



Research Article

Patient-reported Subjective Outcomes on Tooth Whitening Procedures

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Abstract. Introduction: Tooth whitening procedures have gained popularity. Whilst it is important to evaluate the clinical effectiveness of these bleaching products, the patients' opinion on their clinical experience should be investigated.

Aims and Objective: This second article aims to report on the participants' self-reported subjective evaluation of their tooth whitening experience.

Material and Methods: 127 participants were invited to join the study and 77 were enrolled in the study according to the selection criteria. They were randomly divided into 8 groups, each group receiving a different tooth-bleaching product. Clinical data collection was performed at 4 different time points. Patients' subjective outcomes were measured before and at the end of the observation period with pre-piloted questionnaires.

Results: Significant changes between products, from pre-treatment (T0) to 1-month after treatment (T3), were observed, with two products clinically underperforming ($p < 0.05$). Eighty-two percent of participants reported that they would undergo another whitening procedure, whilst 42.5% indicated that tooth whitening was a motivational factor for them to improve and maintain their oral health status.

Patient-reported sensitivity was significantly highest for the Ultradent Opalescence PF HK group ($P \leq 0.001$). Bi- and multi-variate analyses of patients' self-reported levels of satisfaction indicated that patients were able to discern clinical changes. They reported the highest satisfaction rates for Philips Zoom ($P \leq 0.001$) and dissatisfactions with two of the bleaching products.

Conclusions: Patients detected clinical changes and their satisfaction was overall very positive, although some products performed below expectations. Tooth whitening procedures appeared to be a motivational tool.

Keywords: tooth whitening, patient-reported outcomes, oral health

1 Introduction

People are constantly judged by their physical appearance and attractiveness (Hassebrauck, 1998). The issue of appearance goes beyond just mere beauty; it affects psychological well-being as well as social interactions (Patzner, 1997). Evidence shows that the perception of attractiveness lies in a triangular shape with emphasis mainly on eyes, nose and mouth (Mondelli et al., 2012). The individual's smile is pivotal when evaluating facial attractiveness and overall assessment (Otta et al., 1996). Indeed, subjects are more self-aware of their tooth discolouration, and younger people attribute higher importance to colour shade as compared to older individuals (Alkhatib et al., 2004). This great demand for facial appearance has transformed dentistry from a profession that addresses 'functional needs' to one driven by 'aesthetic requisites' of the patient (Reis et al., 2011). Unlike Europe, millions of people in the United States have whitened their teeth over the past two decades without any serious adverse reactions reported in the literature (G. C. Heymann et al., 2010). The American Academy of Cosmetic Dentistry had declared that at the beginning of the year 2015, the annual revenue in the tooth whitening sector rose to eleven billion dollars. In New Zealand, a study was carried out to investigate the response of people opting for aesthetic intervention. The response rate was that of 81.2% with 77.8% opting for tooth whitening as opposed to veneers that were selected by 54.8%. This study continued to elaborate that 97% of patients reported asking for a tooth whitening treatment while the percentage of dentists re-

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commending a whitening treatment to their patients was 37.9%. Since the demand for a 'perfect smile' especially in Western society is on the increase, the dental profession should be better prepared (Comunidade et al., 2012). Even though tooth whitening is not destructive to teeth, it still has its disadvantages such as tooth sensitivity and gingival irritation. These appear to be dose and technique related (Hatherell et al., 2011). Evidence has shown that as long as protocols are adhered to, tooth whitening results can last up to 17 years. Some people like to top-up after three years while others like to top up every month. Topping up every month is not required as long as the initial treatment of whitening had been reached effectively and proper maintenance is instituted (Greenwall, 2016). In a previous study, we reported on the clinical effectiveness of In-Office and At-Home tooth whitening kits. One of the most important findings of this study was that a considerable number of the participants who volunteered and who were eligible for the study required prior dental treatment to optimise their oral health. This underscores a very important issue that tooth-whitening procedures should be carried out by properly qualified professionals who can diagnose oral health issues. Regrettably, Over Counter (OTC) products are readily available in various settings, beyond properly registered dental clinics. Patients might not be aware of ongoing oral health issues and failure to interact with a dental professional may allow oral pathology to go unnoticed and preclude timely dental treatment. In this study, we report participants' subjective evaluation of their tooth whitening experience by exploring post-treatment sensitivity and satisfaction.

