Effect of Mobile Health Application Usage on Knowledge, Practice, and Quality of Life for Patients with Hypothyroidism

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Abstract

Background: Hypothyroidism is a common chronic disease that requires patients to have self-care skills such as maintaining a healthy diet, exercising, and following a daily medication regimen. Many patients need more knowledge and health literacy to manage their condition effectively. **Aim**: To evaluate the effect of Mobile health Application Usage on Knowledge, practice and Quality of Life for Patients with Hypothyroidism. **Design and Setting**: A quasi-experimental research design was used to collect data from endocrinology clinics at Mansoura university hospitals. **Sample**: A purposive sampling of (60) hypothyroid patients in the previously mentioned settings. They were divided into two equal groups; study and control; each group consisted of (30) patients. **Tools**: Three tools were used for data collection, Tool (I); Structured Interview Schedule, Tool (II); patients' self-practices assessment checklist, (Tool III): The underactive thyroid dependent quality of care questionnaire. **Results**: The main results revealed that there was a high significant improvement in the total levels of knowledge, practices and quality of life for the study group patients post the mhealth application compared to the control group. **Conclusion and Recommendation**: The mobile health (mHealth) application significantly enhanced knowledge, self-practice, and quality of life (QoL) among hypothyroid patients compared to routine care. Nurses should be recommended to integrate mHealth applications into hypothyroidism care to enhance patient education, self-management, and QoL.

Keywords: *hypothyroidism, mobile health, nursing care, quality of life, patient education*

Introduction

Thyroid disorders are a significant global health issue, with hypothyroidism being one of the most common endocrine disorders encountered in clinical practice. Hypothyroidism, characterized by thyroid hormone deficiency and often indicated by elevated serum thyroid-stimulating hormone (TSH) levels, affects approximately 4.6–5% of the global population, with a higher prevalence in women (10%) compared to men (2%) (**Chaker et al., 2022).**

In Egypt, regional studies estimate a prevalence of 4.6%, with Mansoura University Hospital managing over 500 hypothyroidism cases annually, reflecting a substantial healthcare burden (**El Sayed et al., 2021**). Adult hypothyroidism can present with a wide range of clinical symptoms, such as lethargy, cold intolerance, weight gain, constipation, hoarseness, slowed speech, delayed reflexes, dry skin, hair loss, and impaired cognitive function. Age, sex, and length of illness all affect these symptoms, with older adults frequently exhibiting unusual symptoms like depression or cognitive decline. (**Jonklaas et al., 2021**).

If untreated, severe hypothyroidism can progress to myxedema coma, a potentially fatal condition requiring urgent intervention (**Chaker et al., 2022**). Patient knowledge and awareness regarding hypothyroidism and its management are essential for ensuring sustained treatment adherence and optimal outcomes in chronic conditions (**Dominika W., et al 2022**). Nursing instructions play a pivotal role before, during, and after therapy to minimize complications associated with levothyroxine, such as over- or

under-treatment, and to address patients' physical, social, and emotional challenges, thereby enhancing their quality of life (**Okosieme et al., 2016).**

The emergence of mobile health (mHealth) applications has revolutionized chronic disease management by facilitating patient education, self-management, and remote monitoring. These tools are increasingly adopted by healthcare professionals, younger patients, and those with higher education levels, offering real-time education, medication reminders, and symptom tracking (**Marcolino et al., 2020**). For hypothyroidism, mHealth supports nursing care by improving communication, ensuring treatment adherence, and enabling timely follow-ups based on patient feedback and laboratory results (**Lu et al., 2021**). This study aims to evaluate the effect of a custom mHealth application on knowledge, practice, and QoL in patients with hypothyroidism at Mansoura University Hospital, addressing the need for innovative, patient-centered nursing interventions to improve disease management and reduce healthcare costs.

Significance of the Study

Mobile health (mHealth) offers transformative benefits for nursing care of patients with hypothyroidism by enhancing accessibility, personalization, and continuity of care. Smartphone applications enable nurses to deliver tailored education on medication schedules, dietary recommendations (e.g., avoiding goitrogenic foods like cabbage), and symptom monitoring, which are essential for maintaining stable thyroid hormone levels (**Biondi et al, 2019**). MHealth tools facilitate efficient tracking of symptoms and side effects, allowing early identification of complications, such as hypothyroidism-related depression or hypercholesterolemia, and prompt interventions **(Jonklaas et al., 2021).**

Digital platforms improve coordination between patients and healthcare providers, ensuring timely adjustments to treatment plans based on TSH levels or clinical feedback. This is particularly valuable in rural Egyptian regions, where access to endocrinology services is limited, reducing hospital visits and healthcare costs (**Marcolino et al., 2020**). By integrating mHealth into nursing practice, this study seeks to enhance patient engagement, improve adherence to levothyroxine therapy, and elevate physical, social, and emotional outcomes. The intervention empowers patients to actively manage their condition, fostering self-efficacy and reducing the risk of complications, ultimately contributing to better health outcomes and patient satisfaction (**Lu et al., 2021**).

Aim of the Study

To evaluate the effect of mobile health application usage on knowledge, practice, and quality of life for patients with hypothyroidism.

