

## Table of Contents

|                                                                       |    |
|-----------------------------------------------------------------------|----|
| Abstract: .....                                                       | 3  |
| 1. Introduction: .....                                                | 4  |
| 1.1 History of Orthodontics: .....                                    | 4  |
| 2. Evolution of adult orthodontic treatment: .....                    | 5  |
| 2.1 Traditional vs Modern Alternatives: .....                         | 5  |
| 2.1.1 Conventional braces: .....                                      | 5  |
| 2.1.2 Ceramic braces: .....                                           | 6  |
| 2.1.3 Lingual braces: .....                                           | 6  |
| 2.1.4 Clear Aligners: .....                                           | 7  |
| 2.1.5 Comparison of different treatment options: .....                | 7  |
| 3. Unique Considerations in Adult Orthodontics: .....                 | 8  |
| 3.1 Physiological Differences: .....                                  | 8  |
| 3.2 Impact of Age on Treatment: .....                                 | 9  |
| 3.3 Pre-existing dental treatment: .....                              | 10 |
| 4. Psychosocial Aspects of Adult Orthodontic Treatment: .....         | 11 |
| 4.1 Gender Differences: .....                                         | 11 |
| 4.2 Professional and Social Influences: .....                         | 11 |
| 4.2.1 Proportion of Educated Adults in Orthodontics: .....            | 13 |
| 5. Treatment Outcomes and Quality of Life: .....                      | 14 |
| 5.1 Effects on Oral Health-Related Quality of Life: .....             | 14 |
| 5.2 Critic of Research Methodologies: .....                           | 15 |
| 5.2.1 Study Design: .....                                             | 15 |
| 5.2.2 Sample Size and Selection: .....                                | 15 |
| 5.2.3 Measurement Tools: .....                                        | 16 |
| 5.2.4 Time Frame: .....                                               | 16 |
| 5.2.5 Multidimensional Approach: .....                                | 16 |
| 5.2.6 Statistical Analysis: .....                                     | 16 |
| 5.3 Approaches and Assumptions of the Present-Day Studies: .....      | 16 |
| 6. Challenges in Adult Orthodontics: .....                            | 17 |
| 6.1 Compliance Problems in Adult Orthodontics: .....                  | 17 |
| 6.2 Equilibrating Aesthetics and Function in Adult Orthodontics ..... | 18 |

|       |                                                                                                |    |
|-------|------------------------------------------------------------------------------------------------|----|
| 6.2.1 | Addressing Multiple Pathologies & Medications in Adults Undergoing Orthodontic Treatment ..... | 18 |
| 7.    | Emerging Trends and Future Directions: .....                                                   | 19 |
| 7.1   | Advancements in Technologies.....                                                              | 19 |
| 7.2   | Personalized Treatment Solutions.....                                                          | 20 |
| 7.3   | Areas for Further Research .....                                                               | 20 |
|       | Conclusion: .....                                                                              | 21 |
|       | Acknowledgments:.....                                                                          | 22 |
|       | References:.....                                                                               | 22 |

## LIST OF FIGURES

|                                                                                                                                        |    |
|----------------------------------------------------------------------------------------------------------------------------------------|----|
| Figure 1: Timeline of Orthodontics [Source: ((Braces History Timeline & Orthodontics infographic   Aceledontics, 2021))]               | 5  |
| Figure 2: Types of conventional and modern braces [Source: (Dental Braces NYC (Ceramic, Clear)   Gibbs Orthodontics, 2024)]            | 6  |
| Figure 3: Acceptable rate of adult orthodontics treatment [Source: (Ra et al., 2019)]                                                  | 8  |
| Figure 4: Different types of classes and problems of adult orthodontics [Source: (Admin, 2024)]                                        | 9  |
| Figure 5: Display of the incisors as functions of age and sex [ Source: (Mucha, 2018)]                                                 | 10 |
| Figure 6: Adults satisfaction rate of orthodontics treatment [Source: (Report makes economic case for investing in oral health, 2024)] | 12 |
| Figure 7: Reasons for adults seeking orthodontics treatment [Source: (Christensen, 2015)]                                              | 14 |
| Figure 8: Post orthodontics treatment satisfaction rates among adults [Source: (Grassia, 2024)]                                        | 15 |
| Figure 9: Reasons of failure of orthodontics treatment [Source: (Chow et al., 2020)]                                                   | 18 |
| Figure 10: Modern techniques of orthodontics treatment [Source: (Liu, Sharpe and Volponi, 2023)]                                       | 20 |
| Figure 11: Global orthodontics market 2023-2030 [Source: (Global Orthodontics Market Size, Trends, Share,Forecast 2030, 2024)]         | 21 |

## LIST OF TABLES

|                                                                                        |    |
|----------------------------------------------------------------------------------------|----|
| Table 1: Comparison of different orthodontics treatment [Source: (Orthodontics, 2024)] | 7  |
| Table 2: Results of satisfaction rate of adult orthodontics treatment                  | 12 |

## **Abstract:**

Adult orthodontics has also developed into a very active specialization to meet various patient demands using modern technologies and individualized therapies. This systematic analysis presents literature dedicated to the diverse area of adult orthodontic procedures and difficulties, including physiological and psychosocial characteristics and treatment outcomes. Some of the notable outcomes signify that patients are likely to experience enhanced self-esteem, facial aesthetics, and functional dental alignment about oral health-related quality of life. The introduction of three-dimensional imaging, artificial intelligent planning, and individualized treatment paths has transformed treating patients. Nevertheless, the present study also points to the need to overcome some current limitations of orthodontic research for the development of new strategies, based on the clinician's knowledge as well as the patient's preference, and the possibilities offered by new technologies in adult orthodontic treatment.

