



International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Operating Publisher
SciFormat Publishing Inc.
ISNI: 0000 0005 1449 8214

2734 17 Avenue SW,
Calgary, Alberta, T3E0A7,
Canada
+15878858911
editorial-office@sciformat.ca

ARTICLE TITLE	AI MONITORING AND MOBILE APPLICATIONS FOR PATIENT COMPLIANCE AND ORAL HEALTH IN ORTHODONTICS: A NARRATIVE REVIEW
----------------------	--

DOI	https://doi.org/10.31435/ijitss.2(50).2026.5630
------------	---

RECEIVED	19 March 2026
-----------------	---------------

ACCEPTED	12 June 2026
-----------------	--------------

PUBLISHED	18 June 2026
------------------	--------------

LICENSE



The article is licensed under a **Creative Commons Attribution 4.0 International License**.

© The author(s) 2026.

This article is published as open access under the Creative Commons Attribution 4.0 International License (CC BY 4.0), allowing the author to retain copyright. The CC BY 4.0 License permits the content to be copied, adapted, displayed, distributed, republished, or reused for any purpose, including adaptation and commercial use, as long as proper attribution is provided.

AI MONITORING AND MOBILE APPLICATIONS FOR PATIENT COMPLIANCE AND ORAL HEALTH IN ORTHODONTICS: A NARRATIVE REVIEW

Ewa Stopa (Corresponding Author, Email: ewa.stopa@outlook.com)

Independent Researcher, Warsaw, Poland

ORCID ID: 0009-0002-8337-6064

Natalia Borek

Independent Researcher, Warsaw, Poland

ORCID ID: 0009-0005-7653-7386

Julia Gałzka

Independent Researcher, Warsaw, Poland

ORCID ID: 0009-0007-8675-6181

Emilia Miśkiewicz

Independent Researcher, Warsaw, Poland

ORCID ID: 0009-0003-7756-1981

Hanna Krupa

Independent Researcher, Warsaw, Poland

ORCID ID: 0009-0004-4366-8999

Zofia Wieczorek

Independent Researcher, Warsaw, Poland

ORCID ID: 0009-0001-9850-8464

Jakub Pochwalski

Independent Researcher, Warsaw, Poland

ORCID ID: 0009-0007-6387-5997

Magdalena Kędrak

Independent Researcher, Warsaw, Poland

ORCID ID: 0009-0008-8954-8633

Dominik Stanisławski

Independent Researcher, Warsaw, Poland

ORCID ID: 0009-0009-8583-9895

Wiktoria Jabłońska-Trzosek

Independent Researcher, Warsaw, Poland

ORCID ID: 0009-0004-1466-928X

ABSTRACT

This narrative review synthesizes the current evidence on the role of artificial intelligence monitoring tools and mobile applications in orthodontics, focusing on oral health outcomes, behavioral changes, and clinical efficiency. A literature search was performed in PubMed/MEDLINE, Scopus, and Google Scholar for articles published in English between 2016 and 2026. Following purposive selection, 17 articles were included in this synthesis. Digital health interventions consistently improve patient compliance, including appointment attendance, appliance wear duration, and oral hygiene. Effectiveness varied by intervention design, with multimedia and gamified approaches showing consistent benefits, whereas simple text reminders produced mixed results. AI-powered platforms reduce the need for in-office visits while maintaining clinical oversight, although the evidence certainty remains low. Important considerations include data privacy, digital equity, and cost-effectiveness, which remain largely unaddressed in the literature. Digital health interventions, including mobile applications and AI-powered monitoring platforms, show promise as supplementary tools for personalized orthodontic care, with evidence of improvements in patient compliance and oral hygiene, although they are limited by study heterogeneity. The effectiveness of these interventions appears to vary according to the intervention design and patient characteristics. Future research should prioritize long-term randomized trials, platform comparisons, and cost-effectiveness analyses to guide the clinical implementation of these technologies.

