



Comparison of the Esthetic Perception and Economic Value of Different Removable Orthodontic Retainers for the Upper Arch

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Authors' contributions

This work was carried out in collaboration among all authors. Authors CRMPV, KMSF, PC, FPV conceptualized and designed the study. Authors AMN, EF, RDRM, LVA, KMSF, CRMPV did data acquisition and interpretation. Authors AMN, EF, RDRM, LVA, PC, FPV wrote and prepared the original draft. Authors AMN, EF, RDRM, LVA, PC, FPV, KMSF, CRMPV revised the manuscript. Author AMN did funding acquisition. All authors read and approved the final manuscript.

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ABSTRACT

Objective: This cross-sectional study aimed to compare the esthetic perception and economic value between two maxillary removable retainers, considering gender, age, and socioeconomic status.

Material and Methods: Photographs of the smiles of 2 volunteers using Hawley and Vivera® retainers were evaluated by 408 laypeople who answered a web-based survey with questions regarding participants' characteristics, retainers' esthetic perception, and economic value (willingness to pay). Descriptive statistics were performed, and the responses were analyzed using independent t-test, ANOVA, Tukey test, and chi-square.

Results: Vivera® was considered the most esthetic retainer for both smiles, without a statistically significant difference between raters' genders. Raters over 46 years old judged with statistically significant greater values the Hawley and Vivera® of male smiles ($p=0.01$; $p=0.02$ respectively) and C2 socioeconomic status to the Hawley for the female smile ($p=0.02$). Considering the economic value, both genders and the different status demonstrated a similar willingness to pay more money for Vivera® as well as a similar amount of money they would be willing to pay. Statistically significant associations were observed between age ranges and economic values; more respondents aged between 18-30 years old reported being more willing to pay for Vivera® ($p=0.03$); however, when the value was asked, the participants aged more than 46 years old were more willing to pay greater prices for Vivera® ($p<0.01$).

Conclusion: The Vivera® was considered more aesthetically pleasing, and most laypeople would pay more for this retainer. However, most were willing to pay an extra value smaller than the laboratory's cost difference.

Keywords: Orthodontic retainers; relapse; esthetics; cost-benefit analysis.

1. INTRODUCTION

Orthodontic retainers are routinely used after orthodontic treatments to maintain the occlusal changes obtained and minimize possible alterations resulting from growth and occlusion maturation processes [1].

Most orthodontists worldwide use Hawley plate [2-4] or vacuum-formed retainers [5-7] in the maxillary arch after active orthodontic treatment. Both are removable, so they are "patient-dependent". The reasons described in the literature for not using removable retainers include discomfort, forgetfulness, appliance loss, maladjustment, speech difficulties, and esthetics [8-10]. Besides these factors, the cost of the appliance may determine whether a particular appliance is chosen [11-14].

Nowadays, social media has a great influence, especially in the aesthetic aspects [15]. Advertising in the media plays a prominent role in influencing the patient's decisions [12,16]. Although vacuum-formed retainers may be fabricated in the dental office, some commercial laboratories produce these appliances. Among them the Align Technology Inc., which produces the Vivera® and invests in social media to advertise it. However, the laboratory fee for

Vivera® retainer fabrication is higher than that for Hawley. Because retainer appliance type may be a patient's choice, and esthetic and cost are among the factors that determine this decision, this study was designed. Previous studies evaluated the economic value of orthodontic appliances [11,13,14,17-19]; however, the authors were unaware of studies assessing the retainers. Therefore, the purpose of this study was to test the following null hypothesis: there is no difference in the laypeople's esthetic perception and economic value of the Hawley and Vivera® retainers.

2. MATERIALS AND METHODS

The sample size calculation for questionnaires was performed with a confidence interval of 95% and a margin of error of 5%, considering the population of 2.3 million in Brazil (203.062.512 inhabitants, according to data released by the Brazilian Institute of Geography and Statistics - IBGE, available in 2023). This resulted in a minimum of 384 respondents. The final sample comprised 408 Brazilian adult laypeople of both genders.

The following inclusion criteria were established for the laypeople: adults (over 18 years old) without dental background

and those who agreed to participate in the study. Dental health care professionals were excluded from the study as their personal perceptions and opinions may be influenced by their training and are not likely to represent those of laypeople.

