Acceptance, Drivers, and Barriers to use mHealth Applications to Improve Quality of Life in Female Patients Affected by Hypothyroidism: a Cross-sectional Study

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Abstract

Background: Hypothyroidism is a common chronic disease associated with lower quality of life, a trend that interventions delivered by mHealth applications could ameliorate.

Objective: The objective of the present study was to assess acceptance, drivers, and barriers to use mHealth applications to improve quality of life in female patients affected by hypothyroidism.

Methods: A survey-based, cross-sectional study, which included N = 318 female patients affected by hypothyroidism (assessed via self-report) was conducted between April 2023 and April 2024. Sociodemographic, health, and eHealth-related data were assessed. To determine acceptance and its drivers and barriers, an extended version of the Unified Theory of Acceptance and Use of Technology model was applied. Group comparisons and multiple hierarchical regression were conducted.

Results: Acceptance of mHealth applications was high (M = 4.10, SD = 0.91), with 76.1% (n = 242) of the participants reporting high acceptance, 18.6% (n = 59) reporting moderate acceptance, and only 5.3% (n = 17) reporting low acceptance. Significant predictors of acceptance were Place of Residence: Medium-sized city (? = .34, p = .02) and small town or rural area (? = .28, p = .003), Fatigue (? = .54, p < .001), Internet anxiety (? = -.20, p = .002), and the UTAUT predictors Effort expectancy (? = .37, p < .001), Performance expectancy (? = .32, p < .001), and Social influence (? = .20, p < .001). The extended model explained 56.1% of variance in acceptance.

Conclusions: The high level of acceptance of mHealth applications observed among females affected by hypothyroidism suggests that mHealth interventions can provide such patients with valuable support to manage the disease. Drivers and barriers should be addressed during the implementation of mHealth interventions Clinical Trial: N/A

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Abstract

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Conclusion: The high level of acceptance of mHealth applications observed among females affected by hypothyroidism suggests that mHealth interventions can provide such patients with valuable support to manage the disease. Drivers and barriers should be addressed during the implementation of mHealth interventions

Keywords: eHealth; intention to use; Unified Theory of Acceptance and Use of Technology; UTAUT; QoL; hypothyroidism

Introduction

Due to their high prevalence, large parts of the health care system are involved in treating and managing thyroid diseases, since about 0.2% and 5.3% in Europe, along with 0.3% and 3.7% in the United States and approximately 3% of all individuals worldwide suffer from hypothyroidism [1,2]. In Germany, 8.9% of females and 1.8% of males are diagnosed with a thyroid disorder [3]. Of all groups in the population, females and older adults, in particular have a significantly increased risk of thyroid disease [4–7].

For patients, thyroid disease can have a wide range of consequences, especially for physical and mental health. Frequent symptoms of overt hypothyroidism include obesity, fatigue, infertility or subfertility, and various cardiovascular symptoms such as bradycardia [8,9]. Thyroid hormone disbalance is also associated with different mental comorbidities, including depression and anxiety, particularly if untreated [10–13] and, overall, with a decreased quality of life [14].

Treating hypothyroidism typically involves thyroid hormone replacement therapy, with levothyroxine [15]. Such therapy requires administering the correct dose of levothyroxine, which can be determined and aggravated by various factors, including body weight, etiology of hypothyroidism, age and clinical context [15]. In case of undertreatment, patients remain hypothyroid, and overtreatment may cause iatrogenic hyperthyroidism [16].

However, even if the correct dose of levothyroxine is administered, as evidenced by normalized serum TSH levels, about 10-15% of the patients are not satisfied due to remaining symptoms of hypothyroidism [15,17–19]. Moreover, in other research only 59% of patients prescribed levothyroxine were fully adherent [20], and 22% of participants (i.e. 72 of 327) in another study reported not adhering to thyroxine replacement therapy [21]. Underlying reasons for nonadherence have included

forgetfulness and carelessness; and non- or poor adherence have also been associated with a lower level of education, long-term therapy (i.e. >12 months) with levothyroxine and unattended medical appointments, as investigated in a study [22]. Concerns about medication, as well as affordability and accessibility, are additional factors that influence adherence [23]. The wide ranges of symptoms and comorbidities, along with the difficulty in adjusting therapy associated with poor compliance, underscore the need to support patients with thyroid disease at higher levels.