2 Materials and Methods

The study design was a prospective cohort study. Ethical approval for the research project was obtained. (UREC-DP 1801011DSG - DSG-2017-18-008). Details of the recruitment process and clinical procedures were discussed previously (Alzoubi et al., 2020). The participation was voluntary following a social media posting and all eligible subjects were selected based on inclusion and exclusion criteria (see table 1).

Participants were randomly allocated to one of the eight 'Tooth Whitening Product' groups as outlined in table 2.

All patients received a clinical examination, oral prophylaxis and oral health instructions. Pre-treatment questionnaire was completed. Subsequently, impressions were taken for those patients allocated to the products requiring customised whitening trays for home use. Each whitening treatment was carried out according to the manufacturer's instructions. A one-use demonstration, following the manufacturer's directions, was given to the participants allocated the home kit. All participants re-

ceived oral hygiene instructions and whitening maintenance advice based on the manufacturer's direction.

Shade measurements using the VITA Easyshade® V digital spectrophotometer (VITA Zahnfabrik, Germany) were carried out 1 month before the treatment (T0), on the day of treatment after bleaching (T1), 2 weeks after the treatment (T2) and 1 month after the treatment (T3). Sequential shade readings were compared and the change in shade from the original pre-treatment reading was calculated to obtain the change in bleaching scores. The participants were asked to complete a second post-treatment questionnaire at the 1-month visit (T3). The pre-treatment (Before-BT) and post-treatment (After-AT) questionnaires included open and close-ended questions, which were later categorised for statistical analysis. The first section collected demographic data such as age, gender and occupation. Subsequent sections questioned medical health conditions, dietary habits, smoking history, oral hygiene self-care (OHSC) habits, knowledge on professional oral prophylaxis and knowledge of EU law regarding tooth whitening procedures.

The AT questionnaire was relatively similar to the BT questionnaire however it further asked participants if they would consider future whitening procedures. It also included two scales measuring tooth sensitivity and patient satisfaction with the results of the whitening procedures. Both questions utilised a scale from 0-10 with zero (0) indicating no sensitivity or unsatisfied with the whitening outcomes, whilst 10 signified extreme sensitivity resulting in pain or complete satisfaction with the whitening outcomes. Both questionnaires were previously piloted on a small group of patients prior to their use in the study.

2.1 Statistical Analysis

All data was put on an Excel sheet. The results were tabulated and analysed with computer software (SPSS software IL, USA). Demographic data collected were analysed to establish homogeneity between the different groups. Data derived from the history and examination of each patient were analysed per group, to assess the effectiveness of the product. The shade readings (VITA Bleaching Score Index) for all the groups were compared together. Questionnaires were used to assess the patients' subjective points of view. Categorical data were analysed by the Chi-square test. The Kruskal-Wallis H Test allowed between groups analysis of the non-parametric continuous scores derived from the various groups. Statistical significance was set at $p < 0.05$

3 Results

One hundred twenty-seven (127) subjects agreed to participate in the study. Following dental examination, 77 sub-

Inclusion Criteria	Exclusion Criteria
Be at least 18 years of age.	Medically compromised patients.
Able to voluntarily consent.	Smoking Habits.
Willing to participate in the post-whitening phase and no prior whitening treatment experience.	Requiring dental treatment due to caries and/or poor oral hygiene.
Presence of all maxillary and mandibular teeth.	Oral pathology requiring immediate care.
Anterior teeth have no restorations.	Previous stains due to Tetracycline.
Absence of Hypersensitivity.	Pregnancy or lactating.

