Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Effectiveness of a novel mobile health application in educating first time complete denture wearers: a prospective clinical study

Aditi Sooda
A J Institute of Dental Science
Vidya K Shenoy
A J Institute of Dental Science
Basappa B Kodada
Canara Engineering College
Aneesh Bhat
A J Engineering College
shobha J Rodrigues
shobha.j@manipal.edu
Manipal College of Dental Science
Kailashchandra Shenoy K
Illinois Institute of Technology

Research Article

Keywords: mHealth, complete dentures, denture hygiene, patient education, mobile application, plaque index

Posted Date: June 28th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10000298/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background:

Effective denture hygiene education is essential for preventing oral complications among complete denture wearers. Conventional education methods are often inconsistent and lack long-term reinforcement. This study evaluated the effectiveness of a mobile health (mHealth) application as an educational tool for first-time complete denture wearers.

Methods:

A prospective controlled clinical study was conducted among 32 first-time complete denture wearers randomly allocated into control (n = 16) and intervention (n = 16) groups. The control group received conventional education (verbal instructions, printed leaflets, and demonstrations), while the intervention group received education through a mobile application (“Denture Guide”). Knowledge regarding denture care was assessed at baseline and after 3 months using a validated questionnaire. Denture plaque was quantified at 3 months using methylene blue staining and digital image analysis. Data was analysed using paired and unpaired t-tests with significance set at $p < 0.05$.

Results:

At baseline, mean knowledge scores were comparable between the control (2.25 ± 1.00) and intervention groups (2.13 ± 1.02) ($p = 0.73$). After 3 months, the intervention group demonstrated significantly higher knowledge scores (9.13 ± 0.80) than the control group (8.13 ± 1.20) ($p = 0.01$). Mean plaque percentage was lower in the intervention group (29.06 ± 4.1) than the control group (30.25 ± 4.5), but this difference was not statistically significant ($p = 0.44$). The application showed high acceptability, with 87.5% of participants reporting it to be useful and 100% willing to recommend it.

Conclusions:

The mHealth application significantly improved denture care knowledge among first-time complete denture wearers but did not result in a significant reduction in plaque accumulation. It may serve as an effective adjunct to conventional education. Further studies are required to evaluate long-term behavioral outcomes.

INTRODUCTION

The increasing number of older adults has led to a growing demand for complete dentures as a primary prosthodontic treatment. [1] However, the long-term success of dentures depends on adequate hygiene practices and patient compliance. Dentures are susceptible to plaque accumulation due to their porous

polymethyl methacrylate (PMMA) surface, which can predispose individuals to oral conditions such as denture stomatitis and candidiasis.[2]

Poor hygiene can lead to conditions like denture stomatitis and caries caused by microbes such as *Candida albicans* and *Streptococcus mutans*.[3,4] Despite the importance of denture hygiene, patient education remains inconsistent.[2] Conventional methods, including verbal instructions and printed leaflets, are often insufficient due to poor retention and lack of reinforcement. [5,6]

With the widespread use of smartphones, mobile health (mHealth) applications have emerged as potential tools to deliver consistent, accessible, and engaging patient education.[7] Mobile applications, including progressive web applications (PWAs), are cost-effective and user-friendly platforms that enhance health literacy and self-care.[8] mHealth applications have been shown to improve oral hygiene outcomes, particularly among younger populations. Therefore, they may also serve as a promising education tool even in denture care.[9–11]

However, there is limited evidence regarding their effectiveness among first-time complete denture wearers.

This study aims to evaluate the effectiveness of a novel mHealth app as both a chairside educational tool and as a reference guide for home denture care. The null hypothesis is that there is no difference in denture care knowledge and hygiene between patients educated via the m-health app and those receiving conventional methods.

MATERIALS AND METHODS

Study Design

This prospective randomized controlled clinical study was conducted among 32 first-time complete denture wearers and was approved by the Institutional Ethics Committee (IEC/PROSTHO22/129/V2). The study was conducted in accordance with the Declaration of Helsinki and is reported in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines. This clinical study was not prospectively registered in a clinical trial registry. Written informed consent was obtained from all participants prior to enrolment in the study.

