

CURRICULUM VITAE

I. BIOGRAPHY

Katie Garrett-McCormack
kgarrett@umaryland.edu

II. EDUCATION

University of Maryland, Baltimore, MD
School of Dentistry, Orthodontics Certificate, M.S. Biomedical Sciences
2020-Expected May 2023

University of Maryland, Baltimore, MD
School of Dentistry, DDS
2016-2020

Towson University, Towson, MD
B.S. Major in Biology, Double Minor in Chemistry and Business Administration
2012-2016

III. RESEARCH EXPERIENCE

Vocal Tract Visualization Lab at University of Maryland School of Dentistry
Department of Neural and Pain Sciences and Orthodontics, Baltimore, MD
2017-2020

Coordination of tongue muscle shortening and volume shifting in speech
Stone M, Woo J, Garrett K, Boroun A, Zhuo J, Prince JL
The Journal of the Acoustical Society of America
Published November 13, 2019

Tongue muscle shortening during speech in controls and glossectomy patients
Garrett K, Woo J, Stone M
University of Maryland School of Dentistry Student Research Day
Poster Presentation August 3, 2018

Diet and Cancer Lab at Towson University
Department of Biological Sciences, Towson, MD
2014-2016

Potential role of the 15kDa Selenoprotein in colorectal inflammation
Peters KM, Carlson BA, Garrett KN, Canter JA, Tobe R, Seifried HE, Yu Y, Ceo L,
Gladyshev VN, Davis CD, Hatfield DL, Tsuji PA
The Federation of American Societies for Experimental Biology Journal
Published April 1, 2016

Effect of dietary selenium and the 15kDa Selenoprotein in a model of inflammatory colitis

Garrett KN, Peters KM, Hartman J, Canter JA, Carlson BA, Gladyshev VN, Yu Y, Cao L, Davis CD, Hatfield DL, Tsuji PA

UMBC Undergraduate Research Symposium

Poster Presentation October 3, 2015

IV. PROFESSIONAL MEMBERSHIP

American Association of Orthodontists

2020-Present

Middle Atlantic Society of Orthodontists

2020-Present

Maryland State Society of Orthodontists

2020-Present

American Dental Association

2016-Present

V. AWARDS AND HONORS

American Association of Orthodontists, Resident Board Member for Council on Governmental Affairs, Political Action Committee, and Council on New and Young Members

July 2022-Present

American Association of Orthodontists, Resident Champion

July 2022-Present

American Association of Orthodontists, Senior Student Award

July 2020

University of Maryland School of Dentistry, Deans Research Award

May 2020

Towson University, Provost Scholarship

2012-2016

ABSTRACT

Title of Thesis: Perception of lip attractiveness: a survey of orthodontists, general dentists, and laypersons

Candidate: Katie Garrett-McCormack, Master of Biomedical Sciences, 2023

Thesis Directed by: Flavio Copello, DDS, MS, PhD
Clinical Assistant Professor
University of Maryland School of Dentistry, Department of Orthodontics and Pediatric Dentistry

Objective: We aim to investigate proposed standards of ideal lip proportions and compare what different people view as most attractive.

Methods: A 16-question survey was distributed via Qualtrics to orthodontists, dentists, and laypersons asking demographics and opinion-based questions regarding a series of facial photographs. Photographs were digitally altered using Adobe Photoshop to produce different dimensions of the lips. Participants were asked to rate perceived attractiveness of the lips shown.

Results: Regardless of occupation, individuals preferred the appearance of slightly protrusive or thicker lips. Retrusive and thin lip varieties had the lowest median attractiveness scores. Average values for lip projection and thickness were not found to be mutually agreed upon across occupation types ($p < 0.05$) and average lip thickness was not mutually agreed upon between age groups of orthodontists ($p = 0.004$).

Conclusion: Based on the results of this study, acceptance of a slightly thick or protrusive lip profile may be a more esthetic or well-accepted patient outcome.

Perception of lip attractiveness: a survey of orthodontists, general dentists, and laypersons

by
Katie Garrett-McCormack

Thesis submitted to the Faculty of the Graduate School of the
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of the requirements for the degree of
Master of Science
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List of Abbreviations

IRB	Institutional Review Board
SPSS	Statistical Package for Social Science Program
VAS	Visual Analog Scale

I Introduction

I.1 Literature review

In orthodontics, we evaluate many aspects of dentofacial esthetics when determining treatment plans. Patients often express a chief complaint relating not only the way their teeth come together, but how their overall mouth, lips, and face appear. The position of the front teeth and degree of protrusion can directly impact the protrusiveness of the lips and profile of the face. Treatment plans are often catered to whether or not the lips need to be retracted or advanced to a more esthetic position. We currently evaluate lip position in relation to orthodontic standards commonly published in texts, but many of these esthetic norms were developed decades ago. This topic begs further consideration into the thoughts and preferences of individuals today, in order to better understand the esthetic outcomes that patients are seeking.

In order to evaluate lip esthetics, it is necessary to understand the dental definitions of lip protrusion and retrusion. Protrusion refers to the forward position of the upper and/or lower front teeth or lips in relation to the rest of the face.¹ When the front teeth are protruded, the lips may appear more forward or "full," creating a more prominent facial profile. However, excessive protrusion can lead to lip strain and dysfunction, as well as increased risk of injury to the teeth or sometimes unaesthetic appearance. Retrusion, on the other hand, refers to the backward position of the upper and/or lower front teeth or lips in relation to the face. When the front teeth are retruded, the lips may appear more recessed or "thin," creating a less prominent facial profile. However, excessive retrusion can also lead to functional and esthetic problems, such as difficulty with speech and self-consciousness about the appearance of the smile.

Orthodontists use various cephalometric reference lines and measurements to determine the optimal position and proportion of the lips in relation to the rest of the face. Multiple lip

analyses have been developed over the years to aid orthodontists in determining the most appropriate treatment plan for individual patients. In this overview, we will discuss five of the most commonly used lip analyses: Ricketts' esthetic line, Steiner (S-line), Merrifield's Z line, Burstone esthetic line, and Holdaway's profile line.

The Ricketts' esthetic line, also known as the E-line, is a reference line used to evaluate the position of the upper and lower lips in relation to the teeth and facial esthetics. The line is drawn from the tip of the nose to the prominence of the chin. The lower lip should be slightly posterior to the line at -2 mm, while the upper lip should be slightly posterior the lower lip at -4 mm behind the E-line.¹ Ricketts stated that most people object to lips that protrude beyond the E-line, but said prominent cheeks warrant more prominent lips. He described "wide full lips that can function without lip strain" combined with a good occlusion and oral health is the pinnacle of beauty.²

The Steiner or S-line is another reference line used to evaluate the position of the upper and lower lips in relation to the teeth and facial esthetics. The line is drawn from the soft tissue pogonion (the most anterior point of the chin) to the subnasale (the midpoint between the nasal tip and upper lip).³ The upper and lower lips should be touching this line, creating a harmonious facial esthetic.

The Merrifield Z-angle is used to evaluate an angular measurement formed by the intersection of Frankfort horizontal (most superior point of porion and most inferior point of orbitale) and the profile line. The profile line is evaluated by drawing a line tangent to soft tissue chin and the most anterior point of the upper or lower lip, whichever is most protruding.⁴ Ideally both lips will be touching this line to create an aesthetically pleasing smile. Merrifield stated,

“Orthodontists long have recognized that occlusion and facial beauty are so interdependent that they must be simultaneous and equal goals of treatment”.

The Burstone esthetic line is used to evaluate relative protrusion or retrusion of the lips. The line is drawn from the subnasale (landmark where the upper lip meets the inferior border of the nose) to the soft tissue pogonion of the chin. The upper and lower lips should lie 3.5 mm and 2.2 mm in front of this line, respectively, creating a harmonious facial esthetic.⁵ However, this differs from many of the previously discussed lip analyses, where the lower lip is supposed to be further anterior than the upper lip.