KEYWORDS

Orthodontics, Artificial Intelligence, Mobile Applications, Patient Compliance, Tele-Orthodontics

CITATION

Ewa Stopa, Natalia Borek, Julia Gałązka, Emilia Miśkiewicz, Hanna Krupa, Zofia Wieczorek, Jakub Pochwalski, Magdalena Kędrak, Dominik Stanisławski, Wiktoria Jabłońska-Trzosek. (2026) AI Monitoring and Mobile Applications for Patient Compliance and Oral Health in Orthodontics: A Narrative Review. *International Journal of Innovative Technologies in Social Science*. 2(50). doi: 10.31435/ijitss.2(50).2026.5630

COPYRIGHT

© **The author(s) 2026**. This article is published as open access under the **Creative Commons Attribution 4.0 International License (CC BY 4.0)**, allowing the author to retain copyright. The CC BY 4.0 License permits the content to be copied, adapted, displayed, distributed, republished, or reused for any purpose, including adaptation and commercial use, as long as proper attribution is provided.

1. Introduction

Orthodontic treatment is a long-term process during which patient cooperation plays a crucial role in achieving successful outcomes. Clinical success depends on daily cooperation in wearing removable devices, following dietary guidelines, and maintaining excellent oral hygiene to prevent demineralization, white spot lesions, and gingival inflammation (Firth et al., 2019). In recent years, digital technologies have emerged as promising tools for addressing compliance challenges in orthodontics. AI-powered remote monitoring platforms enable clinicians to track treatment progress, assess oral hygiene, and send personalized notifications to patients through smartphone applications, reducing the need for frequent in-office visits while improving patient engagement (Snider et al., 2023). Teleorthodontics refers to a comprehensive concept that involves providing orthodontic care, advice, or treatment remotely using information technology (Hansa et al., 2018). It is a rapidly evolving field that expands orthodontic care beyond traditional clinical settings, significantly improving patient accessibility (Srivastava et al., 2025). Beyond monitoring, AI has also been applied to other areas of orthodontics, such as cephalometric analysis, extraction decision-making, and treatment outcome prediction (Kazimierczak et al., 2024), although these applications fall outside the scope of the present review. This narrative review aims to synthesize the current evidence on the role of AI monitoring tools and mobile applications in orthodontics, focusing on oral health outcomes, behavioral changes, and clinical efficiency.

2. Materials and methods

A literature search was conducted in PubMed/MEDLINE, Scopus and Google Scholar databases. The search was limited to articles published in English between 2016 and 2026. The search strategy combined following terms: ("orthodontics" OR "orthodontic treatment") AND ("mobile applications" OR "smartphone" OR "mHealth" OR "tele-orthodontics" OR "telemonitoring" OR "remote monitoring") AND ("artificial intelligence" OR "machine learning" OR "digital health") AND ("patient compliance" OR "adherence" OR "oral hygiene" OR "treatment monitoring"). From the retrieved records, articles were selected based on their

relevance to the review objectives and their contributions to the thematic synthesis. Priority was given to studies that reported on digital health interventions - including mobile applications, AI-based monitoring platforms, social media tools, or telemonitoring systems - used in orthodontic clinical settings, with measurable outcomes related to patient compliance, oral hygiene, or clinical efficiency. Studies were excluded if they were not published in English, were conference abstracts only, or did not report clinical or behavioral outcomes. Following this purposive selection process, 17 articles were included in the thematic synthesis. Additional references were cited in the Introduction and Discussion sections to provide background context and support the interpretation of the findings. The included studies were organized thematically as follows: (1) digital health interventions and patient compliance, (2) mobile phone communication and social media interventions, and (3) artificial intelligence and personalized treatment monitoring.

3. Results

Digital Health Interventions and Patient Compliance

The literature reports consistent evidence supporting the effectiveness of digital health interventions in orthodontics. Significant improvements in compliance were observed across various parameters, including an increase in appointment attendance rates, a rise in the daily duration of appliance wear, and proportion of patients completing prescribed exercises (Almoammar, 2024). These results were supported by systematic review analysis. Choi et al. (2021) reported favorable outcomes in most of the studies they reviewed, while Asarsa et al. (2025), in a systematic review covering seven randomized and controlled clinical trials involving 504 participants aged 10-36 years, demonstrated consistent improvements in oral hygiene indices and compliance among patients who received digital interventions, regardless of age group. However, not all forms of digital communication appear equally effective. In a randomized trial Al-Abdallah et al. (2021) compared conventional instructions with two digital approaches: weekly short text messages and weekly emails with links to educational content. Although the text-only reminders offered no measurable advantage over standard care, the multimedia email group demonstrated a statistically significant decrease in appliance damage. Interestingly, the authors also observed that sociodemographic characteristics, including patient sex, family income level, and parents' educational background, were linked to treatment cooperation.

