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The Quantified Woman: Exploring Perceptions on Health App Use among Austrian Females of Reproductive Age

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Abstract: Smartphones have become the most important commodity for today's digitalized society. Besides direct interpersonal communication, their most used features are third-party applications (apps). Apps for monitoring health parameters (health apps) are extremely popular, and their users are part of the Quantified Self movement. Little knowledge is available on how health apps are perceived by a female target audience, the Quantified Woman. We conducted a study among Austrian females of reproductive age (n = 150) to analyze prevalence, perceived benefits, and readiness for health app use. In the cross-sectional online German survey, nearly all participants used these apps (98.0%), predominantly for monitoring physical activity and female health (both 31.3%). For the latter, participants used a large variety of different apps for monitoring contraception and menstruation. Perceived benefits and readiness of health app use were only of medium range. Our study assessed aspects of health app use in an understudied segment of the general population. From a Public Health perspective, the Quantified Woman could be empowered by health data collection by enabling her to take active control over how her health graphs develop. We suggest assuring data security and privacy for sensitive female health data collected by health apps.

Keywords: female health; online survey; principal components analysis; telecare

1. Introduction

In 2020, an estimated amount of 12 billion mobile devices with an economic value of over $4.5 trillion are in circulation [1]. The omnipresence of smartphones enables almost continuous mobile internet access for all strata of the population. A widespread public technology acceptance, which is relevant for public adoption of telehealth referring to remote healthcare services and information via electronic information and telecommunication technologies, can thus be assumed [2,3].

Mobile applications (apps) addressing health and wellness issues (i.e., health apps, in contrast to medical apps that focus on diagnosis and treatment of diseases) offer pleasant gamification experiences and increase health literacy, while fostering national telehealth strategies [4–6]. The digital health industry has developed into a serious business: In 2017, as many as 325,000 mobile health apps have been available, and figures are expected to rise continuously [7]. Commonly, smartphone users have downloaded at least one health app focusing on various aspects of promoting digital health, some apps serving more than one use [8–12]. The most popular categories of health apps include fitness and nutrition apps, but also apps for weight loss coaching, sleep cycle analysis, stress reduction and relaxation, meditation, menstrual period tracking, and pregnancy.

Already in 2007, Gary Wolf and Kevin Kelly from the magazine Wired founded the so-called Quantified Self movement, which has soon become a worldwide phenomenon [13]. The term is

nowadays widely used as buzzword for any form of self-tracking by wearable digital devices such as the Fitbit Surge or Apple Watch, and of course an enormous variety of smartphone apps. These tools provide feedback on a large number of biometric data, e.g., consumed calories and walked distances, often presented as graphs for a quick overview. David Baker very pointedly describes four key ironies of biometric data logging: (i) know more, know better vs. no more, no better; (ii) greater self-control vs. greater social control; (iii) well-being vs. never being well enough; (iv) more choice vs. erosion of choice [14]. Nevertheless, it has been shown that health app users are more likely to report intentions to eat healthily, be physically active, and reduce weight [8]. From a Public Health perspective, however, health apps presumably motivate users for a healthy lifestyle, thus reducing healthcare expenses caused by non-communicable diseases [15–17].

A growing body of international literature shows that online sources are already more popular for health-related information retrieval than doctors [18]. Socio-demographic characteristics influence online habits in general. Notably, gender is the most studied personal feature in this respect, with a female predominance e.g., in online health information search and health app use [19–24]. A Dutch study found a female preference for nutrition and self-care apps, although genders did not differ in general health app use [25]. In 2015, 27% of Austrian participants from the general population used health apps, also without gender differences [11]. In an Austrian study of 2017 among academics, health app use was higher among females (42%), with apps for tracking activity and nutrition habits most commonly used [26].

Web-based activities such as tweeting, blogging, and exchanging views on health topics with peers correspond to communication needs of women; male users are more likely to consume web content passively or in a strictly goal-oriented manner [27]. In addition, online gaming is more common among males [26]. Online habits seem to reflect gender-linked personality traits and gender-belief stereotypes, as women are thought to be more emotionally aware and engage in both giving and receiving of emotional support compared to men [28,29].