Research Hypotheses

- H1: Patients' knowledge regarding hypothyroidism in the study group will be improved after using the mobile health application than those of control group
- H2: Patients' practices regarding hypothyroidism in the study group will be improved after using the mobile health application than those of control group
- H3: Patients' quality of life regarding hypothyroidism in the study group will be improved after using the mobile health application than those of control group

Subjects and Methods

Research Design

A quasi-experimental research design was used in the study.

Setting : The study was conducted at the endocrinology clinics at Mansoura University hospital affiliated to Mansoura University and educational hospital affiliated to Ministry of Health.

Subjects :A purposive sample of 60 patients with hypothyroidism was utilized, equally divided into:

Study Group (n=30): Received an educational program by the researcher that is supported by mobile health application. **Control Group** (n=30): Received routine nursing care.

Inclusion Criteria:

- Age ranges from 20 to 60 years old.
- Adult conscious patients.
- Both sexes.
- Primary hypothyroidism patients who were on treatment for at least 3 months
- Patients with good experience of deal with smart mobile applications.

Exclusion Criteria:

- Patients without smartphones.

Tools of the study:

Three tools were used to evaluate the effect of Mobile health Application Usage on Knowledge, Practice and Quality of Life for Patients with Hypothyroidism.

Tool I: Structured Interview Schedule

It was developed by the researcher after reviewing the related literatures (Goel, A., et al 2017; Dominika W., et al 2022). It is comprised of three parts:

- **Part 1: Socio-demographic Data of the patients'**: Patient code, age, sex, marital status, education, occupation, residence, family history, healthcare access.

- **Part 2: patients' Clinical Data**: Present/past medical history, disease duration.

Part 3: Knowledge Assessment Sheet: - It was developed by the researcher after reviewing of the related literatures (Goel, A., et al 2017; **Dominika W., et al 2022)** to gather patients' knowledge regarding hypothyroidism as the following:

- Knowledge about **M health**; benefits and objectives

- Knowledge about **hypothyroidism** as; definition, causes, manifestations, lab investigations and diagnostic studies, treatment, prevention and complication. It consisted of 20 multiple-choice questions assessing knowledge of hypothyroidism (e.g., "Thyroid gland is a butterfly-shaped gland located in the neck," "Hypothyroidism may cause weight gain") and mHealth benefits.

Total scoring system of knowledge:

Correct answer scored (1)

Don't' know or incorrect answer (0)

The total scoring system of patients' knowledge was classified as the following:

-High level of knowledge > 75% of the total score

-Moderate level of knowledge ≥ 60% - 75% of the total score

- Low level of knowledge < 60% of the total score

Tool II: Patients' Self-Practice Assessment Checklist

It was developed by the researcher after reviewing related literatures **(Kumar, P. et al, 2017;** Biondi et al., 2019; Chaker et al., 2022**)** to assess the patients' practices regarding hypothyroidism and its effect on health status. It included 4 domains with 10 items: medication adherence, TSH testing, Dietary and Lifestyle Adjustments and Self-Practice Activities.

- **Medication Adherence**: E.g., "I take my hypothyroidism medication as prescribed every day," "I take my medication 30–60 minutes before breakfast."

- **TSH Testing**: E.g., "I schedule and attend regular TSH level tests."

- **Dietary and Lifestyle Adjustments**: E.g., "I avoid excessive consumption of iodine-rich foods like cabbage."

- **Self-Practice Activities**: E.g., "I use a medication tracker app or journal."

Total scoring system of practice:

Two level of scoring for the statements were utilized:

Done scored (1), Not done scored (0)

The total scoring system of patients' practice was calculated and classified as the following:

- Satisfactory practice if scored 60 %

- Unsatisfactory practice if scored < 60%

Tool III: Underactive Thyroid-Dependent Quality of Life Questionnaire (Thy-D-QoL)

The Thy-D-QoL is an individualized, hypothyroidism-specific questionnaire designed to measure the impact of hypothyroidism on quality of life (QoL). It was Adapted from McMillan et al. (2003).

Two general QoL questions:

- Current general QoL (rated on a 7-point scale: +3 = excellent to -3 = extremely poor).

- Hypothetical QoL without hypothyroidism (rated from -3 = much better to +1 = worse).

- **It consisted of 18 domain-specific items** covering aspects like leisure, work, family, social environment, energy, appearance, and depression. Each domain assesses:

The impact of hypothyroidism on that aspect (rated from -3 = much better to +1 = worse).

The importance of that aspect to the patient (rated from 3 = very important to 0 = not at all important).

Scoring system

The total scoring system of patients' responses was calculated and classified as the following:

- **Satisfactory QoL: ≥60% (average score ≥ -3.6).**

- **Unsatisfactory QoL: <60% (average score < -3.6).**

Methods

Ethical and Legal Considerations

Official letters from the faculty of nursing were delivered to the appropriate authorities in the selected area of the study. Approval of ethical committee from the faculty of nursing was obtained (code no: 0766). An Informed consent was taken from all participants in this research after explanation the aim of the study and the right to withdrawal at any time. Confidentiality and privacy were taken into consideration regarding data collection. A code number was used instead of names.