In recent years, mHealth applications have emerged in health care systems and been the subject of diverse studies. Since more than 4.7 billion people worldwide use smartphones, mHealth offers a widely accessible, cost-effective and sustainable way of managing chronic diseases [24–26]. Improving diagnostics by using symptom checkers, implementing interventions for behavioral changes, improving medication adherence, and providing “disease-related education”, as well as facilitating digital exchanges with health care providers, showcase the value of mHealth applications in managing chronic diseases [24,27]. For patients with thyroid disorders, the benefits are numerous. One study evaluating the mHealth application “BOOST Thyroid App” revealed an increase in health literacy, improved patient-doctor interaction with shortened or less frequent doctor’s appointments and improved general quality of life after using the mHealth application [28]. In the study, 95.8% of patients reported that the mHealth solution generally supported them in managing their disease [28]. Overall, these study results clarify the usefulness of mHealth interventions in supporting patients with thyroid disease.

However, implementing mHealth interventions in routine care presents several obstacles, including data privacy, trust in online information, and smartphone access [29,30]. Older adults, in particular, tend to be insufficiently experienced with mHealth

applications, if they are even aware of them, and the lack of face-to-face communication presents a barrier especially for older people [31].

To sustainably implement mHealth applications for patients affected by hypothyroidism despite those obstacles, the acceptance of mHealth applications and influencing factors need to be investigated. However, at present, no study has evaluated the acceptance of mHealth interventions to improve the quality of life of female patients affected by hypothyroidism by using acknowledged measurement methods. Even so, several variables to determine the acceptance of technology can be approached by the Unified Theory of Acceptance and Use of Technology (UTAUT) [32], including the following variables: performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions and behavioral intention (BI) to use (i.e. operationalization of acceptance) new technology [33–35]. Regarding mHealth (e.g., mHealth interventions) applications in particular, various studies have also shown the usefulness of the UTAUT to investigating those variables [35–38].

Objectives

In this study, we aimed to investigate the acceptance of mHealth interventions among female patients affected by hypothyroidism and factors contributing to such acceptance as a means to improve their quality of life. In addition, questions regarding the lack of mHealth interventions implemented in consideration of their acceptance and contributing factors of such acceptance have thus far remained unanswered. In doing so, we used an extended UTAUT model. The additional variables capture sociodemographic and medical issues as well as ICT-related data (information and communication technology), i.e. the technical basis of communication via mHealth applications. As females are more frequently affected by hypothyroidism, the acceptance of a mHealth interventions by women is of major clinical importance, which is why this study focuses on female

patients [5,6].

This study focusses on the following questions:

1. What is the general level of acceptance of mHealth applications among female patients affected by hypothyroidism?
2. To what extent do female patients affected by hypothyroidism differ in their acceptance regarding sociodemographic and medical factors?
3. Which drivers and barriers are most important to influence the acceptance?

Methods

Study Design, Participants and Procedure

A survey-based, cross-sectional study was conducted to assess the acceptance of mHealth applications to improve quality of life for females affected by hypothyroidism. From April 2023 to April 2024, participants were recruited via self-help groups (e.g., Schilddrüsenliga e.V.), social media platforms (e.g., Facebook), and medical practices. The survey was conducted on the online platform Unipark [39] and all participants electronically provided their informed consent prior to the start of the survey. Participation in the survey was voluntary, anonymous and without monetary compensation. The Ethics Committee of the Medical Faculty of the University of Duisburg-Essen waived the study (19-89-47-BO).

