



Patient Satisfaction and Wellness During and after Invisalign® Orthodontic Treatment Technology

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Abstract

Background: With its introduction in 1998, the Invisalign® transparent aligner system has become an important Orthodontic protocol. In 2018, Invisalign® refined its precision Orthodontic aligner process and introduced a smartphone mobile application called “My Invisalign® mobile app” to help inform, guide, remind and encourage patients in their healthcare as they improve their smiles.

Study Aim: This research aimed to determine if the Invisalign® Orthodontic technology and its associated website and mobile smartphone applications improve patients’ health and wellbeing. The Hypothesis for this research was that the Invisalign® technology protocol (i.e., website, mobile technology, and Invisalign® process) is safe and provides adequate patient information and intuitive support throughout the protocol.

Study Methodology and Design: This research model consisted of a) Historical Design (understanding the origin of Invisalign® technology), b) Descriptive Design (understanding through survey responses the decision to use Invisalign®), and c) Evaluation Design (understanding patient acceptability and effectiveness of Invisalign® protocol through observation and surveys). Participants for this research were obtained through cluster / convenience sampling using a SurveyMonkey (Anonymous) National Target Audience (United States) Web-based Survey administered through a SurveyMonkey Account to collect data for specific measures of patient satisfaction and wellbeing during and after the Invisalign® treatment technology. Participants agreed to the informed consent and indicated using or having used the Invisalign® protocol after February 27, 2018 (My Invisalign® Mobile Application Launch).

Results: Adult Invisalign® participants surveyed indicated mostly satisfied / very satisfied overall Orthodontic results and showed extensive use of the My Invisalign® mobile application (weekly use of the Calendar with reminders to change aligners most significant).

Discussion and Conclusion: Invisalign® Orthodontic technology and its associated website and mobile smartphone applications could improve the participant/patient’s health and wellbeing.

Keywords: Invisalign®; Clear aligners; Patient satisfaction; Orthodontics; Health information technology; My invisalign® Mobile application; Smart healthcare

Introduction

The history of Invisalign® began as an innovative “invisible” alternative to metal braces.

It was created by Align Technology, Inc., founded in 1997, by four Stanford University Students (one an Adult Orthodontic patient). The group had the idea of developing a progressive transparent aligners system as an alternative to metal braces (known today

as Clear Aligner Therapy (CAT) systems - Invisalign® is the most comprehensive). In 1998, Align Technology, Inc. received Food and Drug Administration (FDA) Approval to create incremental clear retainers known as Invisalign®. At first, the Orthodontic community was reluctant and skeptical to accept the Invisalign® system since the Align Technology founders were not trained in Orthodontics. However, Johnson Elite Orthodontics (2019) stated

in 2000, "...75 percent of all orthodontists in the United States were trained in Invisalign systems – and then the founders offered it to general dentists." Weir (2017) also indicated that in the 2nd Quarter of the year 2015 (Q2 2015), the Align.

Corporation had the following statistics:

a) Shipped Invisalign® cases = 3.2 million, b) Manufactured Aligners = 199 million, c) Doctors Invisalign® trained = 98,860, and d) Active Invisalign® Doctors = 45,580. In 2018, Invisalign® refined their precision Orthodontic aligner process and introduced a smartphone mobile application called "My Invisalign® mobile app" to help inform, guide, remind and encourage patients in their healthcare as they improve their smiles. The overall purpose of this research study was to increase the knowledge base describing the most current healthcare information on the efficacy, acceptability, and usability of Health Informatics (i.e., Website and mobile technology and the Invisalign® process) in Orthodontics and Healthcare [1-6].

Previous studies on Invisalign® therapy included a 2015 cross-sectional study of Braces versus Invisalign® that evaluated patient satisfaction and oral hygiene during Orthodontic treatment with Braces or Invisalign®. The study concluded that patients treated with the Invisalign® system had greater patient satisfaction and better oral health than patients treated with Braces during Orthodontic treatment. Another study, using a web survey, described Orthodontist and General Dentist perspectives on CAT and on which patient case studies this therapy was most important in addition to their reasons for not using CAT in their practices. Next, two web-based survey studies were identified using validated questionnaires: Dental Impacts on Daily Living Index and the Patient Satisfaction Questionnaire. These two studies, done in 2018, assessed patient satisfaction and quality of life status. Both studies reported high levels of satisfaction among Adult Orthodontic patient participants. In these previous studies and literature review, there appeared to be limited current information on patient use of the Invisalign® system, patient satisfaction, compliance, outcomes, preferences, and use or non-use of the smartphone mobile application called "My Invisalign® mobile app." Because of these limits, the proposed research study can add to the knowledge base with current survey research information [1,2,5-13].

