ORIGINAL PAPERS

Profile of the users of mobile applications monitoring the course of pregnancy and its predictors among pregnant women – a cross-sectional study

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A – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Summary **Background.** Pregnancy is a very sensitive period for a woman and her environment. Technological progress allows women to exercise greater self-control over their health and expands the possibilities of obtaining information about pregnancy, but at present little research focuses on how and why women use mobile applications during pregnancy.
Objectives. The aim of the study was to determine the profile of the use of mobile applications monitoring the course of pregnancy and its predictors among pregnant women.
Material and methods. A cross-sectional study was conducted in 2022 using the CAWI method and responses were obtained by sharing a link to the survey in pregnancy groups on Facebook. The research used the author's questionnaire, the Satisfaction with Life Scale, the Multidimensional Social Support Scale, and the Security Experience Questionnaire.
Results. 1,077 pregnant women participated in the study, 1,002 of whom used and 75 of whom did not use medical applications monitoring the course of pregnancy. Most of the surveyed women were aged 26–35 and were in their first pregnancy and in the third trimester. On the SWLS scale, women represented a moderate level of life satisfaction (23.85 ± 5.28). The average score on the MSPSS scale was 69.13 ± 12.62, with women receiving the most support from a significant other (25.35 ± 4.1).
Conclusions. The probability of using mobile applications by women increased with the presence of comorbidities, treating pregnancy as a stressor, a higher score on the subscale of feeling and reflection on safety and among women aged 26–35.
Key words: pregnancy, mobile applications, maternal health, prenatal care, cross-sectional studies.

Background

Pregnancy is a period of transformation in a woman's life. During this period, women look for health information more intensively, mainly by exploring easily accessible electronic databases, to gain a sense of support or security in this area. High-quality prenatal care and medical counselling are of key importance for improving a mother's health and that of her newborn. The Internet has become a convenient access tool through which women can obtain a huge amount of information about pregnancy and childbirth [1]. The number of pregnant women using mobile applications monitoring the course of pregnancy and child development and supporting this period of parenthood is also growing [2]. Smartphone applications can provide an innovative way to provide health information, facilitate individual access to resources, and increase engagement in health care [3–5].

Given the widespread use of mobile devices and their accessibility, affordability, and relative ease of use, mobile health (mHealth) has a great deal of potential to support problem-solving in the healthcare industry [6]. The Ledford et al. study showed that mobile applications, as a tool for prenatal education, effectively enhanced self-management of pregnant women's health [7]. There are several reasons that motivate pregnant women to seek health information on the Internet, e.g.

the scarcity of information given by healthcare providers, the possibility of asking questions anonymously, and the fact that the Internet and mobile applications also provide a platform for social support and exchange of women's experiences [8].

Research shows that expectant mothers frequently use mobile applications and the Internet to find pregnancy-related information [9, 10]. A study examining the characteristics of pregnant women (*n* = 1,155) who used mobile applications for obtaining health and parenting information, however, found that women from culturally and linguistically diverse backgrounds and with lower incomes were less likely to use mobile applications despite a higher and higher rate of ownership of smart devices [11].

Although there is evidence that pregnant women are using mobile applications more frequently [12], and that they are employing the Internet to obtain information, deal with uncertainty, and make appropriate pregnancy-related decisions [13, 14], as well as to take more accurate pregnancy observations [15], few published studies have examined the sociodemographic, clinical, or psycho-emotional factors that are related to pregnant women's use of pregnancy monitoring applications. The identification of the specific user pattern of mobile pregnancy monitoring apps and their predictors is a gap that must be filled in order to tailor the needs of these apps to the needs of pregnant women who search for reliable sources of information and support. The findings of the study may also help to identify gaps

in Poland's perinatal care system, which may lead to women using the Internet to supplement their knowledge about their condition.

Objectives

The aim of the study was to identify the profile of users of pregnancy monitoring apps, as well as their predictors among pregnant women.

Material and methods

Study design and participants

A cross-sectional study with a non-random sample was conducted in March 2022 by using the Computer Assisted Web Interview (CAWI) method in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [16]. The target sample was pregnant women. The inclusion criteria included being pregnant in any trimester, speaking Polish, belonging to a Facebook support group for expectant mothers, and providing informed consent to take part in the study. The exclusion criteria included refusal to take part in the study and not belonging to any Facebook support group.