On average, completing the questionnaire took approximately *M* = 17 (*SD* = 8) minutes. Initially, *N* = 532 started processing the questionnaire, of which *n* = 362 completed the survey, representing a 68.1% completion rate. Participants who were female, consented to participate, and had a self-reported diagnosis of hypothyroidism (according to WHO ICD-10: E03 [40] and E89.0 [41]), legal age of 18 years or older, sufficient German-language skills, and Internet access were eligible to participate. Thus, *n* = 44 (12.2%) were excluded due to not meeting the inclusion criteria. Therefore, *N* = 318 (59.8%) participants were

included in the final data analysis.

Assessment Instruments

The questionnaire sought to gather sociodemographic, medical, and eHealth-related data. The acceptance of eHealth interventions among females affected by hypothyroidism and its drivers and barriers were determined by using a modified version of the Unified Theory of Acceptance and Use of Technology (UTAUT) model.

Sociodemographic and Medical Data

Sociodemographic data gathered age, gender, marital status, level of education, occupational status, and place of residence (population size). To gauge the participants' health status, we assessed the existence of hypothyroidism and its symptoms by self-report. Participants were also asked whether they had received hormone replacement therapy, for example with levothyroxine in the past or were currently receiving it and might have been affected by therapy's side effects. Participants were also asked whether they had previously undergone surgery as a reason for their hypothyroidism. Beyond that, participants self-reported their physical health, mental health, and quality of life on a numeric rating scale from 0 to 10, with lower scores indicating lower levels of the aforementioned constructs.

eHealth-Related Data

Next, the participant's eHealth literacy was assessed using the revised German version of the eHealth Literacy Scale (GR-eHEALS) [42], with responses given on a five-point Likert scale (1 = "strongly disagree", 5 = "strongly agree"). Its internal consistency was excellent (Cronbach's α = .92). Participants also assessed their digital confidence by rating three items on a five-point Likert scale (1 = "very insecure", 5 = "very confident") [43–45]. Its internal consistency was excellent (Cronbach's α = .91). Next, digital overload was assessed with three items (e.g. "I feel burdened by the constant availability via cell phone or

email") [43,46,47], with answers given on a five-point Likert-type scale 1 = "does not apply", 5 = "does fully apply"). The internal consistency was acceptable (Cronbach's α = .77). Last, internet anxiety was assessed using three items (e.g. "I am afraid I might make an irreversible mistake when using the Internet") [37,45,46,48,49]. Again, answers were given on a five-point Likert-type scale (1 = "does not apply", 5 = "does fully apply"). The internal consistency was acceptable (Cronbach's α = .79).

UTAUT Predictors and Acceptance

To assess the acceptance of mHealth applications and its influencing factors, we used a modified UTAUT questionnaire [33,35]. The modified UTAUT questionnaire contained 14 items - four assessing BI, three assessing SI, three assessing PE, and three assessing EE and answers were given on a five-point Likert scale (1 = "strongly disagree", 5 = "strongly agree"). Internal consistency ranged from acceptable to excellent (Cronbach's α = .9 for BI, Cronbach's α = .77 for SI, Cronbach's α = .82 for PE, Cronbach's α = .82 for EE).

Statistical Analyses

Statistical analyses were performed using R (4.3.8) [50]. Whereas sum scores were calculated for eHealth literacy using the GR-eHEALS, mean scores were calculated for digital confidence, Internet anxiety, digital overload, and for UTAUT scales (BI, EE, PE, and SI). Acceptance was operationalized as BI and was further categorized in accordance with prior research [43,45,51], such that scores from 1 to 2.34 indicated low acceptance, scores from 2.35 to 3.67 indicated moderate acceptance and scores from 3.68 to 5 indicated high acceptance. Descriptive statistics were applied for sociodemographic, medical, and

eHealth-related data.