## **1. Introduction:**

Orthodontics is a branch of dentistry that treats dental malocclusion and facial anomalies in patients older than 18 years of age (Barreto, 2019). This field of dentistry focuses on modifying the look of the patient's smile and their overall oral condition and ability (Littlewood and Mitchell, 2019). Current orthodontic treatments available for adults are traditional metal braces, clear braces, and language braces, which slowly align the teeth (Orhan and Görürgöz, 2021).

### **1.1 History of Orthodontics:**

The origins of orthodontics can be traced back to ancient civilizations, where attempts at correcting the position of teeth included Egyptian mummies that had strings placed around their teeth in a bid to close spaces (Melsen and Luzi, 2022). Romans also tried to place orthodontic techniques using gold wire to join teeth (Orhan and Görürgöz, 2021). However, a new form of orthodontics emerged during the 18th century when a French dentist, Pierre Fauchard made a significant contribution to modern orthodontics and is often referred to as the 'father of modern dentistry' (S. Saccomanno et al., 2022). The field came to popular awareness as a separate treatment approach in the year 1900 with the opening of in the first orthodontic school by Edward Angle (Ra et al., 2019).

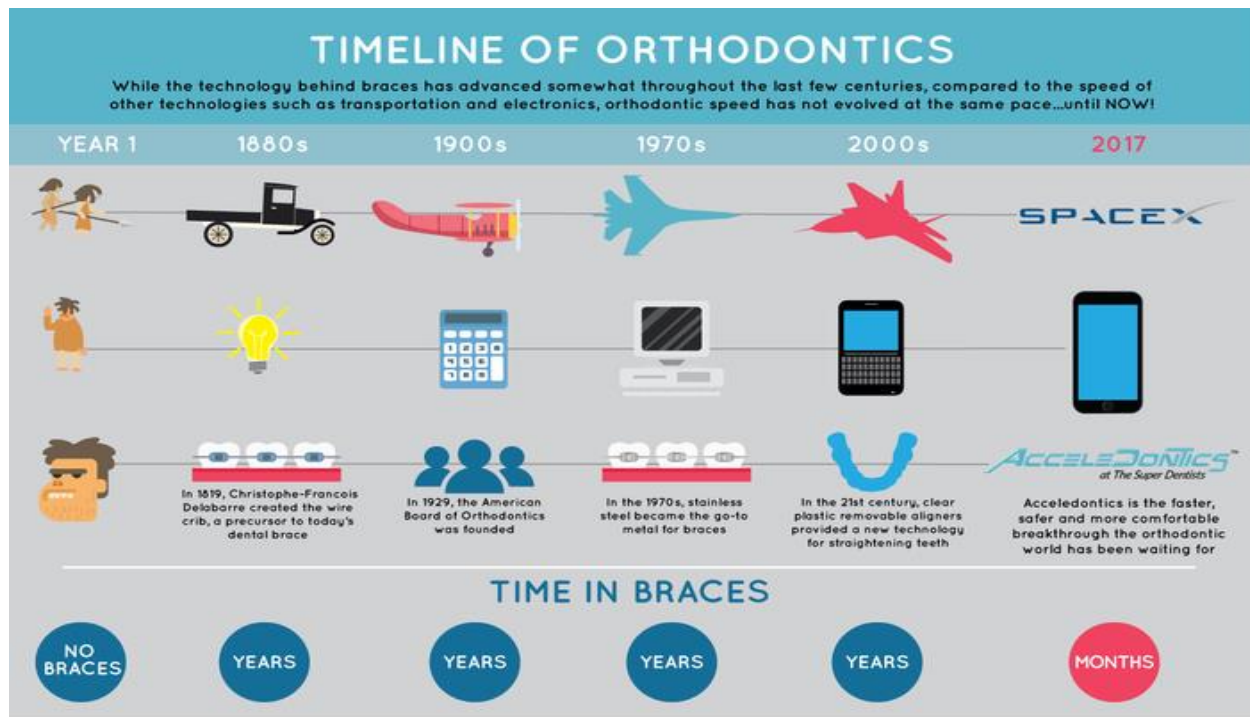


Figure 1: Timeline of Orthodontics [Source: ((Braces History Timeline & Orthodontics infographic | AcceleDentics, 2021)]

Contemporary adult orthodontics has been on the rise and has also developed into a highly specialized field over the years. Compared to adolescents, adults possess dense bones in the jaw, which would bring some challenges in orthodontic correction and may lead to a longer duration of treatment sometimes (Pinto et al., 2020). Secondly, some adults may have specific dental problems like tooth decay or gum diseases which in one way or another may influence the treatment to be offered (Mulimani and Popowics, 2022). However, choosing adult orthodontics has its advantages, such as a healthier mouth and gums, a more beautiful smile, and a boost in self-esteem (Ferati et al., 2024). With the modern advancement in technological value and the development of discreet orthodontic appliances like Invisalign which was introduced in the year 2000, the concept of orthodontics among adults does not cease to exist; in fact, it retains its practice due to its effectiveness, especially to the patient with dental related imperfections (S. Saccomanno et al., 2022).

