Mobile Apps for Allergies: A Systematic Review and Quality Assessment Using the Mobile Application Rating Scale (MARS)

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Abstract

Aim: With the growing reliance on mobile apps by individuals with allergies and food intolerances, this study aimed to evaluate their quality and usability. Using the Mobile Application Rating Scale (MARS), we assessed allergy-related apps available on Google Play and the AppStore.

Methodology: Using the PRISMA elimination method (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), three apps were selected from the available options: Soosee – Allergy & Vegan Scan, The Gluten Free Scanner, and Eat Smart Kiwi: Food Diary. The respondents used these apps for a period of two weeks. Next, the researchers completed the MARS questionnaire, comprising five sections. The apps were evaluated in the categories of engagement, functionality, aesthetics, information content, and subjective quality assessment.

Results: The study revealed that one of the apps, namely Soosee – Allergy & Vegan Scan, received the highest ratings among the apps evaluated, surpassing Eat Smart Kiwi: Food Diary and The Gluten Free Scanner, which received the lowest rating. Analysis of user preferences indicated that the aesthetics of the interface play a crucial role in the perception of mHealth mobile apps, particularly those related to food allergies. An attractive graphical interface significantly impacts user satisfaction and engagement. Notably, the ratings given by the study participants did not align with those seen on Google Play and the AppStore, suggesting potential differences in user expectations and needs depending on usage context and the more detailed assessment conducted in this study.

Implications and recommendations: With numerous mobile apps available, quality assessment is crucial as users often lack the knowledge to evaluate them effectively. While mHealth apps have the potential to improve daily life for individuals with allergies, they must offer an intuitive design, verified information, and user-friendly interfaces to meet expectations.

Originality/value: This study provides a comprehensive evaluation of allergy-related mobile apps using a standardized assessment tool (MARS), offering a more structured analysis than general user ratings. By highlighting discrepancies between expert-based evaluations and user reviews, the research underscores the need for more transparent quality indicators in mHealth applications.

Keywords: mobile apps MARS, mHealth, food allergies

1.   Introduction

Food allergies and intolerances are adverse reactions triggered by consuming, contacting, and/or inhaling specific food ingredients and additives. The prevalence of these reactions, both allergic and intolerance-related, is increasing globally, particularly in highly developed countries (Tang et al., 2019).

Food allergies are immunologically based responses, where symptoms may arise within minutes up to an hour post-exposure to an allergen, with reactions ranging from mild to severe (Nwaru et al., 2014; Tuck et al., 2019). The incidence of food allergies is higher in children (up to 10%) than in adults (approximately 1-2%) (Sicherer & Sampson, 2018). In contrast, food intolerances are non-immunological hypersensitivity reactions that occur following the ingestion of an intolerant level of a specific ingredient, with symptoms emerging several hours post-consumption and lasting from several hours to even days (Licari et al., 2019; Tuck et al., 2019). Intolerances are more common than food allergies, affecting approximately 15-20% of the global population (Nwaru et al., 2014).

Despite ongoing clinical trials exploring new treatment methods for food allergies, the primary means of prevention remains the precise identification and strict avoidance of allergens, even in minimal quantities (Loerbroks et al., 2019). Since 2014 European legislation (Regulation (EU) No 1169/2011 of the European Parliament…) has mandated that food companies provide clear information on nutritional value and the presence of 14 allergens (e.g. gluten, crustaceans, eggs, fish, nuts, soy) on product labels and through verbal or written formats (Regulation (EU) No 1169/2011 of the European Parliament…). However, consumers must actively monitor their own health, regardless of information made available by producers and restaurants.

This need has spurred interest in mobile apps that assist consumers by monitoring products, detecting allergens, and providing health information to aid in meal planning, selecting suitable products, and finding restaurants with allergen-free menu options (Mosa et al., 2012; Oreskovic et al., 2015; Theonest et al., 2024).

Due to the large number of available mobile apps, their appropriate verification is essential, as traditional rating systems, such as star ratings (1-5 scale) and user reviews, may contain misleading or subjective opinions. Additionally, store app descriptions are often imprecise or incomplete, complicating proper quality assessment, particularly concerning sensitive health issues such as food allergies (Hopia et al., 2015; Silva et al., 2015).