The smiles of 2 volunteers (1 female and 1 male) were photographed. Both were Caucasian, aged 18–25 years, without malocclusion and free of oral pathology. The following maxillary retainers were fabricated for each: Hawley retainer (with conventional stainless steel labial bow) and Vivera® retainer (Align Technology Inc). Two photographs were taken of each volunteer, using both retainers *in situ*. The pictures were taken at a standardized distance by the same operator, in the same environment (artificial light), and subsequently for each volunteer, maintaining a constant distance of one meter from the camera, from the camera. The head was positioned at the natural head position. A SLR camera (EOS Rebel T6, Canon, Oita, Japan) equipped with a 100 mm macro lens (Macro Lens EF 100 mm, Canon, Oita, Japan) and a twin flash (Macro Twin Flash Yongnuo YN-24ex, Guangdong, China) was used.

Image standardization for color, size, and resolution (300 dpi) was performed with Photoshop CC (Photoshop CS6; Adobe System, San Jose, Calif, USA). Most of the nose, chin, and cheeks were removed to reduce the number of variables in the images.

An electronic survey (Google Forms) generated a web-based response platform. The online survey was available for responses from July 22, 2023, to October 23, 2023. The questionnaire's introduction described the informed consent approved by the human research ethics committee, and the subjects were informed about the survey's objectives. At the end of this text the subject should answer if "agree" or "not agree" in participating. For those who answered, "not agree", the questionnaire was automatically closed. The authors posted a link to the survey on Facebook, Instagram, and Twitter and sent it through WhatsApp.

The questionnaire was anonymous. Initially, data regarding participants' characteristics (sex, age, sociodemographic data, and use or not of orthodontic and retainer appliances) were collected. The socioeconomic status was based on the criteria of the Brazilian Association of Research Companies (available at:

<https://www.abep.org/criterio-brasil>) [20], which is a standardized socioeconomic classification based on households, and individuals are categorized into classes according to purchasing power. Points are attributed on a checklist, including schooling of the head of the family, ownership of goods (car, dishwasher, refrigerator, freezer, washing machine, DVD player, microwave oven, motorcycle, clothes dryer), whether the street where the individual lives is paved and connection to the sewage system in the house. Each item answered receives a score, resulting in a rating ranging from A1, which has higher purchasing power, to E, which has lower purchasing power.

In the second part of the questionnaire, the participants were asked to evaluate the esthetic perception of the retainers using a five-point Likert scale. Each photograph was shown with the following question: "Give a score from 1 to 5 concerning the esthetics of this retainer device used to maintain results after orthodontic treatment (1 being unaesthetic device and 5 being very esthetic device)". The raters marked the point of the scale that represented their esthetic perceptions [13,14]. They could view the images more than once, and comparisons between photographs were permitted. Additionally, they could change the answers before sending the questionnaire.

The following set of questions were about the retainer's economic value. The next two pages were illustrated with the two male and female Vivera® photographs labeled "A" and the other two using Hawley plate labeled "B". The first photo composition presented the following question: "Considering the costs (prices) of retainers A and B, answer: Would you pay more for appliance A?". A simple "yes" or "no" answer should be checked (Fig. 1). The questionnaire was closed for the participants who answered "no". For those who answered "yes," another page with the same photo composition was shown, and they were asked: "Assume that retainer appliances shown in picture A are more expensive than those in picture B. How much more money would you be willing to pay for them to be placed on your teeth?". One of the following answers should be marked: to pay an extra of U\$100,00, an extra of U\$200,00, and an extra greater than U\$200,00 (Fig. 2). These economic values were established based on the mean costs for each retainer when the study was designed (Hawley: \$75.00; Vivera®: U\$200.00).