Menstrual apps, also known as sexual and reproductive self-tracking, period tracking or cycle apps, are a subgroup of health apps, helping women to observe and analyze menstrual cycle, fertility window, and associated factors based on self-reported data. Coming second to running apps, menstrual apps show one of the most dynamic and rapidly growing app sectors. In 2016, over 200 million women used these apps worldwide, contributing to the accumulation of female health-related big data useful for in-depth research on female health [15,30]. Studies showed that these apps potentially empower females by increasing health literacy and facilitating doctor–patient interactions [31]. On the other hand, menstrual tracking can cause distress and raise substantial data privacy and security concerns [31]. In addition, basic quality criteria regarding evidence base and scientific plausibility are inconsistently found in these apps [32,33]. Phenomena related to health app overload and health information fragmentation have already been recognized as a problem, limiting the usefulness of those little helpers for female empowerment, as international standards are lacking so far.

Digitalization is perceived to reduce the wider health inequalities experienced by women. However, a very sensible kind of biometric data affecting half of the society concerns female health data. Woman searching for suitable menstrual apps in a huge market might be more careful in choosing these apps and sharing the collected information compared to other apps e.g., for physical activity tracking. Despite the increasing popularity of health apps, research on how women of reproductive age, i.e., being younger than 50 years old, as defined by the World Health Organization (WHO) [34], perceive their use is scarce [11]. Thus, we investigated these perceptions among a convenience sample of German-speaking Austrian women. This cross-sectional study aimed at assessing prevalent health app use, which types of apps are used, and further, health app use readiness. Based on similar concepts, e.g., the Quantified Sex [33], we approach the phenomenon of the Quantified Self movement from a gendered perspective in the sense of the "Quantified Woman".

2. Methods

2.1. Study Design

We conducted an online cross-sectional questionnaire-based study among the Austrian population. The online survey in German was enabled by the web-based survey tool SoSci Survey and open and accessible from 28 February to 14 June 2018 [35]. Attempting a snowball sampling approach, we sent the link to the online questionnaire to potential survey participants via email invitations and social media groups, in particular Facebook, blogs, and relevant survey forums, with the request to distribute the link in their network of friends and family. We did not offer incentives for participation. SoSci Survey is a professional tool for the flexible design of online scientific surveys. The program runs on a survey server operated in the internet browser. The use is free for scientific purposes without restrictions on length of the questionnaire and number of respondents. The program does not record personal data, guaranteeing participant anonymity. An electronic cookie ensures single participation. The software prevents non-response, so that fully completed questionnaires could be analyzed without missing values. The survey included a cover page informing about the study aim, and that the respondent was implicitly consenting to the collection of the data requested by completing the survey. We securely stored collected data, which was only accessible for members of the research team. This survey was approved by the ethical committee of the Medical University of Vienna, Austria, on 1 February 2018 and conducted in accordance with the guidelines of the Declaration of Helsinki.

2.2. Study Questionnaire

Telehealth readiness assessment tools are available for the three major participant groups patients/public, healthcare practitioners, and organizations [4,36]. Adapted from previous surveys, the questionnaire in German collected socio-demographic data such as age, gender, level of education, place of residence, having children, and smartphone use as well as health app use [3,4,11,18,37]. In addition, participants were asked to rate seven potential benefits of health app use on a 5-point Likert scale (1 = strongly agree to 5 = strongly disagree).

A further part of the survey contained the adapted version of the patient/public readiness assessment for telehealth tool (PRAT) [38,39]. The PRAT captures the multidimensional concept of telehealth readiness. We chose this tool due to practicability reasons, as the tool has been already adapted to other languages and contexts, and is generalizable for all telehealth projects. In our study, we refer to person instead of patient or public. The original English version of the PRAT asks for readiness for telehealth, which we replaced with "health app use" in this version. This procedure is encouraged and legitimated by the developers of the original PRAT. The PRAT is based on a scoring system that evaluates the participants' degree of readiness for using health apps in the three aspects core readiness, engagement readiness, and structural readiness. Core readiness covers dissatisfaction with the status quo, expectation of change, and a desire to use health apps. Engagement readiness covers awareness as well as perceived health app use-related benefits and barriers. Structural readiness covers the development of adequate technical infrastructure and soft skills for health app use. The total Readiness Score sums up these three domains to allow for an estimate for health app use readiness indicating whether the participants are in a good position to use health apps or they experience certain inhibiting aspects or even barriers to health app use. A 5-point Likert scale collected respective ratings (1 = strongly agree to 5 = strongly disagree).