The study included two groups: a control group and an intervention group. The control group received post-insertion instructions through conventional educational methods, including verbal instructions, printed leaflets, and model demonstrations, whereas the intervention group received education through a newly developed mHealth application. The application, named “Denture Guide,” was developed using Android Studio software and utilized Java and XML (Extensible Markup Language) for multimedia integration.

The content of the application included essential post-denture delivery instructions, denture care guidelines, and oral hygiene instructions supplemented with images and videos. The educational material was designed to ensure that participants received consistent and accurate information, with the additional benefit of multimedia support.

The study included first-time complete denture wearers who possessed a smartphone with internet access and were literate in either English or Kannada. Patients who refused prosthodontic rehabilitation or had physical or mental impairments that prevented them from performing oral hygiene procedures were excluded. Individuals with systemic diseases, those taking medications that could influence oral health, active smokers, and those unwilling to provide informed consent were also excluded from the study.

m-Health app development

The mobile application “Denture Guide” was created using Android Studio with Java and XML (Extensible Markup Language). The app featured three sections: denture care, denture hygiene, and when to visit the dentist.

Prototype Usability

A sample of eight participants, including undergraduate students and first-time denture wearers literate in English or Kannada, were selected for prototype usability testing. The sample size was calculated using the cumulative binomial probability formula. Participants completed tasks on the app, reported issues, and provided feedback. Based on their input, the prototype was revised, ensuring the app was optimized for the study.

Participants and Intervention

Thirty-two eligible first-time complete denture wearers were recruited using convenience sampling. Participants were randomly assigned to either the control group (n = 16) or the intervention group (n = 16) using a computer-generated random number sequence. Allocation concealment was achieved using sequentially numbered opaque sealed envelopes. All participants provided written informed consent before enrolment. No participants were lost to follow-up, and all randomized participants were included in the final analysis. The flow of participants through the study is presented in Fig. 1.

The app was installed in the participants' smartphones and were instructed on its use during the intervention phase. The participants were given instructions as per the intervention and control group protocol. Both research assistants employed a checklist to maintain consistency during the conventional method of education.

Outcome Assessment

Primary Outcome

Knowledge score

Denture care knowledge was assessed using a validated 10-item questionnaire (Table 1) administered at baseline (T0) and at the 3-month follow-up (T1). Each correct response was assigned a score of 1 and each incorrect response a score of 0, yielding a total score ranging from 0 to 10. Higher scores indicated greater knowledge regarding denture care and maintenance.

Table 1
Validated Ten-item questionnaire used to assess participants' knowledge regarding post-insertion complete denture care and maintenance at baseline (T0) and at the 3-month follow-up (T1).

Item No.	Question	Response Options
1	Are you aware that dentures should be removed and soaked in water while sleeping at night?	Yes / No
2	Are you aware that dentures should be cleaned every day?	Yes / No
3	Are you aware that the oral tissues and mouth should be cleaned daily even when wearing dentures?	Yes / No
4	Are you aware that dentures should be rinsed after every meal?	Yes / No
5	Are you aware of the need for regular follow-up visits to the dentist at least once annually?	Yes / No
6	Are you aware that dentures are made of acrylic resin and may fracture if mishandled or dropped?	Yes / No
7	Are you aware that increased salivation may occur during the initial weeks following denture insertion?	Yes / No
8	Are you aware that appearance, speech, and mastication may initially be affected and that sore spots may develop during the adaptation period?	Yes / No
9	Are you aware that maxillary complete dentures are generally more stable than mandibular complete dentures?	Yes / No
10	Are you aware of the dietary modifications and eating habits recommended for new denture wearers?	Yes / No

Scoring: Each correct response was assigned a score of 1 and each incorrect response a score of 0. Total scores ranged from 0 to 10, with higher scores indicating greater knowledge regarding complete denture care and maintenance.