The Holdaway profile line is used to evaluate the face in profile view, similar to previous analyses. The H line or harmony line is drawn tangent to the soft tissue chin and the upper lip. The “H” angle formed between nasion-point B line and the H line should be 7-8 degrees when the ANB is normal (between 1-3 degrees). The upper and lower lips should touch the line, with the projection of the lips and chin in harmony with the overall facial esthetic. Holdaway stressed the importance of variable ideal soft tissue profile based on skeletal convexity and how individuals with different skeletal relationships may have slightly different ideal measurements.⁶

While less lip analyses exist of the frontal view, there are mutually agreed upon standards for the vertical proportions of the lips. The law of the thirds in facial esthetics divides the face into 3 vertical sections (upper third, middle third, and lower third). The lower third can be further divided into thirds that comprise of; 1- the inferior base of the nose to the inferior base of the upper lip at the oral fissure, 2- the superior portion of the lower lip at the oral fissure to the mentolabial fold, and 3- the mentolabial fold to the chin.^{7, 8} In young Caucasians, the ideal ratio of the vertical height of the upper lip to that of the lower lip should be 1:1.6.⁷ Another study confirms similar proportions, but states the upper lip should be 75 to 80 percent of the lower lip.⁹

Overall, these lip analyses provide useful guidelines for evaluating the position and appearance of the lips in relation to the teeth and overall facial esthetic. However, it is important to note that these are just guidelines, and that individual patient preference and expectations should also be taken into consideration when developing a treatment plan. It is also important to realize that these analyses are slightly different with one another, sometimes even providing conflicting information on where the lips should be positioned and which lip is supposed to be in front of the other. These lip analyses were created around the 1950-60s, a time during which beauty standards were different than they are today. Most of these facial analyses only considered the profile of Caucasian individuals, without consideration of cultural preferences.

In attempts to bridge this gap, some studies have since investigated modifications of norms due to ethnicity or racial differences. In a study of Nigerian orthodontists, orthodontic trainees, and students, most participants preferred slightly protrusive lips and almost one-half of all survey participants ranked the ‘normal’ Ricketts’ esthetic line as unacceptable.¹⁰ Results showed that clinical and professional judgment influence perceptions of facial attractiveness and ‘ideals’ outlined in textbooks do not necessarily equate to ideals perceived by laypersons. In another study evaluating the Ricketts’ esthetic line in a Chinese population, significantly more Chinese judges ranked the retrusive profiles higher than the Caucasian judges. The Chinese judges considered a retrusive lip profile of -1 mm behind the E-line as the most esthetic.¹¹ These results, contrasted with the first study, support the premise that different races and ethnicities may have completely opposite esthetic preferences that we as orthodontists need to consider. In a study of brown subjects in Salvador, it was found that preferences closely followed the Ricketts’ established norms. Straight profiles were preferred, but slightly convex or slightly concave lip profiles were also accepted.¹² They recommended that this data could help guide orthodontists to

decide whether or not extractions may be warranted for treatment or beneficial to the individual's profile.

An important concept to consider when treatment planning, is the effect of extractions on the soft tissue profile. As a general rule, the lip will move $\frac{2}{3}$ the distance that the incisors are retracted (i.e. 2 mm of lip retrusion for every 3 mm of tooth retraction), but there can be a great degree of individual variance.¹ Some studies show up to a 1:1 ratio of crown movement to lip movement when retracting upper incisors.¹³ Therefore, when you decide to extract teeth, you need to calculate the amount of incisor retraction planned and decide if the expected effects it will have on the lips will be acceptable for the soft tissue profile.

In orthodontics, sometimes you extract for the face and sometimes you extract for the space. These philosophies differ slightly depending on the provider, but it highlights the fact that there are multiple factors to consider in whether there is a need to extract teeth. If it is determined that one or both lips are too protrusive to be considered acceptable, extractions are usually indicated. The same applies to severe crowding in one or both arches; extractions are usually easily decided upon by orthodontists to achieve the treatment goals. However, borderline cases sometimes make it a difficult decision to determine if extractions are the best option. For example, if a young female patient presents with mild profile convexity, mild protrusion of the lips, and mild to moderate crowding, it may be difficult to determine what is "ideal" for this patient. If borderline, it is important to consider which lip profile will be more acceptable. Sarver stresses that "because female lips do not thicken with age, any extraction plan for females with straight to convex profiles should be cautiously considered".¹⁴ He emphasizes that lip fullness should be viewed in relation to the nose, which will continue to grow as a person ages and therefore the lips may become more suitable over time. Normal measurement analyses are

important to keep in mind, but providers must always focus on the clinical application of individualized treatment planning and effects of personal preferences when it comes to facial proportions.

Today's beauty standards and the evolution of facial esthetics focus highly on "youth restorative" procedures. Lip enhancements and augmentations are becoming increasingly popular not just in the world of plastic surgery but have gained popularity in dentistry due to the relationship between the lips and overall dental esthetics. The Journal of Oral and Maxillofacial Surgery published an article discussing the importance of acknowledging the aging process and diagnosis of senile lip changes in dental planning.¹⁵ Lip atrophy and loss of lip volume over time can lead to poor lip support and overall negative effects on esthetic dental procedures, including orthodontics. Lips thickness is greatest during adolescence and then decreases. Flattening of the lips happens as adults age; lips become thinner with less vermilion display.¹ Mamandras and Nanda et al. both found that males and females reach maximum lip thickness sometime between the ages of thirteen and eighteen.^{16, 17} Therefore, it comes as no surprise that full and well-defined lips are often associated with and described as a youthful, healthy, and attractive appearance, while thin and flat lips may be perceived as suggesting "fragility and senility".¹⁸ For many individuals, the appearance of aging is something they avoid, and many go to lengths to chase a more youthful appearance of themselves.

With so much focus on esthetics in mainstream media, various outlets are constantly promoting images of "ideal" beauty standards. However, the question remains as to who determines these standards and whether they can be generalized to a larger population. Looking further into the effect of fashion and its influence on beauty standards, a photographic analysis of female soft tissue profiles in fashion magazines during the evolution of the 1900s found that over

the last century there has been an increased preference for fuller and more anteriorly positioned lips.¹⁹ A follow-up of this study was conducted to investigate changes in the African American female profile depicted in fashion magazines during the 20th century and the results also supported the same trend towards fuller and more anteriorly positioned lips.²⁰ While beauty standards may be influenced by societal and cultural norms, they are ultimately shaped by a range of factors, including historical trends, personal preferences, and healthcare treatments.

Individuals may have different ideas of what constitutes beauty, and there may be a range of acceptable outcomes that are considered aesthetically pleasing. In the field of orthodontics, for example, treatment plans are multifactorial and may be tailored to address individual patients' desires and needs, while still adhering to general standards of facial harmony and balance. However, it is important to recognize that these standards may vary among different populations and cultures, and that beauty is ultimately subjective and personal. In this study, we intend to further investigate the original proposed standards and if they have been affected by current societal preferences on lip esthetics.

I.2 Study aims

This study investigates orthodontic standards of ideal lip proportions both in profile and frontal views and compares those standards to what different people (i.e., orthodontists, general dentists, and laypersons) view as most attractive. Although facial analyses exist in dental education and orthodontic texts, there still appear to be differences in personal preference among providers and individuals. This study aims to investigate if a consensus can be reached on the ideal standards that should be taught today.

In an increasingly esthetic world where many individuals are seeking out cosmetic procedures such as Botox and/or lip filler to 'enhance' their lips, it begs the question, "what is the

ideal size and proportions of the lips according to today's standards?" Do the common standards in the texts hold true or are standards outdated compared to society's preferences?

This study aims to show facial photographs that have been digitally altered to produce different dimensions of the lips both in vertical height and projection. Survey participants will evaluate the photos and rate them for perceived lip attractiveness and ideal proportions. By asking patients to rate the esthetic attractiveness of different lip positions and facial profiles, orthodontists can gain valuable insights into the range of preferences that exist. This investigation could help to establish or update guidelines for evaluating facial esthetics in the treatment of orthodontic patients in everyday practice.

I.3 Research hypotheses

H.1: It is hypothesized there will be a difference in opinion of ideal attractiveness of the lips amongst orthodontists, general dentists, and laypersons. This could be due to their differing levels of dental education (or lack thereof) on lip esthetics and potential differences between societal beauty standards and the beauty standards taught in classical dental texts.

H.2: The second hypothesis for this study is that younger individuals will prefer thicker, fuller lips with more protrusive profiles than older individuals, regardless of occupation type. An explanation for this could be the recent emphasis on lip enhancing procedures being marketed by dental and orthodontic professionals to the general public. Younger individuals may be more likely to adopt new trends and be more mindful of changes in current beauty standards.

II Materials and methods

The Institutional Review Board (IRB) at the University of Maryland, Baltimore reviewed this study under the application HP-00104133 and approved the referenced protocol as exempt under 45 CFR 46.104(d) from IRB review.

II.1 Survey design

This study (Figure 1) was modeled partly from previous surveys on lip and profile aesthetics.^{12, 21} Care was taken to develop an appropriate set of questions with accompanying photographs to address our research hypotheses. In order to determine individual preferences, a set of demographic questions was included in the questionnaire.

