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Acceptance of Digital Discharge Management Interventions Among Patients After Bariatric Surgery: A Cross-Sectional Study

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Abstract: Bariatric surgery is an effective long-term treatment for severe obesity, but relapse rates remain high. Digital interventions can enhance patient care, yet research on the intention to use digital discharge management interventions is lacking. This study aims to assess the behavioral intention to use digital discharge management interventions after bariatric surgery and to identify differences in sociodemographic and medical characteristics, as well as potential key drivers and barriers. A cross-sectional study with $N = 514$ patients was conducted using the Unified Theory of Acceptance and Use of Technology (UTAUT). Mean scores for behavioral intention and predictors were calculated. Group differences were analyzed with independent *t*-tests and analyses of variance with post hoc tests. Drivers and barriers were assessed through multiple hierarchical regression analysis. The behavioral intention to use digital discharge management interventions was high. Significant predictors included age ($\beta = -0.17$, $p < 0.001$), eHealth literacy ($\beta = 0.10$, $p = 0.037$), internet anxiety ($\beta = -0.15$, $p = 0.003$), and time since bariatric operation ($\beta = -0.13$, $p = 0.005$). The predictors performance expectancy ($\beta = 0.23$, $p < 0.001$), effort expectancy ($\beta = 0.36$, $p < 0.001$), and social influence ($\beta = 0.26$, $p < 0.001$) were significantly positive key factors. These results confirm the need for implementing digital discharge interventions after bariatric surgery, with various drivers and barriers identified for application usage.

Keywords: acceptance; eHealth; UTAUT model; postoperative care; obesity surgery; mobile health app; self-management

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1. Introduction

The WHO has declared obesity a global health crisis due to its rising numbers, which have almost tripled since 1975. Worldwide, 1.9 billion (39%) adults are overweight, including 650 million (13%) being considered obese [1]. "Obesity" and "overweight" are defined by the WHO as an accumulation of excessive fat with potentially negative impacts on health and longevity [1].

Globally, overweight and obesity negatively influence the average life expectancy, reducing it by 5 to 20 years on average [2]. Studies show a substantial impact on population morbidity and mortality, as obesity accounts for about approximately 3.4 million deaths, 3.9% of years of life lost, and 3.8% of disability-adjusted life-years [2]. Obesity is associated with various physical and mental health issues including cardiovascular disease, musculoskeletal disorders [3,4], depression, anxiety, and eating disorders [5], as well as other chronic diseases like diabetes type II, hypertension, and many types of cancer [6].

The initial therapy for obesity represents a lifestyle change that can be supported by pharmacotherapy [7,8]. Nevertheless, with 30–50% of patients regaining or even exceeding their initial weight after therapy [9], bariatric surgery is suggested as a viable long-term treatment option that verifiably results in significant and permanent weight loss [2]. Thus, European and US Guidelines for obesity management recommend bariatric surgery for the treatment of different obesity levels together with obesity-associated comorbidities [10,11], which has led to an increase in such interventions [12].

Nevertheless, post-surgical complications might emerge with a need for extended care. These depend on the performed procedure, including anastomotic stenosis, marginal ulcer, dumping syndrome, hernias, gallstones, and metabolic and endocrine complications [13,14]. Furthermore, malnutrition, limited weight loss or even weight regain, and mental health problems are reported [13,15].

Bariatric patients usually discharge around two to three days after surgery, which makes appropriate self-management at home essential to avoid complications and unplanned hospital readmissions [16–18]. Recent studies confirm that high-quality care transitions with increased self-efficacy at the time of patient discharge are associated with better health outcomes, fewer unplanned hospitalizations, and better adherence to health-promoting behaviors [17–21].

eHealth interventions have been proposed as effective tools to positively influence health outcomes [22,23]. The main benefits are an improvement in health care access, the opportunity to tailor interventions to patient needs, the empowerment of users, cost-effectiveness, and independence of residence. Disadvantages discussed include concerns about the quality and comprehensibility of information and the dependence of internet access. Moreover, the effectiveness of eHealth interventions strongly depends on patients' intention to use them [24]. Based on these insights, eHealth interventions might positively influence discharge management after bariatric surgery, and they thus represent a promising tool for patient compliance and improved long-term outcomes.