The regulation of mHealth technology quality and safety, as defined by the World Health Organization to include medical and public health activities supported by mobile devices (e.g. mobile phones, patient monitoring devices, and other wireless systems), is especially important for apps that support diagnostics, treatment, or disease prevention and clinical decision-making. Even non-medical educational apps addressing food allergies and intolerances require regulation to provide comprehensive information and support users in health-related decision-making (Hopia et al., 2015; Jafleh et al., 2024; Salazar et al., 2018; Theonest et al., 2024).

The growing role of mobile apps in healthcare, known as mHealth, is gaining prominence, especially in the context of the increasing issue of food allergies. Leveraging mobile technology in allergies makes these apps indispensable for individuals dealing with this problem. However, despite the dynamic development of the app market, many apps lack thorough quality assessment and require enhancements. The aim of this article was to perform a systematic review of the Google Play and App Store platforms to identify apps related to food allergies and intolerances and to evaluate their quality and functionnality. The assessment was conducted using the Mobile Application Rating Scale (MARS), focusing on objective and subjective quality aspects. The analysis identified key areas for improvement to enhance the standard of user experience and the overall effectiveness of these tools.

2. Methodology

In December 2023, a study was conducted to evaluate the quality of mobile apps focused on food allergies and intolerances. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology (Page et al., 2021) was employed to systematically review apps available on Google Play (Google LLC) and the App Store (Apple Inc.). The selection process considered five criteria that facilitated narrowing down the apps for further assessment using the Mobile Application Rating Scale (MARS). The selection criteria included:

1. The app is available on Google Play or the App Store.
2. Relevance to topics related to healthy nutrition, allergies, food intolerances, or food scanners.
3. Free access to the app and its availability in Polish and/or English.
4. An average rating of at least four stars.
5. A minimum of 100 reviews on each platform.

The implementation of the PRISMA methodology resulted in the identification of three apps that met the above criteria, and they were then tested by three individuals aged 22-24 residing in Wrocław, who were selected based on their diverse mobile application experience and interest in food allergies and intolerances. All the participants had a basic knowledge of diet management in the context of these conditions, which allowed for a better assessment of the apps' usefulness. The testing took place in real-life conditions, enabling the consideration of practical aspects of their use, such as the intuitiveness of the interface and the relevance of the features offered in various situations. Each participant evaluated the apps after a two-week usage period, utilising the MARS questionnaire, which measures both the subjective and objective quality of mobile apps across several dimensions: aesthetics, functionality, engagement, and information. The obtained results allowed for a detailed analysis and assessment of the applications' usefulness in monitoring food allergies and intolerances.

The MARS scale was employed to assess the quality of the apps, demonstrating high internal consistency ($\alpha = 0.90$) and an inter-rater reliability coefficient (intraclass correlation coefficient) of 0.79. The MARS scale is divided into two main categories. The first category is the classification of apps, comprising six elements with descriptive and technical information: (1) descriptive data (name, number and type of ratings for all versions, developer, version, cost, platform, description, updates), (2) the purpose of the app, (3) theoretical foundations and applied strategies, (4) links, (5) target age group, and (6) technical aspects (login, password protection, internet access, social features, and reminders).

The second category pertains to the quality of the apps, and encompasses two aspects – objective quality and subjective quality. Objective quality includes four sections (engagement, functionality, aesthetics, and information) consisting of 19 elements, while subjective quality comprises four, totaling 23 elements.

For quality assessment, each element was rated on a scale from 1 to 5 (1: inadequate; 2: poor; 3: acceptable; 4: good; 5: excellent). The average score for each app was calculated by dividing the sum of all points by the number of elements. To enhance the objectivity of the measurement, separate averages were calculated for the four sections of objective quality (engagement, functionality, aesthetics, information) and the subjective and app-specific sections.