We pre-tested the questionnaire with eleven participants, both laypersons and scientifically experienced people to ensure general comprehensibility, face validity, and content validity, and integrated their feedback in the final questionnaire. In the pre-test, two items were repeatedly marked as irrelevant for assessing readiness for health app use, namely "I acknowledge the benefits or anticipated benefits/risks" (Engagement readiness) and "I have a practitioner mediated liaison for telehealth programs" (Structural readiness). Thus, we excluded these two items from the readiness assessment tool used in this study. The final tool then consisted of 15 items.

2.3. Statistical Data Analysis

We conducted all statistical analyses using SPSS Version 26.0 (SPSS Inc., Chicago, IL, USA). Median splits created a dichotomized variable for age (young vs. older), i.e., a younger age group with 28.5 years of age or younger and an older age group (>28.5 years), both *n* = 75, respectively. We descriptively summarized collected data to present categorical data as absolute and relative frequencies, and continuous data as mean and standard deviation (SD). Brand names of menstrual apps were collected in a free text field in the according part of the questionnaire. We determined respective subgroup differences for age (young vs. older) and having children (yes vs. no) using chi^2 tests. We analyzed potential correlations using Spearman's rho rs for the variables age (young vs. older), having children (yes vs. no), Benefits Score (i.e., mean score of the seven items of benefits of health apps), and Readiness Score (i.e., mean score of the 15 items of the PRAT). For the latter two scores, lower ratings indicated higher degree of agreement. To determine the internal consistency of the readiness assessment tool, we calculated Cronbach's alpha, with a threshold of 0.6 for acceptable values [40,41].

3. Results

The website was accessed 1605 times; 324 participants started, and 217 of those completed the survey (66.98% completion rate). To analyze a sample of female participants of reproductive age only, we excluded all male participants (*n* = 50) and females over 49 years of age (*n* = 17) from further analysis, yielding a total study sample of 150 with a maximum age of 49 years. The average completion time was 6.7 min (SD 1.9) to completely fill out the questionnaire.

Regarding main residence, 40.7% (*n* = 61 out of in total *n* = 150) of participants lived in Vienna, whereas the majority lived in other parts of Austria. The mean age of the study subjects was 30.9 years (SD 8.2, range 20–49 years). As for education level, 12.7% (*n* = 19) of respondents reported primary, 45.3% (*n* = 68) secondary, and 40.0% (*n* = 60) higher education, and three participants did not provide information on their education level. More than half of the participants did not have children (62.0%, *n* = 93). Most of the participants used apps in general as well as health apps (98.0%, *n* = 147), with 79.6% (*n* = 117) reporting a frequent health app use, i.e., at least once a week, with 28.6% (*n* = 42) even on a daily basis. The most popular types of health apps were those for monitoring physical activity and female health (summing up apps for contraception, contraceptive pill intake, and menstruation), both 31.3%, *n* = 47, sleep and nutrition (both 14.0%, *n* = 21), and calorie intake (13.3%, *n* = 20). Female health apps were used for contraception (*n* = 7, 4.7%), contraceptive pill intake (6.7%, *n* = 10), and menstruation (20%, *n* = 30). A wide variety of specific apps was mentioned in a free text field including Clue Period & Ovulation Tracker with Ovulation Calendar [42], Strawberry week: your expert for menstruation & sustainable monthly hygiene [43], myPill Birth Control Reminder App [44], Period Tracker: Period Calendar and Ovulation Tracker [45], and Lady Cycle [46].

As shown in Table 1, the top benefit of health apps was "Location-independent access to health services" (mean 2.37, SD 1.06), whereas the option "Improved doctor–patient relationship" yielded the lowest approval (mean 3.54, SD 1.05, Table 1). The scale of seven items building the Benefits Score (Mean 3.17, SD 0.76) showed a good internal consistency of alpha = 0.837.