Nonetheless, eHealth interventions are often developed with little involvement of future users [25]. Therefore, the WHO Patient Safety Action Plan 2021–2030 aims to actively involve patients in their care to ensure patient-centered treatment [26]. With regard to the effectiveness of eHealth, the question arises as to what motivates patients to use such technologies after bariatric surgery and which preferences of the subsequent target group promote the actual use of such technologies. A suitable model for predicting the use of eHealth applications is the Unified Theory of Acceptance and Use of Technology (UTAUT) model by Venkatesh et al. [27]. It comprises eight user acceptance models that predict the usage behavior of different technologies [27]. User acceptance is operationalized as behavioral intention (BI) to use a technology, which, in turn, is derived from performance expectancy (PE) as the perceived benefit to the user, effort expectancy (EE) as the expected ease of use, and social influence (SI), which describes the extent to which the user's environment believes that a device should be used [27–29]. To assess the acceptance of eHealth interventions and its underlying factors, we extended the existing model to include factors that are already known to influence BI [30]. Even though former studies with the UTAUT model have already shown that digital tools offer valuable assistance after discharge, there is, to the best of our knowledge, no available examination of patients who have received bariatric surgery [31].

Therefore, our aim was (1) to assess the intention to use digital discharge management interventions after bariatric surgery and to reveal potential differences regarding sociodemographic and medical characteristics and (2) to identify the associated drivers and barriers for the use of a corresponding eHealth intervention in a positive or negative manner.

2. Materials and Methods

2.1. Study Design and Participants

To examine the intention to use digital discharge management interventions among patients after bariatric surgery, a cross-sectional study was conducted between September and December 2022. Participants were recruited in the Department of Surgery, Obesity, and Metabolic Surgery Center in Essen, Germany, and the Helios Obesity Center West in Oberhausen, Germany, via flyers and by hospital staff addressing patients during their hospital stay. Furthermore, topic-related social media groups were addressed via postings and digital flyers. Participation was voluntary, anonymous, and not compensated in any form. Inclusion criteria consisted of bariatric surgery having been performed, good command of the German language, internet access, and legal age (≥18 years). Data were collected via the platform Unipark (TIVIAN GmbH, Berlin, Germany). Beforehand, electronic informed consent of the participants was obtained. Initially, n = 821 participants started the survey, of which 577 (70.28%) completed it. A total of 63 had to be excluded since the inclusion criteria were not met. Therefore, 514 participants were included in the final data analysis. This study was approved by the Ethics Committee of the Medical Faculty of the University of Duisburg-Essen (19-89-47-BO).

2.2. Measures

The assessment consisted of items and scales regarding sociodemographic, medical, and eHealth data, as well as validated measurements for the UTAUT model and eHealth literacy.

Sociodemographic characteristics included gender, age, marital status, education level, occupational status, and place of residence (population size).

For medical data, participants reported their body height (cm), current body weight (kg), body weight before bariatric surgery (kg), time since bariatric surgery (1 month to >36 months (taking account of postoperative long-term effects)), type of bariatric surgery procedure (sleeve gastrectomy; Roux-en-Y gastric bypass; one anastomosis gastric bypass (OAGB); Single Anastomosis Duodeno-Ileal bypass with Sleeve gastrectomy (SADI-S); biliopancreatic diversion; gastric banding; other technique), mental illness, psychotherapeutic treatment, and possible sick leave. The body mass index (BMI) was calculated based on reported body height and pre-/post-surgery body weights.

