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Analysis of the Top Five Most Rated Orthodontic mHealth Apps

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ABSTRACT

Background: Orthodontic mobile apps are more commonly used in the last years and are appreciated by both doctors and patients due to their ability to obtain instant feedback between the patient and the specialist. This comparative research aims to review the top five most rated orthodontic apps available today in App Store® and Google Play®.

Methods: Systematic search using predetermined key words and inclusion/exclusion criteria was conducted in App Store® and Google Play® to identify the top five most rated orthodontic apps with the highest ranking and the greatest number of downloads. Evaluation of the apps was conducted by doctors, patients, and an IT App developer. System Usability Scale, Exit Interview, and Average Score were used for the assessment.

Results: Some apps received good scores from the participants while other apps received poor scores. Invisalign Photo Uploader received good scores from all doctors while Tray Minder was rated as poor by other doctors. My Invisalign was the most appreciated app by the patients and received excellent scores as well as Dental Monitoring while some scores were poor for Fake Braces app. The average scores indicate that My Invisalign was the top ranked app by the patients with an average score of 82 while Invisalign Photo Uploader was most appreciated by the doctors with an average score of 74.5.

Conclusion: A wide range of orthodontic apps is available on App Store® and Google Play® but just a few apps are commonly used by doctors and patients. The most appreciated feature of the apps is the instant feedback between the doctors and patients which makes the patient more compliant with orthodontic treatment.

Keywords: *Orthodontics, mobile apps, preference, App Store, Google Play*

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INTRODUCTION

Recently, a significant surge was shown in mobile phone usage. On a global scale, mobile and tablets use continue to grow rapidly among both business and consumer users. The number of mobile users is expected to surpass 7.1 billion in 2021 and nearly 7.5 billion by the end of 2025. By the end of 2021, the total number of mobile devices, including phones and tablets, will exceed 14.9 billion. The number of mobile devices outnumbers the number of users, as many users own multiple devices. It is predicted that the total number of mobile devices in use will exceed 18.2 billion by the end of 2025 [1]. Global mobile app revenues have reached $581.9 billion in 2020 [2]. Over 5 million apps are available for download on the Apple App Store and Google Play Store combined as of 2021 [2]. Over 2.4 billion apps had been downloaded from the Google Play Store as of April 2021 [2]. As a result, mobile applications play an important part in our lives, especially with easy internet access. In contrast, healthcare apps and in particular, orthodontic apps, did not experience the same boost when compared to other type of apps. The number of orthodontic apps in the main applications stores like App Store® and Google Play® saw a slight growth from 19 apps found in 2013 to 119 apps just a year later in 2014 [3,4]. In 2017, this number increased to reach 354 apps [5]. Other recent studies about orthodontic apps assessment using MARS and BCT's conducted in 2021 by Siddiqui reveal that a limited number of high quality apps is available for the patients while there is a definite need for high quality app development with appropriate BCT's to be created [6]. By developing this type of orthodontic apps, patient compliance with treatment could be improved.

Orthodontic apps have mainly two areas of development towards patients or clinicians, but they vary enormously in objective and design. While the number of orthodontic apps is increasing, the accuracy of these apps has not been studied enough. A few studies investigated the functionality and effects of orthodontic apps in the last 10 years. The most common aspect of the apps investigated was the reminder therapy where 41% of the apps were aiming to [7]. The integration of reminders in the app software resulted into better compliance, less missed appointments, better oral health, diminished white spot lesions and bracket failure while treatment time decreased [8–13]. The apps used to monitor oral hygiene could represent a positive outcome for a practice due to easy implementation and low cost [8,13]. Of all orthodontics apps investigated, 35% were designed to measure the cephalometric values. The most popular apps were One Ceph and Ceph Ninja. These two apps were found to be the most accurate and trustworthy [14–16]. There is a clear limitation of studies for orthodontic apps which use treatment planning. Most apps are designed to monitor, measure, book appointments or send reminders. Artificial intelligence revolution and integration in orthodontic apps will have a great impact in the future in diagnostic aid and treatment planning [4,5,17,18]. A cloud-based, free of charge, artificial intelligence orthodontic platform (Web Ceph) is already available for clinicians where they can access cephalometric analysis, landmark identification, and tracing. This research project aimed to determine the top five most rated orthodontic apps available in App Store® and Google Play® with a new insight into usability perception by different type of participants.