According to PDA® (2010), "approximately four million people in the United States are wearing braces at any one time." More recently, the Dental Tribune America (2016) reported in a 2014 survey from the American Association of Orthodontics that during the period from 2012 – 2014, adults seeking Orthodontic treatment in the United States and Canada increased 16 percent to a record high of 1,441,000 patients age 18 and over. Therefore this research has significance, and the findings may be used to address gaps in current knowledge and provide current research information that addresses recent advances and innovations in this Orthodontic healthcare technology, its website, and mobile application technology [1,5 &14].

The Hypothesis for this Health Informatics Research was that the Invisalign® technology protocol (i.e., website, mobile technology, and the Invisalign® process) is a safe and effective protocol that provided adequate information, intuitive patient support, and interactions during treatment protocols. Specifically, the Invisalign® protocol and technology-enhanced patient access and participation, compliance, safety, outcomes, and satisfaction of Orthodontic Healthcare services. This Health Informatics Research aims to confirm, evaluate, and review the current knowledge on the efficacy, acceptability, and usability of the Invisalign® process and its website and mobile smartphone technology. The main goal of this healthcare technology research was to advance the practice of Healthcare, Health Informatics, and Health Informatics Management.

Materials and Methods

Study design

The study design is a cross-sectional descriptive and evaluation research intended to generate new Health Informatics knowledge about the Invisalign® system. The study design was built to explore the Invisalign® system's usability and measure the satisfaction among the Invisalign® system's users.

Participants

The participants for this research study were recruited through convenience sampling by requesting SurveyMonkey to send the potential National (United States) participants a SurveyMonkey (Account Purchased) Anonymous SurveyMonkey Response request that explained the research purpose and methodology. The study participants were Adults (18 years and older) and are currently following or have completed Invisalign® protocols after February 27, 2018 (Launch date of the My Invisalign® mobile application). Once the participants agreed to participate in the study, the investigators will provide them with a link to the study SurveyMonkey's. The study investigators developed the study survey. The first two survey questions acknowledged informed consent and that the participants had completed or are currently using Invisalign® protocols after February 27, 2018, verifying their validity to participate in the research survey. If a participant chose not to complete the survey or answered "no" to either of the first two survey questions, they were excluded from the research. SurveyMonkey provided the results of the research survey.

Data collection

The current study investigators collected both primary and secondary data to support the study aim. The study data was collected from March 15, 2020, to April 15, 2020. The secondary data were through chronological and literature review of the studied technology as it appears under the introduction section of the current research. The primary data for this study was collected using an internet based SurveyMonkey Survey of a National (United States) SurveyMonkey Target Audience Anonymous Survey. The requested SurveyMonkey National Anonymous Audience were

Adults (18 years and older) who indicated using or having used the Invisalign® protocol since the My Invisalign® Mobile Application launch on February 27, 2018, included in the research study. The investigators designed the survey to collect data around patient satisfaction and wellbeing during and after the Invisalign® treatment technology.

Statistical analysis

The collected study data were analyzed using Microsoft Excel and statistical Charting, graphs, and charts via SurveyMonkey's

Table 1: Responses of the Initial Participants Cohort to the Question "Do You Agree to the Terms of the Study's Informed Consent"?

Do You Agree to the Terms of the Informed Consent?	Responses	Percentages
Yes	197	96.57%
No	7	3.43%

Of the 197 consenting research participants, 51 (25.89%) responded "yes" to the question "Were you undergoing Invisalign® Treatment after February 27, 2018". The 51 participants were included in the research study. In comparison, the remaining 146 participants (74.11%) who either "did not respond" or responded "no" to the same question were excluded from the research,

Table 2: Invisalign® Protocol Status Responses of the Study's Initial Participants Cohort to the Question "Were You Undergoing Invisalign® Treatment after February 27, 2018"?

Were You Undergoing Invisalign® Treatment After February 27, 2018?	Responses	Percentages
Yes	51	25.89%
No / Non-Responsive	146	74.11%

The gender proportion of the research participants were 21 Females (42.86%) and 28 Males (57.14%). The age of the research participants ranged from 13 participants ages 18-25 years (26.53%), 13 participants ages 26-35 years (26.53%), 16

Table 3: Gender and Age Distribution of the study's final Participants Cohort.

