

Patient-Centered Chronic Wound Care Mobile Apps: Systematic Identification, Analysis, and Assessment

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Abstract

Background: Chronic wounds are predicted to increase within the aging population in industrialized countries. Patients experience significant distress due to pain, wound secretions, and resulting immobilization. As the number of wounds continues to rise, their adequate care becomes increasingly costly in terms of health care resources worldwide. eHealth support systems are being increasingly integrated into patient care. However, up to this date, no systematic analysis of such applications for chronic wounds has been published.

Objective: The aim of this study is to systematically identify and objectively assess the quality of publicly available mobile apps in German or English for patients with chronic wounds by both patients and physicians.

Methods: Two reviewers independently conducted a systematic search and assessment of German- or English-language mobile apps for patients with chronic wounds available in the Google Play Store and Apple App Store from April 2022 to May 2022. Three apps met the inclusion and exclusion criteria and were then reviewed independently by 10 physicians using the German Mobile Application Rating Scale (MARS) and the System Usability Scale (SUS). The app with the highest MARS score was subsequently reviewed by 11 patients suffering from chronic wounds, using the German user version of the MARS score (uMARS) and the SUS. Additionally, the affinity for technology interaction (ATI) scale was collected from both patients and physicians.

Results: This study assessed mobile apps for patients with chronic wounds from a pool of 118 identified apps. Out of the 73 apps available in both app stores, 10 were patient-oriented. After excluding apps with advertisements or cost, three apps were evaluated by 10 physicians. Mean MARS scores ranged from 2.64 to 3.88 out of 5, and mean SUS scores ranged from 50.75 to 80.5 out of 100. WUND APP received the highest mean MARS score of 3.88/5 among physicians. Hence, it was subsequently assessed by 11 patients and achieved a similar rating, i.e., a uMARS score of 3.89/5. Technical affinity, measured by ATI, was slightly lower in patients (3.62/6) compared to physicians (3.88/6).

Conclusions: The quality ratings from physicians and patients were comparable, both indicating mediocre app quality. Technical affinity, assessed using the ATI scale, was slightly lower for patients. Adequate apps for patients with chronic wounds remain limited, emphasizing the need for improved app development to meet patient needs. The ATI scale proves valuable for assessing technical affinity among different user groups.

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Abstract

Background

Chronic wounds are predicted to increase within the aging population in industrialized countries. Patients experience significant distress due to pain, wound secretions, and resulting immobilization. As the number of wounds continues to rise, their adequate care becomes increasingly costly in terms of health care resources worldwide. eHealth support systems are being increasingly integrated into patient care. However, up to this date, no systematic analysis of such applications for chronic wounds has been published.

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Conclusion

The quality ratings from physicians and patients were comparable, both indicating mediocre app quality. Technical affinity, assessed using the ATI scale, was slightly lower for patients. Adequate apps for patients with chronic wounds remain limited, emphasizing the need for improved app development to meet patient needs. The ATI scale proves valuable for assessing technical affinity among different user groups.

Introduction

Background

Aging societies in industrialized nations are experiencing an increasing prevalence of chronic wounds, leading to growing challenges in patient care. The high costs of therapy and personnel often limit proper treatment. Chronic wounds significantly impact patients' quality of life, requiring intensive therapy multiple times a week, along with regular medical check-ups. Moreover, they have substantial economic implications, including hospitalizations, personnel costs (such as wound care nurses, home healthcare services, physicians, wound managers, day clinics, etc.), material costs, and management (e.g., medical transportation). Purwins et al. identified hospitalizations, nursing staff, and material costs as the main contributors to the overall expenses[1].

Mobile health applications, often referred to as mHealth apps, hold promise in bridging gaps in healthcare. However, a lack of evidence exists for the effectiveness of available mobile health applications[2] and high-quality trials are needed to examine the effect[3]. So far, only reviews of the use of mobile health applications without systematic search and evaluation have been performed[4]. Addressing this gap in evidence for patients suffering from chronic wounds, a systematic analysis is necessary to gather reliable data in this area.

A study by Svendsen et al. demonstrated that patient-centered smartphone apps can significantly improve treatment adherence in cohorts of psoriasis and rheumatic disease patients[5]. Participants expressed favorable views towards medical apps, indicating a willingness to use such apps if available.

To subjectively assess app quality, the Mobile Application Rating Scale (MARS)[6] has been developed, which evaluates engagement, functionality, aesthetics, and information. Additionally, the System Usability Scale (SUS) is a 10-item questionnaire to assess the usability of a system. It has been effectively applied to evaluate mobile apps related to dementia, depression, pediatric obesity, and smoking cessation[7]. Moreover, the Affinity for Technology Interaction (ATI) Scale[8] provides an easy and reliable means to quantify an individual's technology affinity. Aim of this study is a focused analysis on the core functionality and core features of the included apps which is why we excluded apps with advertisements in order to prevent disruptions of user experience or usability.[9] Advertisement can be a confounding variable and makes it difficult to compare app performance or user experience. Advertisements can frustrate or annoy users and reduce clarity and intuitiveness in the app's interface.[10] We also excluded paid apps to prevent bias towards users with financial means, maintaining analysis inclusivity and to ensure preferences align with intrinsic app quality rather than financial considerations, enhancing the analysis's fairness and validity.