## 2. Evolution of adult orthodontic treatment:

### 2.1 Traditional vs Modern Alternatives:

#### 2.1.1 Conventional braces:

Conventional metal brackets have been the prevalent type of orthodontic appliances for many years. Although they are still utilizable to the present day, particularly when it comes to rather

intricate matters, many problems of traditional lists have been solved in the newer versions of these tools (Almutairi, Alturaif and Alanzi, 2023). Modern metal braces are much more stylish and comfortable as compared with earlier models of metal braces (Chow et al., 2020). As for adult patients who still have certain aesthetic concerns, ceramic braces tie for the second place as they have tooth-colored brackets that somewhat match the enamel (Meyer-Marcotty et al., 2021).



Figure 2: Types of conventional and modern braces [Source: (Dental Braces NYC (Ceramic, Clear) | Gibbs Orthodontics, 2024)]

### **2.1.2 Ceramic braces:**

Ceramic braces are brackets manufactured using a ceramic material called translucent polycrystalline alumina, and these are clear and do not stain the teeth (Watted et al., 2023). These are more attractive compared to normal metal braces and are worn by adults as a more unobtrusive way to fix teeth alignment problems (Nagar et al., 2022). Though costlier compared to metal braces and potentially not as long-lasting, ceramic braces can successfully fix most dental problems without the aesthetic drawbacks of metal braces (Fenton et al., 2021). These braces take between 18-36 months of treatment and are widely accepted by working people and anyone who is in a position to have his/her teeth adjusted without revealing it (Fleming et al., 2022).

### **2.1.3 Lingual braces:**

Lingual braces can be considered a major step in the field of adult orthodontics (Ristoska et al., 2019). These braces are fixed at the back of the teeth, therefore they cannot be easily seen from the front (Joy et al., 2019). This option is ideal for those adults who need an efficient method of fixing their teeth, but do not want the inconvenience of standard braces (Lam, 2020).

It can be argued that the advent of clear aligners has been the most significant advancement in adult orthodontics. Technologically advanced braces like Invisalign and other aligners have

revolutionized the field in a way that looks in harmony with the perceptions of modern-age adults (Meyer-Marcotty et al., 2021).

**2.1.4 Clear Aligners:**

There are invisible aligners now, which makes them even more appropriate for adult patients seeking orthodontist treatment (Almutairi, Alturaif and Alanzi, 2023). These are some of the custom-made, fixed oral appliances used to slowly move teeth into the right positions as an effective form of invisible braces (Nagar et al., 2022).

The major incentive to choose clear aligners is that they are almost invisible to the naked eye and that they are removable (Fenton et al., 2021). It is convenient for adults to take the aligners out while eating, drinking, and practicing oral hygiene, they can be easily worn (Ra et al., 2019). The clear aligners are worn for roughly 22 hours in a day and each batch of aligners is usually worn for one week before changing to the next aligner (S. Saccomanno et al., 2022). Clear aligners can help fix a broad number of orthodontic conditions including; gaps between the teeth, overcrowding, bite problems such as overbite or underbite, open bite as well as crooked teeth (Littlewood and Mitchell, 2019). Nevertheless, it may not fit some situations – especially when severe malocclusions or difficult tooth movements are involved (Orhan and Görürgöz, 2021).

**2.1.5 Comparison of different treatment options:**

Table 1: Comparison of different orthodontics treatment [Source: (Orthodontics, 2024)]

| Feature                         | Conventional braces | Ceramic braces          | Lingual braces              | Clear Aligners        |
|---------------------------------|---------------------|-------------------------|-----------------------------|-----------------------|
| Visibility                      | Most visible        | Less visible than metal | Nearly visible              | Nearly visible        |
| Effectiveness for complex cases | Excellent           | Very good               | Excellent                   | Good                  |
| Comfort                         | Moderate            | Moderate                | Initially uncomfortable     | Generally comfortable |
| Treatment duration (average)    | 18-36 months        | 18-36 months            | 18-36 months                | 6-18 months           |
| Dietary restrictions            | Yes                 | Yes                     | Yes                         | No                    |
| Speech Impact                   | Minimal             | Minimal                 | May affect speech initially | Minimal               |