METHODOLOGY

Ethical approval for this study was obtained from King Abdullah International Medical Research Center (ethical approval # RYD-22-419812-194990).

The Search for the Apps

The apps were selected and researched by two calibrated researchers using Apple and Google smartphones in App Store® and Google Play® in May 2022 (availability, pricing, app updates, features of the app may have changed since the study duration). The researcher conducted the search of the apps, selection, collecting all the feedback from the participants, explaining the type of surveys to the participants and all aspects of the required data. The first search was done on the 1st of May 2022 then was re-done by the researcher within an interval of two weeks to ensure that there is reliability in the selection and

search criteria of the apps. The specific terms used for the search of apps and inclusion criteria key words were orthodontics, braces, orthodontist, orthodontic, aligners. Apps that were not in English were excluded alongside apps that had no reviews, no ratings from the users, no downloads. The second researcher duplicated the search strategy with matching criteria and retrieved identical choice, this was performed to ensure the reliability of the search strategy.

The participants in this study were five dentists, five patients and one expert IT individual. The criteria for the selection of participants were predetermined as the general dentists should have sound literacy to use the selected apps while the patients have volunteered to use the apps. Furthermore, an IT app developer expert was nominated for the evaluation of the apps. The total number of apps found in App Store® was 121 apps and 152 in Google Play®. The source of the data will not need approval from the developer because is an open source.

Selection of Apps

The selection was made by the researcher looking at the apps with most reviews from the App Store® and Google Play®. On the specified platforms, a rating appears under the name of the app, marked with a number of stars from one star to five stars. Furthermore, the rating appears on the right of the stars with a specified number of users which rated the app. Apps were divided based on the app general focus into six categories: apps for orthodontists or dentists, apps for patients, apps for aligners, apps for braces, apps with the highest number of reviews and user rating which could be observe. In the class of apps for orthodontists, 135 apps were found in App Store®. Participants were asked to download only the top five apps which were: Dental Monitoring, Invisalign Photo Uploader, Tray Minder, My Invisalign and Fake Braces Face Photo Editor (See Figure 1).

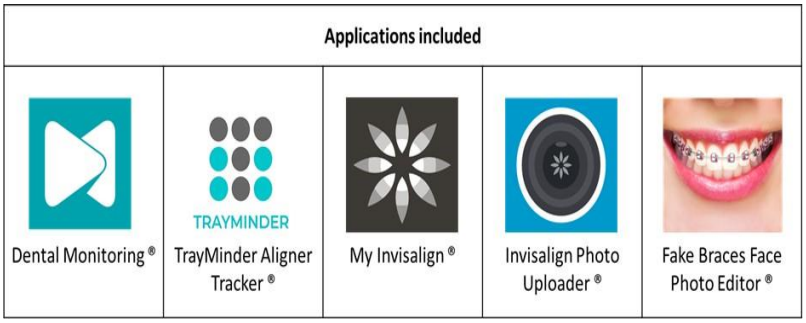

FIGURE 1: List of the applications included in the study.

Evaluation of the Apps

The evaluation of the apps was made by using the System Usability Scale (SUS) to investigate the quantitative method [19]. The System Usability Scale was developed by John Brooke in 1996 and is described as a quick survey scale which would permit the usability practitioner to assess the usability of a given product or service in an easy and quick way [20]. A sample of the usability scale system is enlisted in Table 1. The System Usability Scale instrument has ten questions which are scored on a five-point scale strength of agreement. The final score for SUS could vary from 0 to 100 where elevated scores demonstrate better usability.

SUS (System Usability Score) score was calculated with the following formula.

Step 1: Convert the scale into number for each of the 10 questions.

- Strongly Disagree: 1 point
- Disagree: 2 points
- Neutral: 3 points
- Agree: 4 points
- Strongly Agree: 5 points

Step 2: Calculation

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- X = Sum of the points for all odd-numbered questions—5
- Y = 25—Sum of the points for all even-numbered questions
- SUS Score = (X + Y) × 2.5

TABLE 1: The System Usability Scale Standard Version

	Strongly Disagree	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
I think I would like to use this system frequently.	☐	☐	☐	☐	☐
I found the system unnecessarily complex.	☐	☐	☐	☐	☐
I thought the system was easy to use.	☐	☐	☐	☐	☐
I think that I would need the support of a technical person to be able to use this system.	☐	☐	☐	☐	☐
I found the various functions in this system were well integrated.	☐	☐	☐	☐	☐
I thought there was too much inconsistency in this system.	☐	☐	☐	☐	☐
I would imagine that most people would learn to use this system very quickly.	☐	☐	☐	☐	☐
I found the system very cumbersome to use.	☐	☐	☐	☐	☐
I felt very confident using the system.	☐	☐	☐	☐	☐
I needed to learn a lot of things before I could get going with this system.	☐	☐	☐	☐	☐

TABLE 2: Interpretation of SUS Score.