Aim of this study

The primary objective of this study was to identify and evaluate publicly available smartphone apps designed for patients with chronic wounds. The assessment aimed to provide subjective quality ratings for these apps, while also collecting data on the technical affinity of this specific patient group. To date, a systematic review and assessment of smartphone apps tailored for patients with chronic wounds have not been conducted.

Methods

Ethics

The study was conducted in accordance with the Declaration of Helsinki and ethical approval was waived by the local Ethics Committee of the University of Würzburg.

App Selection

A systematic search of the German Google Play Store and the Apple App Store was performed from April 2022 to May 2022. The search terms used were: „wound“, „pressure ulcer“, „ulcus“, „Wunde“, „Wunddokumentation“, and „wound documentation“. Two independent reviewers searched each app store. Inclusion criteria were: apps had to be available in both app stores (1), available in English or German (2), and specifically designed for patients (3). Apps that were not available free of charge or that contained advertisements were excluded (4).

The following information available in the app stores and on the associated app websites was collected:

- App name
- Target group (e.g. patients, medical personnel)
- Cost
- Platform
- Advertisement
- Features
- Search term used to identify the app

Evaluation of App Quality

MARS[11] was developed to evaluate mobile applications by professional raters and is a validated and reliable score. The uMARS[12] score was designed for users to evaluate the quality of mobile health apps. Both scales are based on a 5-point Likert scale in four sections: engagement, aesthetics, functionality, and information. Additionally, there is a subjective section. Studies using MARS have already been performed for several chronic diseases and apps related to breast cancer. The uMARS[12] has been broadly applied to evaluate apps for rheumatic disease, weight loss, and nutrition or menstrual tracking. SUS is a simple, ten-item attitude Likert scale giving a global view of subjective assessments of usability[13].

Prior to the evaluation, suitable apps were selected based on the inclusion/exclusion criteria, resulting in a total of three apps. The quality of these three apps was then evaluated by 10 physicians using MARS and SUS. Before the assessment, the physicians first watched a short training video explaining MARS and were then asked to use the app for more than 10 minutes. Finally, the best app, i.e. the one with the highest MARS score among the physicians, was evaluated by 11 patients with chronic wounds using uMARS and SUS

Evaluation of Technical Affinity

Many studies evaluating the quality of mobile apps lack information on the cohort's technical affinity, which is necessary to assess and interpret the results. Therefore, Affinity for Technology Interaction Scale (ATI)[8] was used to gather information on physicians' and patients' technical affinity. ATI was designed to quantify a tendency to actively engage in

intensive technology interaction or to avoid it. In both the patient and the physician group, ATI was collected. Pearson correlation was used to correlate the age of patients and ATI score.

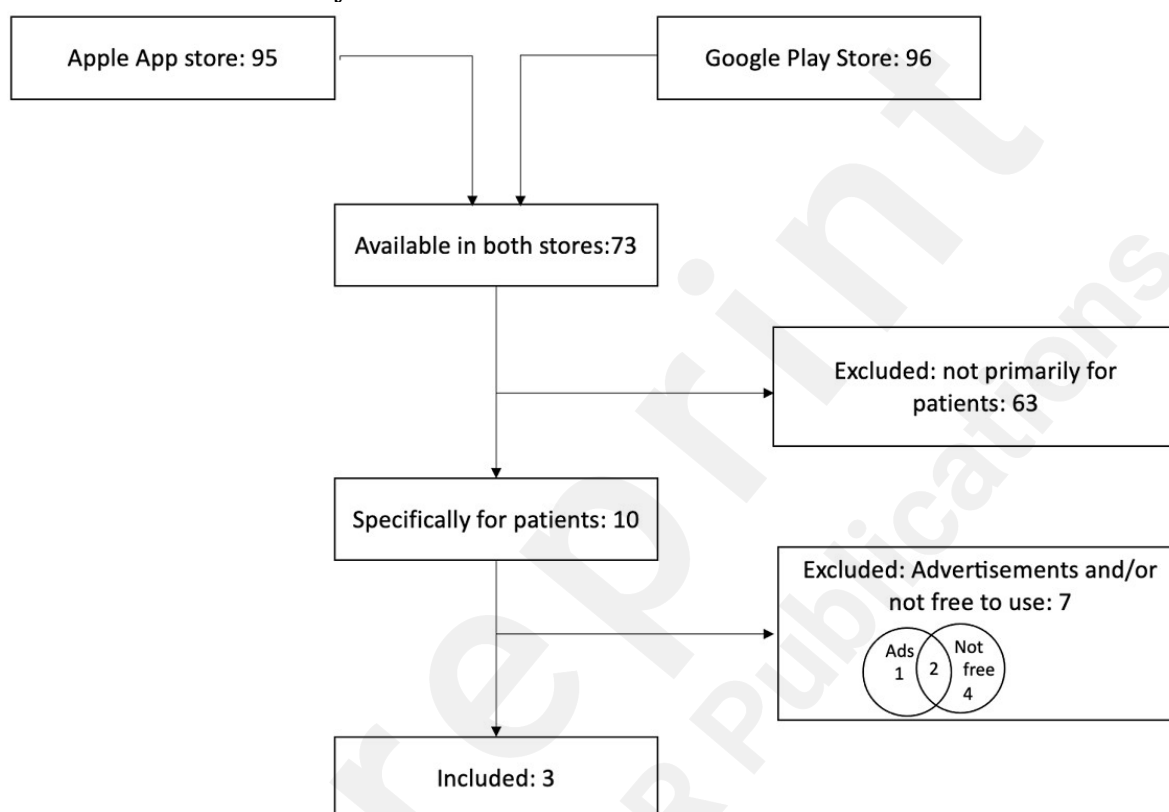
Comparative Analysis of Patients' and Physicians' Data