Secondary Outcomes

Denture plaque quantification

At the 3-month follow-up, denture plaque accumulation was assessed using methylene blue staining. Following staining, standardized digital photographs of the dentures were obtained and analyzed using GNU Image Manipulation Program (GIMP) software to quantify the percentage of denture surface area covered by plaque (Fig. 2).

Application acceptability

Participant acceptability of the mHealth application was evaluated at the 3-month follow-up using a structured feedback questionnaire that assessed perceived usefulness, ease of use, navigation, frequency of use, and willingness to recommend the application to others.

STATISTICAL ANALYSIS

Sample size calculation was performed using G*Power 3.1.9.7 software, with parameters set for an alpha error of 1%, a confidence interval of 99%, study power of 80%, and an effect size of 1.4, including a 10% dropout rate. The data was analysed using SPSS for Windows [version 26.0; IBM Corp., Armonk, NY]. Between-group comparisons were performed using independent samples t-tests, whereas within-group comparisons were performed using paired t-tests. The level of significance was set at $P < 0.05$.

RESULTS

A total of 32 participants (12 males and 20 females; mean age: 62 years) completed the study. Figure 1 illustrates the flow of participants through the study. Thirty-two eligible first-time complete denture wearers were randomized equally into the control group (n = 16) and intervention group (n = 16). No participants were lost to follow-up, and all randomized participants were included in the final analysis.

Knowledge scores :

Baseline knowledge scores are presented in Table 2. Mean baseline knowledge scores were comparable between the control group (2.25 ± 1.00) and intervention group (2.13 ± 1.02), with no statistically significant difference between the groups (p = 0.73).

Table 2
Baseline Knowledge Scores of Participants

Variable	Control Group (n = 16)	Intervention Group (n = 16)	p-value
Baseline knowledge score, mean ± SD	2.25 ± 1.00	2.13 ± 1.02	0.73

Data presented as mean ± standard deviation (SD). Between-group comparisons performed using unpaired t-test.

Knowledge scores at the 3-month follow-up are presented in Table 3. Mean knowledge scores were significantly higher in the intervention group (9.13 ± 0.80) than in the control group (8.13 ± 1.20) (p = 0.01).

Table 3
Comparison of Knowledge Scores Between Groups at 3-Month Follow-up

Outcome	Control (n = 16)	Intervention (n = 16)	p-value
Knowledge score	8.13 ± 1.20	9.13 ± 0.80	0.01
Independent sample t-test.			

Within group comparisons are presented in Table 4. Mean knowledge scores at 3 months were significantly higher than baseline scores in both the control group (p < 0.001) and intervention group (p < 0.001).

Table 4
Within-Group Comparison of Knowledge Scores at Baseline and 3-Month Follow-up

Group	Baseline Mean ± SD	3-Month Mean ± SD	p-value
Control (n = 16)	2.25 ± 1.00	8.13 ± 1.20	< 0.001
Intervention (n = 16)	2.13 ± 1.02	9.13 ± 0.80	< 0.001
Data are presented as mean ± standard deviation (SD). Within-group comparisons between baseline and 3-month follow-up were performed using paired t-tests. Statistical significance was set at p < 0.05.			

Legend: Both groups demonstrated a statistically significant improvement in post-insertion denture care knowledge from baseline to the 3-month follow-up.

Denture Plaque Scores

Denture plaque scores at the 3-month follow-up are presented in Table 5. The mean plaque percentage was lower in the intervention group (29.06 ± 4.10) than in the control group (30.25 ± 4.50). However, the difference between the groups was not statistically significant (p = 0.44).

Table 5
Comparison of Denture Plaque Scores Between the Control and Intervention Groups at the 3-Month Follow-up

Outcome	Control Group (n = 16) Mean ± SD	Intervention Group (n = 16) Mean ± SD	p-value
Plaque percentage (%)	30.25 ± 4.50	29.06 ± 4.10	0.44
Data are presented as mean ± standard deviation (SD). Between-group comparison was performed using an independent samples t-test.			

Legend: Lower plaque percentage values indicate reduced denture plaque accumulation.

