urological problems	11	18.3
Gastroenterological problems	18	30.0
Sleep problem	25	41.7
Sexual problem	2	3.3

Table 3: Comparison of mean and standard deviation of patients' knowledge related to MS in three-time stages before, after one month, and three months after the intervention

Items	**Pre**	**After one month**	**After three months**	**F**	**P**
	Mean ±SD	**Mean ±SD**	**Mean ±SD**		
Nature of the disease	2.45±0.50	6.18±0.85	5.98±0.87	455.55	<0.001*
Prevalence and predisposing factors	1.85±0.36	2.63±0.55	2.55±0.56	44.23	<0.001*
Causes and genetic factors	1.15±0.360	2.61±0.55	2.48±0.62	143.09	<0.001
Diagnostic method and procedure	5.71±0.45	6.20±0.73	5.83±0. 94	7.02	0.001*
Types and treatment	1.80±0.98	3.30±0.56	3.13±0.72	67.00	0.001*
Total knowledge score	12.96±1.32	20.93±1.83	19.98±2.37	316.83	<0.001*

(*) Statistically significant at p < 0.05 **(F) One Way ANOVA**

Table 4: Comparison of patients' knowledge related to MS in three-time stages before, after one month, and three months after the intervention

Items	Pre		After one month		After three months		χ 2 (P) Pre-post	χ 2 (P) Pre-FU
	N	%	N	%	N	%		
Poor <50	7	11.7	0	0.0	0	0.0	104.569 (<0.001*)	97.439 (<0.001*)
Moderate 50-<70	51	85.0	2	3.3	4	6.7		
Good ≥75	2	3.3	58	96.7	56	93.3		

(*) Statistically significant at p < 0.05 (χ 2) chi-square test

Table 5. Comparison of mean scores of treatment adherence among studied patients in three-time stages before, after one month, and three months after the intervention

Items	Pre	After one month	After three months	F	P
	Mean ±SD	Mean ±SD	Mean ±SD		
DMT-Barriers	18.35±5.19	12.58±4.46	11.95±4.56	33.075	<0.001*
DMT-Side Effects,	16.76±4.98	11.13±2.92	10.73±2.97	48.481	<0.001*
DMT-Coping Strategies	1.05±0. 21	1.56±0. 94	1.83±0. 92	15.904	<0.001*
Total treatment adherence	36.33±7.76	25.11±4.80	24.51±4.72	75.931	<0.001*

(*) Statistically significant at p < 0.05 (F), One Way ANOVA DMT disease-modifying treatment

Table 6. Comparison of mean and standard deviation of self-efficacy dimensions among studied patients in three-time stages before, after one month, and three months after the intervention

Items	Pre	After one month	After three months	F	P
	Mean ±SD	Mean ±SD	Mean ±SD		
Independence and activity	16.68±3.75	22.41±2.98	23.20±0.87	69.830	<0.001*
Personal control	14.38±1.24	17.90±1.56	18.20±1.65	119.825	<0.001*
Concerns and interests	12.85±1.102	14.60±1.36	14.83±1.19	46.84	<0.001*
Social confidence	6.90±1.31	8.85±1.10	8.98±0.92	64.473	<0.001*
Overall self-efficacy Score	50.81±4.16	63.7667±4.01	65.21±3.49	247.445	<0.001*

(*) Statistically significant at p < 0.05 (F), One Way ANOVA

Table 7. Correlation between knowledge, self-efficacy, and adherence in three-time stages before, after one month, and three months after the intervention

	Pre				After one month				After three months			
Variables	Knowledge		Self-efficacy		Knowledge		Self-efficacy		Knowledge		Self-efficacy	
	R	p	r	p	R	p	r	p	r	p	r	p
Knowledge	-	-	.277*	.032	-	-	.367**	.004	-	-	.318*	.013
Self-efficacy	.277*	.032	-	-	.367**	.004	-	-	.318*	.013	-	-
Treatment adherence	.129	.327	-.316*	.014	-.329	.010*	-.290*	.025	-.339**	.008	-.269*	0.038