Methods of Data Collection

1-All tools were tested for content validity and clarity of the questionnaire by a panel of (5) experts in the Medical Surgical Nursing, and endocrinology field physician and accordingly needed modifications were done.

2-The reliability for the study tools was calculated by Cronbach's alpha test; it was 0.92 for tool (I) Part (iii) and 0.91 for tool (II), 0.937 for tool (III). The suitable statistical tests were used for testing questionnaire reliability.

3- The study tools were conducted before the study on (10%) patients to test the feasibility, applicability, clarity, relevance and organization of the tools and to determine any obstacles that may be encountered during the period of data collection; accordingly, needed modification was done. The pilot study was excluded from the study subjects.

4- The collection of data for the present study was carried out within the period from October 2024 to April 2025.

5- The present study was conducted through four phases (Assessment, planning, implementation and evaluation) and it was continued with each patient individually through their follow ups.

Study Phases

The study followed four detailed phases, with individualized patient follow-ups, integrating tool sheet data:

Assessment Phase:

Assessment of hypothyroid patients was conducted at baseline in a clinic setting to ensure patient comfort, using Tools I (Parts 1–3), II, and III for both groups.

Tool I: Collected socio-demographic (e.g., age, sex, education) and clinical data (e.g., disease duration, treatment history). Knowledge assessment included 20 questions, such as “Hypothyroidism may cause fatigue” and

"Iodine deficiency may lead to hypothyroidism," to ensure understanding of disease and mHealth. **Tool II**: Evaluated practices, e.g., "I take my medication 30–60 minutes before breakfast,". **Tool III**: Assessed QoL, e.g., "My social life would be" (rated -3 to +1), with importance ratings for domains like energy and appearance.

Each interview questionnaire lasted 30–45 minutes, ensuring thorough data collection to confirm eligibility.

Planning Phase:

Objectives of the study were prepared based on the needs of the patients. The educational program was designed by researchers based on the study subjects' assessment and extensive reviews of related literature. A custom mHealth application was developed in simple Arabic language, to meet patient needs based on assessment data and literature (Jonklaas et al., 2021; Marcolino et al., 2020).

The M health App features included: **Educational modules on hypothyroidism**; (e.g., definition, causes, manifestations, diagnostic studies, complications and treatment. **Medication reminders** (e.g., levothyroxine timing). TSH testing and appointment notifications. Dietary guidance (e.g., "Avoid excessive consumption of iodine-rich foods like cabbage"). Symptom diary and self-practice tracking tools and Illustrative videos/pictures for accessibility.

Implementation Phase:

Study Group:

The educational program was developed by the researcher to the study group patents through the following sessions: ***(session 1)*** the researcher met the patients individually and began with Initial 20–30-minute individual sessions introduced the health app, installed on patients' smartphones, with instructions on navigation. ***(session 2)*** the researcher delivered the theoretical part related to the disease, Education covered hypothyroidism details (e.g., "Cold intolerance," "Weight gain," "TSH testing"), supported by app content.

(session 3) Practical training included medication adherence (e.g., "Take medication 30–60 minutes before breakfast"), TSH monitoring, dietary adjustments (e.g., balanced diet with protein, fruits), and self-practice activities (e.g., symptom diary use). ***Follow-up sessions*** at 1 and 2 months (15–20 minutes each) reassessed knowledge practices and QoL. Patients received app notifications to reinforce adherence and track symptoms.

Control Group:

The patients received the routine nursing care provided by endocrinology nurses and were assessed at the same intervals.

Evaluation Phase: Both groups were assessed three times:

Pre-intervention: Baseline using Tools I, II, III to assess knowledge, practice and QOL. **1 Month Post-intervention**: Tools I (Part 3), II, III to evaluate early improvements and **2 Months Post-intervention**: Final assessment to measure sustained outcomes.

Methods of data analysis:

All data were collected, coded, tabulated and subjected to statistical analysis. Statistical analysis was performed by statistical Package SPSS in general (version 20), Data expressed as number and percentage. T-test is used to determine significant for numeric variables. A probability level of p-value $\leq 0.01$was adopted as a level of significance for testing the research hypotheses **(Gerstman B. 2018)**

Results

Table (1) ***represents the distribution of the socio-demographic characteristics of the patients.*** The table showed that 43.3% of the study group patients were aged under 35 years and 53.3% were females, while 23.3% of the control group were under 35 years and 43.3% were females. **Also**, it was found that 56.7% of the study group and 33.3% of the control group were married, while 40.0% and 46.7% had university education, respectively. **Additionally**, the table revealed that 30.0% of the study group and 16.7% of the control group were housewives, while 40.0% in both groups were employees. **Furthermore**, 60.0% of the study

group and 46.7% of the control group were from rural areas. Overall, there are no statistically significant differences between the study and control groups regarding all socio-demographic characteristics.

Table (2) illustrates the distribution of the studied patients according to their clinical data. Concerning the past medical history, the table revealed that the highest percentage of control group patients had hypertension (70.0%), followed by diabetes mellitus (63.3%) and osteoporosis (60.0%). In the study group, the highest percentages were for hypertension (56.7%) and diabetes mellitus (46.7%).