Table 1: Inclusion and Exclusion Criteria to participate in the study

Group	Intervention
Group 1	Philips Zoom Speed In Office; 6% HP
Group 2	Beyond Osmo In Office; 6% HP
Group 3	Philips Zoom Home-kit (daywear); 6% HP
Group 4	Beyond Corewhite Home-kit (daywear); 6% HP
Group 5	Ultradent Opalescence PF for at-home use (night wear); 18% CP
Group 6	Ultradent Opalescence GO for at-home use (day wear); 6% HP
Group 7	PearlSmile Standard Treatment on cosmetic chair; <0.1% HP
Group 8	Pearl Light Home-Kit at home; <0.1% HP

Table 2: Whitening Products allocated to each Group

jects (61%) were eligible for this study, based on the inclusion and exclusion criteria. Participants were excluded due to dental decay, suboptimal oral hygiene and the need for the dental treatment necessary before tooth whitening procedures. The eligible participants in the study (44 females and 33 males) varied in age from 18 to 60+, however, 65% were between the ages of 18 and 25 years. Normality Tests revealed that gender distribution, medical health conditions, dietary habits, smoking history, oral hygiene self-care (OHSC), knowledge on professional oral prophylaxis and knowledge of EU law on tooth whitening procedures were normally distributed.

3.1 Participants' Change in Bleaching Scores

Figure 1 presents the average change in the bleaching scores as measured with the 3D Master Bleaching Score. Significant differences in results between products, from pre-treatment (T0) to 1-month after treatment (T3), were observed, with two products clinically underperforming.

3.2 Participants' opinions for future tooth whitening treatment

The majority of participants, 82%, reported that they would undergo another whitening procedure. 42.5% of the participants indicated that tooth whitening was a motivational factor for them to improve and maintain their oral health status (see figure 2).

3.3 Patient Self-reported Knowledge of EU legislation on Tooth Whitening

Figure 3 clearly shows that the vast preponderance of the participants are unaware of or have poor knowledge of legislation governing the use of tooth whitening products.

3.4 Patient Self-reported Tooth Sensitivity

Figure 4 presents the patients' self-reported post-treatment levels of tooth sensitivity. Patients reported the highest tooth sensitivity with Ultradent Opalescence PF HK.

3.5 Patient Self-Reported Treatment Satisfaction

Patients' post-treatment satisfaction scores are presented in figure 5. Philips Zoom Home kit showed the highest satisfaction as opposed to the Pearl light Home kit which had the least satisfaction average.

Table 3 shows that the linear regression model for post-treatment patient satisfaction. The model is significant and the patients' self-reported satisfaction levels is explained by the type of bleaching product, the individual's educational level and the initial change in the shade as measured by the Bleaching score for the upper right can-

ine.

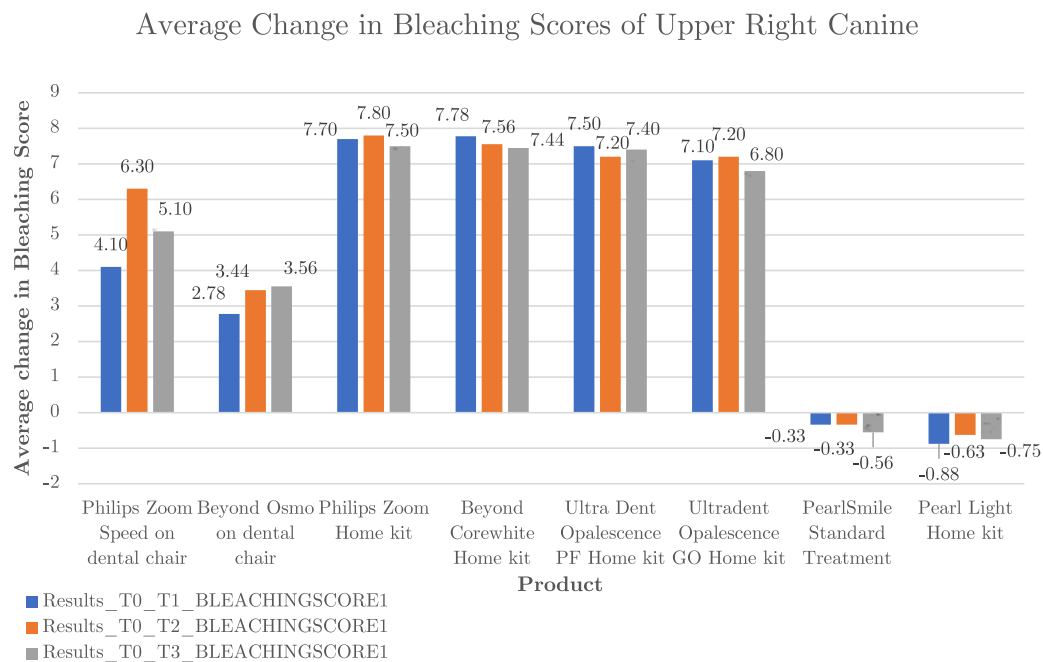
Table 4 shows the generalised linear model differences for the type of bleaching products and clearly shows that two particular types of bleaching agents performed much worse than the rest.