Gender	Number	Percentages
Male	28	57.14%
Female	21	42.86%
Age Group	Number	Percentages
18-25 Years Old	13	26.53%
26-35 Years Old	13	26.53%
36-45 Years Old	16	32.66%
46-55 Years Old	4	8.16%
56-65 Years Old	2	4.08%
66+ Years Old	1	2.04%

Among the 49 research participants, 27 are in progress with Invisalign® treatment (55.10%), and 22 participants completed Invisalign® treatment (44.90%), as shown in Figure 1.

When asked if the participants used the My Invisalign® mobile smartphone application (app) regularly, 34 responded "yes" (69.39%), and 15 answered "no" (30.61%), as shown in Figure 2.

website [15]. The study results are presented through tables and graphs (Bar and Charts), using some inferential statistics when needed.

Results and Discussion

Results

A total of (204) SurveyMonkey Target Audience participants were targeted. Of these, a total of 197 Accepted the Informed Consent (a response rate of 96.57%), and 7 Declined/Refused the Informed Consent (3.43%), as shown in Table 1.

as shown in Table 2. Two research participants out of the 51 participants did not fully complete the research survey, and they were also excluded from the study. So, a total of 49 participants responded and participated in the Web-based survey research study.

participants ages 36-45 years (32.66%), 4 participants ages 46-55 years (8.16%), 2 participants ages 56-65 years (4.08 %) and 1 participant age 66+ years (2.04 %). Table 3 shows the gender and age distribution of the study's final participants cohort.

Of the participants that responded "yes," 10 participants reported using the smartphone application every day (20.41%), 20 said using the My Invisalign® mobile smartphone application every week (40.82%), five reported using the app every two weeks (10.20%), and three reported using the app every month (6.12%). Eleven said using the app "only when prompted by a reminder to use" (22.45%), as shown in Table 4.

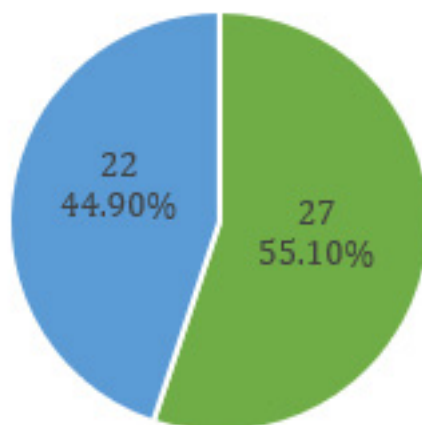


Figure 1: Distribution of the Actual Participants Cohort's Invisalign® Protocol Completion.

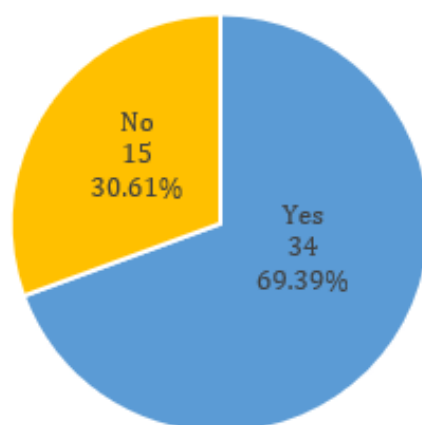


Figure 2: Distribution of the final Participants Cohort Who is Using of the Invisalign® Mobile Smartphone Application.

Table 4: Distribution of My Invisalign® Mobile Smartphone Application Users' Frequency of Using the Application.

How Often are You Using My Invisalign® Mobile Smartphone Application?	Responses	Percentages
Every Day	10	20.41%
Every Week	20	40.82%
Every Two Weeks	5	10.20%
Every Month	3	6.12%
Only when Prompted by a Reminder to Use	11	22.45%

Participants were asked to rank in order of use what features of the My Invisalign® mobile smartphone application they used most. The Calendar - with reminders to change Invisalign® Aligners was ranked highest and used the most (score 3.90). Ranked second is the Social - share smile photos with family and friends (score

3.84). Ranked third is the Social - create a time-lapse video each week of your Orthodontic changes (score 3.02). Ranked fourth is the Education - Invisalign® Frequently Asked Questions (FAQ) (score 2.66). Ranked fifth is Education - Invisalign® Instructional Information and Videos (score 2.00), as shown in Table 5.

Table 5: Distribution and the Average Scores of the Most Used Features of the My Invisalign® Mobile Smartphone Application among the Application Users.