An online survey was conducted. The questionnaire was uploaded on Google Forms and was accessed four times during the survey period. In addition, posts containing the survey were not deleted and continued to be shared throughout the survey period. After having obtained the administrators' approval, the questionnaire was made available on Facebook on eight of the most popular groups for pregnant women („Ciąża – wspieramyprzyszłemamy" – 35.6 thou. members, „Rodzę w 2022 roku! Grupa dla mam (BEZ HEJTU). – 15.5 thou., „Rodzę w 2022 < 3 Największa Grupa Dla Mam! – 11 thou., „Rodzę w 2022 – WYPRAWKA" – 18 thou. „Rodzę w czerwcu 2022 – Czerwcowe mamy 2022" – 3.4 thou., „Mamą być. Ciąża i macierzyństwo" – 3.1 thou., „Rodzę w listopadzie 2022 – Listopadowe mamy 2022" – 1.8 thou. and „Rodzę w Św. Rodziny Poznań" – 1,6 thou.). The questionnaire was anonymous, and respondents could only fill it out once.

Sample size

The minimum sample size was at least 367 pregnant women, calculated based on the assumption: the population size of women associated on selected Facebook portals is 90,000; confidence level α = 0.95 (which means we can be 95% certain of the obtained results); fraction size 0.6 (it is estimated that the studied characteristic occurs in 60% of the population); a maximum error of 0.05 (which informs us about the "correction" we should adopt, i.e. 5%) [17].

Questionnaire

To achieve the aim of the study, a structured survey questionnaire was created, consisting of three standardized tools and an own questionnaire.
- **The Satisfaction with Life Scale (SWLS)** by E. Diener et al. [18] is used to assess the sense of satisfaction with life. This tool consists of 5 statements rated on a seven-point scale. The ratings, when added up, give an overall score that indicates the degree of satisfaction with own life. The score range is from 5 to 35 points, and the higher the score, the greater the sense of satisfaction with life. The author of the Polish adaptation is Zygfryd Juczyński [19].
- **The Multidimensional Scale of Perceived Social Support (MSPSS)** was created by Zimet et al. [20] as a self-report tool for assessing perceived social support and is widely used in many countries. The Polish adaptation of the Mul-

tidimensional Social Support Scale was prepared by the team of Buszman and Przybyła-Basista [21]. The scale takes into account the multidimensionality of perceived social support, with consideration of three basic sources of support: Significant person, Family, and Friends. It consists of 12 statements to which the respondent refers to using a seven-point Likert scale, where 1 means "I strongly disagree" and 7 means "I strongly agree".
- **Security Experience Questionnaire (SEQ)** by Klamut [22] – this contains nine statements, five of which refer to the Sense of Security and four to Reflection. The answers to the questionnaire are given on a five-point scale (from 1 – I strongly disagree, to 5 – I strongly agree). Sample statements for Sense of Security include: "In the current reality, I feel safe"; for Reflection on Security: "I often think about the safety of my family". Crombach's Alpha for Sense of Security = 0.86, for Reflection on Security = 0.71.
- **Sociodemographic, medical, and pregnancy monitoring mobile application variables**
Respondents were also asked to provide a set of sociodemographic data. The questions concerned the following variables: age, gender, place of residence, marital status, education. The medical information included data on the current pregnancy and obstetric history: number of pregnancies, trimester of pregnancy, previous miscarriages, pregnancy-related diseases, and the question: Is pregnancy a stressful experience for you? (Yes/ No). Moreover, the respondents were asked to provide information on their use of mobile pregnancy monitoring applications: application use (Yes, No), as well as the number and type of mobile applications employed.

Ethics approval

All the respondents participating in the study provided written consent, and their participation was anonymous and voluntary. The study protocol was approved by the Bioethics Committee of the Medical University of Lublin (no. KE-0254/139/03/2022).