3. Results

As part of the study on the quality of mobile apps, a selection process was conducted using an elimination method in accordance with PRISMA guidelines. The search was carried out in two popular databases: Google Play and App Store, using appropriately selected keywords: food allergy, allergy, allergens, and gluten. The data collection process took place in December 2023. A flowchart illustrating the stages of the PRISMA-compliant analysis for the selection of apps is presented in Figure 1.
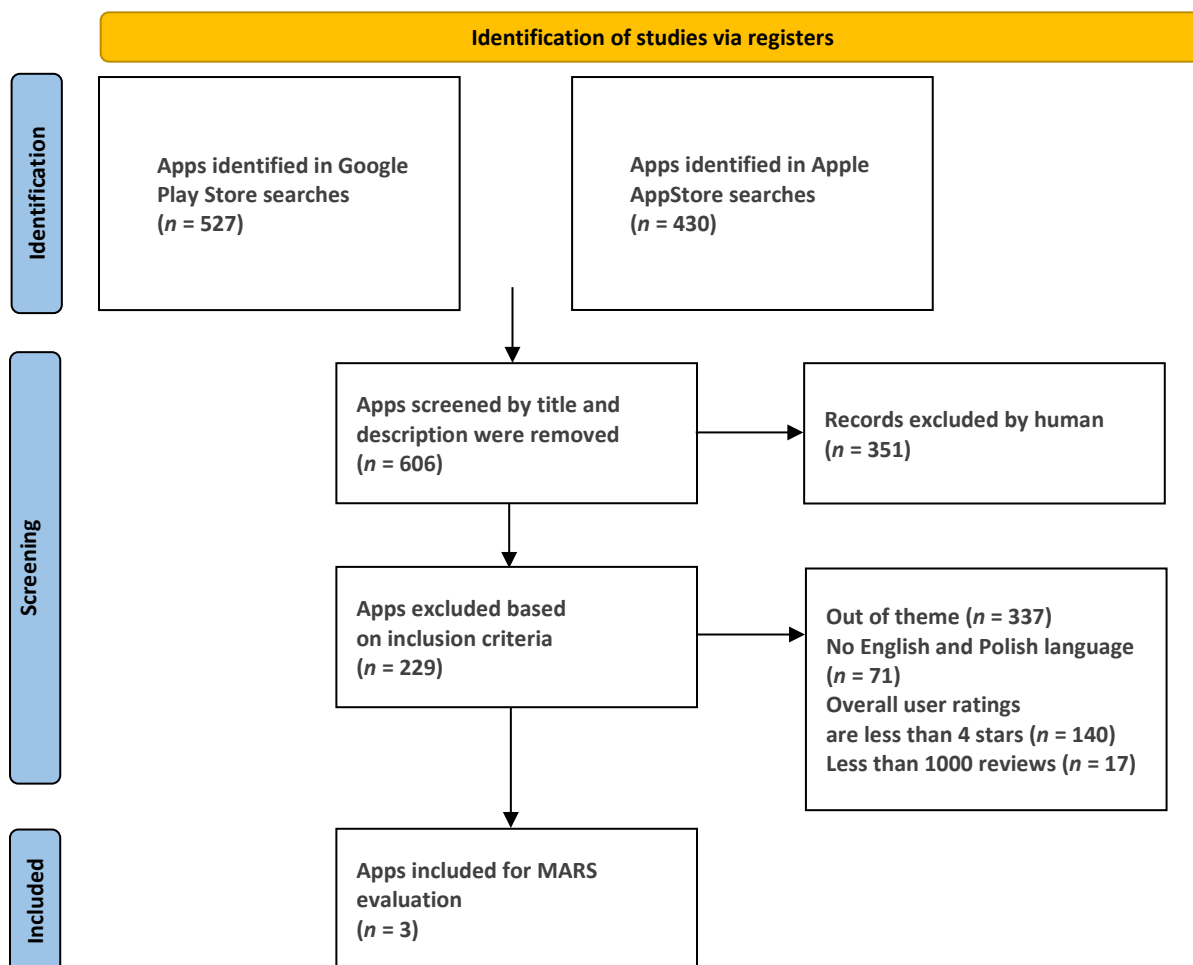
**Fig. 1.** Flow diagram for the selection process of the apps included in the study

Source: own work based on (Page et al., 2021).

The apps selected for analysis were: Soosee – Allergy & Vegan Scan, The Gluten Free Scanner, and Eat Smart Kiwi: Food Diary. They were evaluated using the standardised Mobile Application Rating Scale (MARS) questionnaire developed by Stoyanov et al. for a reliable assessment of mobile application quality (Stoyanov et al., 2015). Brief descriptions of these apps are presented in Table 1, whilst the interfaces of the selected apps are shown in Figures 2, 3, and 4.