SUS Score	Grade	Adjective Rating
>80.3	A	Excellent
68–80.3	B	Good
68	C	Fair
51–68	D	Poor
<51	F	Awful

Furthermore, the Think-Aloud method applied to cover the qualitative method. An Exit interview by the researcher was conducted with the participants to evaluate the overall experience of a participant and to identify opportunities for improvement and better engagement. The Exit interview is a semi-structured open-ended question that is conducted at the end of the evaluation session. The exit interview was explained in details in Utley et al., 2008 study [21].

RESULTS

The results were divided into 3 sections. Firstly, description of the apps that were selected (Table 3) with ratings and reviews. Secondly, the results of the System Usability Scale with dedicated sections for patients and doctors are presented. Finally, an IT expertise and Exit interview was explained. Description of the apps can be found in Table 4. The SUS average score, standard version and interpretation are detailed in Table 5. The Exit Interview done by the doctors can be observed in Table 6. The Exit interview done by patients could be observed in Table 7, while Table 8 presents IT App developer opinion about the Apps.

TABLE 3: App categories.

Apps	Apple/ Google Play Ratings	Review Score out of 5	App Designed for Orthodontists and Dentists	App Designed for Patients	Apps for Braces	Apps for Aligners
Dental Monitoring®	2.2K	4.9	√	√		√
TrayMinder Aligner Tracker®	848	4.7		√		√
Invisalign Photo Uploader®	240	4.7	√			√
My Invisalign®	1.5K	4.7		√		√
Fake Braces Face Photo Editor®	24	3.0		√	√	

TABLE 4: Description of the apps.

App Name	Year of Development	Size	Languages	Free/Paid	Rating out of 5
Dental Monitoring	2016	128 MB	15 languages	free	4.9
Tray Minder	2018	66 MB	11 languages	free	4.7
My Invisalign	2016	170 MB	17 languages	free	4.7
Invisalign Photo Uploader	2016	65.7 MB	10 languages	free	4.7
Fake braces	2017	12.3 MB	1 language	free	3

TABLE 5: SUS Average Score, standard deviation and interpretation done by doctors and patients.

Application	Doctors' Score	SUS Interpretation	Patients' Score	SUS Interpretation
	Average Score (SD)		Average Score (SD)	
Dental Monitoring	71.2 ± (14.28)	Good	77.5 ± (7.77)	Good
Tray Minder	67.1 ± (11.01)	Poor	76.6 ± (4.87)	Good
My Invisalign	74.3 ± (8.28)	Good	82 ± (3.02)	Excellent
Invisalign Photo Uploader *	74.5 ± (4.94)	Good	N/A	
Fake braces	71.8 ± (6.12)	Good	77.2 ± (8.29)	Good

* Invisalign Photo Uploader scores not shown for patients due to limited access on the app just for dentists.

TABLE 6: Exit interview done by doctors.

Apps	Doctor 1	Doctor 2	Doctor 3	Doctor 4	Doctor 5
Tray Minder	This is a good app for monitoring your aligner wear while the patient has the possibility to log multiple aligner providers	Patients were happy to be able to share their aligner usage with me via email or text	I liked the feature of refinements in this app	Treatment plans are easy to adjust using the app	What I found interesting about this app is the notifications received if you keep your aligners longer than needed
Dental Monitoring	The workflow of the app is very easy to follow	The app offered me the possibility to develop a customized protocol for the patient which helped me efficient notifications	It was very easy for me to monitor the patient treatment and progress	The use of a ScanBox is a nice feature of the app because it was easy for me to teach the patient to take good intraoral pictures.	The app has a nice section designed for follow-ups which offered me the possibility to communicate to the patient and get feed-back