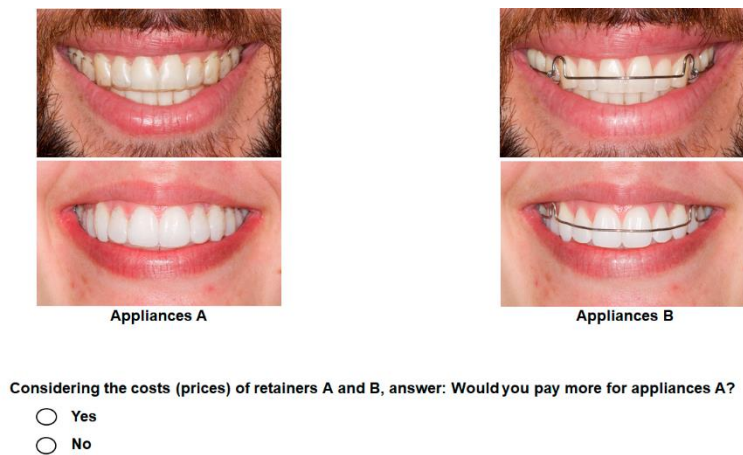


Fig. 1. First question about the retainer's economic value.

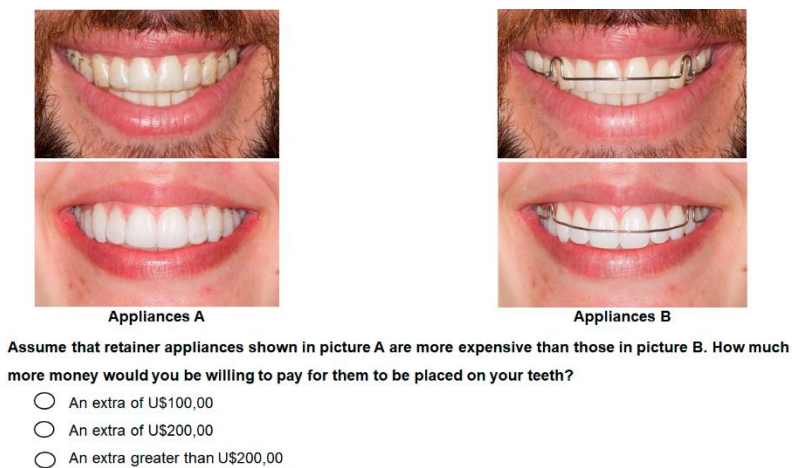


Fig. 2. Question asked for those who answered “yes” to the first question about the retainer's economic value

A structured questionnaire was developed and tested on a pilot population before its administration. The pilot study was done in three stages (pre-piloting among the authors' peers and two cycles of piloting among the same 15 laypeople adults in each phase) to evaluate the clarity of the questions and the language used [21]. Some words were rewritten with synonyms based on the comments, so people were more likely to understand. The pilot study participants were not included in the main study.

Descriptive statistics were performed. Intrarater reliability was evaluated by asking 50 participants to fill out the questionnaire a second time 4 weeks after their initial attempt. To assess attractiveness, the Intraclass Correlation Coefficient (ICC) was applied. For economic

value questions, we assessed intrarater reliability using Cohen kappa test. Data normality was demonstrated by the Shapiro-Wilk test. The esthetic perception intergroup comparison was performed using the independent t-test, ANOVA, and Tukey test. Associations were evaluated with a chi-square test. The level of significance was set at $p < 0.05$. The software SPSS (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp) was used to evaluate the data.

3. RESULTS

A total of 412 individuals accessed the link; however, four declined to participate. Therefore, the total sample consisted of 408 adult laypeople. The participants' characteristics are shown in Table 1.

Table 1. Participants' characteristics

	n	%
Gender		
Male	165	40.44
Female	243	59.56
Age (Years)		
18 – 30	172	42.16
31 – 45	107	26.23
> 45	129	31.61
Region		
North	12	2.90
Northeast	45	11.00
Midwest	19	4.60
Southeast	229	56.00
South	104	25.40
Socioeconomic status		
A	175	42.89
B1	90	22.06
B2	95	23.28
C1	28	6.86
C2	17	4.17
DE	3	0.74
Orthodontic appliance in use		
Yes	47	11.52
No	361	88.48
Orthodontic appliance in the last 3 years		
Yes	105	25.74
No	303	74.26
Orthodontic retainer in use		
Yes	132	32.35
No	276	67.65

The intrarater reliability of participant responses about the attractiveness of the retainers was strong, with a mean ICC of 0.87 (95% CI=0.49–0.94). The intrarater reliability for economic value questions ranged from moderate ($\kappa=75$, 95% CI = 0.46–1.04) to perfect agreement ($\kappa=1$, 95% CI=1-1).