Mobile Phone Communication and Social Media Interventions

Mobile phone communication has emerged as a frequent intervention approach in several studies. Discepoli et al. (2021) analyzed randomized controlled trials and reported this strategy in five of the ten studies. The findings identified mobile phone communication as an attractive alternative for engaging younger patients. The study also highlighted the effectiveness of several other intervention methods, including motivational interviewing, consistent reinforcement, and visual demonstration strategies.

The study conducted by Zotti et al. (2016) demonstrated the use of social platforms by adolescent patients undergoing fixed orthodontic treatment. Eighty participants were randomly assigned to two groups. Those in the intervention group participated in a WhatsApp-based competition that required them to submit monthly selfies documenting their oral hygiene status. This intervention led to significantly lower Plaque Index (PI) and Gingival Index (GI) scores than those in the control group. The researchers also noted a decreased incidence of new white spot lesions and dental caries. In a following study, Zotti et al. (2019) extended this approach to the retention phase, randomizing 60 post-orthodontic adolescents into a WhatsApp-supported group and a control group over one year. Participants who engaged in weekly photographic submissions through WhatsApp showed greater retention stability, and better follow-up attendance, though compliance in the control group notably declined after eight months.

Farhadifard et al. (2020) conducted a randomized clinical trial with 120 orthodontic patients aged 15-25 years to evaluate the Brush DJ smartphone application. Patients who used the app showed significant improvements in both Plaque Index (PI) and Gingival Index (GI) scores over 12 weeks of follow-up, whereas these indices worsened in the control group. Brushing frequency and duration were also positively correlated with the app usage. Pubalan et al. (2024), in a single-blind RCT of 40 patients aged 13-25 years over 12 weeks, reported that the WhatsApp reminder group showed significantly lower plaque scores than the control group. Additionally, Balbaa et al. (2026), in an RCT of 60 patients aged 16-25 years followed for three months, found that the WHO mOralHealth program delivered via 46 WhatsApp messages significantly improved both plaque control and oral health literacy compared to standard instructions. Santos et al. (2021) randomized 44 patients with fixed orthodontic appliances to investigate whether daily WhatsApp text messages could encourage flossing. Patients who received daily messages showed significantly improved flossing habits, lower plaque and gingival bleeding indices, and reduced halitosis compared with the control group that received no messages.

Digital interventions consistently improved clinical parameters across studies, with reported reductions in plaque index, gingival index, and incidence of new white spot lesions (Asarsa et al., 2025; Zotti et al., 2016). Among the reviewed intervention types, gamified applications and telemonitoring platforms were associated with consistent improvements in clinical parameters. Choi et al. (2021) identified additional therapeutic benefits, such as reduced treatment duration and enhanced periodontal health among patients receiving mobile healthcare interventions, further supporting the clinical value of digital orthodontic care.

Artificial Intelligence and Personalized Treatment Monitoring

Several studies have evaluated AI-powered platforms that deliver personalized feedback based on individual patient behavioral data. Thurzo et al. (2021) evaluated the integration of personalized decision algorithms into the strojCHECK® mobile application in a cohort of 86 patients. By responding to observed patient behavior patterns, these algorithms could adapt to individual patient needs and improve compliance outcomes. While adding these smart features improved patient app interaction, treatment discipline, and clinical tracking for most patients, it was more effective for female than for male patients, indicating potential sex-specific differences in how patients respond to digital orthodontic tools. These gender-specific findings are supported by Nair (2025), who tracked 55 patients (33 women, 22 men) using the same strojCHECK® platform and observed that non-compliance declined significantly only among female participants and remained unchanged among males.