The first block of the survey consisted of written consent and basic demographic questions (ex. occupation, education level, age, race or ethnicity, and US zip code). When possible, demographics utilized ‘certified’ questions, defined as “written by experts. Certified questions take advantage of Qualtrics methodology to collect standardized data for easier comparisons”. For question five regarding race and ethnicity, the certified question was modified to include other races/ethnicities not originally stated. Inclusion criteria consisted of adults (over 18 years of age) that identify as orthodontists, general dentists, or laypersons (defined as any occupation not in the dental field). The survey was only offered in the English language. Exclusion criteria consisted of any individual less than 18 years of age, non-English language, and anyone in the dental field that does not identify as an orthodontist or general dentist (orthodontic residents, hygienists, dental assistants, dental technicians, etc.). If survey participants selected an answer that was part of the exclusion criteria, the following error text displayed, “Unfortunately you do not meet the inclusion criteria for this survey. Thank you for your time.” The survey subsequently ended.

The second and third blocks of the survey were experimental blocks, consisting of facial photographs of varying lip proportions (see section II.2 for methodology on photograph alteration) and asking survey participants to evaluate for perceived lip attractiveness. Individuals were asked to rate their opinions on Visual Analog Scale (VAS) from not attractive (0) to very attractive (100). The VAS is a validated system to rate survey photographs and this method was modeled after its use in previous studies on lip and smile esthetics.^{11, 12, 22, 23, 24} The VAS allows individuals to give their personal evaluations on a reproducible scale and standardize how people rate attractiveness based on photographs. The order of the photographs was randomized in Blocks 2 and 3 of the survey.

Once the first draft of the survey was developed, a preview study was analyzed to validate the survey. The preview study was sent to the IRB committee at the University of Maryland, who subsequently approved the application. Then, several members of the University of Maryland orthodontic clinic, including faculty and residents, were asked to critique the preview survey and provide feedback. An independent review on the Qualtrics software was performed and the survey was evaluated by an internal ‘Expert Review’, which determined a survey strength of ‘great’ and 0 recommendations given for adjustment. Finally, the survey was published on the Qualtrics software and distribution began.

Figure 1. Qualtrics survey

Questions	Answer Choices
Block 1 – Demographics	
<p>1. Welcome to the research study!</p> <p>We are interested in studying lip esthetics and comparing what different people view as most attractive or 'ideal'. You will be presented with photographs and asked to answer some questions about the attractiveness of the lips shown. The photographs will be of one individual with varying sizes and proportions of their lips.</p> <p>The study should take you around 10 minutes to complete. Your participation in this research is voluntary. Please be assured that your responses will be kept completely confidential. You have the right to withdraw at any point during the study, for any reason, and without any prejudice. If you would like to contact the Principal Investigator in the study to discuss this research, please e-mail Dr. Flavio Copello at fcopello@umaryland.edu.</p> <p>By clicking the button below, you acknowledge that your participation in the study is voluntary, you are 18 years of age, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.</p> <p>Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.</p>	<p>a. I consent, begin the study</p> <p>b. I do not consent, I do not wish to participate*</p>
<p>2. What is your occupation?</p>	<p>a. General dentist</p> <p>b. Orthodontist</p> <p>c. Orthodontic resident*</p> <p>d. Individual with a different occupation in the dental field than those listed above*</p> <p>e. Any occupation <u>not in the dental field</u></p>
<p>3. What is the highest level of education you have completed? **</p>	<p>a. Some high school or less</p> <p>b. High school diploma or GED</p> <p>c. Some college, but no degree</p> <p>d. Associates or technical degree</p> <p>e. Bachelor's degree</p> <p>f. Graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS, etc.)</p> <p>g. Prefer not to say</p>

Figure 1 continued

<p>4. How old are you? **</p>	<p>a. Under 18* b. 18-24 years old c. 25-34 years old d. 35-44 years old e. 45-54 years old f. 55-64 years old g. 65+ years old</p>
<p>5. Please select the race or ethnicity that best describes you. ***</p>	<p>a. White/Non-Hispanic b. Black or African American c. Hispanic d. American Indian/Native American or Alaska Native e. Asian f. Middle Eastern g. Native Hawaiian or Other Pacific Islander h. Other i. Prefer not to say</p>
<p>6. What is your US Zip Code? **</p>	<p>a. _____</p>

* If selected, the following error text displayed, “Unfortunately you do not meet the inclusion criteria for this survey. Thank you for your time.” The survey subsequently ended.

** Certified question written by experts to take advantage of Qualtrics methodology to collect standardized data for easier comparisons.

***Certified question that was modified to be more inclusive

Block 2 – Frontal Photographs

<p>1. Please rate the attractiveness of the person’s lips in the photo, based on your perception of ideal proportions.</p>	 <p>0 10 20 30 40 50 60 70 80 90 100</p> <p>Not attractive (0) to very attractive (100)</p> <p><input type="text" value=""/></p>
--	--

Figure 1 continued

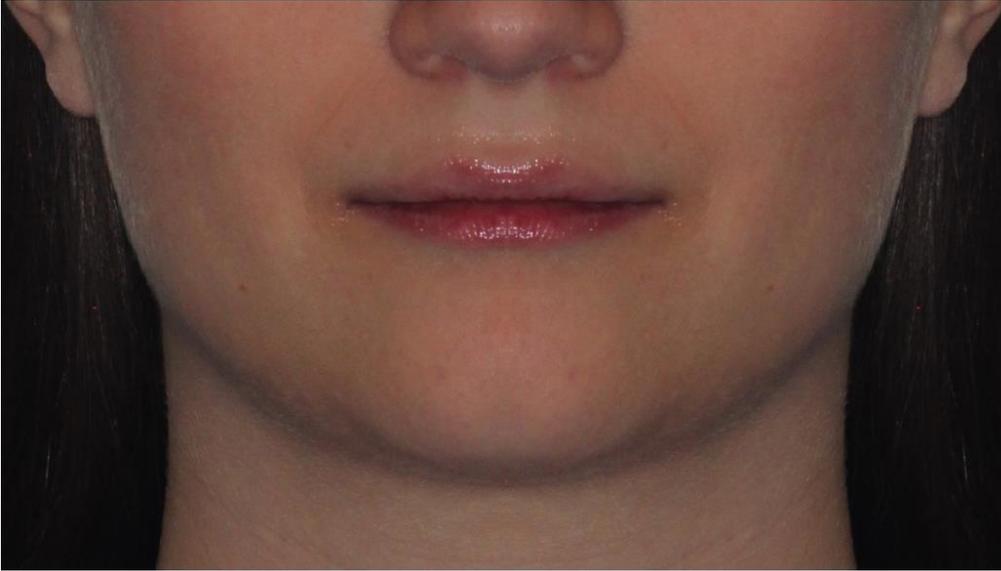
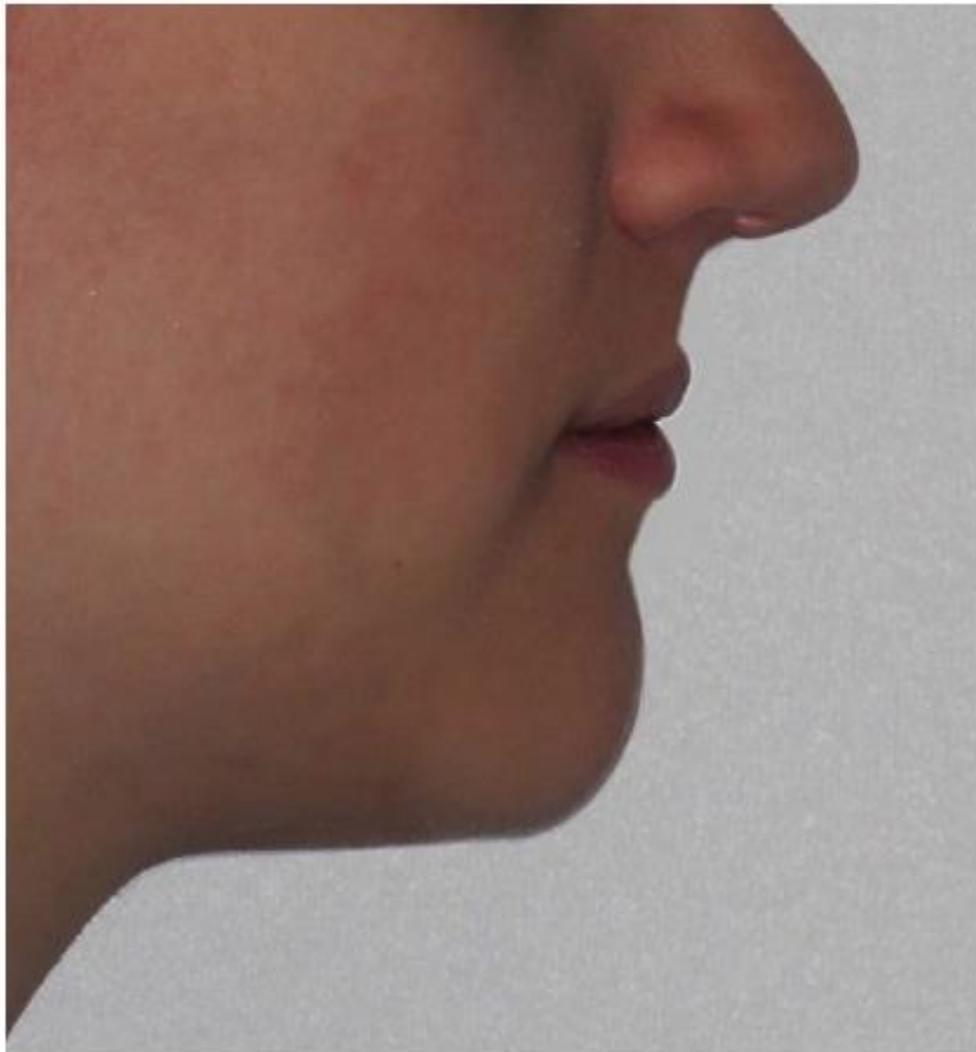
<p>2. Please rate the attractiveness of the person's lips in the photo, based on your perception of ideal proportions.</p>	 <p>0 10 20 30 40 50 60 70 80 90 100</p> <p>Not attractive (0) to very attractive (100)</p> <input type="text" value=""/>
<p>3. Please rate the attractiveness of the person's lips in the photo, based on your perception of ideal proportions.</p>	 <p>0 10 20 30 40 50 60 70 80 90 100</p> <p>Not attractive (0) to very attractive (100)</p> <input type="text" value=""/>