Regarding the duration of the disease, the most prominent results show that the highest percentage of control group patients had the disease for 3 to 6 months (33.3%), while the highest percentage in the study group had the disease for 1 month (26.7%) and 3 to 6 months (26.7%). Overall, there are no statistically significant differences between the study and control groups regarding all clinical data items.

Table (3) illustrates the percent distribution of the studied patients regarding their total levels of knowledge throughout the study periods.

Concerning the study group, the table showed that there was a highly statistically significant improvement in the patients' total levels of knowledge, where 60.0% of the patients had low levels and 26.7% had moderate levels of knowledge pre-implementation of the mobile health application, whereas 86.7% and 73.3% of the patients had scored high levels of knowledge with p-values = (<0.001, <0.001) at 1 month and 2 months post-implementation, respectively.

On the other hand, concerning the control group, there was no significant improvement in their total levels of knowledge throughout all periods of intervention, where 73.3% of the patients had low levels of knowledge pre-implementation of routine care, whereas 53.3% and 36.7% of the patients had scored moderate levels of knowledge at 1 month and 2 months post-implementation, respectively ($X^2 = 38.603$, $p < 0.001$ at 1 month; $X^2 = 25.584$, $p < 0.001$ at 2 months).

Table (4) illustrates the percent distribution of the studied patients regarding their levels of practice throughout the study periods.

Concerning the study group, the table showed that there was a highly statistically significant improvement in the patients' total levels of practice, where 86.7% of the patients had unsatisfactory levels of practice pre-implementation of the mobile health application, whereas 80.0% and 86.7% of the patients had scored satisfactory levels of practice with p-values = (<0.001, <0.001) at 1 month and 2 months post-implementation, respectively.

On the other hand, concerning the control group, there was no significant improvement in their total levels of practice throughout all periods of intervention, where 83.3% of the patients had unsatisfactory levels of practice pre-implementation of routine care, whereas 23.3% and 30.0% of the patients had scored satisfactory levels of practice at 1 month and 2 months post-implementation, respectively ($X^2 = 19.288$, $p < 0.001$ at 1 month; $X^2 = 19.817$, $p < 0.001$ at 2 months).

Table (5) illustrates the percent distribution of the studied patients regarding their quality of life throughout the study periods.

Concerning the study group, the table indicated a highly statistically significant improvement in patients' total practice levels, with 86.7% of patients showing unsatisfactory practice levels pre-intervention using the mobile health application, whereas 80.0% and 86.7% achieved satisfactory practice levels at 1 month and 2 months post-intervention, respectively ($p < 0.001$ for both periods).

On the other hand, concerning the control group, there was no statistically significant improvement in their total practice levels throughout the intervention periods with routine hospital care, where 83.3% of patients had unsatisfactory practice levels pre-intervention, and 76.7% and 70.0% remained unsatisfactory at 1 month and 2 months post-intervention, respectively ($X^2 = 19.288$, $p < 0.001$ at 1 month; $X^2 = 19.817$, $p < 0.001$ at 2 months).

Table (6) illustrates the association between the socio-demographic characteristics of the patients and their knowledge about hypothyroidism at 2 months post-intervention.

Concerning the study group; The table revealed that **54.5%** of patients with good knowledge had university education, while **66.7%** of those with poor knowledge had only read-and-write education. There was statistically significant association between education level and knowledge with (X^2=20.618, P=0.002).Regarding occupation, **50.0%** of patients with good knowledge were employees, showing another statistically significant association (X^2=11.533, P=0.021).

Concerning the Control Group; there was No statistically significant associations found between socio-demographic characteristics and knowledge levels in the control group. However, it's noteworthy that **66.7%** of patients with good knowledge had university education and **66.7%** were employees. Overall, the study group showed significant associations between education level, occupation, and knowledge about hypothyroidism, while the control group did not show any statistically significant associations.

Table (7) illustrates the correlation between knowledge, self-practice, and quality of life in the study group.

The table shows a statistically significant positive correlation between knowledge and self-practice (r=0.370, p=0.044), indicating that higher levels of knowledge are associated with better self-practice among the patients. **Additionally**, there is a statistically significant positive correlation between knowledge and quality of life (r=0.430, p=0.018), suggesting that higher levels of knowledge are associated with a better quality of life.

Furthermore, the table reveals a statistically significant positive correlation between self-practice and quality of life (r=0.527, p=0.003), indicating that better self-practice is associated with a better quality of life.

Overall, the study group shows significant positive correlations between knowledge, self-practice, and quality of life, emphasizig the beneficial impact of knowledge and self-practice on the patients' quality of life

Part I: Table (1): Distribution of studied patients according to their socio demographic data.