Invisalign Photo Uploader	The software allows a quick upload of photos which is a nice feature of this app	The camera setting build in the app is a very good and accurate. I enjoyed taking photos with this app	The app offers a very easy way to add patient information	This app offers the best tools to start an initial assessment for your patient.	A nice feature of this app is the quick creation of the patient profile on the Invisalign Doctor site
My Invisalign	The app is brilliantly designed. It was so easy for me to monitor my aligner wearing time	The reminder notifications were very helpful for me to keep up with my treatment	The progress video function on this app is very helpful	The possibility to view my personal Clin-check plan on the app is the most helpful tool of this app	The Invisalign Virtual Care feedback function with your Dentist offers the best way to monitor the treatment
Fake braces	I found the app very intuitive and easy to see how I would look with braces	The app was easy to use and straightforward	The app offered me wide range of braes	Sharing my result on social media and with friends was a nice feature of this app	It was easy for me to adjust the position of the braces on my teeth.

TABLE 7: Exit interview done by patients.

Apps	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5
Tray Minder	I liked the reminder when to switch to the next aligner.	The possibility to take selfies and upload it into the app is a very nice feature	It was so easy for me to share my photos with my dentist	The color-coded function helped me to organize my aligner wear in my calendar	The app is very flexible and offers multiple ways to monitor your treatment
Dental Monitoring	I found the app to be very straight forward with quick functions to take photos of my treatment	A nice feature of the app was the before and after comparison and treatment progress	I felt motivated to track my treatment using this app	Communication with my dentist was the top feature of this app. Very easy and effective	I was able to track my treatment evolution very easily
My Invisalign	Personalizing my treatment calendar was a very nice feature of the app	I was impressed with the progress video function	It was so nice to be able to see my Clin Check treatment plan shared by my dentist	Invisalign Virtual care function was very easy to use allowed me to share photos	I liked the tips function on how to take care of the aligners
Fake braces	The photo editing feature of this app is very easy to use	I enjoyed sharing photos on social media and friends using this app	This app offered me a good preview on how I would look with braces	The app offers multiple type of braces and colors which is a nice feature	I found the in-app photo editing function very straightforward

TABLE 8: IT App developer opinion about the Apps.

Apps	
Dental Monitoring	Don’t have access. Accounts can only be created by an invitation from the Doctor
Tray Minder	Pretty intuitive user interface, probably built in React Native, does the job. Useful features like ‘Take mirror images’ make it stand out. Nice integration with Siri
Invisalign Photo Uploader	Only accessible to Doctors and Staff. Not allowed to create an account as a patient
My Invisalign	User interface is not aligned properly. Design could be improved. Tools provided are useful. User experience is good if design is improved
Fake braces	User experience is poor. There is no toolbar, you don’t know which component you are selecting. Easy to miss click. Otherwise, useful feature if you manage to manually adjust it. Can be improved drastically if applied automatically as a filter instead of a 2D geometric shape to the picture.

System Usability Scale and Average Scores for Doctors and Patients

Dental Monitoring had a good score on System Usability Scale given by the dentists Tray Minder had a poor score. Invisalign Photo Uploader had a good general score, and users were happy with the features of this app. My Invisalign had a good score. Fake braces had a good score as well (see Figure 2) Patients scored Dental Monitoring as good as seen in Table 5. Tray Minder had mainly good scores. My Invisalign had great reviews from the patients with the majority of ratings being excellent. Most of the scores for Fake braces were good.

Tray Minder received the lowest average score from the dentist's point of view while Invisalign Photo Uploader received the highest average score. My Invisalign and Invisalign Photo Uploader were very close in the average score ranking with a score of 74.3 and 74.5 respectively. Fake braces scored 71.8 points while Dental Monitoring showed an average score of 71.2. Dental Monitoring and Fake Braces received close average scores by the patients with 77.5 points and 77.2 point respectively. My Invisalign was the top ranked app regarding the average score with 82 points while Tray Minder saw 76.6 points. Both average scores results could be observed in Figure 2.