Table 1. Features of apps selected for study

App Name	Operating System	Average User Rating (1-5) and Number of Ratings (count)	Paid/Free	Version
Soosee – Allergy & Vegan Scan	ISO, Android	4.3 (120)	free	2021.16 (13.12.2023)
The Gluten Free Scanner	Android	4.7 (3.1 thousand)	free	01.04.2020
Eat Smart Kiwi: Food Diary	ISO, Android	4.3 (210)	free	8.7.1 (14.12.2023)

Source: own work.
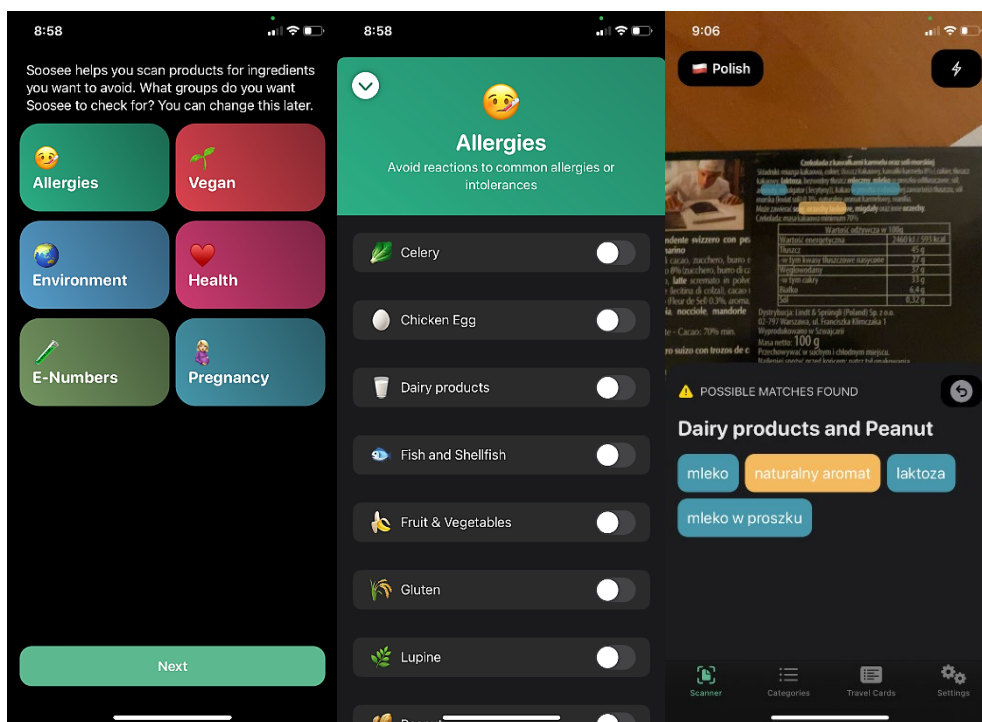
Fig. 2. The Soosee – Allergy & Vegan Scan app interface

Source: own work.

In accordance with the MARS evaluation, the quality of the three apps was assessed across four key categories: engagement, functionality, aesthetics, and information.