The MARS results represent the physicians' evaluations, as stated above, whereas uMARS results correspond to the patients' evaluation. In a next step and after normalization, the Mann-Whitney U test was used to analyze whether there was a significant difference between MARS and uMARS as well as SUS and ATI median scores in patients and physicians. A comparison of the five subcategories within the MARS scores was performed. *P-values* <.05 were considered significant. Data analysis was performed with SPSS 23.

Results

App Selection

A total of 118 apps were identified, 95 in the Apple App Store and 96 in the Google Play Store, of which 73 were available in both app stores (see flowchart, Figure 1). Of these 73 apps, 10 were specifically designed for patients. Out of 10 apps, one contained advertising, four were not free of charge, and two met both exclusion criteria, resulting in a total of seven apps that were excluded from further analysis.



Evaluation of App Quality

Three apps, namely *WoundEducation*, *APD Skin Monitoring*, and *WUND APP*, met all inclusion and exclusion criteria and were evaluated by 10 physicians. *WoundEducation* provides an overview of different wound types and treatment options. *APD Skin Monitoring* includes automated area calculation to quantify wound area. *WUND APP* offers advice and information on chronic wounds and contains a diary function to track patient-related outcomes such as pain or level of wound secretion.

The mean MARS scores (and standard deviation) of the physicians, including subcategories and SUS scores, are provided in Table 1.

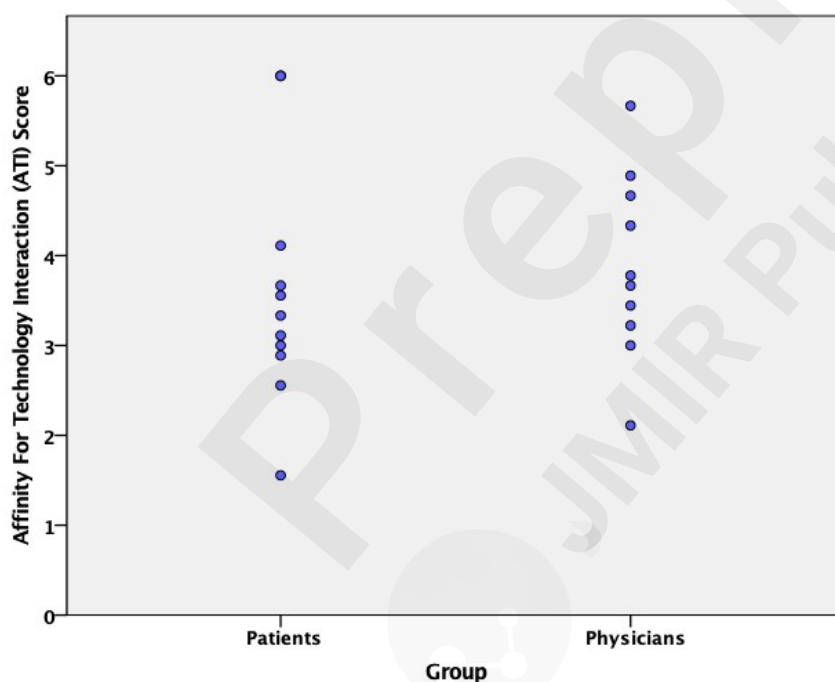
Mobile Application	MARS	Engagement	Functionality	Aesthetics	Information	Psychotherapy	SUS (%)
WUND APP	3.88 (0.65)	3.36 (0.89)	4.38 (0.66)	4.13 (0.76)	3.67 (0.56)	2.98 (0.36)	80.5 (17.7)

Wund APP)	Education	3.01 (0.5)	2.14 (0.44)	3.93 (0.99)	2.73 (0.75)	3.25 (0.58)	2.57 (0.46)	72.75 (18.5)
D Skin p	Monitoring	2.64 (0.65)	2.36 (0.56)	2.65 (0.83)	2.77 (0.69)	2.79 (0.82)	2.47 (0.63)	50.75 (27)

WUND APP showed the highest mean MARS score of 3.88/5 and was subsequently analyzed by 11 additional patients with chronic wounds. *WUND APP* showed a similar mean uMARS score of 3.89/5 when analyzed by patients.