4 Discussion

A rise in the demand for tooth whitening procedures has been observed over these past two decades (Kwon et al., 2015). In North America, teeth whitening procedures are common, with no serious adverse reaction reported in the literature (H. O. Heymann, 2005). This study was carried out to evaluate patients' self-reported subjective outcomes on tooth whitening procedures. The levels of tooth sensitivity and patient satisfaction when comparing eight tooth-whitening products together- five At Home kits (HK) and three In-office Kits (IO), were explored. The objective measurements of the clinical effectiveness of the tooth whitening products studied were reported in a previous paper (Alzoubi et al., 2020).

In this study, patients reported the highest levels of tooth sensitivity with the Ultradent Opalescence PF home kit product. The latter has 18% Carbamide Peroxide (CP) and had to be applied for 4-6 hours for two weeks. Although patients reported these findings, the tooth sensitivity per se may not necessarily be linked with the teeth whitening products as the patients may have had a previous history of sensitive teeth and the procedure might have exacerbated it (Perdigão et al., 2004). One must also consider that as the product is a home kit, the clients may have overused the product with respect to the dosage and time exposure, leading to increased sensitivity (Li et al., 2013). Notwithstanding, one must also point out that these trends were not observed with other the home kits used in this study.

Moreover, this study observed that patients still reported tooth sensitivity with products that had lower hydrogen peroxide concentrations. Indeed, patients who received both Pearl Light HK and PearlSmile Standard Treatment still reported tooth sensitivity despite having 0.1% or less Hydrogen Peroxide (H_2O_2) concentrations. This result is not in accordance with evidence that peroxide concentration and procedural time had an impact on the reported sensitivity (Kossatz et al., 2011). This study's finding, that patients still reported tooth sensitivity even with the use of a product with a dosage of $\leq 0.1\%$ HP product, underscored certain points: firstly, it is in accordance with what was reported earlier that the concentration of HP had no impact on tooth sensitivity (Mondelli et al., 2012), secondly, that the relation between tooth sensitivity and bleach concentration in tooth whitening products is still a grey area that requires further clin-



T0–T3 Bleaching Score 1:* Kruskal–Wallis Test: $p = 0.121$. (Zoom In-office/Pearlsmile Standard Treatment)
 T0–T3 Bleaching Score 1:* Kruskal–Wallis Test: $p = 0.119$. (Zoom In-office/Pearl Light Home-kit)
 T0–T3 Bleaching Score 1:* Kruskal–Wallis Test: $p = 0.02$. (Zoom Home-kit/Pearlsmile Standard Treatment)
 T0–T3 Bleaching Score 1:* Kruskal–Wallis Test: $p = 0.02$. (Zoom Home-kit/Pearl Light Home-kit)
 T0–T3 Bleaching Score 1:* Kruskal–Wallis Test: $p = 0.004$. (Beyond CoreWhite/Pearlsmile Standard Treatment)
 T0–T3 Bleaching Score 1:* Kruskal–Wallis Test: $p = 0.004$. (Beyond CoreWhite/Pearl Light Home kit)
 T0–T3 Bleaching Score 1:* Kruskal–Wallis Test: $p = 0.003$. (Opalescence PF/ Pearlsmile Standard Treatment)
 T0–T3 Bleaching Score 1:* Kruskal–Wallis Test: $p = 0.003$. (Opalescence PF/ Pearl Light Home kit)
 T0–T3 Bleaching Score 1:* Kruskal–Wallis Test: $p = 0.008$. (Opalescence GO/ Pearlsmile Standard Treatment)
 T0–T3 Bleaching Score 1:* Kruskal–Wallis Test: $p = 0.008$. (Opalescence GO/Pearl Light Home kit)

Figure 1: Average change in Bleaching Score compared to other Products (Tooth 13) T0- pre-treatment; T1- immediately after treatment; T2- two weeks after treatment; T3- one month after treatment.