Polizzi et al. (2025) conducted a scoping review on the use of artificial intelligence in remote orthodontic care and found that Dental Monitoring™ is the most frequently used platform in current clinical practice. The research showed important benefits, such as patients needing approximately 33% fewer office visits, while clinicians could still track tooth movement using advanced technology. Patients also showed better oral care and stayed more motivated and involved in their treatment. However, the review also noted important limitations in current AI tools and emphasized that AI should support, not replace, clinical judgment. The visit-reduction capability of Dental Monitoring™ was quantified in a systematic review and meta-analysis by Torres et al. (2023). Pooling data from aligner-based studies, the authors found that patients using Dental Monitoring™ required fewer face-to-face appointments than those receiving standard care. The time to initiate treatment refinements was shorter in the monitored group. However, the authors cautioned that the overall certainty of the evidence was very low and called for additional randomized trials, particularly for fixed orthodontic treatment. Sosiawan et al. (2022), in a review of five studies on Dental Monitoring™, similarly concluded that the platform can decrease the number of visits, enhance oral hygiene, and improve retention stability. They also highlighted the importance of maintaining the doctor-patient relationship when care is delivered remotely. Furthermore, Homsí et al. (2023) provided in vivo validation of the AI-driven tracking algorithm, demonstrating that remotely reconstructed three-dimensional dental models showed no clinically significant difference from those generated by intraoral scanning.

4. Discussion

The findings of this review indicate that digital health solutions and artificial intelligence represent significant advancements in the management of orthodontic patients. Remote monitoring platforms, such as Dental Monitoring™, effectively fill the gap between clinical visits by providing continuous oversight of appliance wear and oral hygiene (Polizzi et al., 2025). Furthermore, AI-driven decision tree algorithms facilitate the transition from passive reminders to smart coaching systems. By analyzing daily data, these systems can detect individual behavioral patterns and offer tailored reinforcement strategies to improve health outcomes.

Both Thurzo et al. (2021) and Nair (2025) noted that gender may influence patient responses to these digital stimuli, with women showing more consistent improvement. However, both studies used the same strojCHECK® platform, so it remains unclear whether this is a generalizable gender effect or a platform-specific design feature: for instance, the app's interface and notification style may appeal differently across genders.

Although gamified apps and social media competitions successfully engage younger patients and reduce plaque buildup, maintaining long-term motivation remains a challenge. Evidence suggests that the efficacy of digital interventions may decline over time, highlighting the need for structured and repeated reinforcement (Discepoli et al., 2021). Zotti et al. (2019) observed that compliance in the control group began to decline, whereas WhatsApp-engaged patients maintained their behavior more consistently, suggesting that sustained social interaction may extend the motivational effect. Notably, Shim (2020) found no significant benefit of

text message reminders in patients who already had good baseline oral hygiene, suggesting that the benefit of digital interventions may depend on the patient's pre-treatment hygiene status.

Clinically, these technologies offer major practical benefits beyond mere compliance. The reported reduction in in-office visits (Torres et al., 2023) optimizes the practice workflow without compromising precision, as AI accurately tracks the tooth movement. However, current AI tools exhibit some variability in decision-making and should be utilized as supportive tools rather than replacements for professional clinical judgment (Polizzi et al., 2025).

AI monitoring platforms that capture intraoral images and track patient behavior raise important data privacy issues. Few, if any, of the included studies explicitly addressed patient data security or compliance with health data regulations, representing a gap in the current literature that warrants attention as these technologies become more widely adopted.

Limitations

Several limitations should be acknowledged. There was considerable heterogeneity in the types of digital interventions used, outcome measures reported, and populations studied, which limited direct comparisons across studies. Furthermore, all reviewed interventions require smartphone access and reliable Internet connectivity, raising concerns about digital equity. Patients from lower socioeconomic backgrounds may be less likely to access these tools.

Although the reported reduction in in-office visits implies potential cost savings, cost-effectiveness was not a primary focus in the reviewed studies, and formal analyses accounting for platform subscription fees and clinician review time are lacking.

It is also important to consider that patients may improve their behavior simply because they are aware of being monitored (the Hawthorne effect), and most of the included studies could not fully control this bias. In studies where the control group received no digital contact at all, the observed difference may partially reflect attention rather than the specific intervention content. Future trials should consider active control groups that receive equivalent digital contact without specific intervention content.

Finally, the risk of publication bias should be acknowledged: studies reporting positive outcomes of digital interventions may be more likely to be published, potentially inflating the apparent effectiveness observed in this review. The purposive selection approach used in this narrative review means that relevant studies may have been missed, and the findings should not be interpreted as a comprehensive synthesis of all the available evidence.

Future research should address several key gaps: (1) conducting randomized trials with extended follow-up periods to determine whether compliance improvements are sustained over time; (2) performing head-to-head comparisons of various digital platforms; and (3) conducting cost-effectiveness analyses to guide clinical decision making.