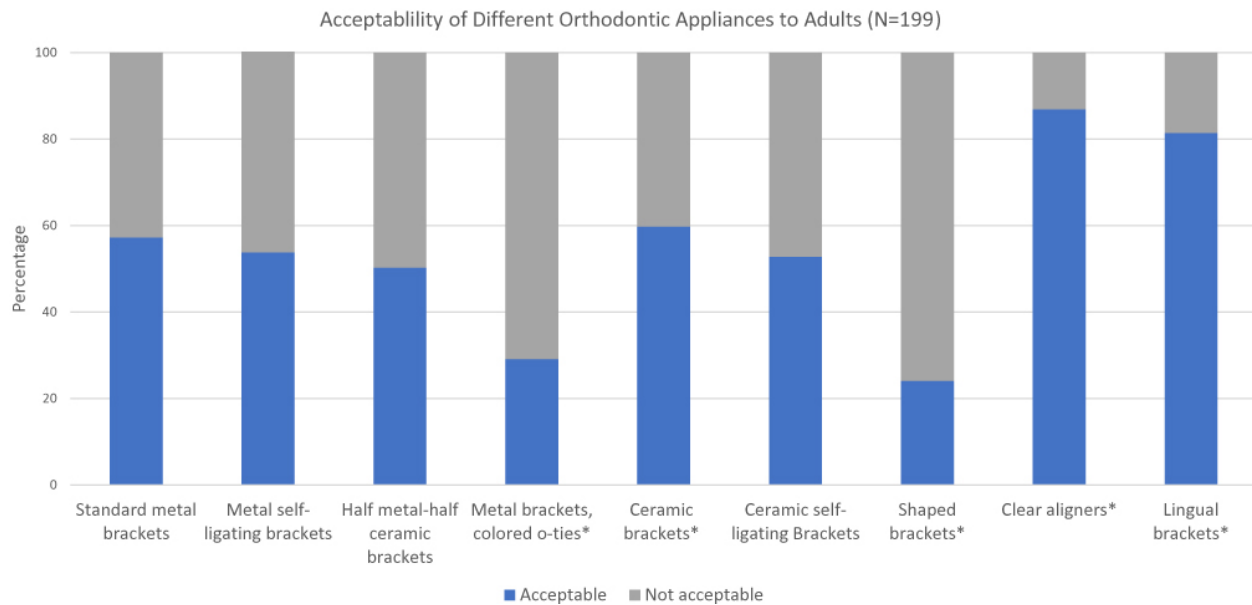


Figure 3: Acceptable rate of adult orthodontics treatment [Source: (Ra et al., 2019)]

### 3. Unique Considerations in Adult Orthodontics:

#### 3.1 Physiological Differences:

Adult orthodontics poses specific problems and concerns that are not typical of younger persons, and these are the reasons that make this area relevant (Pinto et al., 2020). The most important is that bones are no longer growing, and they are denser, and more mature compared to those of an adult (Almutairi, Alturaif and Alanzi, 2023). This makes the bone density increase causing the teeth to shift slowly, especially during the initial stage of the treatment process (Chow et al., 2020). In adults, an entirely different behavior of the periodontal ligament (PDL) under orthodontic forces is observed. Adult PDL shows (Meyer-Marcotty et al., 2021):

- Extended disorganization time
- Increased cell senescence
- Reduced cell signaling
- Increased inflammatory properties of the tumor microenvironment

Moreover, patients of advanced age may evidence substantial decreases in surface area of blood vessels in the PDL during the movement phase and decidedly less flexible fibers (Watted et al., 2023). Compared to the alveolar bone in adults, the bone density is high and there is less activity of osteoblasts and osteoclasts when exposed to orthodontic forces (Nagar et al., 2022). This can lead to a decreased rate of bone remodeling which is essential in tooth movement phenomena (Fenton et al., 2021).

Adults are also at a higher risk for certain complications (Fleming et al., 2022):

- **Root resorption:** It is more prevalent in adults and occurs when the body absorbs the tooth root back into its system, which leads to tooth loss if left untreated.
- **Temporomandibular disorder (TMD):** Thus, it should be noted that adult patients have more significant risk factors concerning potential TMD formation during treatment with orthodontic appliances.



Figure 4: Different types of classes and problems of adult orthodontics [Source: (Admin, 2024)]

### 3.2 Impact of Age on Treatment:

The age-related physiological differences significantly impact orthodontic treatment in adults (Ristoska *et al.*, 2019 ; Joy *et al.*, 2019; Lam, 2020):

- **Treatment Duration:** It is important to note that adult patients tend to take longer time than adolescent patients when undergoing orthodontic treatment. This extended timeline is primarily due to a lower pace of tooth movement due to increased density of the bone tissue and decreased cellular turnover rate.
- **Treatment Approach:** It is common for the orthodontist to ignore the aesthetics especially when dealing with an adult patient and in cases where one has a deep overbite or worn-out teeth the orthodontist aims at achieving the functionality of the bite.
- **Biomechanical Limitations:** Possibilities include lack of bone between tooth roots for blood supply, slight inflammation of gums, or slight recession of the jawbone. These factors can make the procedure of tooth realignment a bit challenging.
- **Tooth Extraction Considerations:** Issues related to previous tooth extractions in adults may occur. Due to biological conditions, it could be impossible to use old extraction sites that require tooth movement without prosthetic bone augmentation. It is even more

challenging when the gaps are between teeth since the bones of adults do not react to pressure as they do in young people.