Regarding eHealth data, participants indicated their daily internet use for private and for professional purposes on a 5-point scale (1 = not at all, 5 = more than 5 h). Digital confidence was measured via three items, which were rated on a 5-point Likert scale (1 = very uncertain, 5 = very certain) [32–35]. Internal consistency was excellent (Cronbach's α = 0.93). Further, digital overload, internet anxiety, and knowledge of eHealth offers were assessed with three items each and rated on a 5-point Likert scale (e.g., 'I'm afraid I might be making an irrevocable mistake when using the Internet.' 1 = strongly disagree, 5 = strongly agree). These constructs have been applied in previous studies [32–35]. Internal consistency was good-to-excellent (Cronbach's α = 0.77 for digital overload, α = 0.77 for internet anxiety, and α = 0.90 for knowledge of eHealth offers). The revised German version of the eHealth Literacy Scale, GR-eHEALS, was applied to measure eHealth literacy [36]. It consists of eight items, which were rated on a 5-point Likert scale (e.g., 'I know how to find websites with useful health information.' 1 = strongly disagree, 5 = strongly agree). The sum score ranges from 8 to 40, where a higher score indicates a higher level of eHealth literacy. Internal consistency was excellent for this scale (Cronbach's α = 0.94).

The intention to use digital discharge management interventions was assessed with the UTAUT model [27,28,36]. Behavioral intention to use (BI) was measured with four items (e.g., 'I would use such an app if it was offered to me.'). Internal consistence was high (Cronbach's α = 0.81). Social influence (SI) and effort expectancy (EE) were assessed via three items each (e.g., SI: 'People close to me would approve of the use of such an app', EE: 'Using such an app would not be an additional burden for me'). Four items were used to measure performance expectancy (PE: E.g., 'Such an app could improve my general well-being'). Internal consistency of the three predictors was high (Cronbach's $\alpha = 0.77$ for SI, $\alpha = 0.81$ for EE, $\alpha = 0.87$ for PE). All items were rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

2.3. Statistical Analysis

Statistical analysis was performed using R (4.1.2,) and RStudio. The current BMI and the BMI before bariatric surgery were calculated (kg/m^2). A sum score for GR-eHEALS and mean scores for digital confidence, digital overload, internet anxiety, and knowledge of eHealth offers were computed. For intention to use (= BI) and the three core predictors of the UTAUT model (SI, EE, PE), mean scores were calculated. In accordance with previous research [32,33,37], BI was divided into three categories: low BI (scores from 1 to 2.34), moderate BI (scores from 2.35 to 3.67), and high BI (scores from 3.68 to 5). Descriptive statistics were applied to examine sociodemographic, medical, and eHealth data. Group differences regarding BI (based on gender, education level, mental illness, BMI, and bariatric procedure) were inspected with independent *t*-tests and ANOVAs with post hoc tests. *p*-values were adjusted for multiple comparisons via Bonferroni's correction. Multiple hierarchical regression analysis was conducted to examine predictors of BI. The following predictors were included blockwise: (1) sociodemographic data, (2) medical data, (3) eHealth data, and (4) UTAUT predictors (SI, EE, PE). The variance inflation factor (VIF) was used to verify absence of multicollinearity. All VIF values were < 1.9. Visual inspection of qq-plots of the residuals showed no signs of violations against normality. Therefore, a normal distribution of residuals can be assumed. A scatter plot of the standardized residuals and the adjusted predicted values was utilized to verify homoscedasticity. The level of significance was set to $\alpha < 0.05$ for all tests. Effect sizes were reported and interpreted according to Cohen, with values around 0.2, 0.5, and 0.8 for small, medium-sized, and large effects [38].

3. Results

3.1. Study Population

Of the 514 participants, 90.27% ($n = 464$) were female. The average age was $M = 46.29$ ($SD = 9.83$) years (range 19–69 years). A total of 15.2% ($n = 78$) of the participants were currently on sick leave. A total of 44.9% ($n = 231$) were affected by mental illness, and 17.3% ($n = 89$) were currently receiving psychotherapeutic treatment. The current BMI was $M = 34.16$ ($SD = 7.40$) kg/m^2 on average, while the BMI before bariatric surgery was $M = 50.33$ ($SD = 8.05$) kg/m^2. The average time since bariatric surgery was $M = 18.63$ ($SD = 13.90$) months. Table 1 gives an overview of further population characteristics.