Figure 1 continued

<p>4. Please rate the attractiveness of the person's lips in the photo, based on your perception of ideal proportions.</p>	 <p>0 10 20 30 40 50 60 70 80 90 100</p> <p>Not attractive (0) to very attractive (100)</p> <input type="range" value="10"/>
<p>5. Please rate the attractiveness of the person's lips in the photo, based on your perception of ideal proportions.</p>	 <p>0 10 20 30 40 50 60 70 80 90 100</p> <p>Not attractive (0) to very attractive (100)</p> <input type="range" value="10"/>

Figure 1 continued
Block 3 – Profile Photographs

6. Please rate the attractiveness of the person's lips in the photo, based on your perception of ideal proportions.



0 10 20 30 40 50 60 70 80 90 100

Not attractive (0) to very attractive (100)

Figure 1 continued

7. Please rate the attractiveness of the person's lips in the photo, based on your perception of ideal proportions.



Figure 1 continued

8. Please rate the attractiveness of the person's lips in the photo, based on your perception of ideal proportions.

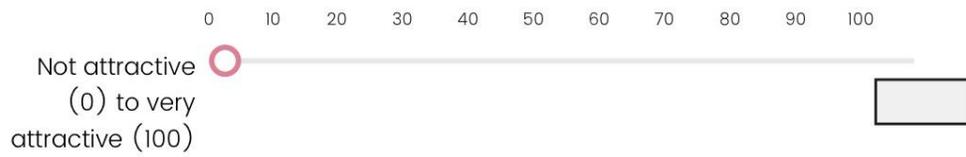


Figure 1 continued

9. Please rate the attractiveness of the person's lips in the photo, based on your perception of ideal proportions.

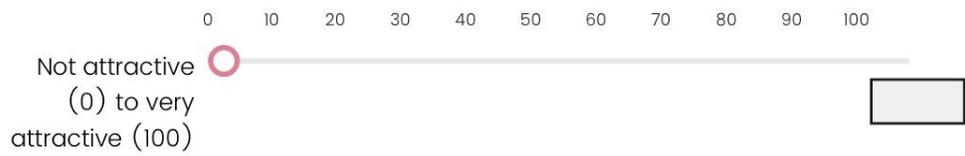


Figure 1 continued

10. Please rate the attractiveness of the person's lips in the photo, based on your perception of ideal proportions.



II.2 Digital alteration of facial photographs

Frontal and side profile photographs were identified of a patient with close to ideal proportions, based on current orthodontic standards used to evaluate patient records (i.e. Ricketts' esthetic plane). Adobe Photoshop desktop (version 23.5, Adobe Inc., USA) was used for the digital enhancement and alteration of photographs for this study to produce lips with varying proportions. The frontal photograph was mirrored horizontally, to ensure the left and right sides of the patient's face were identical. This was done to account for any facial asymmetry and therefore minimize the chance of survey participants allowing asymmetry to affect how they rate the appearance of the photographs. Next, the images were calibrated and scaled to anatomical landmarks measured on the patient's face clinically, to ensure the scale of the photographs was appropriate prior to manipulation of the proportions of the lips. The borders of the lips were then meticulously outlined and selected to ensure only the size of the lips were being increased/decreased by the following protocol.

Altering facial characteristics on Adobe Photoshop can be done through several tools and techniques, but this study utilized the "Liquify" tool to manipulate the shape and size of facial features like the lips, nose, and mouth. Once "Liquify" was selected, the "Pucker" tool was used to shrink the lips for the retrusive/thin lip images. Both the upper and lower lips were retracted to -1 mm and -2 mm of the ideal Ricketts' E-line measurements for the side profile images, as well as -1 mm and -2 mm decreases in height for the frontal facial images (Figure 2). The photo labeled as 'normal' reflects the ideal Ricketts' E-line measurements of the upper and lower lip (-4 mm and -2 mm of the E-line, respectively). The normal image is referred to as 0 mm, relative to the adjacent, altered photos. For the protrusive/thick lip images, the "Bloat" tool was used to enlarge areas of the lips. Both the upper and lower lips were advanced to +1 mm and +2 mm of the ideal Ricketts' E-line measurements for the side profile images, as well as +1 mm and +2

mm increase in height for the frontal facial images. Finally, the "Blur" tool was used to soften the appearance of the skin of any harsh lines from edited portions, in order to make it difficult to ascertain which lips were digitally altered.

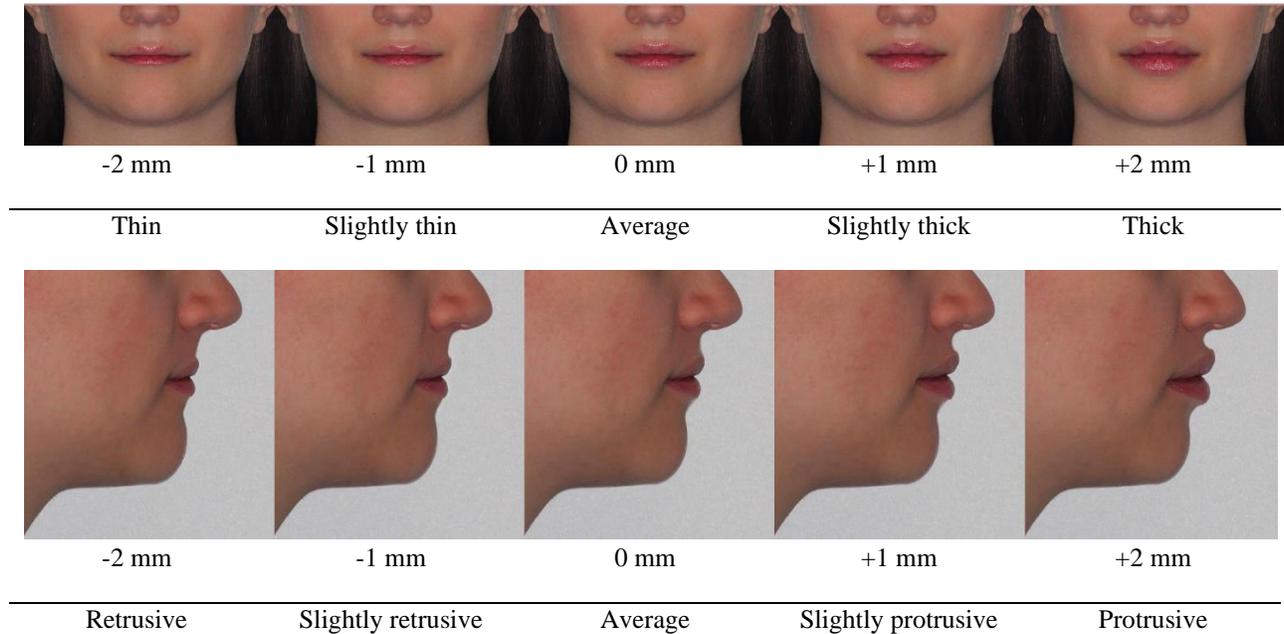


Figure 2. Showing a series of 10 images that were adjusted in lip thickness and projection. Images were adjusted in ± 1 mm increments from average.