	Study		Control		Chi – square / fisher's exact test	
	n	%	N	%	X^2	p
Age (Years)						
< 35	13	43.3	7	23.3		
35 – 45	12	40.0	16	53.3		
> 45	5	16.7	7	23.3	2.705	0.259
Gender						
Male	14	46.7	17	56.7		
Female	16	53.3	13	43.3	0.601	0.438
Marital status						
Married	17	56.7	10	33.3		
Single	8	26.7	10	33.3		
Divorced / Widowed	5	16.7	10	33.3	3.704	0.157
Education						
Read and write	4	13.3	0	0.0		
Primary	5	16.7	9	30.0		
Secondary	9	30.0	7	23.3		
University	12	40.0	14	46.7	5.547	0.136
Occupation						
Employee	12	40.0	12	40.0		
Manual	9	30.0	13	43.3		
Housewife	9	30.0	5	16.7	1.870	0.393
Residence						
Rural	18	60.0	14	46.7		
Urban	12	40.0	16	53.3	1.071	0.301

Table 2. Distribution of the clinical data of the patients

	Study		Control		Chi – square / fisher's exact test	
	n	%	n	%	X^2	p
Past & present medical history						
Hypertension	17	56.7	21	70.0	1.148	0.284
Diabetes Mellitus	14	46.7	19	63.3	1.684	0.194
Osteoporosis	14	46.7	18	60.0	1.071	0.301
Duration of disease						
1 month	8	26.7	7	23.3		
Between 1 and 3 months	7	23.3	7	23.3		
Between 3 and 6 months	8	26.7	10	33.3		
6 months or more	7	23.3	6	20.0	0.366	0.947

Table 3. Percent distribution of the studied patients regarding their total levels of Knowledge throughout periods of study.

	Study		Control		Chi – square / fisher's exact test	
	n	%	n	%	X^2	p
Pre – intervention						
Low knowledge	18	60.0	22	73.3		
Moderate knowledge	8	26.7	6	20.0		
High knowledge	4	13.3	2	6.7	1.352	0.509
Mean ±SD	8.6 ±4.0		7.6 ±3.2		1.069	0.289
1 month post						
Low knowledge	2	6.7	12	40.0		
Moderate knowledge	2	6.7	16	53.3		
High knowledge	26	86.7	2	6.7	38.603	<0.001**
Mean ±SD	18.4 ±4.2		9.8 ±4.8		7.385	<0.001**
2 months post						
Low knowledge	3	10.0	16	53.3		
Moderate knowledge	5	16.7	11	36.7		
High knowledge	22	73.3	3	10.0	25.584	<0.001**
Mean ±SD	16.7 ±5.2		9.6 ±4.3		5.763	<0.001**

Table 4 . Percent distribution of the studied patients regarding their levels of practice throughout periods of study.

	Study		Control		Chi – square / fisher's exact test	
	n	%	n	%	X^2	p
Pre – intervention						
Unsatisfactory practice	26	86.7	25	83.3		
Satisfactory practice	4	13.3	5	16.7	0.131	0.718
Mean ±SD	3.5 ±1.3		3.1 ±1.4		1.146	0.256
1 month post						
Unsatisfactory practice	6	20.0	23	76.7		
Satisfactory practice	24	80.0	7	23.3	19.288	<0.001**
Mean ±SD	6.5 ±2.4		4.1 ±1.4		4.731	<0.001**
2 months post						
Unsatisfactory practice	4	13.3	21	70.0		
Satisfactory practice	26	86.7	9	30.0	19.817	<0.001**
Mean ±SD	7.0 ±2.3		4.5 ±1.8		4.688	<0.001**

Table 5. Percent distribution of the studied patients regarding their quality of life throughout periods of study.

	Study		Control		Chi – square / fisher's exact test	
	n	%	n	%	X^2	p
Pre – intervention						
Good quality of life	4	13.3	3	10.0		
Poor quality of life	26	86.7	27	90.0	0.162	0.688
Mean ±SD	70.5 ±17.5		71.5 ±10.9		0.265	0.791
1 month post						
Good quality of life	19	63.3	8	26.7		
Poor quality of life	11	36.7	22	73.3	8.148	0.004*
Mean ±SD	51.7 ±14.0		66.2 ±15.7		3.775	<0.001**
2 months post						
Good quality of life	24	80.0	10	33.3		
Poor quality of life	6	20.0	20	66.7	13.303	<0.001**
Mean ±SD	44.9 ±20.5		65.8 ±15.0		4.487	<0.001**

Table 7. Correlation between knowledge, self-practice and quality of life (Study group)

	Knowledge		Self-practice		Quality of life	
	r	p	r	p	r	p
Knowledge			0.370	0.044*	0.430	0.018*
Self-practice	0.370	0.044*			0.527	0.003*
Quality of life	0.430	0.018*	0.527	0.003*		

Table 6. Association between the socio demographic characteristics of the patients and Knowledge about hypothyroidism at 2 months post