What Features of the My Invisalign® Mobile Smartphone Application Do You Use the Most?	Score
The Calendar - with reminders to change Invisalign® Aligners	3.9
Social Share Smile Photos with Family and Friends	3.84
Social Create Time Lapse Video Each Week of Your Orthodontic Changes	3.02
Education Invisalign® Frequently Asked Questions	2.66
Education Invisalign® Instructional Information and Videos	2

Satisfaction of the My Invisalign® Mobile Smartphone application technology Ease of Use was reported as 17 participants described being satisfied with the technology (34.69%), 11 participants were very satisfied with the technology ease of use (22.45%), and 16 participants described being neither satisfied

nor dissatisfied (32.65%). Three participants were dissatisfied (6.13%), and two were very dissatisfied (4.08%). Most reported being satisfied with the ease of use of the technology, as shown in Table 6.

Table 6: Overall Satisfaction of My Invisalign® Mobile Smartphone Application among the Application Users.

Are You Satisfied with Using the My Invisalign® Mobile Smartphone Application?	Responses
Very Satisfied	11
Satisfied	17
Neither Satisfied nor Dissatisfied	16
Dissatisfied	3
Very Dissatisfied	2

Satisfaction of the My Invisalign® Mobile Smartphone application technology enhanced the continuity of care received was reported as 20 participants described being satisfied with the technology (40.82%), nine participants said being very satisfied with the technology (18.37%), and 17 participants described

being neither satisfied nor dissatisfied (34.69%). Additionally, 2 participants described being dissatisfied with the technology (4.08%), and 1 participant described being very dissatisfied (2.04%). Most reported being satisfied that the technology-enhanced their continuity of care received, as shown in Table 7.

Table 7: Satisfaction of the My Invisalign® Mobile Smartphone Application enhanced the Continuity of Care Received among the Application Users.

How much are You Satisfied that the My Invisalign® Mobile Smartphone Application has Enhanced the Continuity of Care You Received?	Responses
Very Satisfied	9
Satisfied	20
Neither Satisfied nor Dissatisfied	17
Dissatisfied	2
Very Dissatisfied	1

Satisfaction of the My Invisalign® Mobile Smartphone application technology-enhanced healthcare communication and quality was reported as 21 participants described being satisfied with the technology (42.86%), 11 participants described being very satisfied with the technology (22.45%), and 13 participants

described being neither satisfied nor dissatisfied (26.53%) with the technology. Additionally, four participants described being dissatisfied with the technology (8.16%). Overall, most reported being satisfied with the technology-enhanced healthcare communication and quality, as shown in Table 8.

Table 8: Satisfaction of the My Invisalign® Mobile Smartphone Application in Enhanced Healthcare Communication and Quality among the Application Users.

How much are You Satisfied that the My Invisalign® Mobile Smartphone Application has Enhanced Healthcare Communication and Quality?	Responses
Very Satisfied	11
Satisfied	21
Neither Satisfied nor Dissatisfied	13
Dissatisfied	4
Very Dissatisfied	0

Overall satisfaction of the My Invisalign® Mobile Smartphone application technology (using the Likert score distributions) was reported as 21 participants described being satisfied with the technology (42.86%), 11 participants described being very satisfied (22.45%), and 14 participants described being neither satisfied

nor dissatisfied (28.57%). Additionally, one participant described being dissatisfied (2.04%), and two participants described being very dissatisfied (4.08%). Most reported being satisfied with the technology, as shown in Table 9.

Table 9: Overall Satisfaction of the My Invisalign® Mobile Smartphone Application among the Application Users.

What is your Overall Satisfaction of the My Invisalign® Mobile Smartphone Application?	Responses
Very Satisfied	11
Satisfied	21
Neither Satisfied nor Dissatisfied	14

Dissatisfied	1
Very Dissatisfied	2

The Survey research study also included open-ended questions concerning patient satisfaction and improvement considerations for the Invisalign® Mobile Smartphone application technology. These responses are being utilized to support these research findings and serve as a basis for future research initiatives.

Discussion

Since its introduction in 1998, the Invisalign® clear aligner system (Align Technology) has now become acknowledged as a critical Orthodontic protocol. The most significant result of this survey research is to have contributed to recent healthcare and healthcare informatics knowledge.