5. Conclusions

Digital health interventions, including mobile applications and AI-powered monitoring platforms, show promise as supplementary tools for personalized orthodontic care, with evidence of improvements in patient compliance and oral hygiene, although they are limited by study heterogeneity. The effectiveness of these interventions appears to vary according to the intervention design and patient characteristics. Future research should prioritize long-term randomized trials, platform comparisons, and cost-effectiveness analyses to guide the clinical implementation of these technologies.

All authors have read and agreed to the published version of the manuscript.

Funding Statement: The study did not receive any external funding.

Conflict of Interest Statement: The authors declare no conflicts of interest.

Declaration of the use of generative AI and AI-assisted technologies in the writing process: The authors used Google Gemini to improve the language and readability of the text. All AI suggestions were verified by the authors, who remain responsible for scientific content.

REFERENCES

1. Al-Abdallah, M., Hamdan, M., & Dar-Odeh, N. (2021). Traditional vs digital communication channels for improving compliance with fixed orthodontic treatment: A randomized controlled trial. *The Angle Orthodontist*, 91(2), 227–237. <https://doi.org/10.2319/062720-589.1>
2. Almoammar, S. (2024). The role of tele-orthodontics in enhancing patient compliance and treatment monitoring. *Journal of Pharmacy & Bioallied Sciences*, 16(Suppl. 3), S2676–S2678. https://doi.org/10.4103/jpbs.jpbs_368_24
3. Asarsa, S. K., Manisha, Mehta, M., Madhad, V., Gnanasagar, W. R., & Hema, P. (2025). Effects of digital health interventions on oral hygiene and treatment compliance in orthodontic patients: A systematic review. *International Journal of Orthodontic Rehabilitation*, 16(1). <https://doi.org/10.56501/intjorthodrehabil.v16i1.1224>
4. Balbaa, N., Hamza, M., Abdelaziz, W. E., & Adham, M. (2026). Effectiveness of mobile oral health intervention on orthodontic patients' oral hygiene and oral health literacy: A randomised controlled clinical trial. *BMC Oral Health*, 26, Article 113. <https://doi.org/10.1186/s12903-025-07423-y>
5. Choi, E. M., Park, B. Y., & Noh, H. J. (2021). Efficacy of mobile health care in patients undergoing fixed orthodontic treatment: A systematic review. *International Journal of Dental Hygiene*, 19(1), 29–38. <https://doi.org/10.1111/idh.12459>
6. Discepoli, N., Mirra, R., Marruganti, C., Beneforti, C., & Doldo, T. (2021). Efficacy of behaviour change techniques to improve oral hygiene control of individuals undergoing orthodontic therapy: A systematic review. *International Journal of Dental Hygiene*, 19(1), 3–17. <https://doi.org/10.1111/idh.12468>
7. Farhadifard, H., Soheilifar, S., Farhadian, M., Kokabi, H., & Bakhshaei, A. (2020). Orthodontic patients' oral hygiene compliance by utilizing a smartphone application (Brush DJ): A randomized clinical trial. *BDJ Open*, 6, Article 18. <https://doi.org/10.1038/s41405-020-00050-5>
8. Firth, F., Bennani, F., Stacknik, S., & Farella, M. (2019). Orthodontic patient co-operation: A review of the clinician's role in predicting and improving patient compliance. *Australasian Orthodontic Journal*, 35(1), 5–12. <https://doi.org/10.21307/aoj-2020-027>
9. Hansa, I., Semaan, S. J., Vaid, N. R., & Ferguson, D. (2018). Remote monitoring and “tele-orthodontics”: Concept, scope and applications. *Seminars in Orthodontics*, 24(4), 470–481. <https://doi.org/10.1053/j.sodo.2018.10.011>
10. Homsy, K., Snider, V., Kusnoto, B., Atsawasuwan, P., Viana, G., Allareddy, V., Gajendrareddy, P., & Elnagar, M. H. (2023). In-vivo evaluation of artificial intelligence driven remote monitoring technology for tracking tooth movement and reconstruction of 3-dimensional digital models during orthodontic treatment. *American Journal of Orthodontics and Dentofacial Orthopedics*, 164(5), 690–699. <https://doi.org/10.1016/j.ajodo.2023.04.019>
11. Kazimierczak, N., Kazimierczak, W., Serafin, Z., Nowicki, P., Nożewski, J., & Janiszewska-Olszowska, J. (2024). AI in orthodontics: Revolutionizing diagnostics and treatment planning—A comprehensive review. *Journal of Clinical Medicine*, 13(2), Article 344. <https://doi.org/10.3390/jcm13020344>
12. Nair, R. (2025). Enhancing clear aligners therapy with artificial intelligence and technology. *Journal of Pharmacy & Bioallied Sciences*, 17(Suppl. 3), S2671–S2673. https://doi.org/10.4103/jpbs.jpbs_815_25
13. Polizzi, A., Serra, S., Leonardi, R., & Isola, G. (2025). Clinical applications of artificial intelligence in teleorthodontics: A scoping review. *Medicina*, 61(7), Article 1141. <https://doi.org/10.3390/medicina61071141>
14. Pubalan, S., Hong, O. Z., Yongxian, T., & Mabel, L. (2024). Assessing effectiveness of WhatsApp messaging program in oral hygiene care for orthodontic patients: A randomised controlled trial. *Journal of Orthodontics*, 51(4), 407–414. <https://doi.org/10.1177/14653125241230561>
15. Santos, J. B., Pereira, L. C., Neves, J. G., Pithon, M. M., & Santamaria, M. (2021). Can text messages encourage flossing among orthodontic patients? *The Angle Orthodontist*, 91(5), 650–655. <https://doi.org/10.2319/012121-61.1>
16. Shim, J. (2020). *Effects of active reminders and motivational techniques on oral hygiene and gingival health in orthodontic patients: A randomized clinical trial* [Master's thesis, Virginia Commonwealth University]. <https://doi.org/10.25772/AVV3-XM31>
17. Snider, V., Homsy, K., Kusnoto, B., Atsawasuwan, P., Viana, G., Allareddy, V., Gajendrareddy, P., & Elnagar, M. H. (2023). Effectiveness of AI-driven remote monitoring technology in improving oral hygiene during orthodontic treatment. *Orthodontics & Craniofacial Research*, 26(Suppl. 1), 102–110. <https://doi.org/10.1111/ocr.12666>
18. Sosiawan, A., Jordana, J., Dhywinanda, D. E., Salim, J. F., Ramadhani, N. F., Nurdiansyah, R., Ardani, I. G. A. W., & Nugraha, A. P. (2022). Artificial intelligence driven dental monitoring and surveillance of malocclusion treatment in orthodontic patients. *World Journal of Advanced Research and Reviews*, 16(3), 049–053. <https://doi.org/10.30574/wjarr.2022.16.3.1294>