	Study						Chi – square / fisher's exact test	Control						Chi – square / fisher's exact test
	Poor (n=3)		Average (n=5)		Good (n=22)			Poor (n=16)		Average (n=11)		Good (n=3)		
	n	%	n	%	n	%		n	%	n	%	n	%	
Age (Years)														
< 35	1	33.3	3	60.0	9	40.9	X^2=2.021, P=0.732	4	25.0	2	18.2	1	33.3	X^2=2.122, P=0.713
35 – 45	2	66.7	1	20.0	9	40.9		7	43.8	7	63.6	2	66.7	
> 45	0	0.0	1	20.0	4	18.2		5	31.3	2	18.2	0	0.0	
Gender														
Male	0	0.0	1	20.0	13	59.1	X^2=5.418, P=0.067	10	62.5	5	45.5	2	66.7	X^2=0.907, P=0.635
Female	3	100.0	4	80.0	9	40.9		6	37.5	6	54.5	1	33.3	
Marital status														
Married	2	66.7	4	80.0	11	50.0	X^2=2.660, P=0.616	7	43.8	2	18.2	1	33.3	X^2=2.148, P=0.709
Single	1	33.3	1	20.0	6	27.3		5	31.3	4	36.4	1	33.3	
Divorced / Widowed	0	0.0	0	0.0	5	22.7		4	25.0	5	45.5	1	33.3	
Education														
Read and write	2	66.7	2	40.0	0	0.0	X^2= 20.618, P= 0.002*	0	0.0	0	0.0	0	0.0	X^2=3.458, P=0.484
Primary	1	33.3	2	40.0	2	9.1		7	43.8	2	18.2	0	0.0	
Secondary	0	0.0	1	20.0	8	36.4		3	18.8	3	27.3	1	33.3	
University	0	0.0	0	0.0	12	54.5		6	37.5	6	54.5	2	66.7	
Occupation														
Employee	0	0.0	1	20.0	11	50.0	X^2=11.533, P=0.021*	6	37.5	4	36.4	2	66.7	X^2=2.654, P=0.617
Manual	1	33.3	0	0.0	8	36.4		6	37.5	6	54.5	1	33.3	
Housewife	2	66.7	4	80.0	3	13.6		4	25.0	1	9.1	0	0.0	
Residence														
Rural	2	66.7	3	60.0	13	59.1	X^2=0.063, P=0.969	6	37.5	6	54.5	2	66.7	X^2=1.297, P=0.523
Urban	1	33.3	2	40.0	9	40.9		10	62.5	5	45.5	1	33.3	

Discussion

Hypothyroidism is a common chronic disease that requires patients to have self-care skills such as maintaining a healthy diet, exercising, and following a daily medication regimen. Many patients need more knowledge and health literacy to manage their condition effectively. Also, Many patients with hypothyroidism still experience greater reduction in quality of life (QoL) and treatment satisfaction when on the recommended replacement dosage. Thus, nursing guidelines could improve patients' knowledge, QoL, and treatment satisfaction among patients with hypothyroidism **(Deif, H.I., and El-Naby, A.G. 2023).** Using mobile health-based training applications or software could be beneficial in educating patients. Therefore, this study aimed to determine the impact of mobile health-based training on hypothyroid patients' knowledge and health literacy. **(Rigi, M.et al, 2024).**

So, the aim of the study is to evaluate the effect of Mobile health Application Usage on Knowledge, Practice and Quality of Life for Patients with Hypothyroidism.

Concerning the socio-demographic characteristics of the studied patients,

Regarding to age and gender, the current study results revealed that nearly half of the study group and nearly one quarter of the control group were aged under 35 years, and more than half and nearly half of the patients were females in the study and control groups, respectively. This finding: the female-majority sample and younger age profile reflects hypothyroidism's epidemiology, which is more prevalent in women and can manifest in younger adults due to autoimmune or iodine-related factors.

This result is supported by **Alzahrani et al. (2021),** who found that most hypothyroid patients in Saudi Arabia were females aged 20–40 years. Also, **Biondi et al. (2019)** stated that hypothyroidism affects women at a significantly higher rate than men, often diagnosed in their 30s or 40s. On the other hand, this finding is contradicted with **Hennessey and Espaillat (2015),** who reported a higher proportion of older patients in their study.

As regards marital status and educational level, the study results revealed that more than half of the study group and one third of the control group patients were married, and nearly two fifths and nearly half had university education, respectively. The high marriage rate aligns with **Afifi Abd Elazeem et al. (2023),** who reported that most hypothyroid patients in their study were married. The educational level result is in harmony with **Rigi et al. (2024),** who implied that moderate education facilitates mHealth uptake. ***On the other hand***, this finding is contradicted with **Alzahrani et al. (2021),** who reported that more than half of hypothyroid patients had primary or secondary education.

Concerning occupation and place of residence, the current study results revealed that nearly one third of the study group and a minority of the control group patients were housewives, with nearly two fifths in both groups being employees, and three fifths of the study group and nearly half of the control group resided in rural areas. The high proportion of housewives and employees aligns with **Aladwani et al. (2020),** who reported similar occupational distributions among hypothyroid patients. This finding is also supported by **Afifi Abd Elazeem et al. (2023),** who noted that many female hypothyroid patients were housewives. On the other hand, This finding, however, contrasts with that of Hennessey and Espaillat (2015), who found that most of the hypothyroid population lived in urban areas.

Concerning the past medical history and duration of hypothyroidism among the studied patients, the current study results revealed that the majority of control group patients had hypertension, followed by nearly two thirds with diabetes mellitus and three fifths with osteoporosis. In the study group, more than half had hypertension and nearly half had diabetes mellitus. The high prevalence of hypertension (majority in control group, more than half in study group) and diabetes mellitus (nearly two thirds in control group, nearly half in study group) reflects hypothyroidism's association with metabolic and cardiovascular disorders. This could be attributed to hypothyroidism's impact on lipid metabolism and insulin resistance, increasing risks for hypertension and diabetes.