The maximum score (5) was given by 290 raters in Vivera®'s photograph of the male smile and 325 respondents for the same retainer on the female smile. Vivera® was voted the most esthetic retainer for both smiles, demonstrating statistically significant greater values for both respondents' genders (Table 2).

The comparison between the age range of the respondents and the scores given to the retainers' esthetic perception showed statistically significant differences for both retainers in male smiles (Hawley $p<0.01$; Vivera®: $p=0.02$), demonstrating that raters aged more than 46 years old judged with greater values (Table 3).

Considering the socioeconomic status, the scores given by C2 status were statistically significantly greater when Hawley retainer for the female smile was rated (Table 4).

Most respondents reported a willingness to pay more to buy the Vivera® retainer (Tables 5, 6, 7) without a statistically significant difference between the genders and socioeconomic status (Tables 5, 7).

The different age ranges evaluated showed statistically significant differences in the willingness to pay more for Vivera® ($p=0.03$) and how much more money they would be able to pay ($p<0.01$), Table 6. More frequently, the respondents between 18 and 30 years old were willing to pay more. However, when asked how much extra money they would be willing to pay, the participants over 46 years old showed a greater willingness to pay a value greater than U\$200,00 for the more esthetic retainer.

Table 2. Mean values and standard deviations (SD) of the esthetic perceptions of Hawley and Vivera® of male and female smiles and comparisons between the raters' genders

General esthetic perception			
	HAWLEY	VIVERA®	
	Mean (SD)	Mean (SD)	p-value*
Male smile	2.66 (1.26)	4.62 (0.69)	<0.00
Female smile	2.74 (1.23)	4.74 (0.58)	<0.00
Esthetic perception according to gender's rater			
	MALE RATERS	FEMALE RATERS	
	Mean (SD)	Mean (SD)	p-value*
Hawley male	2.76 (1.20)	2.59 (1.29)	0.16
Vivera® male	4.62 (0.62)	4.61 (0.74)	0.82
Hawley female	2.84 (1.22)	2.67 (1.24)	0.17
Vivera® female	4.73 (0.60)	4.75 (0.56)	0.65

*independent t-test results

Statistically significant difference at $p < 0.05$

Table 3. Comparison of the esthetic perception among the age ranges of the raters to Hawley and Vivera® for male and female smiles

Age range (years)	18-30	31-45	More than 46	p-value
Retainer type	Mean (SD)	Mean (SD)	Mean (SD)	
HAWLEY Male	2.55 (1.19) ^A	2.44 (1.13) ^A	2.98 (1.39) ^B	<0.01
VIVERA® Male	4.53 (0.72) ^A	4.60 (0.74) ^{AB}	4.74 (0.60) ^B	0.02
HAWLEY Female	2.68 (1.17) ^A	2.59 (1.13) ^A	2.95 (1.37) ^A	0.05
VIVERA® Female	4.70 (0.57) ^A	4.77 (0.59) ^A	4.78 (0.57) ^A	0.39

*ANOVA and Tukey test results.

Different capital letters in the same row indicate statistically significant differences (Tukey test).

Table 4. Comparison of the esthetic perception among the socioeconomic status of the raters to Hawley and Vivera® for male and female smiles

Status	A	B1	B2	C1	C2	DE	p-value*
Retainer	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
HAWLEY Male	2.5 (1.18) ^A	2.56 (1.39) ^A	2.77 (1.27) ^A	2.82 (1.31) ^A	3.29 (1.05) ^A	2.67 (0.58) ^A	0.21
VIVERA® Male	4.67 (0.70) ^A	4.62 (0.65) ^A	4.49 (0.77) ^A	4.64 (0.56) ^A	4.76 (0.56) ^A	4.00 (1.00) ^A	0.21
HAWLEY Female	2.66 (1.11) ^A	2.58 (1.37) ^A	2.88 (1.28) ^{AB}	2.79 (1.32) ^{AB}	3.65 (1.06) ^B	2.67 (0.58) ^{AB}	0.02
VIVERA® Female	4.76 (0.62) ^A	4.81 (0.42) ^A	4.65 (0.63) ^A	4.75 (0.52) ^A	4.82 (0.39) ^A	4.00 (1.00) ^A	0.10

*ANOVA and Tukey test results.