Table 2 shows the ratings for the readiness assessment tool, with items ordered by highest agreement levels. The overall Readiness Score was mean 2.87 (SD 0.45, 15 items, alpha = 0.680). In the domain for Core readiness (overall mean 3.56, SD 1.73), the item "I have a desire for change and want to actively be involved in my health and healthcare condition" scored highest (mean 2.40, SD 1.16). In Engagement readiness (overall mean 2.08, SD 1.69), the item "I have a sense of ownership regarding my wellbeing and that of my community" scored highest (mean 1.3, SD 0.59). In Structural readiness (overall mean 3.20, SD 1.02), the item "I have access to health apps and the ability to use them" scored highest (mean 1.59, SD 0.77). We found the overall lowest approval for "I am aware of education campaigns about health apps" (mean 4.6, SD 0.79).

Table 1. Ratings for benefits of health apps (*n* = 150).

Benefits of Health Apps	Mean	SD
Location-independent access to health services	2.37	1.06
Higher quality of healthcare	3.05	1.08
Higher efficiency in healthcare resource allocation	3.15	1.14
Reduced healthcare costs	3.24	1.03
Higher efficiency in medical consultation	3.31	1.08
Reduced multiple diagnostics	3.53	1.09
Improved doctor–patient relationship	3.54	1.05
Benefits Score	**3.17**	**0.76**

Table 2. Public readiness assessment for health app use (*n* = 150).

Items	Mean	SD
As a person, in order to meet the requirements for health app use, I . . . :		
Core Readiness		
Have a desire for change and want to actively be involved in my health and health care condition	2.40	1.16
Feel dissatisfied with usual doctor–patient interaction or have a desire for a more comfortable setting for obtaining health information	3.54	1.33
Identify with a sense of dissatisfaction with the current state of health care	3.73	1.20
Acknowledge unmet healthcare needs	3.96	1.24
Identify with a sense of isolation and a lack of access to healthcare	4.13	0.99
Core Readiness Score	**3.56**	**1.73**
Engagement Readiness		
Have a sense of ownership regarding my wellbeing and that of my community	1.35	0.60
Believe that health apps are not a replacement, but an addition to traditional care	1.59	0.76
Am knowledgeable about health apps and/or want to know what health apps are	1.70	0.79
Am comfortable with using health apps	2.03	1.06
Believe that cultural issues can be addressed when using health apps	2.77	1.08
Believe that concerns specific to privacy/confidentiality/security have been addressed when using health apps	3.04	1.12
Engagement Readiness Score	**2.08**	**1.69**
Structural Readiness		
Have access to health apps and the ability to use them	1.59	0.77
Have access to information about health apps from official sources (e.g., brochures, from doctors)	2.96	1.33
Am a local champion who has an ambition to bring telehealth to my community	3.65	1.19
Am aware of education campaigns about health apps	4.60	0.79
Structural Readiness Score	**3.20**	**1.02**
Readiness Score	**2.87**	**0.45**

We did not find statistically significant subgroup differences (age and having children) for the benefits scale and the readiness assessment tool. We found a strong negative correlation (rs = −0.65) for having children and age, as the mean age for participants with children was much higher than those without (mean 37.54 years, SD 7.26 vs. 26.80, SD 5.73, respectively), and a medium positive correlation (rs = 0.38) between the Benefits Score and the Readiness Score (both *p* < 0.0001).

4. Discussion

We conducted an online study among females of reproductive age assuming that health app use is higher among females compared to males [24]. We aimed at analyzing the current status of health app use and assessing readiness for health app use among a cross-section of Austrian women reachable by the online snowball sampling approach. Thus, we herein present a status quo evaluation of prevalent health app use among this stratum of the population.

Nowadays, smartphone apps unequivocally form an integral part of how we experience and structure our modern life. This is especially true for health apps designed for collecting, sharing, visualizing, combining, and comparing self-reported personal health data in the sense of the Quantified Self movement. With the emergence of a culture of measurement, users treat their lives, bodies, and selves as enormous tracking and logging projects [47]. A female of reproductive age then joins the ever growing movement of the Quantified Woman. Although digitalization is perceived to reduce the wider health inequalities experienced by girls and women, we suggest that especially for the Quantified Woman, pitfalls might exist. Research suggests that about one fifth of reviewed women´s health apps did not keep what they promised, e.g., avoid pregnancy or maximize conception chances [6]. Obstetricians and gynecologists are already sounding the alarm, as period trackers are "misused" for natural contraception, a very unsafe technique. In addition, it seems that there is a lack of good quality apps tailored to fertility problems, crossing the indistinct line between health apps and medical apps. Noteworthy, artificial intelligence-guided big data analysis from menstrual apps could advance our knowledge to combat infertility, a potential that has not been exploited so far [30]. The novel advancements in health technology are immense, and promising innovations that combine mobile apps with artificial intelligence algorithms are already in the pipeline [48].