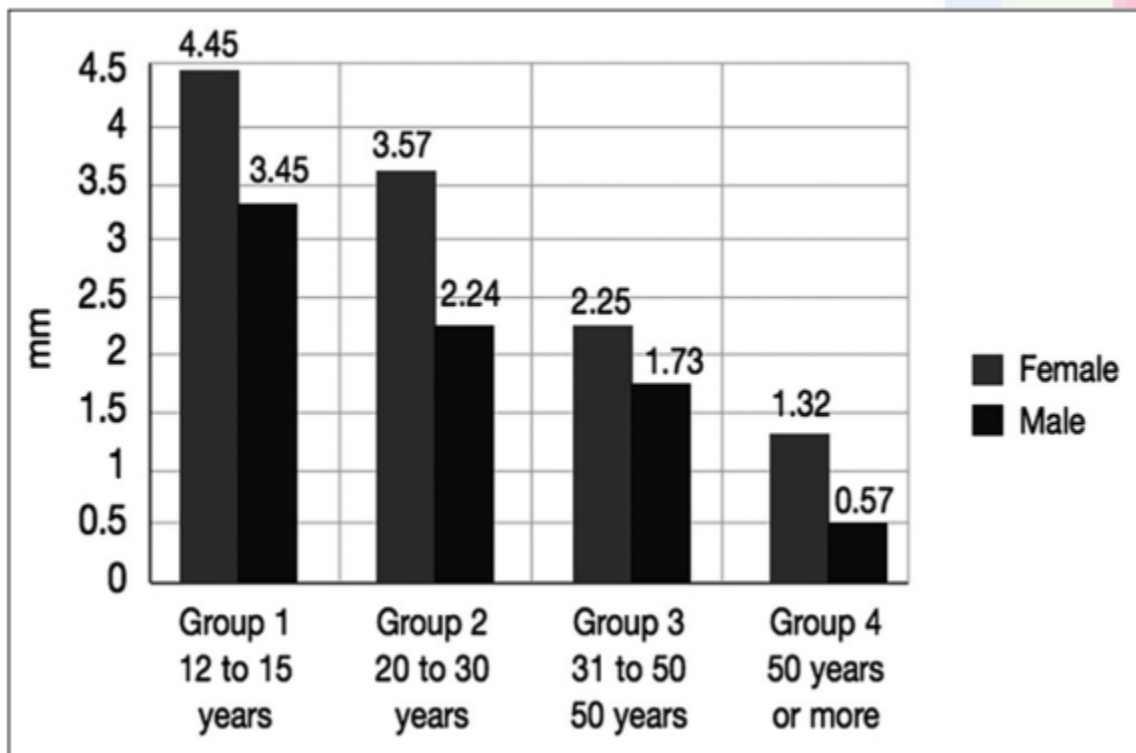


Figure 5: Display of the incisors as functions of age and sex [ Source: (Mucha, 2018)]

- **Appliance Selection:** The selection of orthodontic appliances can be limited depending on the lifestyle and attitudes of the adult patient. Options which are clear aligners or ceramic braces are normally preferred by most adult clients due to appearance.
- **Treatment Expectations:** The expectations of adult patients are higher than children because they expect better treatment outcomes, more comfort, and less time taking. Such consumers more frequently require additional details regarding the treatment stages and the estimated costs.
- **Compliance and Cooperation:** Adults on the other hand are more likely to abide by the orthodontist's instructions but they experience more pain and are more conscious about the metallic appliances.

### 3.3 Pre-existing dental treatment:

Pre-existing dental conditions are a crucial consideration in adult orthodontics, as they can significantly impact treatment planning and outcomes (González, Romero and Peñacoba, 2019; Han et al., 2019; Dipalma et al., 2023; Fleming et al., 2022):

- **Periodontal Disease:** Periodontal diseases of at least moderate severity are seen more frequently in adults. This condition should be treated at least before or during orthodontic treatment since movement of the teeth increases inflammation of the gums.

- **Tooth Decay:** It is very important to manage any cavity or decay in the present teeth before installing orthodontic appliances. Unfortunately, if the decay is not treated, it may become significantly more problematic when braces or aligners are used.
- **Missing Teeth:** There may be cavities and gum diseases among adults which leads to extraction of the teeth. This may cause challenges when determining whether to close the spaces or leave them open for the placement of prosthetic appliances.
- **Restorations:** It is also important to know if the patient already previously other interproximal restorations like crowns, bridges, or implants as this had will also influence the treatment possibilities as well as the prognosis. Some restorations that have been placed may require replacement or modifications during or after the orthodontic treatment has been done.
- **Temporomandibular Joint (TMJ) Issues:** TMJ problems are another factor that needs to be considered because certain orthodontic treatments may worsen such conditions.
- **Worn or Damaged Teeth:** Accumulated age, constant usage, or certain habits can cause teeth to become irregular or damaged and this will make it difficult to fix the bite.

## 4. Psychosocial Aspects of Adult Orthodontic Treatment:

### 4.1 Gender Differences:

Several studies have identified gender as a vital factor in different levels and aspects of orthodontic treatment in adulthood (González, Romero and Peñacoba, 2019). Females are more likely to require orthodontic treatment than their male counterparts, this is so because many of them are more conscious of their looks than they ought to be (Han et al., 2019). This gender difference in the usage of health care may be attributed to culture and gender roles that require them to act accordingly (Dipalma et al., 2023). From the physiological point of view, male and female patients have essential differences that influence the outcome of orthodontic treatment (Moharib, 2023). Men generally have more significant skeletal and dental measurements than women, particularly in terms of nose, facial bones, mouth, and mandibular canines (Watted et al., 2023). Moreover, males have higher, quantitatively, growth changes that are also observed in the later stages of development, which include tooth eruption and maturation. On the other hand, there are no gender differences in cephalometric angular measurements (Almutairi, Alturaif and Alanzi, 2023).

However, the differences outlined above suggest that there are physiological differences between males and females, and yet the response to the number of orthodontic and orthopedic therapies seems to be very comparable (Joy et al., 2019). This means that although there may be a need for distinguishing gender differences in growth and development, treatment strategies can follow without much difference (Chow et al., 2020).

### 4.2 Professional and Social Influences:

The choice of receiving an orthodontic treatment as an adult is highly connected with professional and social demands (Nagar et al., 2022). Thus, a confident charismatic smile is becoming more

and more an essential advantage in a hardworking professional contemporary world today (Fenton et al., 2021). Most adults are seeking to undergo orthodontic treatment, as they understand that having a good appearance, and a beautiful and healthy smile, especially during employment interviews, client meetings, and other important social encounters is very vital (Moharib, 2023).