Differences in acceptance based on sociodemographic and medical variables were examined with independent t-tests and analyses of variance (ANOVAs). Bonferroni correction was applied to adjust p-values for multiple comparisons, and Levene's test indicated homoscedasticity. Due to the given sample size, normal distribution of residuals was assumed.

Multiple hierarchical regression analysis was conducted to examine drivers of and barriers to the acceptance of mHealth applications among females affected by hypothyroidism. Predictors were included block-wise: 1) sociodemographic data, 2) medical data, 3) eHealth-related data, 4) UTAUT predictors. The variance inflation factor (VIF) was used to verify the absence of multicollinearity (all VIF values < 2.0). A visual inspection of q-q-plots of the residuals showed no signs of violations against normality: therefore, the normal distribution of the residuals was assumed. Scatter-plots of the standardized residuals and the adjusted predicted values verified homoscedasticity. The level of significance was set to $\alpha < .05$ for all tests. Effect sizes were reported according to Cohen, with values around 0.2, 0.5, and 0.8 indicating small, medium, and large effects, respectively [52].

Results

Study Population

On average, females affected by hypothyroidism in our sample were *M* = 42.6 (*SD* = 10.7) years old. The youngest participant was 20 years old, while the oldest was 71 years old. In the context of participants' hypothyroid disease, the vast majority of participants (82,4%, *n* = 262) reported fatigue as a symptom, whereas only 18.9% (*n* = 60) reported irregular menstruation as a symptom. Table 1 presents a complete description of the study population. Participants reported moderate physical health (*M* = 5.45, *SD* = 1.97, range 0-

10), mental health (*M* = 5.86, *SD* = 2.45, range 0-10) and quality of life (*M* = 5.94, *SD* = 2.23, range 0-10).

In terms of eHealth, participants reported high levels of eHealth literacy (*M* = 31.85, *SD* = 6.22, range 8 – 40) and high digital confidence (*M* = 4.13, *SD* = 0.93, range 1 – 5), whereas Internet anxiety (*M* = 1.59, *SD* = 0.70, range 1 – 5) was low, and digital overload was moderate (*M* = 2.56, *SD* = 0.96, range 1 – 5).

Table 1

Sample Characteristics

	N (%)
Marital status	
Single	67 (21.1)
In a relationship	78 (24.5)
Married	147 (46.2)
Divorced/ separated	19 (6.0)
Widowed	4 (1.3)
Other	3 (0.9)
Educational level	
No or lower secondary education/ other	23 (7.2)
Higher secondary education	79 (24.8)
Higher education entrance qualification	105 (33.0)
University education	111 (34.9)
Occupational status	
Student	21 (6.6)
Non-working	8 (2.5)
Sick leave	14 (4.4)
Part-time employed	89 (28.0)
Full-time employed	157 (49.4)
Retired	13 (4.1)
Other	16 (5.0)
Place of residence (population size)	
Large city (> 100,000 residents)	98 (30.8)
Medium-sized city (> 20,000 residents)	89 (28.0)
Small town/ rural area (< 20,000 residents)	131 (41.2)
Symptoms	
Fatigue	262 (82.4)
Weight gain	219 (68.9)
Depressed mood	218 (68.6)
Poor concentration	195 (61.3)
Dry skin	185 (58.2)
Loss of libido	165 (51.9)

Increased sensitivity to cold	155 (48.7)
Hair loss	140 (44.0)
Constipation	82 (25.8)
Low pulse/ low blood pressure	64 (20.1)
Irregular menstruation	60 (18.9)
Hormone replacement therapy	289 (90.9)
Side effects of the hormone replacement therapy	31 (9.1)
Surgical operations	26 (8.2)
Total	318 (100.0)

Acceptance of mHealth Applications

Overall, the acceptance of mHealth applications among female patients affected by hypothyroidism was high (M = 4.10, SD = 0.91, range 1 – 5). More precisely, 76.1% (n = 242) of participants reported high acceptance, 18.6% (n = 59) reported moderate acceptance, and only 5.3% (n = 17) reported low acceptance.