The Soosee – Allergy & Vegan Scan app was evaluated using these four criteria (Table 2). The average engagement score was 3.87, with extreme values in this category, including a minimum score of 3.80 received by two respondents and a maximum score of 4.00. In the functionality category, the average rating was 4.33, with the highest score being 4.50 and the lowest score being 4.00. The aesthetics score averaged 3.53, with the highest rating in this category being 3.60 and the lowest 3.40. For the information category, the average score was 3.57, with extreme values of 4.00 for the highest score and 3.28 for the lowest score assigned.
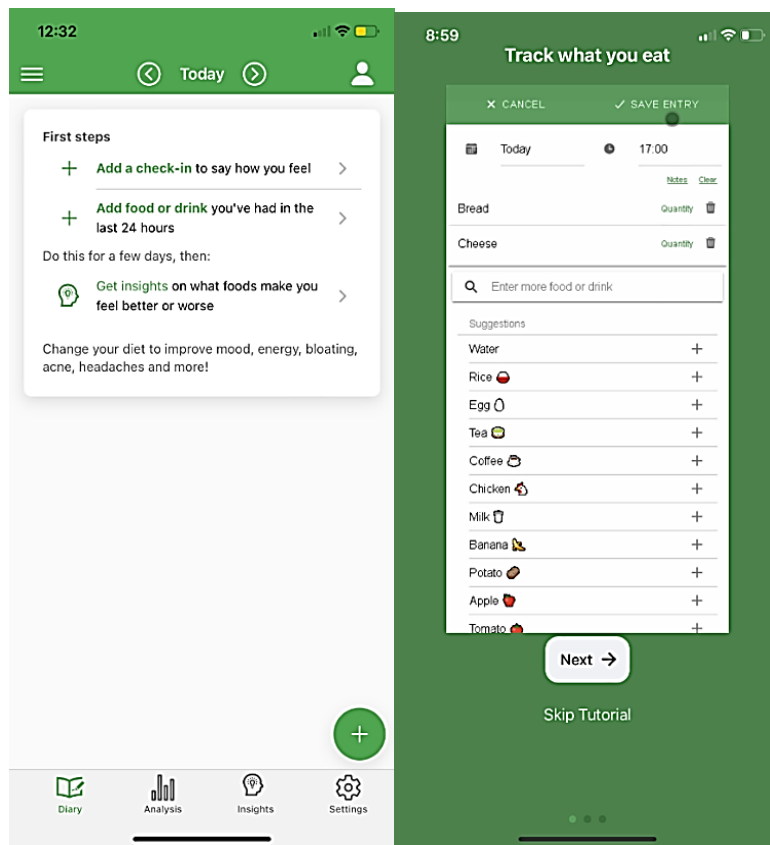
Fig. 3. The Eat Smart Kiwi: Food Diary app interface
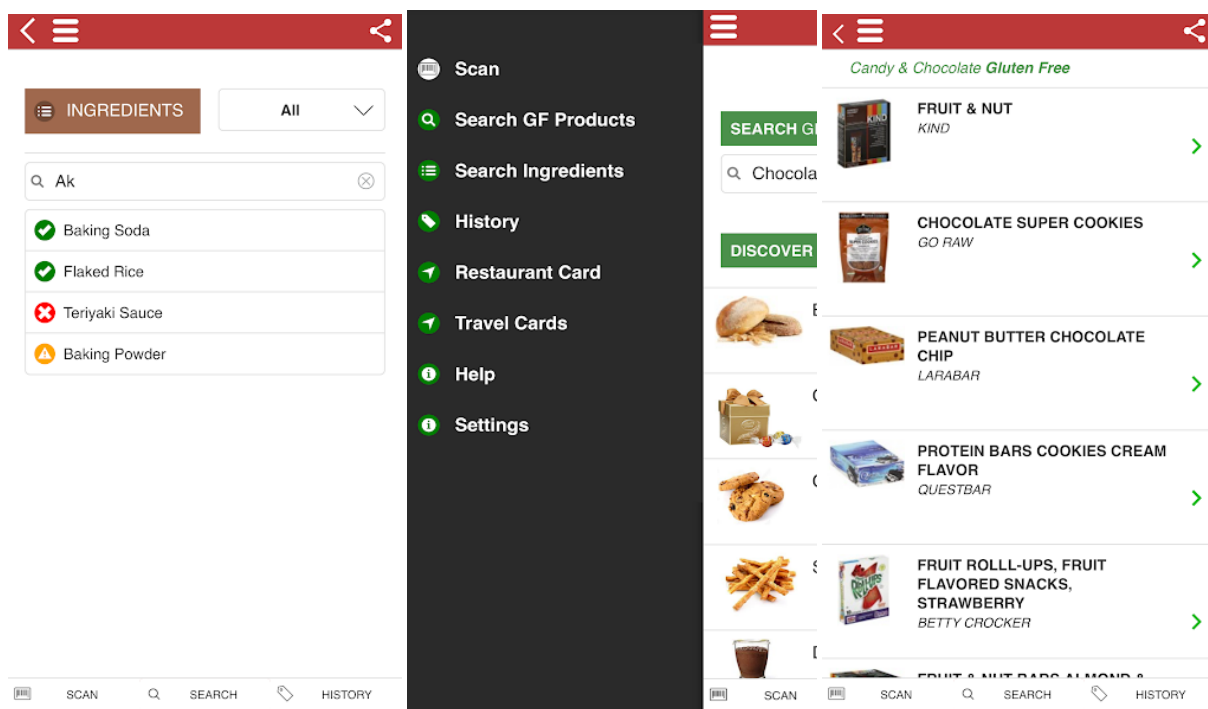
Source: own work.