Different capital letters in the same row indicate statistically significant differences (Tukey test).

Table 5. Associations among willing to pay more for Vivera® retainer and the gender* and among how much more money would they pay for the Vivera® retainer and the gender (Chi-Square)**

*Considering the costs (prices) of retainers A (Vivera® photo) and B (Hawley photo), answer: Would you pay more for appliance A?				
Willing to pay	Yes	No		
Gender	n	n		p-value
	(%)	(%)		
Male	139 (39.49)	26 (46.43)		X ² = 0.96 DF= 1
Female	213 (60.51)	30 (53.57)		p= 0.32
TOTAL	352 (100)	56 (100)		

**Assume that retainer appliances shown in picture A (Vivera® photo) are more expensive than those in picture B (Hawley photo). How much more would you be willing to pay for them to be placed on your teeth?				
Value	An extra of U\$100	An extra of U\$200	An extra greater than U\$200	p-value
Gender	n	n	n	
	(%)	(%)	(%)	
Male	117 (48.35)	23 (42.59)	25 (44.64)	X ² = 0.72 DF= 2
Female	125 (51.65)	31 (57.41)	31 (55.36)	p= 0.69
TOTAL	242 (100)	54 (100)	56 (100)	

4. DISCUSSION

Orthodontic retention is an important stage of orthodontic treatments, and patients must be able to collaborate with this phase using retainers. Different types of maxillary removable retainers are available; however, the literature regarding their esthetic and economic value is still scarce. Social media has a significant impact on the way people present themselves to the world, and many individuals feel pressured to share an esthetically pleasing image with others [16,22]. This may lead people to spend more money on clothes, accessories, make-up, and other products that create a more esthetic appearance [23]. Because patients may choose the retainer appliance, and considering that the costs may influence patients' decisions [12], this study was carried out.

An online survey was applied since it allows easier access and preserves participants' anonymity, reducing the tendency of socially desirable responses. Even so, the methodology expanded the sample to all Brazilian regions and covered different age ranges (Table 1).

The willing-to-pay method was assessed to evaluate the economic value as in previous orthodontics studies [11,13,14,17-19,24,25]. Willingness to pay is a way of measuring monetary values to the costs since it allows an economic rating by asking people how much they would pay to obtain the benefits of treatment [14].

The Vivera® was considered the most esthetic retainer for both smiles. Previous studies with different orthodontic appliances [11,13,14] and retainers [21,26,27] have also shown greater pleasantness of appliances with less or no metal exposure.

Both genders rated the esthetic perception similarly. This result is not in accordance with a previous study that showed that men judged with lower scores than women for orthodontic appliances [13]. This difference is probably due to the different types of appliances tested since the present study evaluated removable retainers and the previous orthodontic appliances, and also to the time differences when the studies were carried out. Probably, the social, technological, and economic changes that have

taken place in recent decades have led to different customers. Moreover, the present study was done after the pandemic. During the COVID-19 pandemic, with the increase in time spent at

home, people have had more time to look at themselves, especially with the advent of video calls placing more value on esthetic aspects [16,22].

Table 6. Associations among willing to pay more for Vivera® retainer and the age ranges* and how much more money they would pay for the Vivera® retainer and the age range (Chi-Square)**

***Considering the costs (prices) of retainers A (Vivera® photo) and B (Hawley photo), answer: Would you pay more for appliance A?**

Willing to pay	Yes	No	
Age ranges (years)	n (%)	n (%)	p-value
18-30	154 (43.75)	18 (32.14)	X ² = 6.62 DF= 2
31-45	95 (26.99)	12 (21.43)	
More than 46	103 (29.26)	26 (46.43)	p= 0.03
TOTAL	352 (100)	56 (100)	

****Assume that retainer appliances shown in picture A (Vivera® photo) are more expensive than those in picture B (Hawley photo). How much more would you be willing to pay for them to be placed on your teeth?**

Value	An extra of U\$100	An extra of U\$200	An extra greater than U\$200	
Age range (years)	n (%)	n (%)	n (%)	p-value
18-30	105 (43.39)	27 (50.00)	22 (39.29)	X ² = 13.72 DF= 4
31-45	76 (31.40)	11 (20.37)	8 (14.28)	
More than 46	61 (25.21)	16 (29.63)	26 (46.43)	p<0.00
TOTAL	242 (100)	54 (100)	56 (100)	