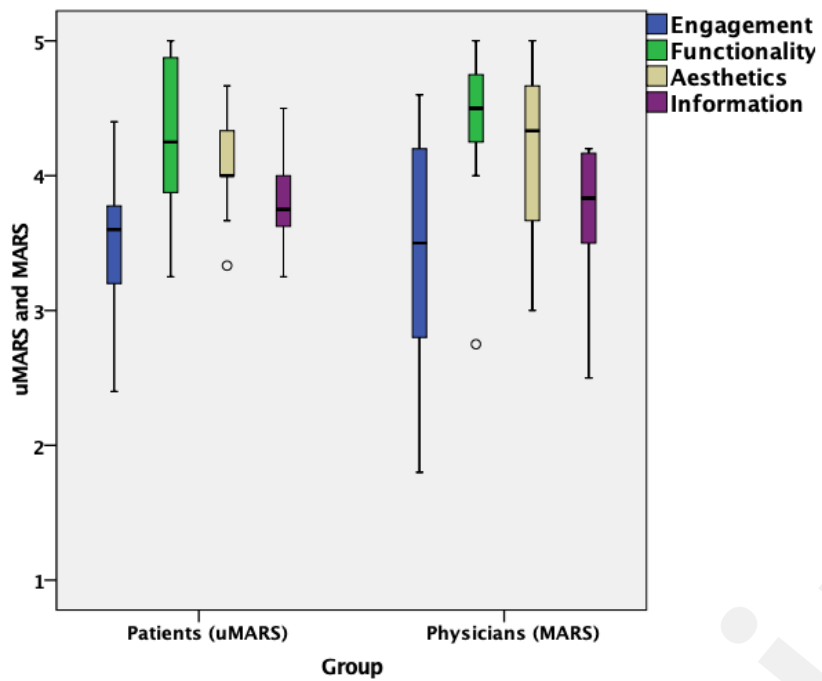
Evaluation of Technical Affinity

The ATI ranges from 1.56/6 to 6/6 for patients and from 2.11/6 to 5.67/6 for physicians (Figure 2). An ATI score greater than 3 is considered average technology affinity and greater than 4 is considered high technology affinity[8]. Mean ATI scores were slightly lower for patients than for physicians (3.62/6 vs. 3.88/6) but not statistically significant ($p=0.426$). Patients ranged in age from 28 to 70 years, 7 were male and 4 were female. Physicians ranged in age from 26 to 43 years, 4 were male and 6 were female. Pearson correlation coefficient between ATI and age in patients was -0.706 ($p=0.015$) what corresponds to a strong negative correlation.



Comparative Analysis of Patients' and Physicians' Data

MARS and uMARS scores were almost identical. The subcategory "Information" was rated worse by physicians, while "Functionality" was rated worse by patients (Figure 3). In the subcategories "Aesthetics" and "Engagement", no differences between physicians and patients were found. No statistically significant difference (Mann-Whitney U test) was found between MARS and uMARS scores ($p=0.756$), nor between SUS scores ($p=0.387$) in patients (Suppl. Table 1) and physicians.



Discussion

Principal Findings

This study represents the first systematic examination aimed at identifying and assessing smartphone apps specifically designed for patients suffering from chronic wounds. The quality of these apps was evaluated by independent professional reviewers (physicians) and by patients utilizing well-validated scoring systems such as MARS, uMARS, and SUS. Utilizing subjective measures in the assessment of eHealth is relevant and essential, and it is crucial to recognize this fact. Agreement among the assessors, even about subjective measures, is a good sign of the reliability of the assessment.[14]

The overall findings indicate that the apps received moderate ratings. Among all apps evaluated, *WUND App* demonstrated the highest MARS score of 3.88 when assessed by physicians. Similarly, it received an uMARS score of 3.89 when evaluated by patients. Given that the preselection was exclusively conducted by physicians, patients' assessments might have differed.

The *WUND APP* includes a diary function for documenting wound photos and patient-related outcomes, such as pain or wound secretion. Furthermore, it entails a reminder function for necessities such as doctor's appointments or dressing changes. Its user interface is clear, and the application is user-friendly. Consequently, physicians assigned high scores in the subcategories of engagement (3.36), functionality (4.38), and aesthetics (4.13). Additionally, the app provides information on cause, diagnostics and treatment of the different wound types resulting in a MARS score of 3.67 for the subcategory of information.