Discussion

Multiple sclerosis (MS) is a persistent condition that poses patients with a variety of caring challenges, thus it is essential to empower patients according to their actual requirements. The fact that MS becomes worse over time, associated with a variety of symptoms, causes social or emotional changes, and creates a complicated scenario that challenges healthcare providers, necessitating multidisciplinary services **(Bayat, Negarandeh, & Pashaeypoo, 2025).**

In this combination, nurses play a vital role as they interact with patients and their families throughout the entire process, empowering patients to make decisions regarding maintaining healthy behaviors. The use of telehealth services has recently made significant progress in the management of many chronic conditions. Smartphones are used regularly and are simple to operate; additionally, the clinical status of patients can also be monitored quickly on this device. Mobile-based applications can also track symptoms and treatment, and rehabilitation **(Abd Elsalam & Ali, 2022).**

So, the study aimed to assess the effect of continuous nursing model based on a smartphone application on self-efficacy and treatment compliance among multiple sclerosis patients.

In terms of demographic features, the current study revealed that the average age of the patients was 32.16±7.85 years, and more than two-thirds of them were female. This finding is in line with the findings of a study conducted by **Elshaaer, Ali, and Elsayed (2021),** which revealed that more than three-quarters of patients with multiple sclerosis were female, while less than a quarter were male. The peak age of MS patients was between 20 and 30 years. Most patients were married, nearly half had completed secondary education, and a significant proportion had higher education. The majority were from rural areas with insufficient monthly income. These results are consistent with **Ibrahim et al. (2020) and Jelinek, Facem, and O'Donoghue (2022),** who found that most MS patients live with their families and many are unemployed, which may reflect the impact of the disease on the ability to work and maintain financial independence.

The findings of the current study demonstrated that relapsing remitting multiple sclerosis (MS) was the most common type, with a mean disease duration of 5.03±3.18 years and a low percentage of smokers. Less than half of the patients reported one hospitalization per year, and about half had experienced two relapses in the past year. The most commonly reported symptoms were fatigue, pain, and urinary problems. This finding is supported by **Habibi et al. (2021),** who explained that many individuals with MS are hospitalized multiple times, particularly during relapse phases of the disease. They also noted that approximately one-quarter of the MS population is hospitalized annually. Also, these results are consistent with **Batista et al. (2022)** and **Gustavsen et al. (2021),** who reported similar disease duration patterns, and with **Nabil & Abd Elsatar (2022),** who emphasized that fatigue affects 60–70% of MS patients and is a significant factor in quality of life.

The study demonstrated that, there was a significant improvement in all mean knowledge subscales as nature of the disease, prevalence and predisposing factors, causes and genetic factor, diagnostic method and procedure and types and treatment of MS after one month and three months following the implementation of intervention compared to pre-intervention phase as well as total knowledge mean score with statistically significant difference. This showed that the studied patients had needs about the disease and its self-management information and were keen to acquire this information, which might be attributed to the effect of continuous nursing model based on a smartphone application on self-efficacy and treatment compliance. The “MS hop Path” application provided multimedia resources, reminders, and direct communication with nursing staff, which likely enhanced patients’ engagement and retention of information.

These results are consistent with **Kazemi et al. (2022) and Saad & Elsayed (2021),** who found that structured educational programs improve MS patients’ disease-specific knowledge and self-management capabilities.

However, the improvement in this study was particularly pronounced, possibly due to the integration of real-time nurse-patient interaction, which aligns with Bandura's Social Cognitive theory, highlighting that learning is reinforced when information is paired with feedback and social support.

The findings revealed that there was a significant improvement in all mean treatment adherence dimensions as well as total treatment adherence after one month and three months following the implementation of the intervention compared to the pre-intervention phase. This suggests that CNM interventions not only educate but also provide ongoing problem-solving support, enabling patients to address practical and emotional challenges in real time.