Statistical analyses

In the case of qualitative variables, the number and percentage of response categories were indicated. Quantitative variables were described using the following statistics: mean, median, standard deviation, minimum and maximum values. Logistic regression was applied to identify factors influencing willingness to use a pregnancy monitoring application. All tests were carried out at an alpha level of significance of 0.05. All data was analyzed using IBM SPSS Statistics (v28.0; SPSS, Inc., Chicago, IL, USA).

Results

Characteristics of participants

Table 1 presents the characteristics of the study group. The study involved 1,077 pregnant women. The average age in the study group was M = 28.85; SD = 3.13 years. The majority were women aged 26–35 (58.4%, n = 629), people living in the city (65.9%, n = 710), in relationships (93.2%, n = 1,003), with higher education (61.1%, n = 658). These were pregnant women most often in their first pregnancy (63.4%, n = 683) and in the third trimester (59.4%, n = 640). Of the entire group, 1,002 women (n = 93) employed mobile applications monitoring the course of pregnancy. The women most often used the following applications: Preglife (68.9%, n = 690) and Ciąża+ (54.2%; n = 543).

In order to verify the homogeneity of the samples of the pregnant women that belonged to various Facebook groups, disparities in the variable distributions were evaluated with respect to basic demographics and trimester of pregnancy, assum-

Table 1. Sociodemographic, pregnancy course, obstetric history analysis of the study group, and type of mobile applications used (*n* = 1077)

Variables	Categories	Study group *n* (%)
Age (year)[a, b]	below 18	6 (0.6)
	18–26	360 (33.4)
	26–35	629 (58.4)
	over 35	82 (7.6)
	M = 28.85; SD = 3.13	
Place of residence[a]	city	710 (65.9)
	village	367 (34.1)
Marital status[a]	in relationship	1003(93.2)
	single (unmarried, divorced, widow)	74 (6.8)
Education[a]	basic	25 (2.3)
	vocational	67 (6.2)
	secondary	327 (30.4)
	higher	658 (61.1)
Number of pregnancies[a]	first	683 (63.4)
	second	257 (23.9)
	third	92 (8.5)
	fourth or more	45 (4.2)
Trimester of pregnancy[a]	I trimester	83 (7.7)
	II trimester	354 (32.9)
	III trimester	640 (59.4)
History of miscarriage[a]	yes	229 (21.3)
	no	848 (78.7)
Pregnancy-related diseases[a]	yes	235 (21.8)
	no	842 (78.2)
Use of mobile applications monitoring pregnancy[a]	yes	1002 (93.0)
	no	75 (7.0)
Type of mobile applications*	Preglife	**690 (68.9)**
	HiMommy	122 (12.2)
	Baby Chat	6 (0.6)
	Asystentciąży	72 (7.2)
	Jestem w ciąży	22 (2,2)
	Ciąża+	**543 (54.2)**
	Ciąża Sprout	7 (0.7)
	Moja ciąża tydzień po tygodniu	14 (1.4)
	Happy Baby	23 (2.3)
	Moja ciąża z eDziecko.pl – porady i wiedza w ciąży	3 (0.3)
	Flo	53 (5.3)
	Mommly	27 (2.7)
	Pregnancy	6 (0.6)

[a] – *n* (%), [b] – M–mean, SD – standard deviation.
* The number does not add up to 1,002 because most women used more than one application.

Table 2. Results of the chi-square test on the use of pregnancy monitoring applications, including selected variables

Use of mobile applications	Place of residence	Age	Education	Marital status	What pregnancy trimester are you currently in?
Chi-square	38.21	46.09	27.37	18.96	26.85
df	40	30	30	30	20
p	0.551	0.465	0.604	0.941	0.140

Pearson's chi-square test; *df* – degrees of freedom; *p* – *p*-value, probability value.

ing that respondents could select more than one app to use. Table 2 shows that regardless of the mobile application employed, the distributions of variables such as age, place of residence, education, marital status, and pregnancy trimester do not differ.