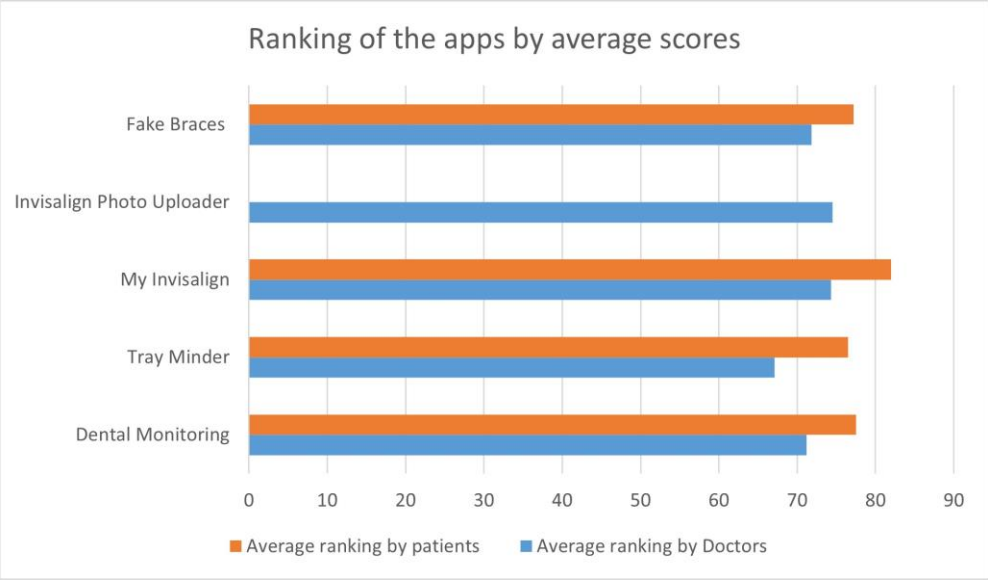

FIGURE 2: Ranking of the apps by average scores.

Exit Interview and IT App Developer Expertise

The IT app developer expert rated Tray Minder 'intuitive' while the general view of this app was a good one with features that stand out and a useful integration with Siri. The rating of the IT App developer expert could be observed in Table 8. Invisalign Photo Uploader and Dental monitoring could not have been reviewed due to specific previous access needed from a doctor after a treatment plan is agreed. My Invisalign had a good review from the IT App development team while some functions of the app like user interface or design could be improved. Some of the features of the Fake braces app was reviewed as useful but this app needs serious improvement in order to deliver a friendly and easy interface. The Exit Interview done by doctors seen in Table 6, concluded that Tray Minder is a very useful app while features like notifications and aligner wear monitoring were appreciated the most. Dental Monitoring received good feedback from the users while the most appreciated function of the app was the option to use Scan Box where photos could be taken by the patient and uploaded to the app in order to monitor treatment progress. Invisalign Photo uploader is a widely used app which is used by the majority of the Dentists for Orthodontic treatment. Although

most of the features of this app were appreciated, the most important feature was the speed of upload on the Invisalign website from the phone in a matter of seconds. Doctors were pleased to have this information stored quickly in the web portal where they could develop and revise their treatment plan. The most appreciated feature of My Invisalign app was the possibility to see the Clin Check treatment plan on the patient device and check the progress of the treatment at every stage. Doctors were pleased to be able to share photos with friends or on social media of themselves with braces using the Fake Braces app. Furthermore, few patients found the photo editing function very intuitive and easy to use while others appreciated the tool which could offer a preview on how they would look with braces. The diversity of bracket type was another appreciated feature of the app while the editing function was described by a participant as very straightforward. Patients liked the reminder function on Tray Minder app which allowed them to know the exact time to switch to the next aligner while other participants enjoyed the color-coded function which helped them to organize the aligner wear in the calendar. Dental Monitoring was found to be an intuitive app by the patients while functions like before and after comparison of the treatment was much appreciated. Other patients were impressed by the feedback function that offers the user direct communication with the dentist. Additionally, function which permitted the user to take photos of the treatment progress were valued. A useful tool on My Invisalign app was the option to personalize the treatment calendar which was much appreciated by one of the patients while the virtual care function allowed the participants to share photos easily. Another patient valued the progress video function while the possibility to share the Clin Check plan by the dentist was quite important for one of the patients. Moreover, one patient found the tip function very useful. This comparative research could offer new perspectives regarding not only the availability of orthodontic apps investigated in the previous studies but shedding a light on evaluating the usability of the top 5 most rated apps and offering a clear ranking of the preferred apps by the doctors and patients.