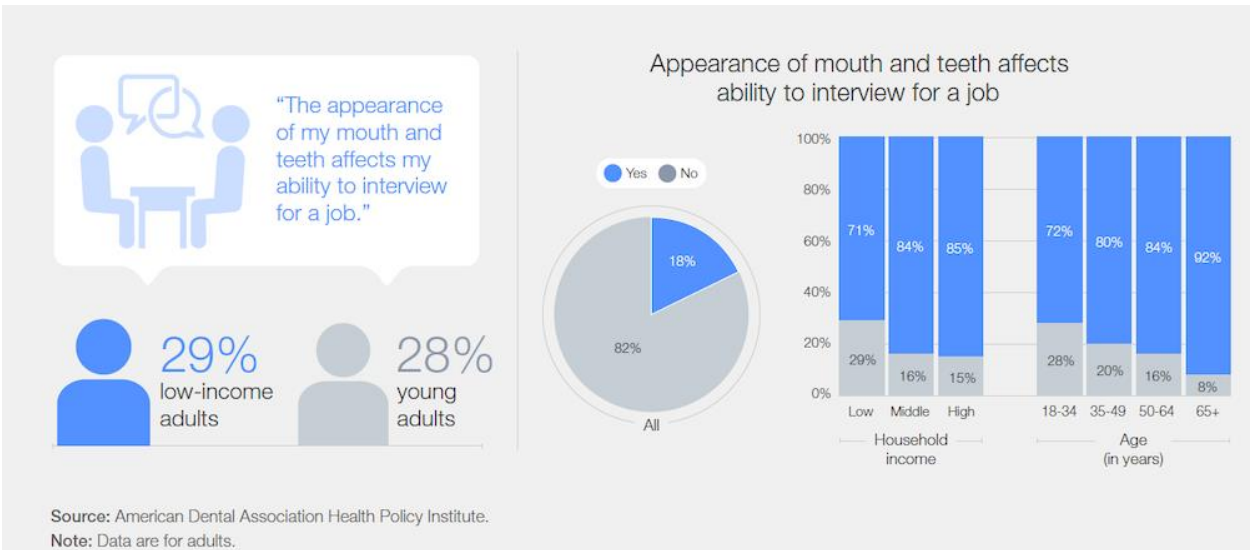


Figure 6: Adults satisfaction rate of orthodontics treatment [Source: (Report makes economic case for investing in oral health, 2024)]

People tend to turn to social media as one way of encouraging them to seek orthodontist treatment as adults (Hassani et al., 2021). The same study revealed that 31% of participants chose the option that related to a desire to see themselves on social media as one of the essential social factors that prompted them to consider treatment (AISeraidi et al., 2021). This constant visibility of their image on different social platforms has increased awareness and the need to enhance aesthetics in the dental field (Gao et al., 2022).

Innovations in other technical interventions, too, have also favored adult orthodontics (Issa et al., 2020). Modern orthodontic treatment now offers more friendly solutions to adults, clear aligners have gotten rid of the embarrassment associated with metal braces (Sahu et al., 2022). Such contemporary approaches tend to take less time and frequent orthodontist visits are something convenient with the tight schedules of most adults (Liu, Sharpe and Volponi, 2023).

Table 2: Results of satisfaction rate of adult orthodontics treatment

| Aspect                   | Stats                       | Source              |
|--------------------------|-----------------------------|---------------------|
| Gender Distribution      | 61.1% female, 38.9% male    | (Hung et al., 2023) |
| Age group                | 26-55 years (83% of adults) | (Morley, 2023)      |
| Influence of socializing | 65%                         | (Morley, 2023)      |

|                                             |                                                                      |                          |
|---------------------------------------------|----------------------------------------------------------------------|--------------------------|
| Increase in adult patients                  | 76%                                                                  | (Dipalma et al., 2023)   |
| Patient satisfaction with facial appearance | Increased from 38.2% to 77.5% post-treatment                         | (K, B and V, 2022)       |
| Patient satisfaction with a smile           | Increased from 14.7% to 97.1% post-treatment                         | (Hassani et al., 2021)   |
| Self-esteem improvement                     | Increased from 56.9% to 98.1% post-treatment                         | (Kaitsas et al., 2021)   |
| Education level                             | Higher likelihood of malocclusion issues in those with a Master/PhD. | (AlSeraidi et al., 2021) |

#### **4.2.1 Proportion of Educated Adults in Orthodontics:**

The role of education level in understanding different aspects of adult orthodontic treatment, including the frequency of some orthodontic problems, patients' compliance, and satisfaction has been established (Lam, 2020). Some findings (González, Romero and Peñacoba, 2019; AlSeraidi et al., 2021; Gao et al., 2022; Issa et al., 2020) suggest that oral health and particularly orthodontics are significantly linked with educational achievements in those with advanced degrees particularly with Master's or Ph.D (Kaitsas et al., 2021). This could be attributed to enhanced knowledge of dental health or the willingness to seek dental treatment among the more educated persons (Hassani et al., 2021).

Numerous studies (Issa et al., 2020; Sahu et al., 2022; Liu, Sharpe and Volponi, 2023; Liu, Sharpe and Volponi, 2023) have drawn a correlation between education level and both the degree of compliance and satisfaction in the case of orthodontic treatment. Similarly, patients with high literacy levels are also more inclined to adhere to therapy regimens, likely because of an enhanced insight regarding the role of treatment (Sahu et al., 2022). When compliance is increased, it means treatment will be effective and this helps in curing the diseases (Gao et al., 2022).

However, it is crucial to acknowledge that formalized education should not be a criterion for patient education because all patients should get a complete education (Liu, Sharpe and Volponi, 2023). All patients should be given appropriate information and details by the orthodontists to make decisions about the need for orthodontic treatment (Zhang, Sang and Tang, 2023). This approach makes it possible to explain the rights of the patients by enabling them to understand the options available to them as well as the likely outcomes (Brown et al., 2022).

The relationship between education level and orthodontic treatment emphasizes the exigency of combined and individualized communication processes (Brown et al., 2022). Orthodontists should expect to adapt their language and presentation of treatment information based on the patient's education level so that everyone receives appropriate care (Gassem et al., 2022).