Fig. 4. The Gluten Free Scanner app interface

Source: own work.

Table 2. Evaluation results for the Soosee – Allergy & Vegan Scan app

Soosee – Allergy & Vegan Scan				
Category	Respondent Ratings		Average Rating	Standard Deviation
Engagement (A)	3.80	3.87	3.80	3.87	0.12
Functionality (B)	4.00	4.33	4.50	4.33	0.29
Aesthetics (C)	3.60	3.53	3.40	3.53	0.12
Information (D)	3.28	3.57	4.00	3.57	0.38

Source: own work.

The Gluten Free Scanner received the lowest scores in evaluating mobile app quality according to the MARS scale (Table 3). The average score in the engagement category was 1.75 (range: 1.65 – 1.80). Functionality was rated with an average of 3.58, with a highest score of 3.75 and a lowest score of 3.50. Aesthetics received an average score of 1.78, with values ranging from 1.60 to 2.00. In the information category, the standard deviation was 0.034641, indicating a high level of agreement among the respondents' ratings. The average information score was 1.82, with the highest rating of 1.86 and the lowest rating of 1.80.

Table 3. Evaluation results for The Gluten-Free Scanner app

The Gluten-Free Scanner				
Category	Respondent Ratings			Average Rating	Standard Deviation
Engagement (A)	1.80	1.80	1.65	1.75	0.08
Functionality (B)	3.75	3.50	3.50	3.58	0.14
Aesthetics (C)	1.60	2.00	1.75	1.78	0.20
Information (D)	1.80	1.86	1.80	1.82	0.03

Source: own work.

The Eat Smart Kiwi: Food Diary was evaluated in terms of quality, with all average scores exceeding 3.00 (Table 4). In the engagement category, the average score was 3.13, with a highest rating of 3.20 and a lowest rating of 3.00. The app's functionality received an average score of 3.25, with the highest score of 3.50 and the lowest score of 3.00. In the aesthetics category, the average score was 3.47, with a highest value of 3.67 and a lowest of 3.33. For the information category, the average score was 3.40, with a lowest rating of 3.00 and a highest rating of 3.71.

Table 4. Evaluation results for the Eat Smart Kiwi: Food Diary app

Eat Smart Kiwi: Food Diary				
Category	Respondent Ratings			Average Rating	Standard Deviation
Engagement (A)	3.20	3.20	3.00	3.13	0.12
Functionality (B)	3.50	3.25	3.00	3.25	0.25
Aesthetics (C)	3.67	3.33	3.40	3.47	0.18
Information (D)	3.71	3.00	3.50	3.40	0.36

Source: own work.

The three appls – The Gluten Free Scanner, Soosee – Allergy & Vegan Scan, and Eat Smart Kiwi: Food Diary – were evaluated in the quality assessment of mobile apps using the MARS scale. The Gluten Free Scanner, available only on Android, received the lowest scores, attributed to its simplified

functionality limited to scanning products for gluten content. In the category of engagement, this app was rated the lowest, while Soosee and Eat Smart Kiwi, available on both platforms, scored above 3. The results indicate that additional features and a more interactive interface increase user engagement.

In terms of functionality, all the apps received average scores above 3, with Soosee achieving the highest (4.3), reflecting its intuitive and smooth operation. The Gluten Free Scanner also performed well due to its simple interface, while Eat Smart Kiwi, although more complex to navigate, features a tutorial that aids user interaction.

Regarding aesthetics, Soosee and Eat Smart Kiwi received the highest ratings for their cohesive design and clear interface, positively impacting daily usability. The Gluten Free Scanner, scoring approximately 1.7 points lower, fell short of the competition in this category.

In the information category, Soosee achieved the best score by providing high-quality data and clear warnings about potentially harmful ingredients. Eat Smart Kiwi generates graphs and analyses dietary components, which can benefit users without allergies. The Gluten Free Scanner, restricted to a single--function scanner, provides essential information but has relatively limited usefulness.

The average MARS quality scores and users' subjective ratings showed discrepancies compared to the ratings on the Google Play and App Store platforms. Soosee (average score of 3.86 and subjective 3.42) received a lower rating than Google Play (4.3), while The Gluten Free Scanner scored MARS averages of 2.23 and 1.82, significantly lower than the user rating (4.7). The low rating for The Gluten Free Scanner was likely due to its limited value for individuals without gluten intolerance. Eat Smart Kiwi, rated at 3.31 and 2.88, is helpful for users analysing their dietary habits, which may require a more extended usage period for a comprehensive evaluation.