Group comparisons showed differences in acceptance depending on the place of residence ($F(2, 315) = 3.66$, $p = .03$, $f = 0.15$). Post-hoc group comparisons showed that participants living in a medium-sized city (> 20,000 residents) reported significantly higher rates of acceptance than those living in big cities (> 100,000 residents; $t(315) = -26$, $p_{adj} = .04$, $d = .23$).

Participants who reported fatigue as a symptom of their hypothyroid disease reported higher levels of acceptance than ones who do not reported suffering from fatigue $t(316) = -3.56$, $p_{adj} < .001$, $d = .53$). However, differences in acceptance were neither dependent on marital, educational, or occupational status nor dependent on undergoing hormone replacement therapy or surgical operations.

Predictors of Acceptance of mHealth Applications

Multiple hierarchical regression analysis was performed to determine predictors of the acceptance of mHealth applications to improve the quality of life of female patients affected by hypothyroidism. First, sociodemographic data were included ($R^2 = .034$, $R^2_{adj} = .015$,

F(6,31) = 1.83 *p* = .09). *Place of Residence: Medium-sized city (> 20,000 residents)* (β = .34, *p* = .02) and *Place of Residence: Small town or rural area (< 20,000 residents)* (β = .28, *p* = .003) were significant predictors of acceptance. The explained variance of the first step was 3.4%.

Medical data were included in the second step (R^2 = .086, R^2_{adj} = .056, *F*(10,307) = 2.88 *p* = .002). That step increased the explained variance significantly to 8.6% (ΔR^2 = .052, *F*(4,307) = 8.85, *p* < .001). *Fatigue* (β = .54, *p* < .001) emerged as a significant predictor of acceptance.

In the third step, eHealth data (R^2 = .013, R^2_{adj} = .09, *F*(14,303) = 3-25, *p* < .001), significantly increased the explained variance to 13% (ΔR^2 = .044, *F*(4,303) = 7.63, *p* < .001). *Internet anxiety* (β = -.20, *p* = .002) was a significant predictor of acceptance.

In the final step, the three UTAUT predictors - EE, PE, and SI - were included (R^2 = .561, R^2_{adj} = .537, *F*(17,300) = 22.62, *p* < .001). Explained variance of the final increased significantly to 56.1% (ΔR^2 = .431, *F*(3,300) = 98.42, *p* < .001). EE (β = .37, *p* < .001), PE (β = .32, *p* < .001), and SI (β = .20, *p* < .001) were significant predictors. Table 2 contains the final UTAUT model of acceptance and its predictors.

Table 2

Hierarchical Regression Model of Acceptance of mHealth Applications Among Females Affected by Hypothyroidism

Predictors	*B*	β	*t*	R^2	ΔR^2	*p*
Intercept	0.88	- .18	- 0.97			.33
Step 1: Sociodemographic data				.034	.034	
Age	.00	.03	0.61			.54
Educational level						
(ref. No or lower secondary education or other)						
Higher secondary education	.02	.03	0.16			.87
Higher education entrance qualification	- .15	- .17	- 1.04			.30
University education	- .00	- .01	- 0.03			.97
Place of residence (Population size)						
(ref. Large city (> 100,000))						
Medium-sized city (> 20,000)	.06	.07	0.68			.49

Small town/rural area (< 20,000)	.03	.04	0.41		.68
Step 2: Medical data				.086	.052
Physical health	.02	.04	0.78		.44
Mental health	- .00	- .00	- 0.02		.98
Quality of life	- .02	- .05	- 0.97		.33
Fatigue	-22	.24	2.18		.03
Step 3: eHealth-related data				.13	.044
eHealth literacy	- .00	- .02	- 0.38		.70
Digital confidence	- .00	.00	0.07		.95
Digital overload	- .01	- .01	- 0.20		.84
Internet anxiety	- .10	- .08	- 1.75		.08
Step 4: UTAUT predictors				.561	.431
EE	.40	.37	8.04		< .001
PE	.32	.32	6.69		< .001
SI	.19	.20	4.38		< .001