Wound Education app is presented in a straightforward structure resembling an article with embedded links, delivering medical information, and illustrating various wound types through examples. The application received high ratings for overall functionality (3.93) and information provision (3.25). However, it demonstrated limited interactivity, reflected in the lowest score for the engagement subcategory (2.14). Additionally, aesthetics (2.73) was rated the lowest among the three applications.

APD Skin Monitoring [15] employs a coin as a reference point for calculating the area of a wound, proving particularly useful in assessing wound progression and healing status despite irregular shapes. In addition, the coloration of wounds can be analyzed and tracked over time. However, the app received the lowest ratings in functionality (2.65) and engagement (2.36).

Our findings revealed that a limited number of wound apps were specifically tailored for patients, accounting for only 13.7% (10/73) of all apps available in both app stores. Overall, both physicians and patients rated *WUND APP* similarly; however, noteworthy, although not statistically significant, differences emerged in two subcategories. Clinicians rated the information content lower, which could be attributed to their expertise in medical knowledge. As professionals, they may have higher expectations regarding the app's information content and may find certain aspects less informative. A recent study has shown that patients trusted recommendations and reviews from medical organizations and healthcare professionals when selecting apps.[16] Their motivation to continue using apps was driven by features that supported goal setting and tracking, data sharing, decision-making, and empowerment.

On the other hand, patients rated the functionality lower, possibly due to their limited involvement in the app's development process. One systemic review demonstrated that healthcare professionals were engaged in the development process in only 35% of the seven analyzed apps specifically designed for rheumatoid arthritis patients.[17] A second systematic review revealed that patients were only engaged in 15% of the 32 analyzed apps designed for individuals with Rheumatic and Musculoskeletal Diseases.[18] Inclusion of patients in the

development process of future wound apps could help to ensure that the apps meet their specific needs and preferences. Our study highlights the scarcity of wound apps designed explicitly for patients and the importance of involving patients in the app development process. Tailoring apps to meet patients' specific requirements and involving them in the design process will likely lead to improved app functionality and overall user satisfaction.

To the best of our knowledge, this study represents the first systematic study to collect data on technical affinity in wound patients. Surprisingly, no statistically significant difference was observed between wound care patients and physicians, even with the inclusion of patients up to the age of 70. Nevertheless, future studies and app development projects should aim to encompass elderly patients and comprehensively assess and address their specific needs. Low adoption and usage of mobile health applications among elderly patients are frequently attributed to inadequate designs.[19]

In 2019, Germany introduced a digital health applications (DiGA) directory that includes scientifically validated apps. Physicians have the possibility to prescribe DiGAs similar to prescribing medications.[20] However, as of today, no DiGA specifically tailored for patients suffering from chronic wounds is available in the directory. It is worth noting that physicians with a higher technical affinity and those identifying as female held significantly more positive attitudes towards DiGAs.[21]

The absence of such an app highlights the unmet potential for innovative digital solutions to address the needs of chronic wound patients. The inclusion of validated and effective wound care apps in the DiGA directory could significantly improve patient outcomes and healthcare management in this specific area. It is imperative for future app development initiatives to focus on developing and validating apps that cater to the unique requirements of patients with chronic wounds, providing them with accessible and effective digital healthcare resources.

Multiple attempts have been made to implement mHealth applications into wound care.[22] It ranges from wound care measurements,[23] wound care dressing decision support system[24] to home based self-management systems.[25] An Australian study assessed an artificial intelligence application for wound assessment, involving 166 patients in the standard group and 124 in the intervention group. The intervention group demonstrated significantly improved wound documentation, with positive outcomes including enhanced patient adherence, efficient virtual care provision, and substantial reductions in wound size.[26]

A cultural shift towards greater technology affinity has been accelerated by the Covid-19 pandemic.[27] Patients are increasingly using mobile applications when they perceive clear benefits by their usage, such as reducing social contacts during the Covid-19 pandemic. For patients with chronic wounds, these benefits may include utilizing the app as a diary function, while for others, it may offer the advantage of saving time and transportation costs through telemedicine services. Telemedical approaches could significantly alter and improve the current wound care landscape. It bears the potential to improve efficiency, accuracy, and accessibility in both diagnosis and treatment. Telemedicine in chronic wound management has shown noninferior to conventional standard care in a systematic review and meta-analysis[28]. Earlier diagnosis of complications such as wound infections can reduce the use of antibiotics and lower health care costs by preventing hospital stays.

Limitations

Due to the limited number of apps that met our strict inclusion and exclusion criteria, only a small subset could be analyzed in this study. The selection of apps was conducted within a relatively short timeframe, which might have further restricted the available options for evaluation.