Variable	Parameter Estimate (β)	Standard Error	p -value
(Constant)	11.246	2.582	.000
Type of Bleaching Product	-.473	.149	.002
Age	-.514	.388	.190
Gender	.157	.650	.810
Nationality	.186	.764	.809
Educational Level	-.619	.318	.051
Occupation	-.044	.142	.757
Results_T0_T1_BLEACHINGSORE1	.188	.091	.044
Results_T0_T1_BLEACHINGSORE2	-.010	.125	.937
Results_T0_T1_BLEACHINGSORE3	-.028	.122	.819

$$F = 4.042; p = 0.0001; R^2 = 0.374$$

Table 3: Linear Regression Model for Post Treatment patient's self-reported Satisfaction Levels.

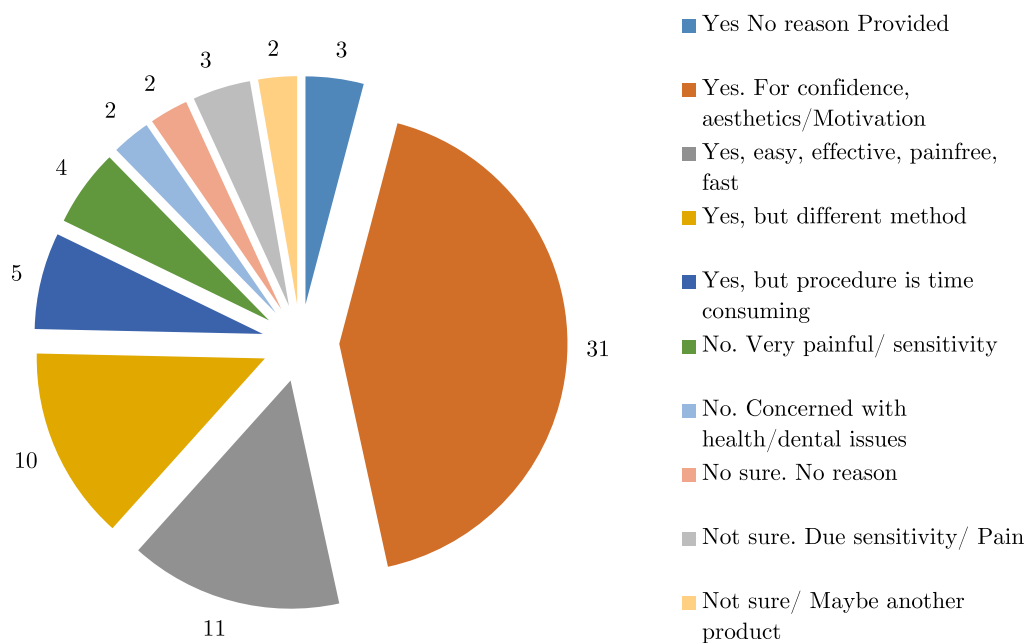


Figure 2: Participants' Opinions for future tooth Whitening Treatment.