Note. *N* = 318. In Step 2, 3, and 4 only the newly included variables are presented. *B* = Unstandardized beta. β = Standardized beta. *t* = Test statistic. R^2 = Determination coefficient. ΔR^2 = Changes in R^2. ref. = Reference level. GR-eHEALS = Revised German version of the eHealth Literacy Scale, EE = Effort expectancy, PE = Performance expectancy, SI = Social influence, UTAUT = Unified Theory of Acceptance and Use of Technology.

Discussion

The purpose of our study was to determine the acceptance of mHealth applications, along with the factors influencing it, among female patients affected by self-reported hypothyroidism and/or thyroid medication to improve quality of life. Due to the reduced quality of life because of its physical and mental symptoms and difficulties in therapy (e.g., in the adjustment of medication), the results of this study could contribute to improved care for females affected by hypothyroidism. The overall acceptance of mHealth was high; more than three quarters (76.1%) of participants reported high acceptance while 18.6% reported at least moderate acceptance. Compared to similar studies representing different populations of patients with other chronic diseases [43–46], acceptance among female patients affected by hypothyroidism is on high level, which may result in higher utilization in practical implementation.

Acceptance of mHealth was especially high among patients affected by fatigue, which was also identified as a predictor of acceptance. Fatigue was a common symptom of participants in our study and is common in overt hypothyroidism in general [53,54]. Added

to its frequency, fatigue as a symptom of various diseases is primarily associated with a reduction in quality of life [54–56]. As a result, mHealth interventions may contribute to managing symptoms by enhancing understanding and ways of coping with symptoms of fatigue. Regarding physical and mental health, no significant predictor of acceptance was identified, contrary to other studies [43–46]. At the same time, participants reported only moderate levels of physical and mental health. It can therefore be assumed that there is a need for additional health care offerings - for example, via mHealth interventions.

In regards of the sociodemographic characteristics, living in a small or medium sized city emerged a significant predictor of acceptance, as previously found in another study as well [44]. This relationship might be explained by a potentially lower availability of health care facilities and self-help groups in less populated areas. In response, mHealth interventions could address the lack of healthcare services and provide health care for patients in less densely populated areas. Unlike other studies, acceptance was not significantly predicted by age [43,45,46,51,57]. This finding is plausible considering the growing tendency for older adults to use digital media, which might likely reflect the trend in the future [58]. Overall, the level of acceptance was also high among older female patients affected by hypothyroidism, for whom the use of mHealth interventions represents a viable option in this patient collective. Moreover, unlike in previous studies, educational status did not surface as a significant predictor of acceptance [51,59,60]. It should be noted, however, that 67.9% of patients surveyed had at least a higher education entrance qualification or even university education, whereas only 7.2% had no or lower secondary education. That phenomenon is commonly observed in research on online health care [59,60], and, in response, mHealth interventions should be adapted to the needs of less-educated patients.

Concerning eHealth-related data, Internet anxiety emerged as an important predictor of acceptance. Overall, there was a low level of Internet anxiety, which can partly be explained

by the fact that the survey was conducted and completed entirely online. However, with higher levels of Internet anxiety, it was a significant negative predictor of acceptance. Thus, Internet anxiety seems to represent a barrier to using mHealth interventions, which should be taken into account when designing and implementing such interventions [35,37] – including concerns about privacy, trust in online information, and smartphone access [29,30]. Internet anxiety also primarily affects older adults [61,62], though a positive trend may be expected along those lines due to the increasing number of older smartphone users [58]. Last, the level of digital confidence and eHealth literacy was high but was not a significant predictor of acceptance, which is contrary to other studies [43,45,46].