The non-significant differences in physicians' and patients' ratings in this study may be attributed to the small sample size of only eleven patients and ten physicians, resulting in

limited statistical power and therefore emphasizing the importance of cautious interpretation and the consideration of larger sample sizes for future research.

Another factor influencing the study's results is the inclusion of patients who agreed to evaluate the application. This approach introduces a potential selection bias, as it may not represent the true technical affinity of a larger cohort of patients suffering from chronic wounds. The overall technical affinity among a more extensive and diverse patient population might be lower than what is observed in this study. Future studies with a larger patient cohort might provide a more comprehensive understanding of the technical affinity and usability experience among patients with chronic wounds when using mobile health applications. The assessment relies on a qualitative survey, a method that may be susceptible to various biases; however, to truly ascertain the effectiveness of the app, a randomized controlled trial is needed.

Conclusions

Patient involvement is crucial in app development. By involving all stakeholders including physicians, wound care experts, and patients throughout the development process, apps can be tailored to meet the specific needs and preferences of the end-users, leading to increased user satisfaction and improved health outcomes.

The Affinity for Technology Interaction (ATI) score proves to be a valuable and validated tool for evaluating an individual's technical affinity. In future studies and app evaluations, technical affinity should be included to generalize outcomes to specific patient and consumer cohorts.

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Conflicts of Interest

None declared.

Abbreviations

MARS: Mobile Application Rating Scale

uMARS: user version of the Mobile Application Rating Scale

ATI: affinity for technology interaction scale

SUS: System Usability Scale

Figure legend

Figure 1

Flow chart illustrating the screening process for identifying suitable mobile applications.

Figure 2

Scatter plot depicting Affinity for Technology Interaction (ATI) scores in patients and physicians.

Figure 3

Comparison of MARS and uMARS subscales (Engagement, Functionality, Aesthetics, Information) between physicians (professional raters) and patients.

Table legend

Table 1

Evaluation of *WUND APP*, *APD Skin Monitor* and *WoundEducation* by 10 physicians using MARS and SUS (mean scores and standard deviation).

Supplemental Material

Supplemental Table legend

Supplemental Table 1

Patient characteristics (age, sex) and ATI, SUS and uMARS scores (including subcategories) of all 11 patients who participated.