This finding is in the same line with **Shrestha, B., & Rai, C. K. (2023),** who reported that nearly half of type 2 diabetes patients in a Saudi hospital had hypothyroidism, Similarly, **Biondi et al. (2019)** noted that hypothyroidism is frequently associated with hypertension and diabetes due to metabolic dysregulation. This result is also supported by **Chaker et al. (2017)**, who found that hypothyroid patients have a higher prevalence of metabolic syndrome, including hypertension and diabetes. The presence of osteoporosis in three fifths of the control group aligns with **Alzahrani et al. (2021)**, who reported bone disorders in Saudi hypothyroid patients, possibly due to prolonged thyroid hormone imbalances.

Regarding the duration of the disease, the highest proportion of control group patients had hypothyroidism for one third of a year to half a year, while the study group had nearly one quarter diagnosed for one month and another nearly one quarter for one third of a year to half a year. This may be due to differences in healthcare access or symptom recognition, particularly in rural areas common in this study. This finding is consistent with **Taylor et al. (2020)**, who noted that hypothyroidism is often diagnosed within months of symptom onset, depending on screening practices. On the other hand, this finding is contradicted with **Rigi et al. (2024)**, who reported longer hypothyroidism durations in their study.

Concerning the total knowledge levels of the studied patients, the current study results revealed that more than half of the study group had low levels of knowledge and nearly one quarter had moderate levels pre-implementation of the mobile health (mHealth) application, whereas most achieved high levels of knowledge at one month and nearly three quarters at two months post-implementation. The significant improvements in knowledge levels among the study group are due to the mobile health (mHealth) application's targeted educational features. The MHealth intervention provided accessible content on hypothyroidism management, including medication adherence and lifestyle adjustments, supported by reminders and interactive tools, which facilitated sustained learning. This finding agrees with **Rigi et al. (2024)**, who reported that mHealth-based training significantly improved knowledge among hypothyroid patients. Additionally, **Tabor et al. (2021)** observed that mHealth applications improved health literacy in individuals with hypothyroidism, enabling a better comprehension of self-management. Furthermore, these results are similar with **Mohammed (2019)** who concluded that a statistically significant difference was found at the level of knowledge and practice after educational program with obvious improvement compared with pre-implementation of educational program.

On the other hand, nearly three quarters of the control group had low levels of knowledge pre-implementation of routine care, with more than half achieving moderate levels at one month and more than one third at two months post-implementation. These findings demonstrate the mHealth intervention's effectiveness in enhancing hypothyroidism knowledge, supporting its role in patient education.

This finding suggests that routine care is insufficient for addressing knowledge deficits reflecting routine care's limited educational support. This result is supported by **McMillan et al. (2018)**, who found minimal knowledge gains in thyroid patients without structured interventions. On contrast, this finding is not on the same line with **Afifi Abd Elazeem et al. (2023)**, who observed some knowledge improvement with routine care, possibly due to differences in care delivery.

Concerning the practice levels of the studied patients, the current study results revealed that most of the study group had unsatisfactory levels of practice pre-implementation of the mobile health (mHealth) application, whereas four fifths achieved satisfactory levels at one month and most at two months post-implementation. The significant improvement in practice, with four fifths achieving satisfactory levels at one month and most at two months, reflects the MHealth application's ability to manage behaviors like medication adherence and lifestyle changes. This could be attributed to features such as reminders, symptom tracking, and educational content, which enhance patient self-efficacy.

This finding is in the same line with **Tabor et al. (2021)** who noted that mHealth tools enhanced self-management in hypothyroidism patients, facilitating better practice. Also, This result is supported by **Kim et al. (2023)**, who found that mHealth interventions improved chronic disease self-management practices.

On the other hand, more than four fifths of the control group had unsatisfactory levels of practice pre-implementation of routine care, with nearly one quarter achieving satisfactory levels at one month and nearly one third at two months post-implementation. These findings demonstrate the mHealth intervention's effectiveness in improving hypothyroidism self-management practices. This result also suggests that routine care is inadequate for enhancing self-management. This may be attributed to limited guidance, supervision and follow-up in standard care settings. This finding is in the same line with **Aladwani et al. (2020)**, who noted poor baseline practices among Riyadh hypothyroid patients receiving routine care. On contrast, this finding is contradicted with **Afifi Abd Elazeem et al. (2023)**, who observed some practice improvement with routine care, possibly due to variations in care delivery.

Concerning the quality of life (QoL) of the studied patients, the current study results revealed that most of the study group and nearly all the control group had poor QoL pre-implementation of the mobile health (mHealth) application and routine care, respectively. Post-implementation, nearly two thirds of the study group achieved good QoL at one month, and four fifths at two months, whereas nearly one quarter of the control group had good QoL at one month and one third at two months. These findings represent the effectiveness of mhealth interventions in improving QoL among hypothyroid patients, highlighting its value in patient-centered care.