Application Acceptability

Participant responses regarding application acceptability are summarized in Table 6. All participants (100%) reported that the photographs and videos included in the application were informative and indicated that they would recommend the application to other denture wearers. Most participants considered the application useful (87.5%) and easy to navigate (75.0%). More than half of the participants (56.3%) reported that the application was easy to use, while 18.8% reported some difficulty in using it. Furthermore, 81.3% of participants needed assistance with the application, and 68.8% reported that the application made denture maintenance and adaptation more comfortable.

Table 6
Participant Acceptability of the Denture Guide Mobile Application (n = 16)

Question	Yes n(%)	No n(%)	Not Sure n(%)
Used the application frequently	9 (56.3)	7 (43.8)	0 (0.0)
Would recommend the application to others	16 (100.0)	0 (0.0)	0 (0.0)
Found the application useful	14 (87.5)	2 (12.5)	0 (0.0)
Felt more comfortable while using the application	11 (68.8)	5 (31.3)	0 (0.0)
Found the application easy to use	9 (56.3)	3 (18.8)	4 (25.0)
Found photographs and videos informative	16 (100.0)	0 (0.0)	0 (0.0)
Found navigation easy	12 (75.0)	4 (25.0)	0 (0.0)
Required assistance while using the application	13 (81.3)	3 (18.8)	0 (0.0)

Data are presented as number (percentage) of participants. Responses were obtained from participants in the intervention group following 3 months of application use.

DISCUSSION

The present study evaluated the effectiveness of a mobile health (mHealth) application as an educational tool for first-time complete denture wearers. The findings demonstrated that participants who received education through the mHealth application showed significantly greater improvement in denture care knowledge than those who received conventional education. However, no statistically significant difference was observed in denture plaque accumulation between the two groups. Consequently, the null hypothesis was partially rejected, as a significant improvement was observed in knowledge scores, whereas no significant difference was found in plaque accumulation between the groups.

One of the key findings of this study is that digital education through a mobile application can enhance knowledge retention more effectively than traditional methods such as verbal instructions and printed leaflets. Conventional approaches are often limited by variability in delivery, lack of reinforcement, and poor long-term retention.[12] In contrast, the mHealth application provided standardized, readily accessible, and multimedia-supported information, which likely contributed to improved understanding and recall among participants. These findings are consistent with previous studies demonstrating that mobile-based educational interventions can significantly improve oral health knowledge and patient engagement.[7,9]

Despite the observed improvement in knowledge, the lack of a significant reduction in plaque scores suggests that increased awareness does not necessarily translate into behavioural change. Oral hygiene practices, particularly among complete denture wearers, are influenced by multiple factors including manual dexterity, motivation, habits, and reinforcement of instructions over time. The findings indicate that while mHealth applications are effective for knowledge dissemination, additional strategies such as periodic reminders, follow-up reinforcement, or behaviour modification interventions may be required to achieve measurable clinical improvements.

The results of this study are in agreement with previous research that has demonstrated the effectiveness of mobile applications in improving oral health knowledge.[13–16] However, unlike studies conducted in younger populations or among patients with fixed appliances, this study specifically focused on first-time complete denture wearers, a group that often requires more comprehensive and repeated guidance. The absence of significant improvement in plaque outcomes also aligns with studies suggesting that behavioural adherence may lag behind knowledge acquisition, particularly over short follow-up periods.[17]

The mHealth application developed in this study demonstrated high acceptability among participants, with the majority reporting that it was useful, informative, and easy to navigate. The incorporation of visual aids such as images and videos likely enhanced user engagement and comprehension. Furthermore, the accessibility of the application allows it to serve not only as a patient education tool but also as a reference for caregivers, which may be particularly beneficial in supporting older adults with limited independence.

This study has certain limitations that should be considered when interpreting the findings. The sample size was relatively small, which may limit the generalizability of the results. The follow-up period of three months may not have been sufficient to detect significant changes in clinical outcomes such as plaque accumulation. Additionally, the inclusion of only smartphone users may introduce selection bias, as individuals without access to digital technology were excluded. Future studies with larger sample sizes, longer follow-up durations, and more diverse populations are recommended to validate these findings.