The UTAUT model, which aims to predict users' intentions to use an mHealth intervention and their actual usage behavior [33], contributed significantly to the explained variance and the three UTAUT predictors (i.e., EE, PE, and SI) emerged as significant predictors of acceptance. Those findings are in line with the results of other studies [46,48,63–66]. Of all predictors identified, EE was the most significant predictor of acceptance. Accordingly, acceptance depends on the expected effort involved in interacting with the mHealth intervention, and overly complicated use has a particularly strong (negative) influence on the level of acceptance. For that reason, mHealth interventions should be easy to use. A further significant predictor of acceptance was PE, which highlights the importance of ensuring that patients are convinced of the benefits of the intervention. Last, SI was a significant predictor of acceptance, so acceptance may be increased by recommendations from healthcare professionals and by sharing positive experiences with other patients [33]. In conclusion, the UTAUT predictors EE, PE, and SI, along with the other predictors identified, should be considered when developing, implementing, and promoting mHealth offerings for females affected by hypothyroidism

Limitations

When discussing and interpreting our results, e.g., for practical implications, the following limitations should be taken into account. First, the questionnaire was only available via Internet access and the diagnosis of hypothyroidism could not be objectively verified, as it is based on self-report. Along those lines, it should also be noted that some participants were recruited online - for example, via online self-help groups and social media. Younger patients, accordingly, and participants with a higher level of digital confidence or less Internet anxiety may have been overrepresented. Even so, digital confidence among older adults has increased in recent years [67], nevertheless, targeting older people and those with barriers to using digital media (e.g., Internet anxiety, digital confidence) should be a focus of future studies. Second, the intention-behavior gap needs to be considered. Accepting an mHealth intervention leads to a higher intention to use it but does not necessarily result in actual use and behavior to the same degree [68,69] – the actual use should therefore be investigated in future studies. Last, male patients were not included in our study: Not only are females significantly more likely to suffer from hypothyroidism [5,6], but similarly designed studies have also shown that these questionnaires are less likely to be completed by males [44–46]. However, it is important to assess the needs of male patients and investigate whether these may differ from those of female patients.

Conclusion

Altogether, our study showed a generally high level of acceptance regarding mHealth applications to improve quality of life among female patients affected by hypothyroidism, particularly among those experiencing fatigue. Several predictors of acceptance were identified as well: Along with the UTAUT predictors EE, PE, and SI, not living in a highly populated city was a driver of acceptance. Internet anxiety was found to be a barrier to using mHealth applications. Regarding the reduced quality of life among females with hypothyroidism and considering the possibilities of mHealth interventions, those findings

may contribute to sustainably implementing appropriate mHealth interventions and thereby enhance the quality of life of female patients affected by hypothyroidism.

Declarations

Author contribution: conceptualization: A.B., M.D., H.D., and M.T.; data curation: R.C. and L.M.J.; formal analysis: R.C. and L.M.J.; methodology: A.B., R.C. and L.M.J.; project administration: A.B. and M.D.; supervision: A.B., E.-M.S., H.D., D.F. and M.T.; writing-original draft: M.D., A.B., R.C. and L.M.J.; writing – review and editing: M.D., A.B., M.T., R.C., L.M.J., H.D., D.F., E.L., M.T., and E.-M.S. All authors have read and agreed to the published version of the manuscript.

Data availability: The data supporting the results presented in this article is available upon reasonable request to the corresponding author.

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Ethics and informed consent: The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Medical Faculty of the University of Duisburg-Essen (19-89-47-BO). Electronically informed consent was mandatory to participate.

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Abbreviations

ANOVA	analyses of variance
BI	behavioral intention
EE	effort expectancy
GR-eHEALS	revised German version of the eHealth Literacy Scale
ICT	information and communications technologies
mHealth	mobile health
PE	performance expectancy
SI	social influence

UTAUT Unified Theory of Acceptance and Use of Technology