4. Discussion

The analysis of current trends in mobile interface design reveals a growing preference for apps that excel in both usability and aesthetic appeal. The highest-rated ones have clear interfaces, cohesive color schemes, and graphics that align with their themes. Among the apps assessed, the Soosee – Allergy & Vegan Scan received the highest ratings from the respondents, highlighting its intuitiveness, visual appeal, and extensive functional features, which set it apart from other apps targeted at individuals with food allergies and intolerances.

The rising popularity of health and wellness apps is also corroborated by research indicating that the portability of mobile devices promotes their more frequent use in health contexts (Silva et al., 2015; Stoyanov et al., 2015). At the same time, consumers still have limited access to reliable assessments of the quality of these apps, relying solely on user reviews available in the Google Play Store and App Store (Cummings et al., 2013). In the conducted study, MARS assessed the quality of the selected health apps, focusing on their execution and functionality. The results revealed significant discrepancies between user ratings of the store apps and the evaluations made by the researchers, who deemed that they should offer more advanced features and ensure higher user data security.

Therefore, the present study employed the MARS framework to assess the quality and functionality of the selected health apps. The findings revealed notable discrepancies between user ratings in app stores and the evaluations conducted by the researchers, who suggested that these apps should incorporate more advanced features and provide a higher level of user data security. The respondents rated the highest the apps that were functional but also aesthetic and ergonomic. For example, some studies (Li et al., 2019) found that many apps aimed at allergy sufferers are underdeveloped, requiring technological innovations and containing inconsistent information, which limits their usability. These

results were confirmed by Mandracchia et al. (2020), who noted that user engagement in the context of health apps could be improved by increasing interactivity and expanding databases with new food products and restaurants offering allergen-free menus.

Other research has shown that users of health apps are concerned about issues such as data privacy breaches and outdated software, which increases their skepticism toward such apps (Furmankiewicz et al., 2016). Technological limitations and the age of the users also present particular barriers that may impact their engagement levels and the effectiveness of using mobile apps. The insufficient involvement of specialists in the mHealth application design process is another issue, which can lead to the dissemination of incorrect information that threatens user safety (Hopia et al., 2015; Tonkin et al., 2017; West et al., 2017).

In summary, analysing health apps quality is crucial from the perspective of social responsibility and the growing demand for tools that support individuals with food allergies and intolerances. Evaluations conducted by experts can serve as a valuable source of information for users, as these apps should not only be intuitive and aesthetically pleasing but also contain reliable and verified data.

5. Suggestions for Future App Development

Based on the conducted assessment of the apps, several recommendations can be formulated for the future design of high-quality tools aimed at improving the well-being of individuals with food allergies or intolerances:

- The information contained within the apps should be validated by medical experts and scientists, enabling users to access more reliable data regarding food allergies and intolerances (Lyzwinski et al., 2019).
- Conducting scientific research on the apps would help evaluate their reliability and effectiveness in detecting food allergens and enhancing user knowledge (Byambasuren et al., 2018).
- In the future, it would be worthwhile to consider introducing regulations for non-medical apps, as this could prevent the development of ineffective solutions and provide users with more accurate information, thereby increasing the value of mHealth technology (Carpenter et al., 2010).
- The quality of apps should be assessed using innovative methods that consider various perspectives, such as the MARS tool. Although this tool has been widely tested, its future validation is necessary to enhance its value (Grainger et al., 2017).

6. Conclusions

The highest average functionality rating of the apps was 4.30, while the highest aesthetic rating was 3.53. The findings from the study indicate that users of health-related apps particularly value high quality in both functionality and aesthetics, which directly influences their engagement and willingness to continue using these tools. The analysis of app quality using the Mobile Application Rating Scale (MARS) revealed significant discrepancies in user ratings, suggesting the need to develop more comprehensive and precise evaluation methods to accurately measure both app quality and safety. In the context of health apps, especially those designed for individuals with food allergies and intolerances, it is crucial that they be developed in collaboration with experts to ensure the reliability of the information provided and to minimise the risk of errors that could negatively impact their functionality.