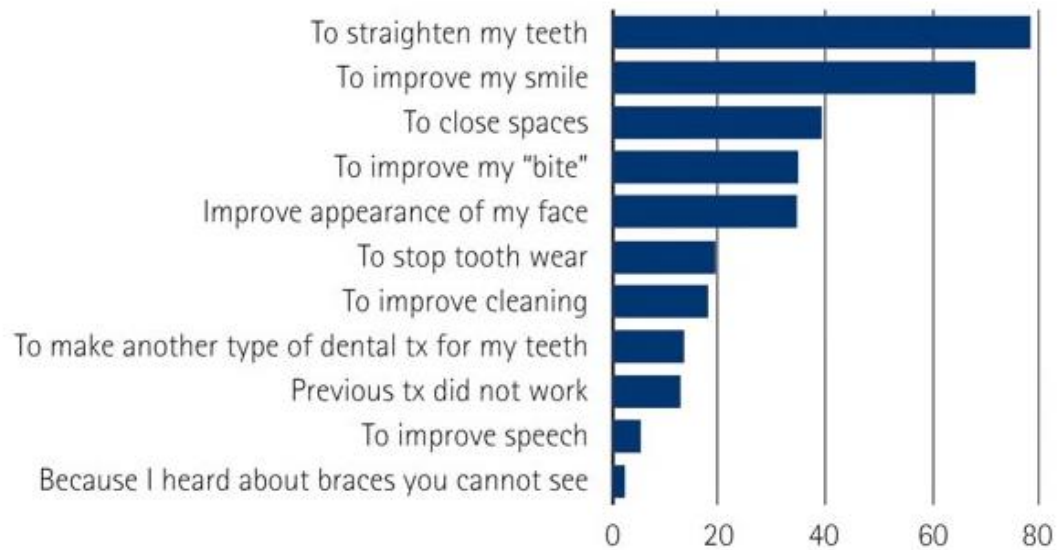


Figure 7: Reasons for adults seeking orthodontics treatment [Source: (Christensen, 2015)]

## 5. Treatment Outcomes and Quality of Life:

### 5.1 Effects on Oral Health-Related Quality of Life:

Several studies (Maaz and Fida, 2022; Gehlot et al., 2021; Leon-Valencia, Alarcon and Martin, 2024) have demonstrated the benefits of orthodontic treatment in adults on OHRQoL. A prospective study by Shen et al. (2023) concluded that although there is a significant decline in OHRQoL in the first three months of treatment, it regains its baseline values at 6 months. This means that patients might perceive primary unpleasant or inconvenient symptoms at the beginning of treatment, but not at later stages.

Significant effects on OHRQoL are observed with orthodontic treatment in the long-term perspective. In another study by Ali, Sukhia and Fida (2022) a significant improvement in the general health-related quality of life of patients was reported after receiving orthodontic treatment. Specifically (Hassani et al., 2021; AlSeraidi et al., 2021; Kaitsas et al., 2021; K, B and V, 2022):

- The level of their satisfaction with their facial appearance enhanced from 38.2% to 77.5%
- The satisfaction of their smile improved significantly from 14.7% to 97.1%
- Self-esteem increased from 56.9% to 97.1%.
- Self-confidence improved its rating from 60.8% to 96.1%.

Such enhancements in self-esteem and confidence are clear evidence of the psychological boost of adults opting for orthodontic treatment (Hassani et al., 2021). The aesthetics of the smile are improved as well as the occlusion which overall results in better quality of life as well as oral health (Leon-Valencia, Alarcon and Martin, 2024).

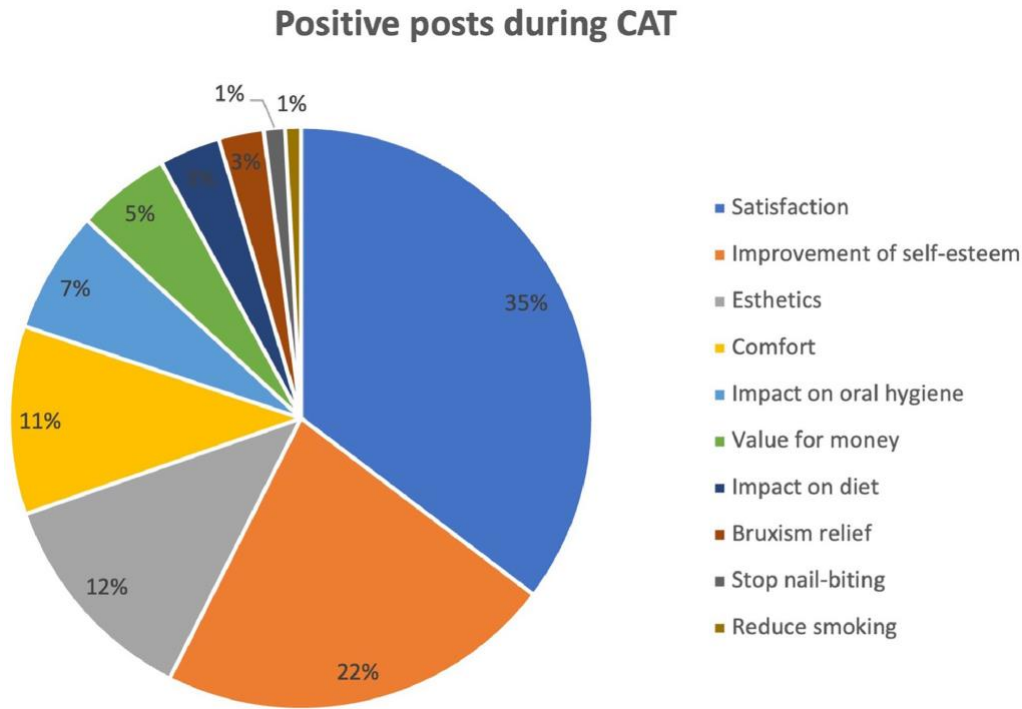


Figure 8: Post orthodontics treatment satisfaction rates among adults [Source: (Grassia, 2024)]