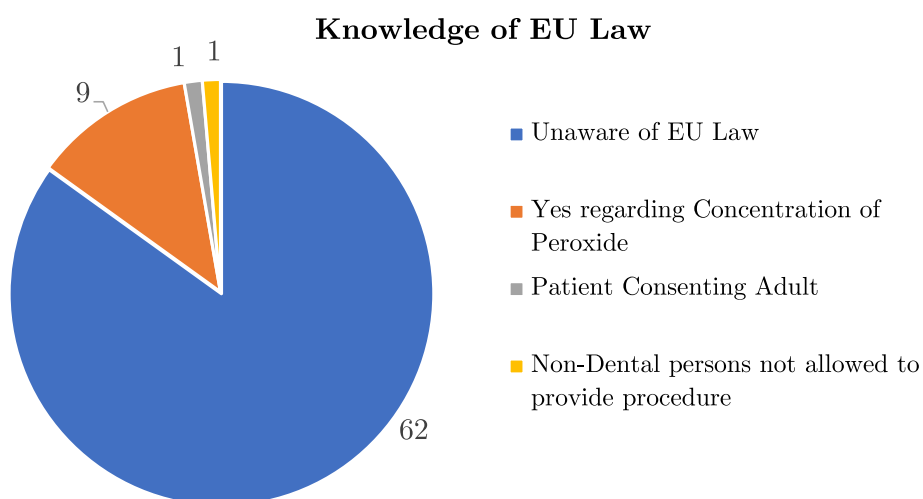
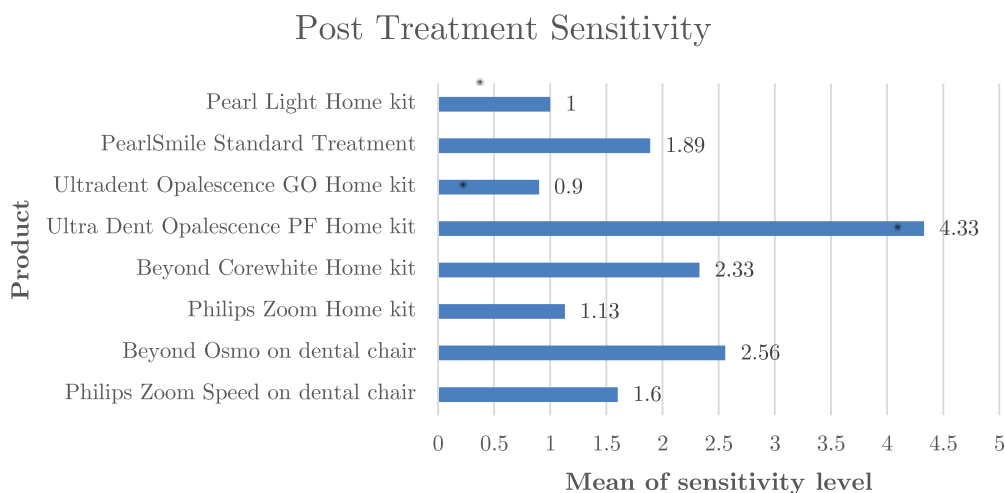
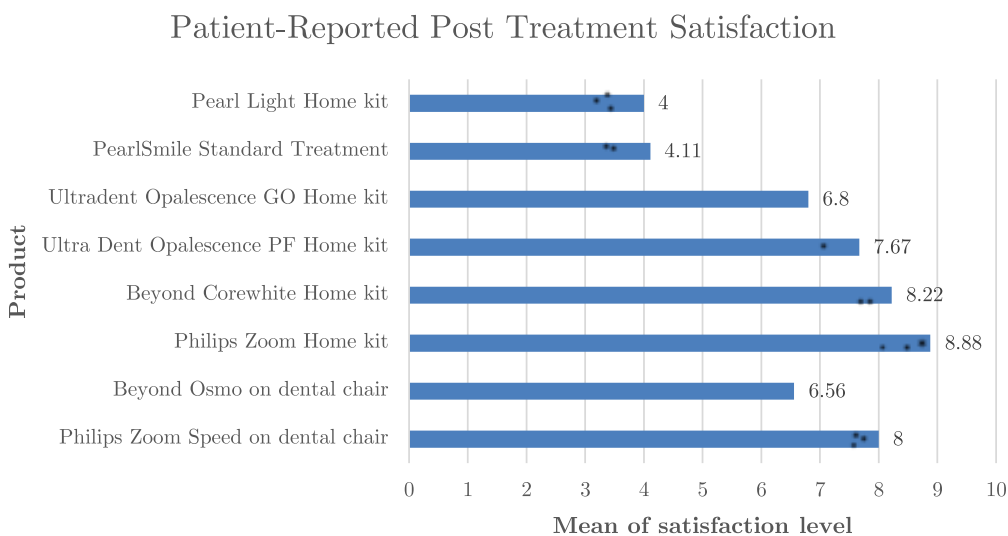


Figure 3: Participants' Knowledge on tooth Whitening Treatment under EU law.



* Kruskal–Wallis Test: $p = 0.037$. (Opalescence PF Home kit/ Opalescence GO Home kit) * Kruskal–Wallis Test: $p = 0.040$. (Opalescence PF Home kit/ Pearl Light Home kit)

Figure 4: Mean Scores of Tooth Sensitivity.