II.3 Survey distribution and data collection

The 16-question survey was administered through the Qualtrics survey platform, approved by the University of Maryland, Baltimore, Institute for Clinical & Translational Research. The survey link was distributed to orthodontic program directors across the U.S., as well as through online orthodontic forums, such as orthodontic Facebook groups. In a better effort to distribute to general dentists, the survey was sent to clinical directors in the departments of general dentistry at University of Maryland, as well as through dental online forums and Facebook groups. Individuals were encouraged to share the survey with any non-dental colleagues and the survey

was distributed via iPad to patients at the University of Maryland to collect ‘layperson’ data. Data collection continued for approximately 3 months (from dates November 20, 2022 to February 13, 2023) until enough survey responses had been collected. The minimum number of survey responses was determined by statistical power analysis and sample size estimation.

The sample size calculation was performed based on a previous study¹² using the PANDIS formula. The following criteria was used: the power of the test was 80% ($\beta=0.20$), the error was 5% ($\alpha=0.05$), the relevant clinical difference adopted was 12 points in the mean VAS score and the standard deviation was 24.49 (VAS). The result suggested the use of 65 subjects per group. For all analyses, the level of significance was 5%. The normality of the sample was verified by the Shapiro-Wilk test. If the sample distribution was normal, the ANOVA one-way test was performed. If the sample had a non-parametric distribution, the Kruskal-Wallis test was used.

There were a total of 296 responses, with an unknown response rate due to inability to determine how many individuals saw postings on online forums or were forwarded the email link. Out of the total survey participants, one respondent selected “I do not consent, I do not wish to participate” to the consent, one respondent did not meet inclusion criteria (individual selected “under 18” for age), and eighty-one respondents did not fully complete the survey. Those eighty-three respondents were excluded giving a total of 213 responses to be included in the data analysis (Figure 3).

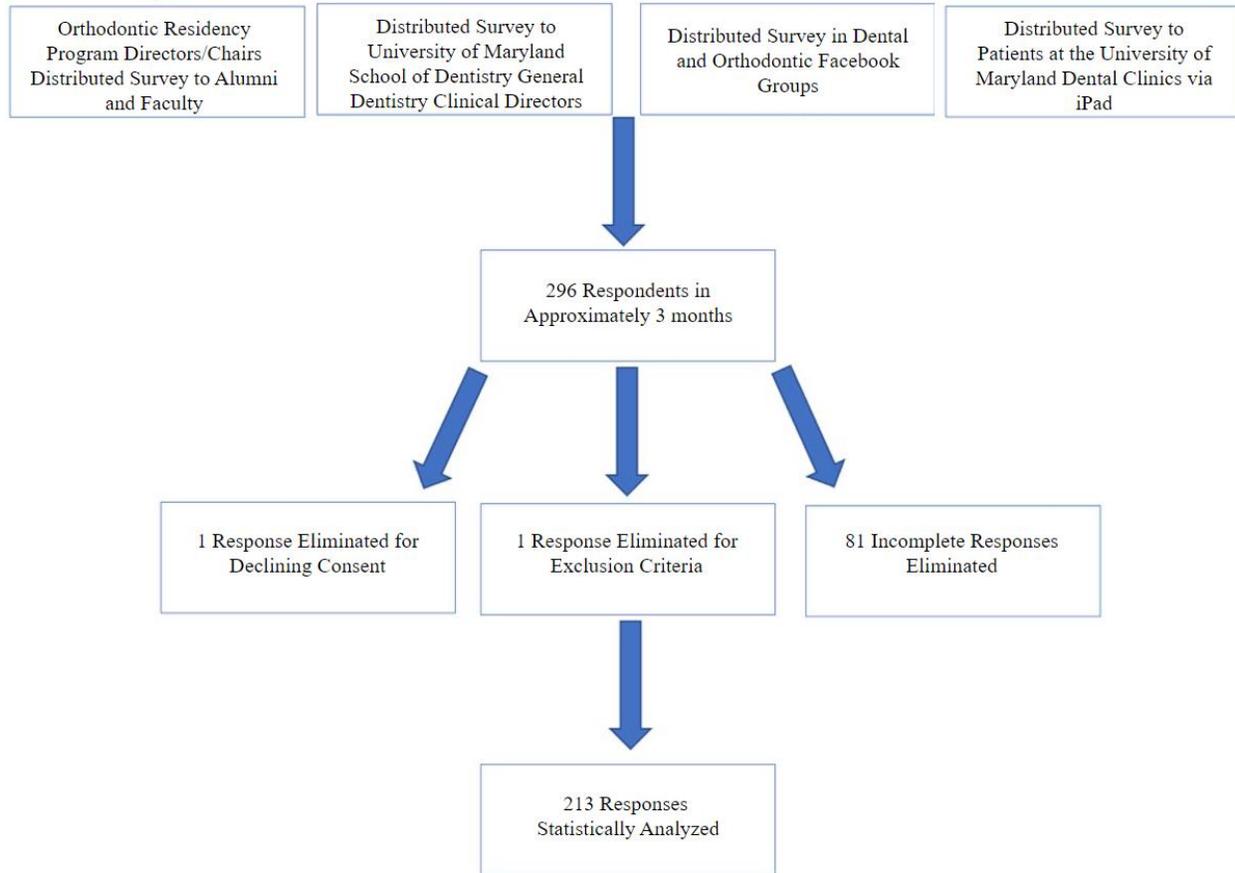


Figure 3. Survey distribution and filtration methods for statistical analysis

II.4 Statistical analysis

The statistical analysis was performed using the Statistical Package for Social Science Program (Version 23.0, SPSS Inc., USA). The normality of the sample was verified by the Kolmogorov-Smirnov test ($\alpha = 0.05$). When the occupation was used as the main factor to analyze each question, the sample did not show a normal distribution. Therefore, the Kruskal-Wallis test was performed to analyze the effect of the groups (General dentists, Orthodontists and Laypersons) on the questionnaire answers ($\alpha = 0.05$). Once a statistically significant difference was found, it was preceded by a pairwise multiple comparison test with Bonferroni correction ($\alpha = 0.016$) to verify between which group the significant statistical result was found. When analyzing the effect of age only between Orthodontists, the sample showed a normal

distribution. So, the one-way ANOVA test was performed with Tukey Post hoc test to analyze the difference between the groups of age ($\alpha = 0.05$).

III Results

The pairwise multiple comparison tests can be found in Table 3. Statistically significant differences were found between occupation types for the questions 3, 4, 6, 7, 8 and 10 ($p < 0.05$). The median and interquartile range for each group and p values for Kruskal-Wallis test are displayed in Table 2. For question 3 (0 mm, average thickness), the difference was between the General dentists and Orthodontists ($p < 0.001$). For question 4 (+1 mm, slightly thick), the difference was between laypersons and Orthodontists ($p = 0.001$). Regarding question 6 (-2 mm, retrusive) the difference was found between General dentists and Orthodontists ($p < 0.002$). For question 7 (-1 mm, retrusive), the difference was found between General dentists and Orthodontists ($p < 0.001$) and laypersons and Orthodontists ($p = 0.016$). Regarding question 8 (0 mm, average projection) the difference was found between the groups General dentists and Orthodontists ($p < 0.001$). Finally, for question 10 (+2 mm, protrusive), the difference was found between laypersons and Orthodontists ($p < 0.001$).