Within these limitations, the findings of the present study suggest that mHealth applications can serve as effective adjuncts to conventional denture education by improving knowledge and patient

engagement. However, to achieve meaningful improvements in oral hygiene outcomes, these tools should be integrated with behavioral reinforcement strategies and regular clinical follow-up.

CONCLUSION

The mHealth application improved denture care knowledge and was well accepted by participants but did not result in significant changes in plaque accumulation. It may serve as a useful adjunct to conventional education. Further studies are required to evaluate its long-term impact on oral hygiene behaviour.

Declarations

Data availability: The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Author contributions : Dr Aditi Sooda, Dr Vidya K Shenoy, Mr Basappa B Kodada contributed to conception, design, data acquisition, analysis, and interpretation, drafted the manuscript; Dr Shobha J Rodrigues, Mr Kailashchandra Shenoy K and Aneesh Bhat contributed to conception, design, data analysis, and interpretation, critically revised the manuscript. All authors gave final approval and agree to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate: Ethical approval for this study was obtained from the Institutional Ethics Committee of A.J. Institute of Dental Sciences, Mangalore (IEC/PROSTHO22/129/V2). All procedures were performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrolment.

Clinical Trial No: Not Applicable
Consent for publication : Written informed consent was obtained from all participants prior to enrolment in the study.

Conflict of interest : The authors declare no conflicts of interest.
Funding statement: The authors declare that no financial support was received for the research and/ or publication of this article.

References

1. Suresan V, Mantri S, Deogade S, Sumathi K, Panday P, Galav A, Mishra K. Denture hygiene knowledge, attitudes, and practices toward patient education in denture care among dental practitioners of Jabalpur city, Madhya Pradesh, India. J Indian Prosthodont Soc. 2016;16(1):30–5.
2. Mylonas P, Milward P, McAndrew R. Denture cleanliness and hygiene: an overview. Br Dent J. 2022;233(1):20–6.

3. Coulthwaite L, Verran J. Potential pathogenic aspects of denture plaque. Br J Biomed Sci. 2007;64:180–9.
4. Emami E, Taraf H, de Grandmont P, et al. The association of denture stomatitis and partial removable dental prostheses: a systematic review. Int J Prosthodont. 2012;25:113–9.
5. Ng JYM, Lim TW, Tarib N, Ho TK. Development and validation of a progressive web application to educate partial denture wearers. Health Inf J. 2022;28(1):14604582211069516.
6. Li L, Zeng Y, Zhang Z, Fu C. The impact of internet use on health outcomes of rural adults: evidence from China. Int J Environ Res Public Health. 2020;17(18):6502.
7. Ng JY, Lim TW, Tarib N, Ho TK. Effect of educational progressive web application on patient's oral and denture knowledge and hygiene: A randomised controlled trial. Health Inf J. 2021;27(3):14604582211035821.
8. Alkadhi OH, Zahid MN, Almanea RS, et al. The effect of using mobile applications for improving oral hygiene in patients with orthodontic fixed appliances: a randomised controlled trial. J Orthod. 2017;44:157–16312.
9. Marchetti G, Fraiz FC, Nascimento WM, et al. Improving adolescents' periodontal health: evaluation of a mobile oral health app associated with conventional educational methods: a cluster randomized trial. Int J Paediatr Dent. 2018;28:410–41913.
10. Scheerman JFM, van Meijel B, van Empelen P, et al. The effect of using a mobile application (WhiteTeeth) on improving oral hygiene: a randomized controlled trial. Int J Dent Hyg. 2020;18:73–83.
11. Toniazzo MP, Nodari D, Muniz FWMG, et al. Effect of mHealth in improving oral hygiene: a systematic review with meta-analysis. J Clin Periodontol. 2019;46:297–309.
12. Cankaya ZT, YURKADOS A, Kalabay PG. The association between denture care and oral hygiene habits, oral hygiene knowledge and periodontal status of geriatric patients wearing removable partial dentures. Eur oral Res. 2020;54(1):9–15.
13. Sharif MO, Alkadhimi A. Patient focused oral hygiene apps: an assessment of quality (using MARS) and knowledge content. Br Dent J. 2019;227:383–6.
14. Vagrani A, Kumar N, Ilavarasan PV. Decline in mobile application life cycle. Procedia Comput Sci. 2017;122:957–64.
15. Zlatarić DK, Čelebić A, Valentić-Peruzović M. The effect of removable partial dentures on periodontal health of abutment and non-abutment teeth. J Periodontol. 2002;73:137–44.
16. Yadav AK, Yadav R, Kishlay K, et al. Periodontal health status in RPD wearing patients visiting to dental hospital in Azamgarh. J Adv Med Dent Sci Res. 2019;7:131–3.
17. Zaror C, Espinoza-Espinoza G, Atala-Acevedo C, et al. Validation and usability of a mobile phone application for epidemiological surveillance of traumatic dental injuries. Dent Traumatol. 2019;35:33–40.