Kruskal–Wallis Test: $p = 0.015$. (Zoom in-office/Pearl Smile Standard Treatment)
 Kruskal–Wallis Test: $p = 0.011$. (Zoom in-office/Pearl Light Home-kit)
 Kruskal–Wallis Test: $p = 0.002$. (Zoom Home-kit/Pearl Smile Standard Treatment)
 Kruskal–Wallis Test: $p = 0.002$. (Zoom Home-kit/ Pearl Light Home kit)
 Kruskal–Wallis Test: $p = 0.011$. (Beyond Core White/ Pearl Smile Standard Treatment)
 Kruskal–Wallis Test: $p = 0.008$. (Beyond Core White/Pearl Light Home kit)
 Kruskal–Wallis Test: $p = 0.05$. (Ultra Dent Opalescence PF Home Kit /Pearl Smile Standard Treatment)
 Kruskal–Wallis Test: $p = 0.008$. (Ultra Dent Opalescence PF Home Kit /Pearl Light Home kit)
 Kruskal–Wallis Test: $p = 0.038$. (Opalescence PF/Pearl Light Home kit).

Figure 5: Mean Scores of Patient-reported Satisfaction with Whitening Products.

Type of Bleaching Product	Mean	Std. Error	95% Wald Confidence Interval		Sig.
			Lower	Upper	
(Intercept)					.000
Philips Zoom Speed In Office	8.00	.694	6.64	9.36	.000
Beyond Osmo In Office	6.56	.731	5.12	7.99	0.13
Philips Zoom Home kit	8.88	.775	7.36	10.39	.000
Beyond Core White Home kit	8.22	.731	6.79	9.66	.000
Ultradent Opalescence PF Home kit	7.67	0.731	6.23	9.10	.000
Ultradent Opalescence GO Home kit	6.80	.694	5.44	8.16	.005
PearlSmile Standard Treatment in Office	4.11	.731	2.68	5.54	.914
Pearl Light Home kit	4.00	.731	2.57	5.43	.926

Dependent Variable: Post-treatment Patient Satisfaction. $p = 0.0001$

Table 4: Linear Regression Model for Post Treatment patient's self-reported Satisfaction Levels.

ical studies to explore the underlying reasons and, lastly, that these products should be curtailed to professional use only, as adverse reactions can only be dealt with by dental professionals. The implications of the latter observation are more pronounced when one considers that 39% of the patients who attended these tooth-whitening procedures were clinically unsound and required optimisation of their oral health prior to the application of these whitening procedures. Additionally, omitting the dental examination stage might mean missing serious conditions such as pre-malignant or malignant lesions in the oral cavity. Furthermore, foregoing oral prophylaxis prior to teeth whitening also decreases the effectiveness of the bleaching product. When using an over the counter preparation, this stage is more often than not, skipped. This could lead to unsatisfactory outcomes. Patients reported reasonably high levels of satisfaction with the procedures for most of the products, irrespective of the delivery mode. The improvement in aesthetics was perceived by the participants and was a motivational factor to maintain their oral and general health (Richins, 1991). When comparing all products, one can suggest that the Philips Zoom home kit outperformed the other products—patients reported the highest mean satisfaction levels along with the lowest levels of tooth sensitivity. The linear regression model, which was statistically significant, explored the reasons for post-treatment patient self-reported satisfaction. The model identified that patient satisfaction was explained mainly by the type of bleaching product, the educational level of the participant and the initial change in the shade as measured by the Bleaching score. This model explained 37% of the variability observed in the study population. Moreover, when the type of bleaching

product was further explored, the generalised linear model differences for the type of bleaching products clearly shows that two particular products performed much worse than the rest. Indeed all the products were significantly better than these two products. The Pearl Light home-kit and Pearlsmile Standard Treatment both have lower hydrogen peroxide concentrations, and this study suggests that concentrations of 0.1% hydrogen peroxide or less, are not clinically effective for tooth whitening. This indicates that tooth whitening is indeed dependant on HP concentration and also on the duration of treatment, as suggested in previous studies (Meireles et al., 2012).