Digital confidence ($M = 4.19$, $SD = 0.87$) and prior knowledge about eHealth offers ($M = 3.53$, $SD = 1.05$) were high among the study participants. The patients reported low digital overload ($M = 2.23$, $SD = 0.95$) and low internet anxiety ($M = 1.43$, $SD = 0.64$). eHealth literacy was high ($M = 32.89$, $SD = 6.07$) in this sample. Most participants (83%) stated that their private internet use exceeded 1 h per day. In contrast, use for professional purposes was reported as one hour or less (51%).

Table 1. Overview of the study population.

	n (%)
Marital status	
Married	295 (57.4)
In a relationship	82 (16.0)
Single	71 (13.8)
Divorced/separated	59 (11.5)
Widowed	7 (1.4)
Educational level	
University education	75 (14.6)

Table 1. *Cont.*

	n (%)
Higher education entrance qualification	120 (23.3)
Secondary school	215 (41.8)
Lower secondary education/no qualification	104 (20.2)
Occupational status	
In education (e.g., school, university)	8 (1.6)
Unemployed (e.g., job seeking, occupational disability)	46 (8.9)
Certified unfit for work	17 (3.3)
Part-time employed	130 (25.3)
Full-time employed	219 (42.6)
Retired	56 (10.9)
Other	38 (7.4)
Place of residence (population size)	
Large city (>100,000 residents)	203 (39.5)
Medium-sized city (>20,000 residents)	138 (26.8)
Small town (>5000 residents)	83 (16.1)
Rural area (<5000 residents)	90 (17.5)
BMI after bariatric surgery	
Normal weight	45 (8.8)
Overweight (pre-obese: BMI < 30)	115 (22.4)
Obese (class I: BMI of 30 to <35)	149 (29.0)
Obese (class II: BMI of 35 to <40)	91 (17.7)
Obese (class III: BMI of ≥40)	114 (22.2)
BMI before bariatric surgery	
Overweight (pre-obese: BMI < 30)	1 (0.2)
Obese (class I: BMI of 30 to <35)	1 (0.2)
Obese (class II: BMI of 35 to <40)	26 (5.1)
Obese (class III: BMI of ≥40)	485 (94.5)
Missing value	1 (0.2)
Bariatric procedure	
Sleeve gastrectomy	247 (48.1)
Roux-en-Y gastric bypass	202 (39.3)
One anastomosis gastric bypass OAGB	44 (8.6)
Other	21 (3.1)
Total	514 (100.0)

3.2. Intention to Use Digital Discharge Management Interventions

Overall, intention to use digital discharge management interventions was high ($M = 4.54$, $SD = 0.62$). A total of 92.6% ($n = 476$) of the participants reported high BI, while only 6.2% ($n = 32$) and 1.2% ($n = 6$) reported moderate and low BI. There were no differences in BI based on gender, education level, mental illness, BMI, and bariatric procedure (p-values > 0.05).

3.3. Drivers and Barriers of the Intention to Use Digital Discharge Management Interventions

Predictors of BI were determined by multiple hierarchical regression analysis. A total of $N = 23$ participants had to be excluded due to missing data regarding eHealth literacy.

Sociodemographic data were included in the first step ($R^2 = 0.031$, $R^2_{adj} = 0.021$, $F(5, 485) = 3.14$, $p = 0.008$). Age ($\beta = -0.17$, $p < 0.001$) was a significant predictor. The explained variance was 3.1%.