Figures

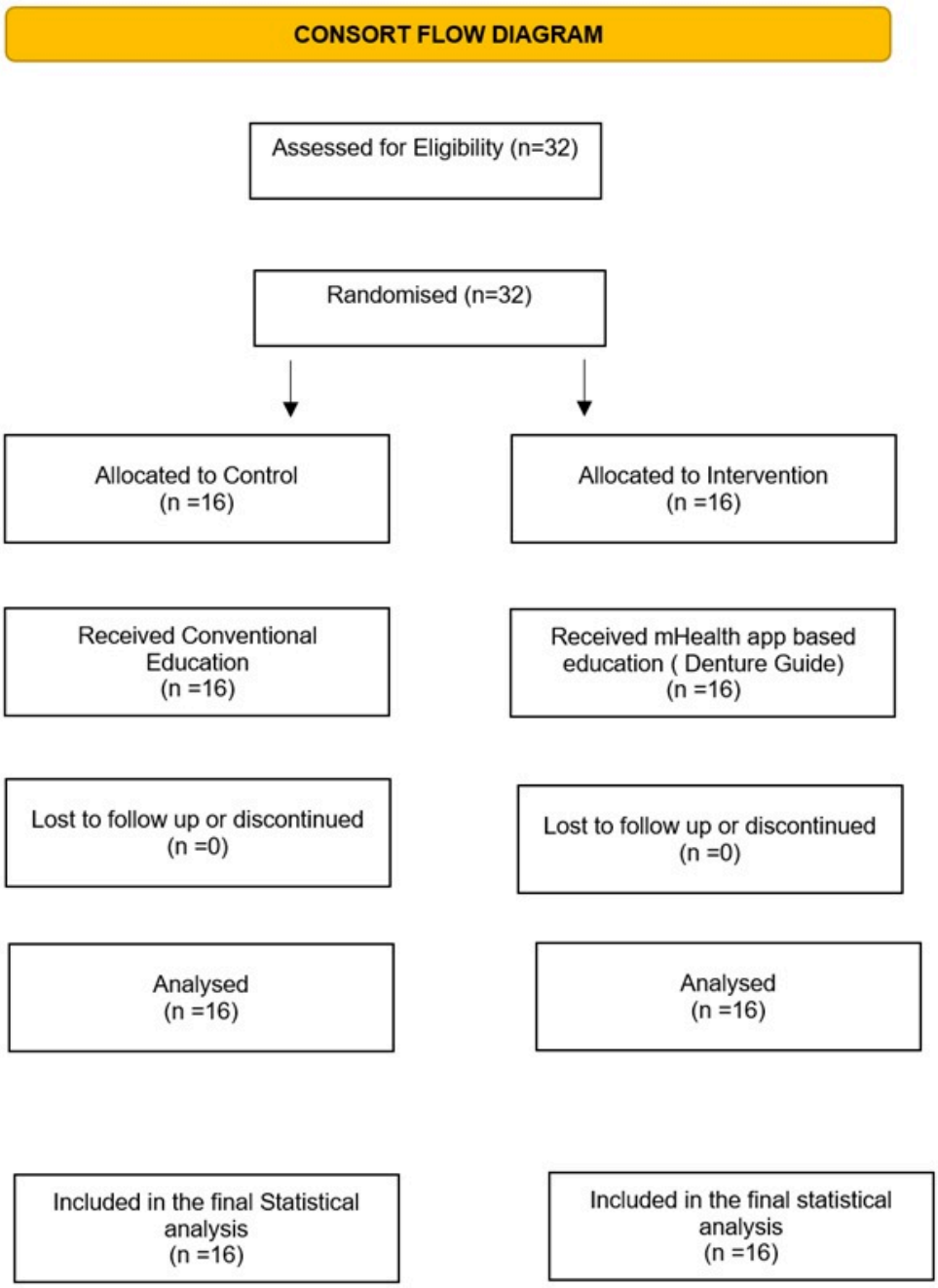


Figure 1

CONSORT flow diagram of participant recruitment, randomization, allocation, follow-up, and analysis. Thirty-two first-time complete denture wearers were randomized equally to conventional education (control group) or mHealth application-based