Distribution of the analyzed features according to the SWLS, MSPSS and SEQ scales

Table 3 lists the respondents' results in terms of mean scores on the measurement scales applied. The total score on the SWLS scale in the study group was 23.85 ± 5.28, which indicates a moderate level of life satisfaction. The average score on the MSPSS scale was 69.13 ± 12.62 (max – 84), and women received the most support from a significant other – 25.35 ± 4.10. The average result obtained in the SEQ scale concerning the subscale of the Sense of Security was 4.07 ± 0.66, and in the subscale concerning Reflection on Security – 4.39 ± 0.50.

Table 3. Distribution of the analyzed features in scales	
Scales	**M ± SD**
SWLS – Total score	23.85 ± 5.28
MSPSS – Perceived support – Total score	69.13 ± 12.62
MSPSS – Friends	21.42 ± 6.05
MSPSS – Family	22.36 ± 5.50
MSPSS – Significant Other	25.35 ± 4.10
SEQ – Sense of Security	4.07 ± 0.66
SEQ – Reflection	4.39 ± 0.50

SWLS – Satisfaction with Life Scale; SEQ – Security Experience Questionnaire; MSPSS – Multidimensional Scale of Perceived Social Support.

Predictors of women's use of mobile applications monitoring the course of pregnancy

The statistics for the obtained model were satisfactory: chi^2 = 81.115; $p < 0.001$; Nagelkerke's R^2 = 370. The correctness of the model was also verified by applying the Hosmer-Lemeshow test (chi^2 = 3.148; $p = 0.925$). The results for the considered model indicate that a good fit of the model can be concluded. The logistic function correctly predicts membership in one of the two groups 78.9% of the time.

Factors significantly associated with the use of pregnancy monitoring apps include (Table 4):
- Age between 26 and 35 Exp(B) = 0.356, 95% CI [0.140, 0.905] $p = 0.030$).
- Age over 35 Exp(B) = 0.139, 95% CI [0.035, 0.548] $p = 0.005$). As age increases, the likelihood of using apps decreases.
- Treating pregnancy as a stressful experience (Exp(B) = 1.980, 95% CI [1.001, 3.924] $p = 0.049$). Treating pregnancy as a stressful experience increases the likelihood of using an application.
- Having comorbidities Exp(B) = 0.178, 95% CI [0.077, 0.411] $p < 0.001$). Having pregnancy-related conditions increases the likelihood of using an app.
- A sense of experienced security Exp(B) = 3.557, 95% CI [1.534, 8.251] $p = 0.003$). A higher sense of experienced security increases the likelihood of using the application.
- Reflection on experienced security Exp(B) = 2.786, 95% CI [1.137, 6.827] $p = 0.025$). A higher level of reflection on experienced security increases the likelihood of using an application.

Table 4. Logistic regression analysis for factors associated with willingness to use a pregnancy monitoring application							
Variables		**B**	**Wald**	***p***	**Exp(B)**	**Lower limit**	**Upper limit**
Sociodemographic variables	18–25 years (reference)		8.246	0.016			
	26–35 years	-1.033	4.705	**0.030**	**0.356**	**0.140**	**0.905**
	Above 35 years	-1.976	7.931	**0.005**	**0.139**	**0.035**	**0.548**
	Place of residence[A]	0.300	0.656	0.418	1.349	0.653	2.787
	Master's degree (reference)		3.904	0.142			
	Bachelor's degree	-0.304	0.352	0.553	0.738	0.270	2.015
	Secondary/vocational education	-0.834	3.690	0.055	0.434	0.185	1.017
	Marital status[B]	-0.812	1.819	0.177	0.444	0.136	1.445
	Very good (reference)		0.781	0.677			
	Good	0.194	0.156	0.693	1.214	0.465	3.171
	Average/bad	-0.223	0.128	0.720	0.800	0.236	2.710
	Very good (reference)		0.106	0.949			
	Good	0.100	0.042	0.839	1.105	0.423	2.890
	Average/bad	0.207	0.105	0.746	1.229	0.353	4.282
Pregnancy-related variables	Number of pregnancies[C]	-0.264	0.463	0.496	0.768	0.358	1.644
	I trimester (reference)		3.394	0.183			
	II trimester	-0.234	0.143	0.705	0.791	0.235	2.660
	III trimester	0.431	0.509	0.476	1.539	0.471	5.035
	Pregnancy is stressful experience[D]	0.683	3.826	**0.049**	**1.980**	**1.001**	**3.924**
	Family members' support during pregnancy[E]	-0.200	0.070	0.791	0.819	0.187	3.591
	Pregnancy-related diseases	-1.725	16.318	**< 0,001**	**0.178**	**0.077**	**0.411**
SWLS		-0.018	0.151	0.697	0.983	0.899	1.074
SEQ	Sense	1.269	8.739	**0.003**	**3.557**	**1.534**	**8.251**
	Reflection	1.025	5.021	**0.025**	**2.786**	**1.137**	**6.827**