Comparable outcomes were reported by **Young et al. (2021),** who demonstrated that digital self-management tools improve adherence in chronic neurological conditions. The continuous presence of a nurse via the app fostered accountability and self-monitoring, critical components of adherence behavior according to the Health Belief Model.

The study revealed a significant improvement in all mean self-efficacy dimensions, including independence and activity, personal control, concerns, and social confidence, after one month and three months of implementing the intervention, compared to the pre-intervention phase, as well as the overall self-efficacy mean score, with statistically significant differences. This supports the premise that continuous, interactive nursing support reinforces patients' confidence in managing symptoms, making lifestyle adjustments, and adhering to complex treatment regimens. These findings align with **Ehde et al. (2021),** who emphasized that interventions incorporating coaching and feedback significantly strengthen self-efficacy in MS patients.

The study showed that there was a significant positive correlation between knowledge and self-efficacy in all intervention phases. At the same time, there was a significant negative correlation between knowledge and treatment adherence after one month and three months following the intervention. Also, there was a significant negative correlation between self-efficacy and treatment adherence at pre-intervention, one-month post-intervention, and three months post-intervention. This may reflect a more nuanced behavioral reality. As patients become more informed and confident, they may critically evaluate treatment regimens and occasionally adjust or skip doses based on perceived necessity. This suggests the need for reinforcing the importance of consistent adherence even in the absence of symptoms.

Similarly, a systematic review by **Safdar et al. (2021)** verified that knowledge-sharing and self-efficacy are positively correlated. This agrees with **Rizk and Elmowafy (2022)**, who found a strong positive correlation between knowledge and global satisfaction among the studied groups, which was highly statistically significant. This supports the theory that educational interventions can improve self-efficacy by equipping individuals with the necessary information and skills.

Also, this finding was supported by **Üstündağ, Yeşilbalkan, & Kabay (2024).** They stated that a negative correlation between patients, knowledge level, and their total treatment adherence was observed at pre- and post-implementation of the mobile education application. These agreements were associated with increasing knowledge through digital nursing intervention was effective in improving treatment adherence. The high adherence gains in the present study may have been aided by cultural norms valuing close nurse-patient relationships and the novelty of mobile health tools in the studied population.

Study Limitations

Despite the encouraging outcomes, it is essential to recognize a few limitations:

- The study was carried out on a small, purposive sample from a single hospital, which may have limited its generalizability.
- Duration of follow-up: The three-month follow-up might not adequately capture the long-term impact of behavior change.
- Self-reported measures, which are susceptible to social desirability bias and recall, were used to gauge adherence and self-efficacy.

Conclusion

The implementation of a smartphone-based continuous nursing model significantly improved patients' knowledge about MS, adherence to disease-modifying treatments, and self-efficacy over three months. The model effectively addressed barriers to treatment adherence and fostered personal empowerment by enhancing independence, control, and social confidence. Moreover, the positive correlations found between knowledge, self-efficacy, and adherence reinforce the importance of integrated, interactive nursing models. These results underscore the potential of mobile-based care in improving health outcomes for MS patients, especially in regions where continuous in-person care is not feasible.

Recommendations

Based on the findings and current evidence:

1.Nurses should adopt the CNM through mobile apps as a standard approach for long-term MS management, especially in outpatient settings and rural areas.

2.Health authorities and hospital systems should support the development and deployment of evidence-based digital health applications tailored for MS care.

3.Nursing education programs should include training on digital health tools and their role in chronic disease management, particularly MS.

4.Future apps should be developed based on user feedback, ensuring flexibility, customization, and features like symptom tracking, medication reminders, and educational content.

5.Further longitudinal, multicenter randomized controlled trials are needed to assess the long-term effectiveness, cost-efficiency, and impact on quality of life of digital CNM interventions.

6.The CNM can be adapted for other chronic conditions where continuous nursing support and patient engagement are essential.

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