education (intervention group). No participants were lost to follow-up, and all participants were included in the final analysis.

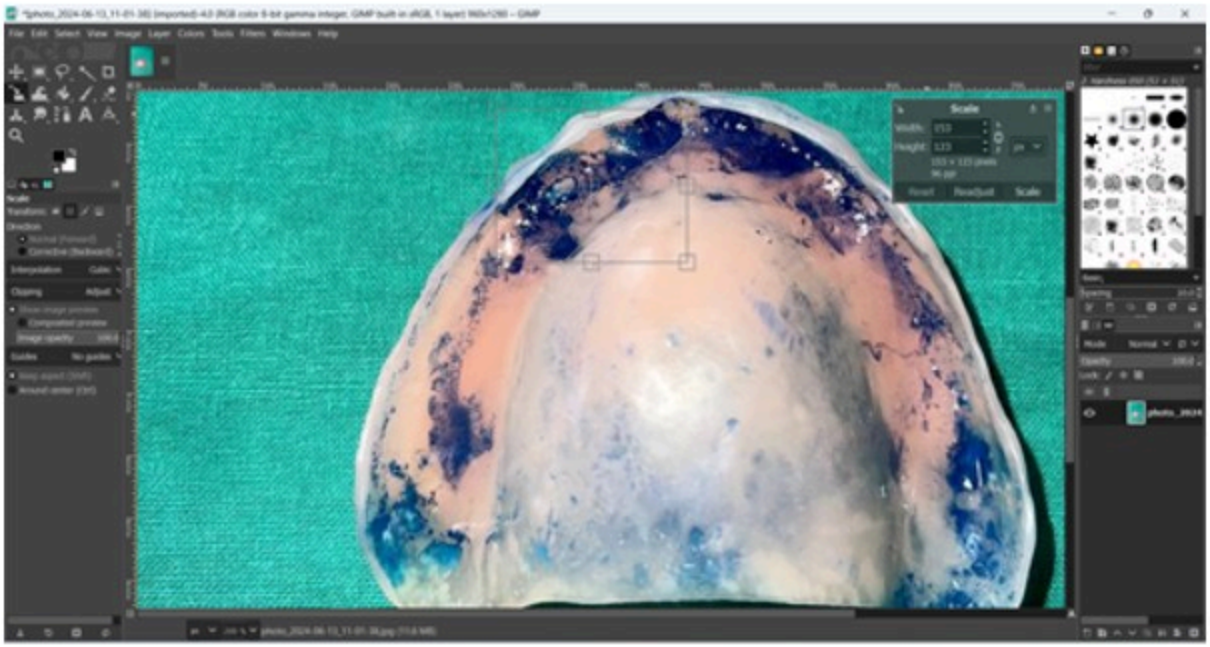


Figure 2

Plaque quantification using GIMP software

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryTables.docx