Table 4. Logistic regression analysis for factors associated with willingness to use a pregnancy monitoring application							
Variables		**B**	**Wald**	***p***	**Exp(B)**	**Lower limit**	**Upper limit**
MSPSS	Friends	0.048	1.851	0.174	1.049	0.979	1.123
	Family	0.023	0.267	0.605	1.023	0.938	1.115
	Significant other	-0.064	1.049	0.306	0.938	0.831	1.060
	Constant	-7.874	10.672	0.001	0.000		

[A] 1 – city; 0 – village; [B] 1 – single; 0 – in relationship; [C] 1 – first; 0 – another; [D] 1 – yes; 0 – no; [E] 1 – yes; 0 – no; [F] 1 – not under treatment; 0 – under treatment.

SWLS – Satisfaction with Life Scale; SEQ – Security Experience Questionnaire; MSPSS – Multidimensional Scale of Perceived Social Support.

Discussion

The incredible development of mobile technologies is observable in every aspect of life. In 2023, as many as 5.25 billion people were smartphone users [23], and the number of mobile application users is growing. Pregnant women also find products that are important to them in the Google Play or AppStore stores. Smartphone applications have become a common way to provide information to women during pregnancy, and the demand for information during this period increases significantly [24]. In a 2019 study by Wang et al. [25], as many as 93% of all pregnant women were found to employ such applications, which indicates a significant increase in interest in accessing mobile applications for pregnancy monitoring. The results of our research also confirm such a high rate (93%) of using mobile applications monitoring the course of pregnancy. Although the use of mobile applications by pregnant women in our study was almost universal, the main strength of this study is that it revealed the specific characteristics of this group of users. The findings of our study reveal that the profile of predictors of women's use of mobile applications monitoring the course of pregnancy include age between 26 and 35, treating pregnancy as a stressful experience, the occurrence of comorbidities during pregnancy, and the sense and reflection on the experienced safety related to the used application.

According to Sayakhot and Carolan-Ola's systematic review [12] examining the characteristics of women using the Internet as a source of information about pregnancy, women with higher education were three times more likely to seek advice than women with secondary education or lower, and single and multiparous women were also less likely to seek advice than married and nulliparous women. Beyond the aforementioned, significant differences were observed in other studies between pregnant women's age group, education, employment status, total number of pregnancies, and Internet use [26, 27].

Additionally, it is worth mentioning that the results of various studies suggest that women in the first trimester are more willing to use the Internet to find information about their health, which is most likely due to the too low frequency of visits in the first trimester of pregnancy, when women definitely have more questions and doubts they want consultation on [28, 29].

Another factor, i.e. treating pregnancy as a stressful experience, increases the likelihood of employing mobile applications according to Wang et al. [25], and reports by Fiks et al. [30] indicate that obtaining information about the risks and disturbing symptoms of pregnancy using mobile applications reduces the level of stress among pregnant women and their partners. It is very important in this case to draw attention to the fact that the high level of risk among pregnant women is increased by the risk of premature birth [31]. Factors determining the need to employ mobile applications among pregnant women also include diseases comorbidity with pregnancy, disorders during pregnancy, and control of healthy behaviors [32–34]. What is more, research observations indicate that the use of mobile applications has a positive impact on changing the lifestyle of pregnant women struggling with obesity [35]. Moreover, women suffering from gestational diabetes also adhere to rec-

ommendations better and monitor their glycemia levels more accurately using a mobile application [36]. Unfortunately, the research results presented by Buraczwska et al. [37] show that the participation of doctors in education on gestational diabetes is definitely insufficient, and women are educated in this area mainly via the Internet.