Current published research has discussed and compared patient satisfaction and wellness on Invisalign® therapy to include a 2015 cross-sectional study of Braces versus Invisalign® that evaluated patient satisfaction and oral hygiene during Orthodontic treatment with Braces or Invisalign®. The study concluded that patients treated with the Invisalign® system had greater patient satisfaction and better oral health than patients treated with Braces during Orthodontic treatment. Another study, using a web survey, described Orthodontist and General Dentist perspectives on CAT and on which patient case studies this therapy was most important in addition to their reasons for not using CAT in their practices. Next, two web-based survey studies were identified using validated questionnaires: Dental Impacts on Daily Living Index and the Patient Satisfaction Questionnaire. Both studies were done in 2018 assessed patient satisfaction and quality of life status after Invisalign® or Braces (Conventional fixed appliances) and found increased patient satisfaction and wellness after treatment. However, as we have noticed from these two important studies and other current related articles we mentioned under the introduction section, there is appeared limited current information on patient use of the Invisalign® system, patient satisfaction, wellness, preferences, and use or non-use of the Invisalign® treatment technology [1,2,5-13,16]. This survey research study provided results that contributed to the current knowledge and can be used for future research initiatives. This study explored the usability of the Invisalign® system and assessed the system end-users satisfaction.

Other significant results of this current survey research study revealed that adult participants had not just used the Invisalign® protocol (73.98 % completed vs. 26.02 % are in progress), but also used regularly and interactively the My Invisalign® smartphone application (69.39% vs. 30.61%). This finding supports the improvement in digital literacy and awareness among the Invisalign® system's adult users. The results showed that most participants used the My Invisalign® smartphone application (69.39% vs. 30.61%). This finding will fill the gap in the current literature about the application's usability within the system's

adult users. The present study tried to find adequate answers to all possible questions concerning the My Invisalign® smartphone application usability and satisfaction from all 49 participants through an intensive exploration. These findings and researched answers could be a good mine for the researchers to consider for their future related scholarship work.

The My Invisalign® smartphone application users mostly revealed being "Satisfied" or "Very Satisfied" with the application for "Ease of Use (34.69% vs. 22.45 % respectively), Enhanced Continuity of Care Received (40.82% vs. 18.37% respectively), Enhanced Healthcare Communication and Quality (42.86% vs. 22.45% respectively), and Overall Satisfaction of the My Invisalign® mobile smartphone application was reported (42.86% vs. 22.45% respectively)." Some participants reported being neither satisfied nor dissatisfied with the new technology. Even the dissatisfaction responses are significant to be considered for future research to improve the satisfaction, wellness, communication, and quality of the Invisalign® treatment protocols [1,2,5-13,16].

A significant number of the participants reported using the My Invisalign® smartphone application and ranked the applications' components. The users ranked the Calendar feature highest and most used. The second was the Social - sharing of smile progress photos with family and friends. The third was Social - Creating a time-lapse video each week of Orthodontic changes. The fourth was Education "Frequently Asked Questions." Last was Education - Invisalign® Instructional Information and Videos. These results are significant in determining what features are most beneficial and vital to Invisalign® patients. However, the Education features of the My Invisalign® smartphone application were not accessed as frequently as the Calendar, Photos, or Video [1,2,5-13,16].

This research study surveyed Adult Invisalign® participants who had undergone Invisalign® treatment on the satisfaction and use of the Invisalign® treatment technology protocol and its associated website and smartphone mobile application in promoting and enhancing health wellbeing in Adults. Overall, these survey research participants indicated satisfaction and positive outcomes. The findings of this research are also similar and consistent with current published research in having had overall positive findings of "Satisfied" and "Very Satisfied" for the Invisalign® treatment technology [[1,2,5-13,16-18].

Conclusion

This survey research study confirmed the aim of the current research. It determined that Invisalign® Orthodontic technology and its associated website and mobile smartphone applications have improved the participant/patient's health and wellbeing as indicated through positive responses and satisfied/very satisfied survey result responses. The benefit of this research could be the

basis for current knowledge and can provide knowledge for future research and technology enhancements. Opportunities for future studies should include all aspects of the Invisalign® Treatment Protocol and Treatment Technology throughout the course of the patient's Orthodontic Invisalign® treatment to determine what enhancements are needed to provide additional patient information to evolve a complete scientific research study for publication. The future research study should also include more participants to increase the study's validity and have the complete Invisalign® protocol and use of My Invisalign® Technology Treatment during treatment protocol intervals such as start, middle, completion, and retainer/enhancement phases of the Invisalign® treatment.

The Hypothesis for this research was also confirmed from this web-based survey and stated that the Invisalign® technology protocol (i.e., website, mobile technology and Invisalign® process) is safe and provided effective patient information and intuitive support throughout the protocol (as indicated through positive responses and satisfied/very satisfied survey result responses). Specifically, the Healthcare Provider, the Invisalign® technology, and the My Invisalign® website and smartphone mobile application enhanced patient access, participation, usability, and satisfaction with orthodontic services.

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Conflicts of Interest

None declared.

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