The health app market is huge and continuously growing [7]. In our study, we found a broad range of menstrual apps used. The uncontrollable access to non-evidence-based health apps could cause serious problems, leading to the occurrence of health app overload and insecurity [49]. In their review, Zwingerman et al. found 140 fertility and menstrual tracking apps for the iPhone, of which only 90 were free [6]. Although most users would not pay for health apps in general [12], the Quantified Woman might be more prone to pay for her favorite menstrual app [47].

Studies showed that the main users of health apps are young, well educated, healthy, and have a higher income [8,12,15]. Although not expected, we found that the socio-demographic factors age and having children showed no significant influence on health app use. This observation suggests that surveyed women expressed quite homogenous preferences in this respect. Yet, this finding remains to be confirmed in controlled trials, especially as evidence is lacking on the impact of having children and reproductive age on health app use in the general population.

Surprisingly, we found quite low ratings for benefits of health app use (mean over three in all items except for location-independent health service access), although most of the participants used these apps frequently, even more than expected in view of the pertinent literature. This observation was also mirrored in the readiness assessment with an average Readiness Score of medium range (mean slightly below three), which suggests that the participating females experienced certain inhibiting aspects to health app use. In line with related studies, we found issues concerning data privacy and security, questions of responsibility, doctor–patient interaction, and reliability of information [26]. This discrepancy suggests that health apps might be more often used for personal convenience to organize everyday life and are not perceived as relevant to healthcare delivery among females of reproductive age.

Study Limitations

Our study contributes to the field by providing a German version of a questionnaire for evaluating health app use in an understudied segment of the general population. However, the findings of our study are subject to several limitations. General limitations of conducting an online survey include collection of self-reported information introducing recall, survey response, and social desirability bias.

Still, place- and time-independent data collection at very low costs compensate potential weaknesses of this sampling approach regarding lack of representativeness of our study sample and generalizability of the study results, resulting in a somewhat selective study population [50]. Only German-speaking people that were part of the online community were able to participate. Notably, our sample consisted of women with a higher education level and fewer children than the Austrian female population, as Austrian women have an average of 1.5 children [51]. This could be due to demographic indicators with a fertility age of over 30 years and the average first birth at 29.5 years. In this study, participants reported a very high use of health apps compared to similar studies.

We found a very wide variety of apps, concluding that factors such as personal recommendation by friends or media advertisements might have a relevant impact on individual choices. Potential reasons for their choice, user friendliness, and contentedness with the apps were beyond the scope of this study and should be assessed in in-depth mixed-method studies. The overall readiness assessment tool showed a rather low internal consistency with an alpha value of about 0.7. However, in accordance with the literature, we considered this as acceptable [40,41]. We suggest that our tool might be useful in assessing trends and new developments among a representative study sample, expanding the research hypothesis beyond women of reproductive age [52,53]. Thus, improvement or deterioration in readiness to use health apps could be assessed in a longitudinal study design with multiple measurements over a period of time. Follow-up studies could use advanced recruiting strategies and incentives for survey participation to increase response rates [46].

5. Conclusions

Though international evidence certifies that gender inequality still persists to a certain extent, socio-economic and individual factors are becoming less influential on engagement with mobile devices and health app use. The digitalization of information and communication processes in healthcare represents both opportunities and risks for women. Data collection options empower female users by enabling them to take active control over their health. In addition, health literacy as well as health communication between doctor and patient could be improved. The downside is that the common app users are unable or not willing to adequately control use and transmission of personal data following data sharing principles of the Quantified Self movement. Yet, the potential for health apps is enormous from a wider Public Health perspective. Clearly, digitalization of the healthcare system can only advance if users are remotely connected to healthcare providers, using their private mobile devices as a preferably standardized, secured information hub for health data.

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