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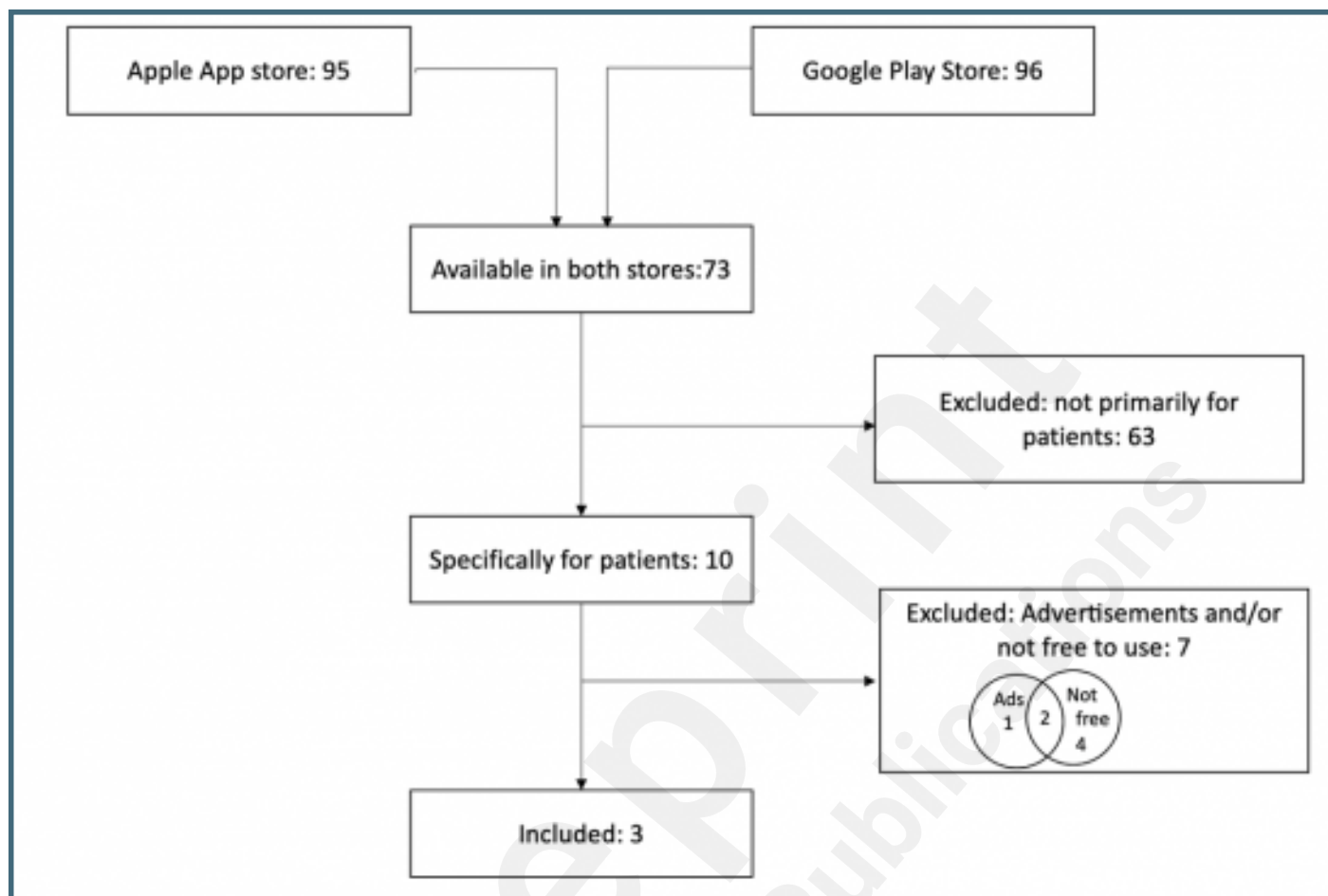
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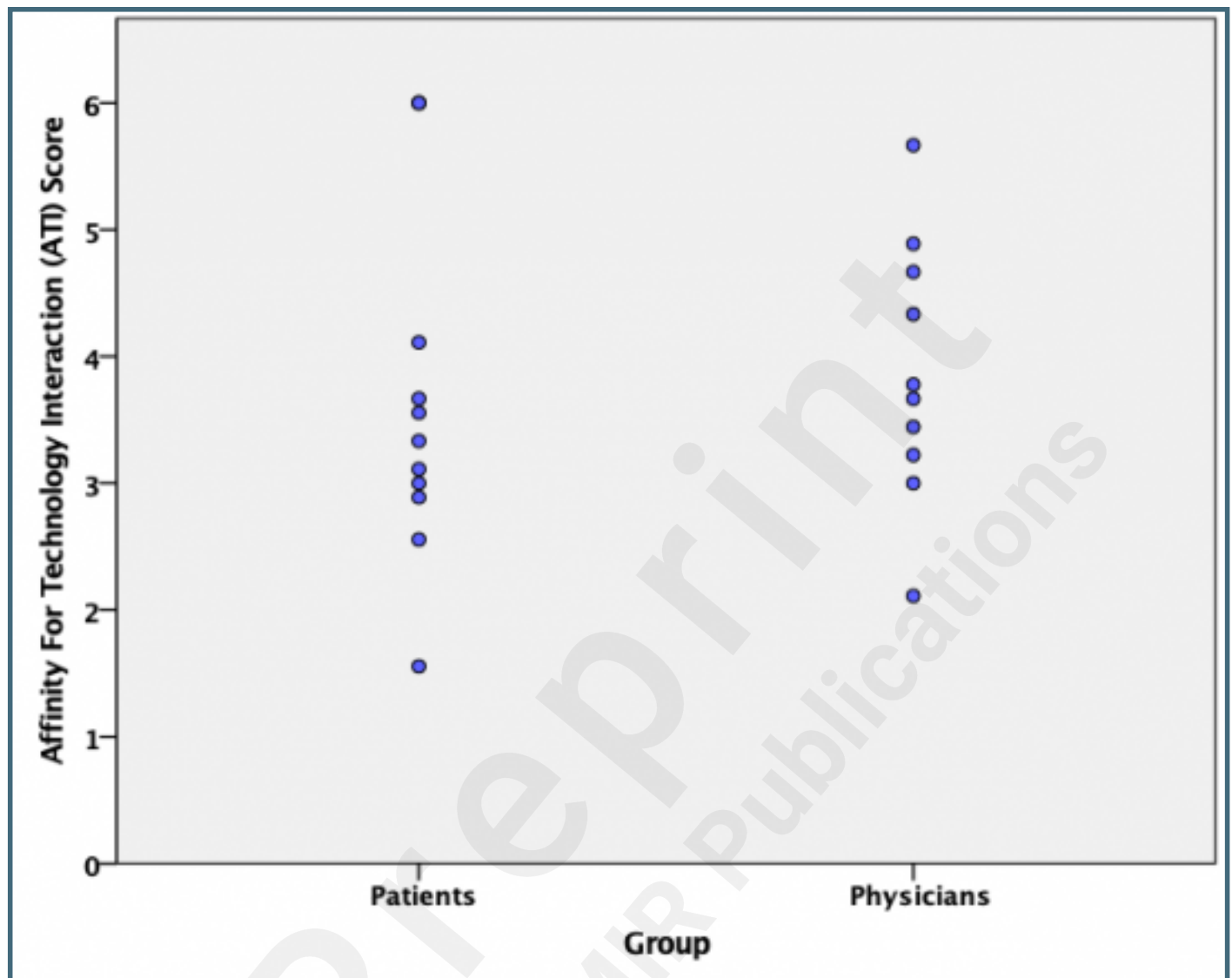
Supplementary Files