There is also a pressing need to enhance transparency regarding protecting user data privacy and implementing regular software updates. Users expect health apps to be secure and offer personalised features that support them in making health-related decisions.

An important aspect is the significance of innovative features and the customisation of apps to meet the evolving needs of users. Introducing new solutions, such as a restaurant search engine with menus tailored for individuals with allergies or comprehensive food product databases, can significantly enhance the value of apps and improve the quality of life for their users. The development of apps dedicated to allergy sufferers and individuals with food intolerances in Poland could yield tangible social benefits, provided they deliver verified information and address the real needs of this user group.

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Aplikacje mobilne dotyczące alergii: przegląd systematyczny i ocena jakości za pomocą skali MARS (Mobile Application Rating Scale)

Streszczenie

Cel: Wobec rosnącej liczby osób borykających się z alergiami i nietolerancjami pokarmowymi, które korzystają z dedykowanych aplikacji mobilnych, podjęto badanie mające na celu ocenę jakości tych aplikacji. Celem pracy była ocena jakości i użyteczności aplikacji mobilnych dostępnych na platformach dystrybucji cyfrowej: Google Play oraz AppStore za pomocą kwestionariusza Mobile App Rating Scale (MARS).

Metodyka: Badanie przeprowadzono na grupie trzech osób w wieku 22-24 lat. Z dostępnych aplikacji, przy użyciu metody eliminacji PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*), wyselekcjonowano trzy: Soosee – Allergy & Vegan Scan, The Gluten Free Scanner oraz Eat Smart Kiwi: Food Diary. Respondenci korzystali z wybranych aplikacji przez okres dwóch tygodni. Po tym czasie badacze wypełnili kwestionariusz MARS, składający się z pięciu sekcji. W badaniu oceniono aplikacje w kategoriach: zaangażowania, funkcjonalności, estetyki, zawartości informacyjnej oraz subiektywnej oceny jakości. Następnie obliczono średnie oceny dla poszczególnych kategorii, ogólną ocenę jakości aplikacji oraz oceny subiektywne, które porównano z ocenami użytkowników w Google Play Store i AppStore.

Wyniki: Wyniki badania wykazały, że aplikacja Soosee – Allergy & Vegan Scan uzyskała najwyższe oceny wśród badanych, przewyższając Eat Smart Kiwi: Food Diary oraz The Gluten Free Scanner, która została oceniona najniżej. Analiza preferencji użytkowników ujawniła, że estetyka interfejsu odgrywa kluczową rolę w odbiorze aplikacji mobilnych z obszaru zdrowia mobilnego (*mHealth*), szczególnie tych dotyczących alergii pokarmowych. Atrakcyjna szata graficzna znacząco wpływa na satysfakcję użytkowników i ich zaangażowanie. Ponadto wielofunkcyjność aplikacji okazała się istotnym czynnikiem, który

przyciągał użytkowników oraz wpływał na wyższe oceny. Aplikacje oferujące rozbudowane menu i niestandardowe, interesujące funkcje częściej angażowały użytkowników i były przez nich bardziej doceniane. Warto również zauważyć, że oceny nadane aplikacjom przez uczestników badania nie były zgodne z ocenami widniejącymi na platformach Google Play oraz AppStore, co może sugerować różnice w oczekiwaniach i potrzebach użytkowników w zależności od kontekstu użytkowania oraz bardziej szczegółowej oceny przeprowadzonej w badaniu.

Implikacje i rekomendacje: Ocena jakości aplikacji mobilnych ma kluczowe znaczenie w kontekście ogromnej liczby aplikacji dostępnych na platformach Google Play i AppStore. Użytkownicy często nie dysponują wystarczającą wiedzą na temat ich jakości, choć oczekują, że aplikacje te będą realnym wsparciem w codziennym życiu z alergiami lub nietolerancjami pokarmowymi. Aplikacje *mHealth* mają duży potencjał poprawy jakości życia dzięki łatwemu dostępowi, jednak muszą cechować się intuicyjną obsługą, dostarczać wiarygodnych, zweryfikowanych informacji oraz oferować spójny i przejrzysty design, aby mogły w pełni spełniać oczekiwania użytkowników.

Słowa kluczowe: aplikacje mobilne, MARS, *mHealth*, alergie pokarmowe