19. Srivastava, A., Agrawal, P., Baggaa, D. K., & Priya, K. (2025). The digital transformation of orthodontics: From clinic to clicks. *Journal of Scientific and Technical Research*, 15(2), 86–91. <https://doi.org/10.21863/jstr/2025.15.2.009>
20. Thurzo, A., Kurilová, V., & Varga, I. (2021). Artificial intelligence in orthodontic smart application for treatment coaching and its impact on clinical performance of patients monitored with AI-TeleHealth system. *Healthcare*, 9(12), Article 1695. <https://doi.org/10.3390/healthcare9121695>
21. Torres, D. K. B., Santos, M. C. C. D., & Normando, D. (2023). Is teledentistry effective to monitor the evolution of orthodontic treatment? A systematic review and meta-analysis. *Dental Press Journal of Orthodontics*, 28(4), Article e2322195. <https://doi.org/10.1590/2177-6709.28.4.e2322195.oar>
22. Zotti, F., Dalessandri, D., Salgarello, S., Piacino, M., Bonetti, S., Visconti, L., & Paganelli, C. (2016). Usefulness of an app in improving oral hygiene compliance in adolescent orthodontic patients. *The Angle Orthodontist*, 86(1), 101–107. <https://doi.org/10.2319/010915-19.1>
23. Zotti, F., Zotti, R., Albanese, M., Nocini, P. F., & Paganelli, C. (2019). Implementing post-orthodontic compliance among adolescents wearing removable retainers through WhatsApp: A pilot study. *Patient Preference and Adherence*, 13, 1587–1595. <https://doi.org/10.2147/PPA.S200822>