The results of our research also uncovered factors significantly related to women's use of pregnancy monitoring applications. These include treating pregnancy as a stressful experience and the presence of comorbidities. Other predictors determining the use of mobile pregnancy monitoring applications by women are age and the sense of security associated with their use. In our studies, women's age between 26 and 35 years best predisposed them to use mobile applications for pregnancy monitoring, while in the studies of Grądzik et al. [38], a parenting application was most often used by women aged 23–26, in the study by Lupton and Pedersen [39], this was women aged 25 to 40, and in the study by Al-Dahshan et al. [40], the age group was 26–35 years.

The sense of safety of pregnant women as a factor related to the use of mobile applications for pregnancy monitoring has not yet been included in the analyses of research results, although a systematic review of 44 studies conducted by Sakamoto et al. [41] aimed at examining the role of mHealth in the psychosocial health of pregnant women and mothers, showed that mHealth enhanced self-management, acceptance of pregnancy/motherhood, and social support, and that the surveyed women benefited from the use of mHealth for improving their psychosocial health. However, a study by Bakhireva et al. [42] discovered that pregnant Internet users (62.1%) frequently asked questions regarding the safety of medications in pregnancy.

Studies on women's opinions about perinatal care suggest that good communication is crucial in determining whether women are satisfied with the care they receive [43]. The Internet and mobile apps have a visible and important impact on women's decision-making in all aspects of pregnancy. A key emerging theme during pregnancy is the great need for information [44], yet systematic review results (*n* = 3359) indicate that most pregnant women do not discuss information obtained from the Internet with their doctors, hence healthcare providers may be unaware of potentially inaccurate information or incorrect beliefs about pregnancy reported online [12]. Healthcare workers, including doctors, midwives, and prenatal care providers, should be aware of this issue and provide more evidence-based information to women when they need it, as well as recommend reliable sources of information. Future research should address ways to better inform women about the risks associated with online research.

Limitations of the study

This study has several limitations. Firstly, a cross-sectional study that selects groups non-randomly is exploratory in nature and cannot be used to draw cause-and-effect conclusions. The fact that some of the women in the study group were first-time mothers, urban residents, and highly educated could have an impact on the intensity of the profile determinants analyzed for

the group. Secondly, since the CAWI research methodology was employed, this study was restricted to self-reporting in a non-representative group. As a result, data from women who potentially refused to participate in the survey could not be collected. It should also be noted that there were no other participants in the study group other than Facebook users, as only Facebook, one of the most popular social media groups for expectant mothers, was involved. It should also be considered that the use of mobile apps monitoring pregnancy progress increases the real assets of "securing" the situation of the studied pregnant women, but they can only be a supporting tool for effective and safe assistance offered to women by professional therapeutic and care teams. However, our study's findings might serve as a useful reference point for future research into the factors affecting women's willingness to use pregnancy monitoring apps.

Conclusions

Our study's results show that the profile of women using pregnancy monitoring applications is determined by the following factors: age between 26 and 35 years, experiencing pregnancy as a stressful event, suffering concomitant illnesses in pregnancy, and feeling and reflecting on pregnancy-related safety. Mobile applications supporting pregnancy monitoring, in addition to providing information to women during pregnancy, may support, to a certain extent, the need to reduce stress and strengthen the sense of security in order to improve women's psychosocial health, which is worth remembering when designing the scope of functionality of these types of mobile applications.

Conclusions from our research indicate several important implications for clinical practice and future research. A defined profile of pregnant women using mobile apps shows that women more often seek information when perceiving pregnancy as a stressful event, enhancing their sense of safety, especially in relation to accompanying diseases during pregnancy. Moreover, these are mature women aged 26–35. In perinatal care practice, doctors and midwives should initiate conversations about mobile apps and information found online. Healthcare providers can guide pregnant women in their online research by providing reliable and safe information on websites and in mobile apps, warning women against misleading and inaccurate information commonly available online. Additionally, it is important to inform women that health information online should not be treated as a substitute for professional information and advice, and pregnant women should be cautioned not to take any actions before consulting a healthcare worker.

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