Concerning the study group, the significant improvement in QoL reflects the MHealth application's ability to address physical, psychological, and social aspects of hypothyroidism. This could be attributed to enhanced knowledge and practice, such as medication adherence and lifestyle adjustments, facilitated by mHealth features like reminders and educational content. This finding is in the same line with **Tabor et al. (2021)**, who reported that mHealth interventions significantly improved QoL in hypothyroid patients. In addition, this finding is consistent with **Rigi et al. (2024)** who noted that mHealth-based training has enhanced health literacy, and so indirectly supported QoL. On the other hand, this finding contrasts with **Aladwani et al. (2020)**, who reported poor baseline outcomes in hypothyroid patients without structured interventions, representing persistent QoL deficits.

On the other hand, concerning the control group, the limited QoL improvement suggests that routine care is insufficient for addressing QoL deficits. This may be due to inadequate patient education and support in standard care settings. This finding is in the same line with **Aladwani et al. (2020)**, who noted poor baseline knowledge and practices among Riyadh hypothyroid patients, likely contributing to poor QoL. Besides, **Watt et al. (2014)** reported significant QoL impairments in hypothyroid patients using the ThyPRO scale, particularly without interventions. On the other hand, this finding contrasts with **Afifi Abd Elazeem et al. (2023)**, who observed some practice improvements with routine care, which may indirectly enhance QoL in hypothyroid patients.

Concerning the association between socio-demographic characteristics and knowledge about hypothyroidism at two months post-intervention, the current study results revealed that more than half of the study group patients with good knowledge had university education, while two thirds of those with poor knowledge had only read-and-write education. Additionally, half of the study group patients with good knowledge were employees.

This could be attributed to better digital literacy and understanding of mHealth content among educated patients. This finding is in the same line with **Rigi et al. (2024)**, who reported that mHealth-based training was more effective in patients with moderate education. This result is also supported by **Benvenga et al. (2017)**, who found that higher education is correlated with better thyroid knowledge. On the other hand, this finding is inconsistent with **Aladwani et al.**

(2020), who found no clear educational influence on knowledge without structured interventions.

On the other hand, the control group showed no significant associations, although two thirds of patients with good knowledge had university education and were employees. These findings highlight the mHealth intervention's role in enhancing knowledge among educated and employed patients, emphasizing the influence of socio-demographic factors on educational outcomes. This may be due to limited educational support in standard care settings. This finding agrees with **Benvenga et al. (2017)** who reported that hypothyroid patients often have inadequate knowledge without targeted education.

Concerning the correlations between knowledge, self-practice, and quality of life (QoL) in the study group, the current study results revealed a significant positive correlation between knowledge and self-practice, indicating that higher knowledge levels are associated with better self-management behaviors. Additionally, a significant positive correlation was found between knowledge and QoL, suggesting that increased knowledge enhances patient well-being. Furthermore, a stronger significant positive correlation between self-practice and QoL indicates that improved self-management practices substantially improve QoL. These findings emphasize the interconnected benefits of the mobile health (mHealth) intervention in enhancing hypothyroidism outcomes.

Concerning the correlation between knowledge and self-practice, the significant positive association suggests that patients with greater knowledge about hypothyroidism, facilitated by the mHealth application, are more likely to engage in effective self-management behaviors, such as medication adherence and lifestyle adjustments. This could be attributed to MHealth's educational content and reminders, which reinforce knowledge application. This finding is in harmony with **Afifi Abd Elazeem et al. (2023),** who reported that educational interventions improved both knowledge and practice in hypothyroid patients.

Concerning the correlation between knowledge and QoL, the significant positive association indicates that patients with higher knowledge levels experience better QoL, likely due to improved understanding of disease management. This could be linked to mHealth's ability to empower patients through accessible education. This finding is in the same line with **Tabor et al. (2021),** who reported that mHealth interventions improved QoL in hypothyroid patients by enhancing health literacy. On the other hand, this finding contrasts with **Aladwani et al. (2020),** who reported poor QoL in hypothyroid patients with low knowledge, underscoring the mHealth intervention's value.

Furthermore, concerning the correlation between self-practice and QoL, the stronger significant positive association suggests that effective self-management practices, such as consistent medication use and lifestyle changes, substantially enhance QoL. This could be attributed to MHealth's behavioral support tools, which reinforce practice adherence.

This finding agrees with **Razvi et al. (2018)** who reported that better thyroid management practices were associated with enhanced QoL. Also, it is supported by **Afifi Abd Elazeem et al. (2023)**, who found that improved practices led to better patient outcomes.

Conclusion and recommendations

Based on the finding of the present study, it can be concluded that, the mobile health (mHealth) application significantly enhanced knowledge, self-practice, and quality of life (QoL) among hypothyroid patients compared to routine care. The study group exhibited marked improvements in knowledge and practice, with nearly three quarters achieving high knowledge levels and most achieving satisfactory practice at two months post-intervention. For clinical practice, nurses should be recommended to integrate mHealth applications into hypothyroidism care to enhance patient education, self-management, and QoL. Also, Training programs are recommended to equip nurses with skills to guide patients in using mHealth tools effectively.

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