The descriptive statistics for the difference between the age groups among orthodontists can be found in Table 4. Statistically significant differences were found between orthodontist age groups for the questions 1, 2, 3, 6, 9, 10 ($p < 0.05$). For question 1 (-2 mm, thin), the youngest orthodontists (25-34 years old) gave the lowest mean attractiveness, which was statistically different from the 55-64 year old age group, who more than doubled the attractiveness score given by 25-34 year old orthodontists ($p = 0.004$). For question 2 (-1 mm, slightly thin), a similar result was found in that the youngest orthodontists rated a significantly lower score (less than half) compared to the score given by the 45-54, 55-64 and 65+ age groups ($p < 0.001$). For

question 3 (0 mm, average thickness), once again the youngest orthodontists (25-34 years old) gave a significantly lower score than the oldest three age groups ($p=0.004$). For question 6 (-2 mm, retrusive), the 25-34 and 44-54 year old age groups rated significantly lower than the 55-64 and 65+ age groups for lip attractiveness ($p=0.003$). For question 9 (+1 mm, slightly protrusive), all age groups rated the slightly protrusive lip profile as fairly attractive, but 55-64 year old orthodontists rated this significantly higher than the 25-34 year old orthodontists, at about a 20 point difference in mean attractiveness ($p=0.008$). Lastly, question 10 (+2 mm, protrusive) revealed a significantly lower score from 65+ year old orthodontists than 35-44 year old orthodontists, who had over a 20 point difference in calculated means for lip attractiveness ($p=0.033$).

III.1 Demographics

According to Figure 4 and Table 1, there were a well-distributed number of orthodontists (33.8%), general dentists (34.7%), and laypersons (31.5%). Due to dentists and orthodontists comprising 68.5% of the sample population, the large majority was highly educated and had a graduate or professional degree (83.1%). The age distribution was fairly well-spread, but still skewed by almost half of respondents being in the 25-34 age group (46.0%). The majority of the sample population identified as White/Non-Hispanic (70.9%), with smaller percentages identifying as Asian (11.7%), Middle Eastern (6.1%), Black or African American (3.8%), Hispanic (3.8%), American Indian/Native American or Alaska Native (0.5%), other (1.4%), or prefer not to say (1.9%).

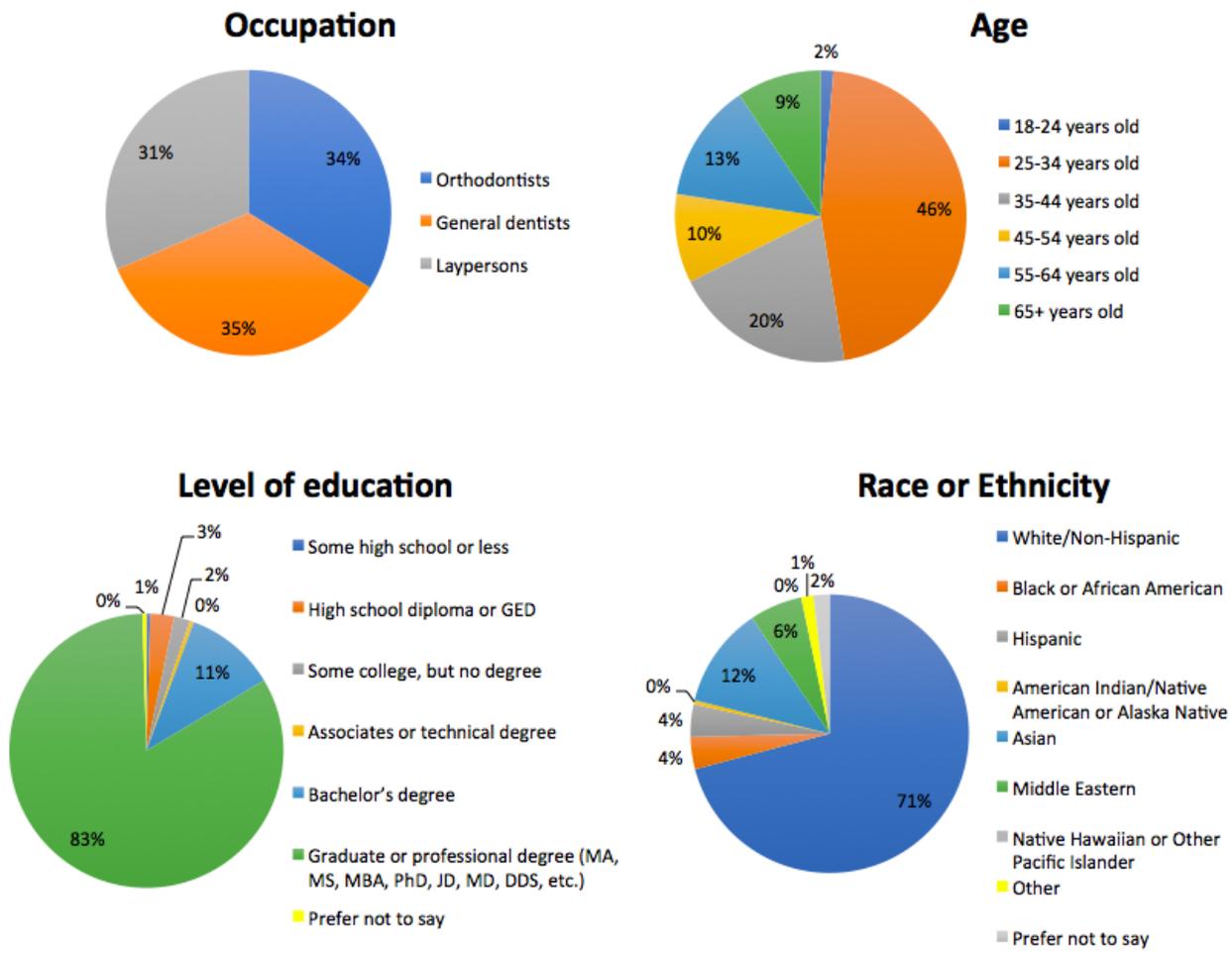


Figure 4. Demographic distribution

Table 1. Frequencies and percentages of included responses.

What is your occupation?	Frequency	Percent
Orthodontists	72	33.8
General dentists	74	34.7
Laypersons	67	31.5
Total	213	100.0
What is the highest level of education you have completed?		
Some high school or less	1	0.5
High school diploma or GED	6	2.8
Some college, but no degree	4	1.9
Associates or technical degree	1	0.5
Bachelor's degree	23	10.8
Graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS, etc.)	177	83.1
Prefer not to say	1	0.5
Total	213	100.0
How old are you?		
18-24 years old	3	1.4
25-34 years old	98	46.0
35-44 years old	43	20.2
45-54 years old	21	9.9
55-64 years old	28	13.1
65+ years old	20	9.4
Total	213	100.0
Please select the race or ethnicity that best describes you.		
White/Non-Hispanic	151	70.9
Black or African American	8	3.8
Hispanic	8	3.8
American Indian/Native American or Alaska Native	1	0.5
Asian	25	11.7
Middle Eastern	13	6.1
Native Hawaiian or Other Pacific Islander	0	0.0
Other	3	1.4
Prefer not to say	4	1.9
Total	213	100.0

III.2 Descriptive statistics by occupation type

According to Figure 5, the general trend was an increase in the median attractiveness scores accompanied by increased lip thickness. For lip projection, a similar trend was found, except in orthodontists who demonstrated a more bell-shape curve.

Orthodontists ranked the slightly thick lips and slightly protrusive lip profile as most esthetic. General dentists ranked the thick lips and slightly protrusive lip profile as most esthetic.

Laypersons ranked the slightly thick and protrusive lip profiles as most esthetic. Across all occupation types, thin lips and retrusive lip profile was ranked the lowest or least esthetic.

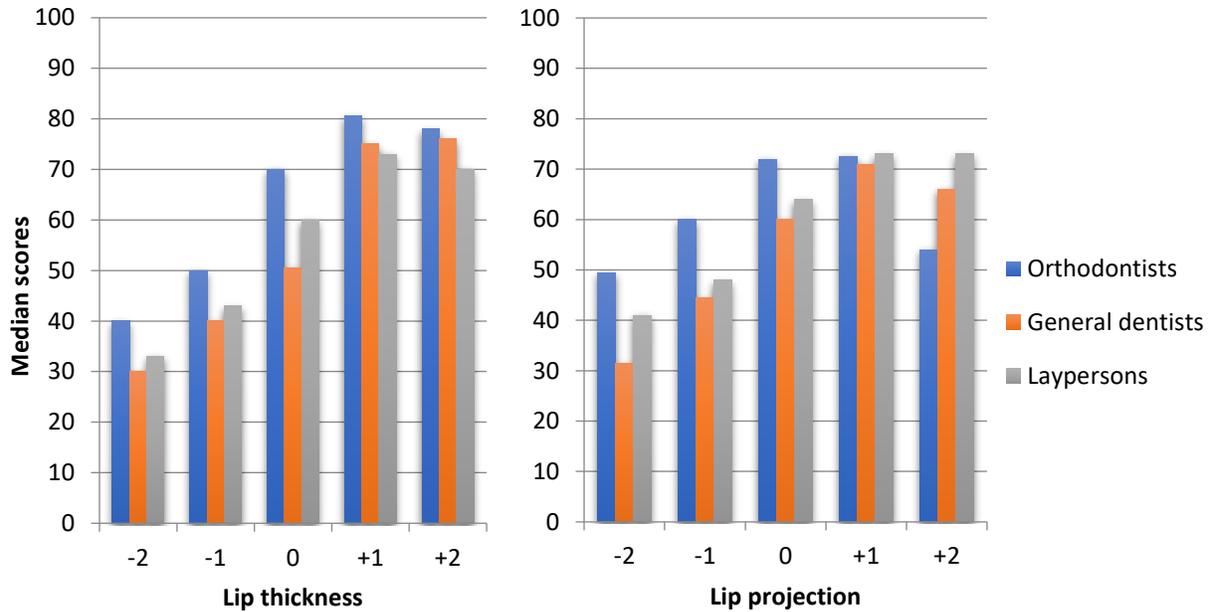


Figure 5. Median attractiveness scores (VAS) for degrees of lip thickness and projection across occupation types.