Table 7. Associations among willing to pay more for Vivera® retainer and the economic status* and how much more money they would pay for the Vivera® retainer and the economic status (Chi-Square)**

***Considering the costs (prices) of retainers A (Vivera® photo) and B (Hawley photo), answer: Would you pay more for appliance A?**

Willing to pay	Yes	No	
Socioeconomic status	n (%)	n (%)	p-value
A	155 (44.03)	20 (35.71)	X ² = 2,73 DF=5
B1	74 (21.02)	16 (28.57)	
B2	82 (23.30)	13 (23.21)	p=0.74
C1	24 (6.82)	4 (7.15)	
C2	14	3	

***Considering the costs (prices) of retainers A (Vivera® photo) and B (Hawley photo), answer: Would you pay more for appliance A?**

	(3.98)	(5.36)
DE	3	0
	(0.85)	(0)
TOTAL	352	56
	(100)	(100)

****Assume that retainer appliances showed in picture A (Vivera®) are more expensive than those in picture B (Hawley). How much more money would you be willing to pay for them to be placed on your teeth?**

Value	An extra of U\$100	An extra of U\$200	An extra greater than U\$200	p-value
Socioeconomic status	n (%)	n (%)	n (%)	
A	101 (41.74)	25 (46.30)	29 (51.79)	$\chi^2= 7.74$ DF=10
B1	56 (23.14)	8 (14.81)	10 (17.86)	p=0.65
B2	53 (21.90)	16 (29.63)	13 (23.21)	
C1	19 (7.85)	2 (3.70)	3 (5.36)	
C2	10 (4.13)	3 (5.56)	1 (1.78)	
DE	3 (1.24)	0 (0)	0 (0)	
TOTAL	242 (100)	54 (100)	56 (100)	

Raters aged more than 46 years old gave greater values for esthetic perception for both retainers in male smiles. According to Pithon et al. [28], younger persons are more critical when evaluating esthetics.

Considering the socioeconomic status, the esthetic perceptions of the retainers were similar to most of them; only the scores given by C2 status showed statistically significant greater values to Hawley retainer for the female smile. Rosvall et al [14]. observed that annual income was insignificant for attractiveness. The authors of the present study speculated that this difference might probably be related to the differences in methodology, culture, and time.

Most laypeople reported that they were willing to pay more for the most esthetic retainer, corroborating with the findings of previous studies that evaluated orthodontic appliances [11,13,14,17,19]. The highest socioeconomic status showed a slight tendency to be willing to pay extra money for the most esthetic orthodontic appliance, but this was not enough to generate statistically significant differences.

Regarding age range, more frequently, the respondents aged between 18 and 30 years old were willing to pay more, corroborating the findings observed by Feu et al [13]. However, when asked how much extra money, the participants over 46 years old showed a greater willingness to pay more than U\$200,00 for the more esthetic retainer.

The results showed that despite the willingness to pay extra for the Vivera® retainer, the majority of respondents reported that they would pay amounts that did not cover the cost of this device to the orthodontist (an extra of U\$100.00) since there was a mean difference of U\$125.00 to the laboratory fee at the moment that this study was designed. This finding suggests that the orthodontist should inform their patients that an additional cost should be considered if they choose to use Vivera®. The aim of the present study was not to establish or suggest pricing for the retainers evaluated since the economic market sets the final value of orthodontic appliances [14].

Some limitations of this study must be considered, such as comfort, efficacy, and functional aspects not being evaluated.

However, previous studies have already assessed these factors [9,10], and orthodontists should consider all of these factors in the final decision.

5. CONCLUSION

Vivera® was considered more esthetically pleasing than the Hawley retainer.

Most laypeople are willing to pay the additional cost of Vivera®. However, the value most frequently reported was below the laboratory fees.

Data obtained indicated that the esthetics market continues to increase in value.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ETHICAL APPROVAL AND CONSENT

This cross-sectional study received approval from the local human research ethics committee (protocol number: 5.590.935), and informed consents were obtained from the photographed volunteers and from the respondents.

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COMPETING INTERESTS DISCLAIMER

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper

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