In the second step, medical data were included ($R^2 = 0.051$, $R^2_{adj} = 0.035$, $F(8, 482) = 3.21$, $p = 0.001$). The explained variance significantly increased to 5.1% ($\Delta R^2 = 0.020$, $F(3, 482) = 6.25$, $p < 0.001$). Time since bariatric operation ($\beta = -0.13$, $p = 0.005$) was revealed as a significant predictor.

eHealth data were included in the third step (R^2 = 0.099, R^2_{adj} = 0.076, F(12, 478) = 4.36, p < 0.001), which significantly increased the explained variance to 9.9% (ΔR^2 = 0.048, F(4, 478) = 11.67, p < 0.001). Significant predictors were eHealth literacy (β = 0.10, p = 0.037) and internet anxiety (β = −0.15, p = 0.003).

The three UTAUT predictors were included in the last step (R^2 = 0.511, R^2_{adj} = 0.496, F(15, 475) = 33.11, p < 0.001). The explained variance in the final model was significantly increased to 51.1% (ΔR^2 = 0.452, F(3, 475) = 133.57, p < 0.001). EE (β = 0.36, p < 0.001), PE (β = 0.23, p < 0.001), and SI (β = 0.26, p < 0.001) were significant predictors. Table 2 shows the final UTAUT model (including steps 1–4).

Table 2. Hierarchical regression model of intention to use digital discharge management interventions.

Predictors	*B*	β	*T*	R^2	ΔR^2	*p*
(Intercept)	2.11	−0.06	7.99			0.001
Step 1: Sociodemographic data				0.031	0.031	
Age	−0.00	−0.07	−2.01			0.045
Female gender	−0.05	−0.08	−0.68			0.494
Education: university	−0.03	−0.05	−0.43			0.665
Education: lower secondary education/No qualification	0.04	0.07	0.68			0.499
Education: secondary school	0.06	0.09	1.11			0.266
Step 2: Medical data				0.051	0.020	
BMI	−0.00	−0.01	−0.16			0.875
Time since bariatric operation	−0.00	−0.05	−1.33			0.183
Mental illness	0.03	0.06	0.87			0.387
Step 3: eHealth data				0.099	0.048	
eHealth literacy	0.00	0.04	1.14			0.256
Digital confidence	−0.05	−0.07	−1.96			0.050
Internet anxiety	−0.07	−0.07	−1.96			0.051
Digital overload	0.05	0.08	2.13			0.034
Step 4: UTAUT predictors				0.511	0.452	
EE	0.31	0.36	8.28			<0.001
PE	0.16	0.23	5.56			<0.001
SI	0.19	0.26	6.77			<0.001

Note. N = 491. In steps 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. EE = effort expectancy, PE = performance expectancy, SI = social influence.

4. Discussion

In general, high intention to use digital discharge management interventions was found among the patients after bariatric surgery (92.6%). Significant predictors were age, time since bariatric surgery, eHealth literacy, and internet anxiety. Furthermore, the UTAUT predictors PE, EE, and SI were identified as significant predictors, confirming a positive association with intention to use [33,39].

In detail, intention to use was negatively associated with age, supporting previous studies attributing higher eHealth usage to younger users [32,40]. A reason for these intergenerational differences might be that although they show a high willingness to adapt, the elderly simultaneously face crucial inhibitions related to perceived complexity of app usage [41] and uncertainty about the value and safety of private health information [42–45]. Nevertheless, current studies show a constantly growing amount of eHealth application usage together with people obtaining health information online [40,43,46]. The present sample corresponds to these findings, demonstrating a high level of digital confidence and prior knowledge of eHealth offerings. Therefore, age-related differences might increasingly lose their significance on intention to use in the future.

Further, we found internet anxiety and eHealth literacy as significant predictors for intention to use [28,47]. Emotions such as anxiety are a highly relevant concept, especially in the contexts of voluntary usage, because they are related negatively to using technological devices [28,48,49]. However, a positive perception can be achieved by providing sufficient information about the process and offering technical assistance to ensure user support in case of upcoming questions [50]. Further, several reviews report positive associations between digital literacy and health outcomes [51,52]. In fact, eHealth literacy training can directly improve motivation and reduce negative emotional factors such as stress and anxiety that inhibit the use of eHealth technologies [53,54]. Therefore, eHealth literacy is not only a positive influencing factor in terms of a patient's use of digital health information, but it also increases the use of digital applications for, e.g., self-management and the associated patient well-being [55].