Figures

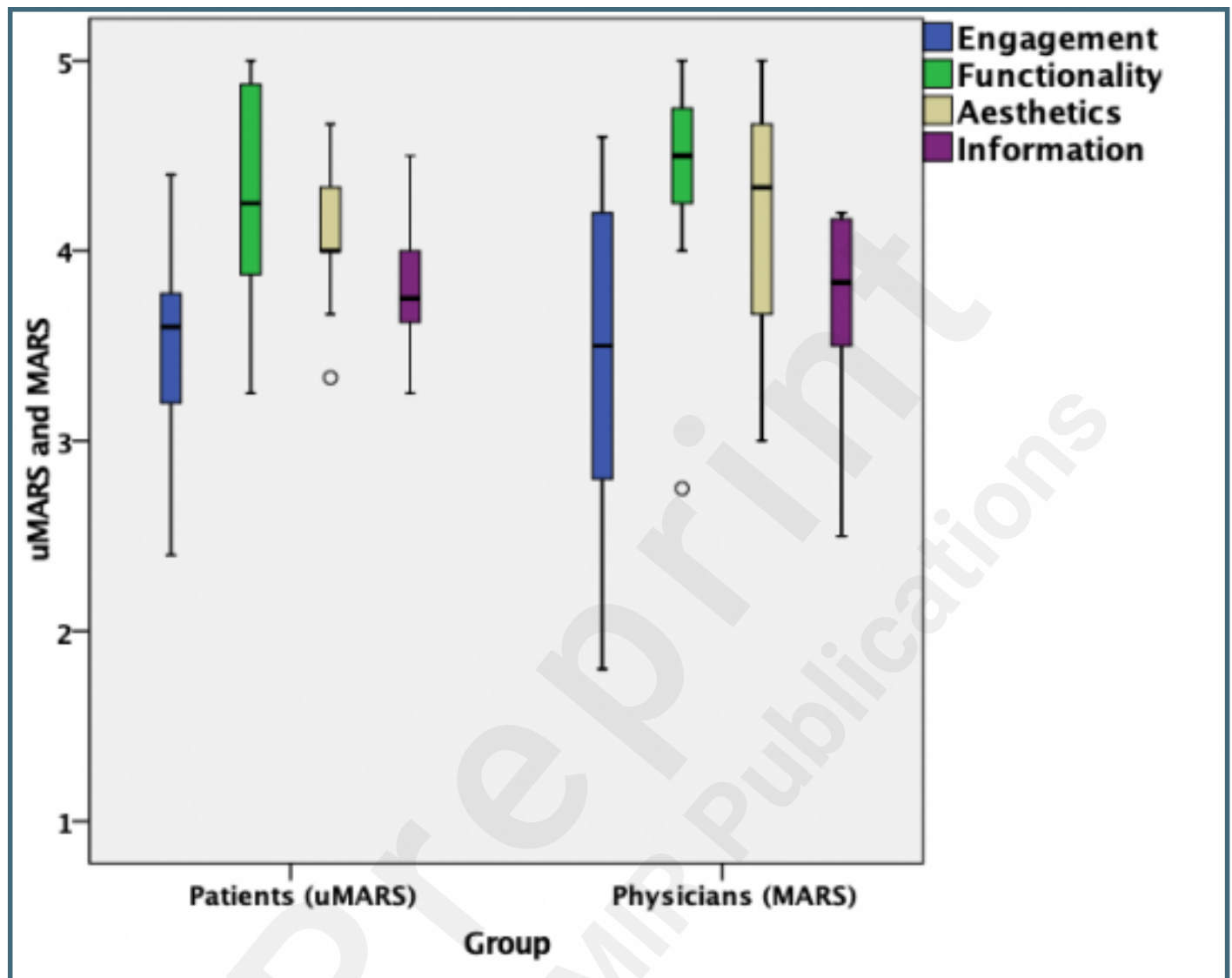
Flow chart illustrating the screening process for identifying suitable mobile applications.



Scatter plot depicting Affinity for Technology Interaction (ATI) scores in patients and physicians.



Comparison of MARS and uMARS subscales (Engagement, Functionality, Aesthetics, Information) between physicians (professional raters) and patients.



Multimedia Appendixes

Evaluation of WUND APP, APD Skin Monitor and WoundEducation by 10 physicians using MARS and SUS.

URL: <http://asset.jmir.pub/assets/0da1e751a799b995de2a422549e4ed31.docx>

Patient characteristics (age, sex) and ATI, SUS and uMARS scores (including subcategories) of all 11 patients who participated.

URL: <http://asset.jmir.pub/assets/c275720bbf7fbee71d023cb72002fbc5.docx>