5 Conclusions

Within the limitations of the study, it can be concluded that patients can detect clinical outcomes. Their satisfaction with the bleaching products was overall very positive, although some products performed below the expectations. There is poor patient knowledge of EU legislation regulating these products. Tooth whitening appears to be a motivational tool. The fact that roughly a third of the study participants required preprocedural optimisation of their oral health highlights the need that these procedures are provided by properly trained oral health care professionals.

References

- Alkhatib, M. N., Holt, R. & Bedi, R. (2004). Prevalence of self-assessed tooth discolouration in the united kingdom. *Journal of Dentis*, 32(2), 561–566.
- Alzoubi, E. E., Elgaroushi, F., Mcberry, I., Gatt, G. & Attard, N. (2020). The effectiveness of tooth whiten-

- ing products in the maltese market: A clinical study. *Xjenza*, 8(5), 67–78.
- Comunidade, S., Leopoldino, S., Filho, C., Monteiro De Castro Machado, F., Ozawa, T. O., De, A., Cavassan, O., De, M. & Cardoso, A. (2012). Bracket/wire play: What to expect from tipping prescription on pre-adjusted appliances. *Dental Press Journal of Orthodontics*, 1717(44), 85–9585.
- Greenwall, L. (2016). Tooth whitening: The last 25 years. *Aesthetic Dentistry Today*, 6(2), 15–19.
- Hassebrauck, M. (1998). The visual process method: A new method to study physical attractiveness. 123, 111–123.
- Hatherell, S., Lynch, C. D., Burke, F. M., Ericson, D. & Gilmour, A. S. M. (2011). Attitudes of final-year dental students to bleaching of vital and non-vital teeth in cardiff, cork, and malmö. *Journal of Oral Rehabilitation*, 38(4), 263–269.
- Heymann, G. C., Tulloch, C. J. F., De Clerck, H. J., Cornelis, M. A. & Cevindanes, L. H. (2010). Orthopedic traction of the maxilla with miniplates: A new perspective for treatment of midface deficiency. *Journal of Oral and Maxillofacial Surgery*, 67(10), 2123–2129.
- Heymann, H. O. (2005). Tooth whitening: Facts and fallacies. *British Dental Journal*, 198(8), 514.
- Kossatz, S., Dalanhol, A. P., Cunha, T., Loguercio, A. & Reis, A. (2011). Effect of light activation on tooth sensitivity after in-office bleaching. *Operative Dentistry*, 36(3), 251–257.
- Kwon, S. R. & Wertz, P. W. (2015). Review of the mechanism of tooth whitening. *Journal of Esthetic and Restorative Dentistry*, 27(5), 240–257.
- Li, Y. & Greenwall, L. (2013). Safety issues of tooth whitening using peroxide-based materials. *British Dental Journal*, 215(1), 29–34.
- Meireles, S. S., Fontes, S. T., Coimbra, L. A. A., Della Bona, Á. & Demarco, F. F. (2012). Effectiveness of different carbamide peroxide concentrations used for tooth bleaching: An in vitro study. *Journal of Applied Oral Science*, 20(2), 186–191.
- Mondelli, R. F. L., de Azevedo, J. F. D. e. G., Francisconi, A. C., de Almeida, C. M. & Ishikiriama, S. K. (2012). Comparative clinical study of the effectiveness of different dental bleaching methods - two year follow-up. *Journal of Applied Oral Science*, 20(4), 435–443.
- Otta, E., Abrosio, F. F. E. & Hoshino, R. L. (1996). Reading a smiling face: Messages conveyed by various forms of smiling. *Perceptual and Motor Skills*, 84(3 suppl.), 1111–1121.
- Patzner, G. L. (1997). Improving self-esteem by improving physical attractiveness. *Journal of Esthetic and Restorative Dentistry*, 9(1), 44–46.
- Perdigão, J., Baratieri, L. N. & Arcari, G. M. (2004). Contemporary trends and techniques in tooth whitening: A review. *Practical Procedures & Aesthetic Dentistry: PPAD*, 16, 3.
- Reis, A., Tay, L. Y., Herrera, D. R., Kossatz, S. & Loguercio, A. D. (2011). Clinical effects of prolonged application time of an in-office bleaching gel. *Operative Dentistry*, 36(6), 590–596.