One further result is the negative correlation between intention to use and time since bariatric surgery. A study by Woods et. al. reported that "Some patients did not find technology to be useful in their daily activities because they were already comfortable with their routines" [56]. From this, we can conclude that the convenience of proceeding with established routines might outweigh the technical challenges associated with mastering the use of new digital technologies [56]. Another consideration for the timely introduction of digital technologies is the prevalence of procedure-specific side effects, which will subside over time [56]. Accordingly, it is important to inform the patient about suitable technical support at an early stage to enable the integration of technology into everyday life and to support the best possible aftercare.

Concordant with Venkatesh et al. and further research using the UTAUT model in patients' intention to use eHealth interventions [27,33], the examination of the influencing factors EE, PE, and SI showed a high relevance with intention to use. EE in this context refers to the patient's easiness of using discharge applications. Further, PE represents the extent to which an individual believes that using technology will benefit them and improve the recovery process. SI describes the extent to which an individual believes that their social environment approves the use of new technologies [27], thereby creating trust and increasing chances of use. To achieve the greatest possible intention to use, all three influencing factors should be considered for further development and implementation.

We found no difference in intention to use based on BMI, mental illnesses, and bariatric procedure, and, contrary to previous studies, we also found no impact on intention to use in terms of gender and education level [27,40–43]. Therefore, the following assumptions can be made: First, effective discharge management through digital applications is independent of the surgical procedure, making eHealth a comprehensive care medium for follow-up care. Second, the current literature contains contradictory results regarding the correlation between intention to use and mental disorders [32–34]. It therefore can be assumed that other factors have a greater influence on consumers' usage behavior. Third, intention to use eHealth applications was generally very high [37], suggesting only small differences in intention to use, which, in turn, can be explained by the significant predictors discussed above.

Our results confirm that there is a relevant need for digital discharge applications on the healthcare market, which is why these should be developed with high priority for the discharge process. The associated positive consequences would be that patient care could not only be supported but also improved and facilitated. In addition, barriers of traditional medical care could be reduced in the future. Further, intrinsic and extrinsic motivators such as receiving factual information, incentives, notifications, and a simple user interface might be considered for consumers who show little willingness to use eHealth applications [57,58]. Technology-averse users may need guidance in using digital applications. Transparent data handling could prevent data privacy concerns. Moreover, app costs, especially among low-income users, should be considered, which could be achieved by providing the app's services via health insurance companies or at a low monetary cost [59].

Limitations

Selection bias need to be considered, as only participants who were able to adequately use electronic devices were included in this study. Therefore, the study sample might have had a higher affinity for digital offers. Further, the UTAUT model measures BI, which does not necessarily align with actual use and is defined as an intention–behavior gap [60]. A possible discrepancy that may have arisen as a result and the question of actual use is the subject for further research. The assessment of the actuality of specific eHealth interventions needs to be addressed in further research. Female participants were highly overrepresented in this study. Since women represent the majority of bariatric surgery patients, the present distribution is not necessarily detrimental [61]. Nevertheless, male post-bariatric patients need to be approached in more specific ways in order to offer individualized and patient-centered care. The data collected were based on self-reporting, and a diagnosis of obesity could not be objectively confirmed, which may have led to method bias [62].

5. Conclusions

An overall high intention to use digital discharge management interventions among patients after bariatric surgery could be observed in this study. Seven drivers and barriers were identified (age, time since bariatric operation, internet anxiety, eHealth literacy, EE, PE, and SI). The latter were shown to have the greatest influence on patients' intention to use discharge management interventions. Overall, our results confirm an existing relevant need for digital discharge interventions in patient care. Such interventions could simplify and improve aftercare in a patient-centered manner and reduce the need for local proximity for further treatment. Moreover, additional research should be pursued to determine the detailed expectations, needs, and requirements of patients after bariatric surgery regarding such tailored interventions to further increase motivation and eHealth application usage.

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