DISCUSSION

Previous researches has mainly focused on the availability of orthodontic apps and accuracy of a few orthodontic applications, but our research has aimed to identify the most used apps nowadays in App Store® and Google Play® with the highest number of ratings and downloads. Our results showed that a few apps are commonly used and downloaded by the patients or doctors for orthodontic purposes. Most of the participants in this study were comfortable using the apps while some encountered minimal problems when they started using the apps but quickly get used with the features. By integrating The System Usability Scale and Exit Interview for the participants in the methodology, this study offered an accurate and effective evaluation of the available apps. The advantage of SUS is that the design is technology agnostic, making this survey flexible to assess a wide range of interface technologies from correlative voice response systems, new hardware platforms to the usual and more traditional computer interfaces. Moreover, the survey could be easily used by different types of participants or researchers with a single score on a scale that could be easily understood by a wide range of people, making this type of survey a reliable assessment tool. Another important feature of this type of survey is its non-proprietary, making it cost effective.

The Exit Interview is a unique way to highlight the findings of research using a unique application of ‘’member check’’ strategy and to offer instant distribution of findings in this case for app performance and capability of improvement. The exit-interview consultation is linked to an organized group and individual sessions which were assisted with a certain number of participants at the end of a case study. Participants were able to use and assess different tools of the apps while the input from the IT reviewer was a plus. This IT app developer evaluation offered a strong and analytical view regarding the development of the app and technical terms. In contrast, some participants found some features of the apps slightly difficult to use. A more in-depth study should be conducted to obtain a better view on how difficult the access of those specific features was. Overall,

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the participants were happy and comfortable with the apps after a few days and managed to understand most of the features.

This study brings a new light over the Orthodontic apps available in App Store® and Google Play® while showing that even if there are many apps available, the majority of the users prefer to download and use the most common ones with the greatest number of downloads and the best reviews. Furthermore, most of the participants were happy and comfortable using the features of the apps. This study intended to find out which are the top five most rated apps in App Store® and Google Play® while offering an insight into the use of different features utilized by the participants. A comprehensive approach was designed to search, select, evaluate the apps while the IT participant offered a new and targeted view over the apps.

The limitations of this study are that the survey could be conducted on a larger number of top apps to include analysis of the top 20 apps. Moreover, it has been suggested that usability testing with a number between five to nine participants is efficient but more participants could offer a more detailed insight about the apps quality, design, ease of use, speed of use, ease of access, instant interaction with the dentist, photos upload features, account creation, login speed, virtual monitoring, ease of download [22]. Future research could be conducted to address all the aspects above and offer a better understating of the top-rated apps with the greatest number of downloads by the users. Another point for future research potential could be the identification of the orthodontic apps used by teenagers nowadays with a clear view of which are the most used apps in a specific age category. Studies could be conducted also on adults and reveal which apps are preferred by them and the ease of use for adults compared to teenagers.

CONCLUSIONS

As a result, this comparative research studied the top 5 apps available in App Store® and Google Play® with the greatest number of users and downloads. While a large variety of orthodontic apps is available on App Store® and Google Play® platforms to download and use, just a small percentage of apps is really downloaded and used by the public. Apps were easy to download by the users on their mobile phones and some features like aligner wear monitoring, feedback with the dentist, ability to share photos on social media, take photos and monitor the progress of the treatment, were very appreciated. After performing a systematic search, selection and evaluation of the apps using the System Usability Scale, Average Scores and Exit Interview, the following conclusions could be reached within the limitation of this study:

- Most of the participants have found the apps and their features easy to use, easy to download and have quick access to the main menus.
- The IT app developer ranked Tray Minder the highest.
- An increased number of participants appreciated the virtual function where they can have feedback from the dentist and communicate about their treatment plan.
- Invisalign Photo Uploader and My Invisalign received the best reviews from the users.
- My Invisalign was the top ranked app by the patients while Invisalign Photo Uploader was the most appreciated by the dentists.
- Further research is needed to investigate new features of the apps, availability of orthodontic apps for the teenagers or which apps are used in a specific age group.
- More studies could be conducted to compare the preferred apps between adults and teenagers.
- As this field is fast changing, regular analysis of Orthodontics apps will enlighten our knowledge of the current trends in the mobile apps sector.

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Institutional Review Board Statement

Ethical approval for this study was obtained from King Abdullah International Medical Research Center (ethical approval # RYD-22-419812-194990).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Not applicable

Conflicts of Interest

The authors declare no conflict of interest.

Abbreviations

MB	Megabyte
SUS	System Usability Scale
BCT's	Behaviour change technique
MARS	Mobile App Rating Scale

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