To determine differences between occupation types, a Kruskal-Wallis test was performed to discover which questions displayed a statistically significant difference between the groups in regards to the median attractiveness scores given (Table 2). Surprisingly both Q3 and Q8, which are supposed to be representative of commonly agreed upon norms or averages in lip thickness and reference to E-line, elicited statistically different median scores between occupation types ($p < 0.05$). The other questions that also demonstrated statistically significant differences between groups were Q4 (slightly thick), Q6 (retrusive), Q7 (slightly retrusive), and Q10 (protrusive). On the contrary, Q1 (thin), Q2 (slightly thin), Q5 (thick), and Q9 (slightly protrusive) did not demonstrate statistically significant difference between groups. In other words, there was enough agreement between the groups to not elicit a significant difference in the median scores.

Groups	Questions (Median ± Interquartile Range)									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Orthodontists	40 ± 31	50 ± 38	70 ± 29	80.5 ± 20	78 ± 26	49.5 ± 30	60 ± 31	72 ± 32	72.5 ± 24	54 ± 33
General dentists	30 ± 29	40 ± 26	50.5 ± 31	75 ± 26	76 ± 24	31.5 ± 33	44.5 ± 33	60 ± 25	71 ± 25	66 ± 27
Laypersons	33 ± 41	43 ± 44	60 ± 35	73 ± 34	70 ± 31	41 ± 40	48 ± 35	64 ± 28	73 ± 18	73 ± 22
P-value	0.152	0.079	0.002*	0.025*	0.312	0.007*	0.002*	0.003*	0.275	0.002*

Table 2. Descriptive statistics for the difference between groups (VAS) on the questionnaire.

* Indicates statistical significance between the groups verified by the Kruskal-Wallis test ($\alpha = 0.05$)

Table 3 shows the pairwise multiple comparison tests to determine for which groups a statistically significant difference occurred. For Q3 and Q8 (average lip thickness and average lip projection, respectively), there was a statistically significant difference in the opinions on median attractiveness scores between general dentists and orthodontists ($p < 0.001$). For Q4 (slightly thick lips), the difference was between laypersons and orthodontists ($p = 0.011$). For Q6 (retrusive lips), the difference in opinions once again came from general dentists and orthodontists ($p = 0.002$). For Q7 (slightly retrusive lips), the difference was found between general dentists and orthodontists ($p < 0.001$), as well as laypersons and orthodontists ($p = 0.016$). Finally, for Q10 (protrusive lips), the difference was found between laypersons and orthodontists ($p < 0.001$).

Table 3. Post-test pairwise multiple comparisons between the groups for the questions with statistical difference.

	Multiple comparisons		Sig.
Q3	General dentists	Laypersons	0.258
	General dentists	Orthodontists	<0.001*
	Laypersons	Orthodontists	0.027
Q4	General dentists	Laypersons	0.590
	General dentists	Orthodontists	0.039
	Laypersons	Orthodontists	0.011*
Q6	General dentists	Laypersons	0.102
	General dentists	Orthodontists	0.002*
	Laypersons	Orthodontists	0.144
Q7	General dentists	Laypersons	0.299
	General dentists	Orthodontists	<0.001*
	Laypersons	Orthodontists	0.016*
Q8	General dentists	Laypersons	0.388
	General dentists	Orthodontists	<0.001*
	Laypersons	Orthodontists	0.018
Q10	General dentists	Laypersons	0.087
	General dentists	Orthodontists	0.062
	Laypersons	Orthodontists	<0.001*

* Indicates statistical significance between the groups. The Bonferroni correction was applied ($\alpha = 0.016$)

III.3 Descriptive statistics by age groups of orthodontists

Although it was not our main outcome, further analysis of performed on the differences between age groups of orthodontists. As seen in Table 4, most questions demonstrated a general trend of more critical or lower scores from young orthodontists (25-34 years old) compared to other age groups. Overall, there was a statistically significant disagreement in scoring for lip attractiveness in the thin (Q1), slightly thin (Q2), average thickness (Q3), retrusive (Q6), slightly protrusive (Q9), and protrusive (Q10) lip profiles. For Q1 (thin lips), the youngest orthodontists (25-34 years old) gave the lowest mean attractiveness scores of all other photographs they rated. This low score was a statistically significant difference from the 55-64 year old age group, who more than doubled the attractiveness score given by 25-34 year old orthodontists ($p=0.004$). For Q2 (slightly thin lips), a similar result was found in that the youngest orthodontists rated a significantly lower score (less than half) compared to the score given by the 45-54, 55-64 and 65+ age groups ($p<0.001$). For Q3 (normal lip thickness), once again the youngest orthodontists (25-34 years old) gave a significantly lower score than the oldest three age groups ($p=0.004$). For Q4 (slightly thick lips), the youngest orthodontists (25-34 years old) gave the highest mean attractiveness scores of all the lip photographs. There was no statistical difference in means between age groups for Q4 or Q5 (slightly thick and thick lips, respectively), but all groups scored these lip thicknesses favorably compared to other lip proportions. For Q6 (retrusive lips), the 25-34 and 44-54 year old age groups rated significantly lower than the 55-64 and 65+ age groups for lip attractiveness ($p=0.003$). For Q7 and Q8 (slightly retrusive and average lip profile), there was no statistical difference in means across age groups, but there was still about a 20 point difference in means from the lowest scoring group (25-34 years old) compared to the highest scoring groups (55-64 years old for Q7 and 65+ years old for Q8). For Q9, all age groups rated the slightly protrusive lip profile as fairly attractive, but 55-64 year old orthodontists rated

Age	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
25-34 years old	24.92 ± 14.305 ^a	25.33 ± 13.446 ^a	48.83 ± 23.354 ^a	70.50 ± 18.725 ^a	68.50 ± 16.284 ^a	30.33 ± 14.164 ^a	42.50 ± 21.365 ^a	58.33 ± 19.956 ^a	60.50 ± 16.801 ^a	54.17 ± 22.376 ^{ab}
35-44 years old	33.89 ± 16.528 ^{ab}	44.78 ± 19.228 ^{ab}	62.28 ± 17.603 ^{ab}	76.06 ± 13.414 ^a	77.94 ± 15.660 ^a	43.28 ± 20.858 ^{ab}	53.67 ± 23.349 ^a	65.06 ± 18.841 ^a	77.56 ± 13.343 ^{ab}	63.28 ± 20.213 ^b
45-54 years old	45.54 ± 24.562 ^{ab}	53.08 ± 23.041 ^b	72.38 ± 19.290 ^b	82.85 ± 12.144 ^a	69.00 ± 19.434 ^a	43.62 ± 23.454 ^a	58.00 ± 22.520 ^a	74.69 ± 13.512 ^a	74.31 ± 22.585 ^{ab}	50.15 ± 22.678 ^{ab}
55-64 years old	52.00 ± 20.214 ^b	61.22 ± 20.812 ^b	72.22 ± 13.273 ^b	78.06 ± 17.966 ^a	75.67 ± 18.705 ^a	57.78 ± 15.090 ^b	63.83 ± 14.026 ^a	72.61 ± 16.375 ^a	80.06 ± 14.707 ^b	61.89 ± 14.418 ^{ab}
65+ years old	39.55 ± 21.030 ^{ab}	54.36 ± 16.008 ^b	69.91 ± 13.509 ^b	85.18 ± 11.965 ^a	73.45 ± 18.013 ^a	57.36 ± 25.905 ^b	60.82 ± 21.752 ^a	77.00 ± 19.401 ^a	63.73 ± 14.698 ^{ab}	40.64 ± 23.863 ^a
P-value	0.004*	<0.001*	0.004*	0.154	0.525	0.003*	0.081	0.059	0.008*	0.033*

Table 4. Descriptive statistics for the difference between the age groups in the Orthodontists group (VAS).

* Indicates statistical significance between the groups verified by the one-way ANOVA ($\alpha = 0.05$)
 Different letters indicate statistically significant differences among groups (one-way ANOVA/Tukey test) ($p < 0.05$)

this significantly higher than the 25-34 year old orthodontists, at about a 20 point difference in mean attractiveness ($p=0.008$). Lastly, Q10 (protrusive lips) received a significantly lower score from 65+ year old orthodontists than 35-44 year old orthodontists, who had over a 20 point difference in calculated means for lip attractiveness ($p=0.033$).

IV Discussion

The importance of this study is centered on the revolution of facial esthetics in the world today. We are in an era of anti-aging treatments and facial harmonization, where voluntary procedures are being undergone to either minimize or volumize facial features to be more esthetic. Botox and fillers are commonplace not only in the realm of plastic surgery, but are increasing in popularity in the dental field. The primary hypothesis was rooted in the thought process that these esthetic demands have changed what individuals view as ideal, particularly in terms of lip esthetics.

The goal of this study was to survey a large variety of orthodontists, general dentists, and laypersons to determine if there is a mutual consensus on the ideal lip size and proportions in regards to facial esthetics. Ideally, a larger number of respondents would have completed the survey to truly be representative of each demographic category, and therefore be generalizable to the populace at large. By asking individuals to evaluate close-up facial photographs that sometimes only differed from other photos by 1 mm per photo, the authors had to rely on survey respondents to very carefully evaluate the photos and not answer haphazardly by cursory glance. The second goal was to try to establish a consensus on the current measurements and/or establish new guidelines for how orthodontists should evaluate the lips when treatment planning using a very individualized approach.

While many additional photos using multiple subjects of varying ethnicities could have been used for this study, the one of the main purposes was to evaluate the initial standards for lip analyses (which were based on Caucasian individuals) and determine if they still hold true today. Based on the results of this study, it can be concluded that the standards are not as objective and mutually agreed upon as perhaps when they were established. Beauty is subjective by nature, so it is not surprising that lip esthetics is an area in which opinions differ based on the individual, which complicates standardization in the field. This topic could be expanded on with further research to include more diversity in race, age, and gender for future studies. Norms and guidelines need to be periodically revisited to ensure their continued validity and if necessary, allow amendments to be made.

IV.1 Comparisons by occupation type

To determine if the Ricketts' esthetic analysis is still the standard of ideal lip esthetics, particular focus was placed upon the photographs that were representative of an ideal subject. The study found that questions 3 and 8, which were intended to capture these commonly agreed-upon 'normal/ideal' values for lip thickness and projection, actually produced statistically different median scores between occupation types. This finding suggests that there is a lack of consensus among different groups regarding what constitutes an ideal lip thickness and reference to E-line. For both the normal lip thickness photograph and the ideal Ricketts' esthetic position, there was disagreement between general dentists and orthodontists on the level of attractiveness. Since these are supposed to be an objective norm, it is surprising to find statistically significant differences for these photographs. Even for a difference to occur, a more expected result would have been a difference between laypersons and one of the doctor types (general dentists or orthodontists). This highlights that there are differences in the training and standardization of lip

esthetics in the dentistry world. This study shows that there is an apparent disconnect in calibration of measurements across dental specialties or disciplines.

It is interesting to note that in every “difference between groups” orthodontists were the common denominator. There was never a statistically significant difference between general dentists and laypersons, only between orthodontists and general dentists or orthodontists and laypersons. Disagreements between orthodontists and other groups may be due to the fact that orthodontists are the only ones that get specialized training in these specific facial analyses on an in-depth level. Therefore, when photographs are shown that only differ by 1 mm from other photographs, orthodontists may be the only ones able to detect and pick up on these differences. While general dentists get substantial training in overall dental esthetics, there are still nuances of micro vs. macro details that some providers or occupation types may focus on more, due to their training. It is also possible that orthodontists are the “pickiest” of graders, due to the perfectionist nature of our profession.

IV.2 Orthodontist comparisons by age groups

Overall, there was a statistically significant disagreement in scoring for lip attractiveness in the thin (Q1), slightly thin (Q2), average thickness (Q3), retrusive (Q6), slightly protrusive (Q9), and protrusive (Q10) lip profiles. For most questions, there was a general trend of more critical or lower scores from young orthodontists (25-34 years old) compared to other age groups. The youngest orthodontists gave some of the lowest scores for the thin, slightly thin, and retrusive lip profiles. These results indicate a strong aversion of thin lips from young orthodontists, as these lip sizes and proportions were given the lowest scores out of the whole study (mean of about 30/100 or less on attractiveness scale). It is not difficult to imagine why the youngest orthodontists would view these lips as very unattractive, when the youngest generations

are the ones most exposed and influenced by social media and beauty trends, which in this case favor fuller lips. Question 3, which showed an average lip thickness, received statistically significant differences in mean lip attractiveness values when comparing the youngest orthodontists (25-34 years old) and the three groups of older orthodontists (45-54, 55-64, and 65+ years old). This was an interesting study finding, as it indicates orthodontists disagree upon a supposed universal standard. One would hope that out of all the categories, the averages or norms could be at least somewhat agreeable among groups. However, the results of this study show that even 'norms' are subjective and people's views of them can be significantly different (statistically speaking) from one another. This finding reinforces the need to reevaluate the accepted norms published in orthodontic texts, because results show they are not as mutually agreed upon today as when they were initially proposed.

IV.3 Remarks, biases, and limitations

This study supports the primary hypothesis that there is a difference in opinion of ideal attractiveness of the lips amongst orthodontists, general dentists, and laypersons. The study's results do not provide sufficient evidence to support the secondary hypothesis that younger individuals, across all occupation types, prefer thicker, fuller lips with more protrusive profiles than older individuals. This is because the study did not have enough data to run comparative age statistics for all occupation types. As such, comparative age statistics were available for orthodontists and statistically significant differences in the mean lip attractiveness values were found. However, since this data was only analyzed for orthodontists, it is unknown if these age differences apply to general dentists or laypersons.

One potential source of bias in this study is the possibility that respondents may have evaluated other facial characteristics, such as nose appearance, chin size, skin color, or

pigmentation of the lips, which could have influenced their scoring of lip size and proportions. The Ricketts' esthetic line, as well as most other lip facial analyses discussed in the introduction, compare the lip position to the proportion of the nose and chin. By nature, individuals look at the nose and chin in reference to the lips, even though the survey prompt instructed them to focus on rating the attractiveness of the lips only.

Several limitations were present in this study, including a small sample size and an uneven distribution of demographics in some categories (such as racial/ethnic backgrounds, age, education level). Location data was unable to be statistically analyzed due to uneven geographic spread from zip code data. The survey did not collect demographic information on gender, which was a downfall to not being able to discuss the role of male and female differences in esthetic preferences. Additionally, the survey was only distributed in English, which may have excluded individuals who are more comfortable communicating in other languages. These non-native English speakers not wanting or being able to participate in the survey may have negatively affected the racial and ethnic distributions. Most of the respondents (70.9%) identify as White, Non-Hispanic, which is not representative of the general U.S. population. These limitations may have impacted the study's generalizability and the ability to draw extensive conclusions.

Another key limitation of this study is that respondents were asked to evaluate the appearance of only one subject, which provides limited data and may have skewed the results. Because the study did not include multiple subjects, it is difficult to determine whether the findings are generalizable to the larger population. Future research could address this limitation by using larger sample sizes or including multiple subjects with varying lip characteristics.

Future studies could attempt to modify previous standards, taking into account the preferences of today's population, in order to provide an updated and more widely accepted set of

ideal lip measurements. In order to evaluate the esthetic demands patients are often seeking today, it would be noteworthy to include facial photographs of patients that have undergone esthetic enhancements, such as lip filler, to alter the proportions of the lips.

Conclusion

Given the lack of mutual agreement among orthodontists, general dentists, and laypersons regarding the current accepted norms for lip and profile esthetics, it is important to establish new educational standards that are based on evidence-based research.

The study's findings suggest that orthodontic treatment should prioritize avoiding retrusive or thin lips to achieve more esthetically pleasing outcomes for patients. Thus, orthodontists should consider accepting a slightly thick or protrusive lip profile, which is often more well-received by patients.

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