## 5.2 Critic of Research Methodologies:

The research methodologies employed in studying adult orthodontics and its impact on quality of life have both strengths and limitations:

### 5.2.1 Study Design:

Most of the studies like Yassir (2022), Wang et al. (2022) and Y. Zhao et al. (2024) employ a prospective design whereby data collection occurs at several points in time. This approach makes it possible to monitor changes and has a wider perspective of different treatment impacts. However, many of the articles do not include a control group which reduces the likelihood of different changes being more due to orthodontic treatment.

### 5.2.2 Sample Size and Selection:

The sample size also differs largely from one study to another. Some like Wang et al. (2022) requiring 102 participants have a large sample size while others might have minimal participants available. There are also issues regarding samples 'representativeness' since many studies are conducted in single institutions or practices.

### **5.2.3 Measurement Tools:**

Questionnaires that have been tested and proven to be effective like the OHIP-14 and the Rosenberg Self-Esteem Scale are often applied (AlSeraidi et al., 2021). These questionnaires offer quantitative comparisons of OHRQoL and self-esteem with other studies' indexes. Still, they aren't always comprehensive biosocial chronicling of the patient experiences.

### **5.2.4 Time Frame:**

Patients' patrols can differ considerably about follow-up periods of the studies. Some of them, such as in the study by (K, B and V, 2022) directly monitor patients up to the end of their treatment period and even in the post-treatment phase, while others may provide follow-up for a specific period only. More extended studies are required to evaluate the sustainability of the reported changes in OHRQoL.

### **5.2.5 Multidimensional Approach:**

More recent work, for example, the study of (Y. Zhao et al., 2024), Wall et al. (2024) and Pattanaik et al. (2024), uses records analysis supplemented with patient questionnaires. This is advantageous because it gives other treatment outcomes and other patients' experiences as well.

### **5.2.6 Statistical Analysis:**

The lack of appropriate statistical methods such as matching or using untreated scores and only paired t-tests for pre and post-comparisons provide limitations to the study. But other, more sophisticated methods including multivariate regression might reveal more details as to what would impact outcomes most.

## **5.3 Approaches and Assumptions of the Present-Day Studies:**

Several limitations and potential biases exist in the current body of research on adult orthodontics (H. Zhao et al., 2024; Hung et al., 2023; Mheissen et al., 2024; Fleming and Andrews, 2024):

- **Recall Bias:** Often, data is collected based on the past, which is not always accurate and may be subject to recall bias when determining whether a participant met certain criteria before treatment.
- **Selection Bias:** These studies recruit patients who have opted to get orthodontic treatment which may not represent everybody, but rather those who are sure of the outcome of the treatment.
- **Lack of Diversity:** Most of the studies are carried out in a single geographical area or a single clinical setting, and therefore the heterogeneity of the improvement is restricted and might impact the applicability of the results.
- **Short-term Focus:** While some investigations paint a picture of patients up to the end of treatment, very little is understood about the stability of the changes in OHRQoL several years after treatment.
- **Limited Control Groups:** Many of the works presented do not include control groups and it can be problematic to distinguish the effects of changes in OHRQoL solely due to orthodontic

treatment with influences arising from other aspects or the natural development of the individuals.

- **Publication Bias:** There can be a bias where only favorable results are reported, thus inflating the number of articles with favorable findings as compared to neutral or negative results.
- These issues should be considered in future research to better capture the overall well-being benefits of adult orthodontic treatment.

## 6. Challenges in Adult Orthodontics:

### 6.1 Compliance Problems in Adult Orthodontics

Perception of compliance has been reported to be a major issue, especially in orthodontic treatment for adults (Mheissen *et al.*, 2024). A recent study by Grybaite, Awawdeh and Singh (2024) on the level of compliance established that there was a negative relationship between age and level of compliance where a negative correlation coefficient of -0.28 was established at a significant level of 0.05. The participants' level of compliance with the guidelines was also measured; with 43.8% claiming to have excellent compliance, 38.3% good compliance, and the remaining 18.0% claiming to have poor compliance (Grybaite, Awawdeh and Singh, 2024).

Factors contributing to non-compliance in adult patients include (Orthodontics, 2024):

- Loss of time due to work pressure and other extracurricular activities
- Soreness or sensitivity arising from the use of orthodontic appliances
- Challenges in cleaning and flossing teeth while using braces
- Lack of compliance in the wearing of removable appliances or elastic search

It is often challenging for adult patients to stick to prescribed treatment regimens because they have their schedules and responsibilities (Jang *et al.*, 2024). Tolerating the discomfort related to treatment, keeping appropriate oral hygiene, and wearing elastics or removable appliances as instructed also affect the treatment outcome (Ronsivalle *et al.*, 2024).

To address these compliance issues, orthodontists may need to implement strategies such as (Hodges *et al.*, 2024):

- Ensuring precise, step-by-step instructions are given and refreshed frequently
- More flexible appointment schedules
- Supervising and incentivizing adherence through mechanisms such as smartphone applications.
- Focusing on the long-term outcomes when enforcing treatment and compliance

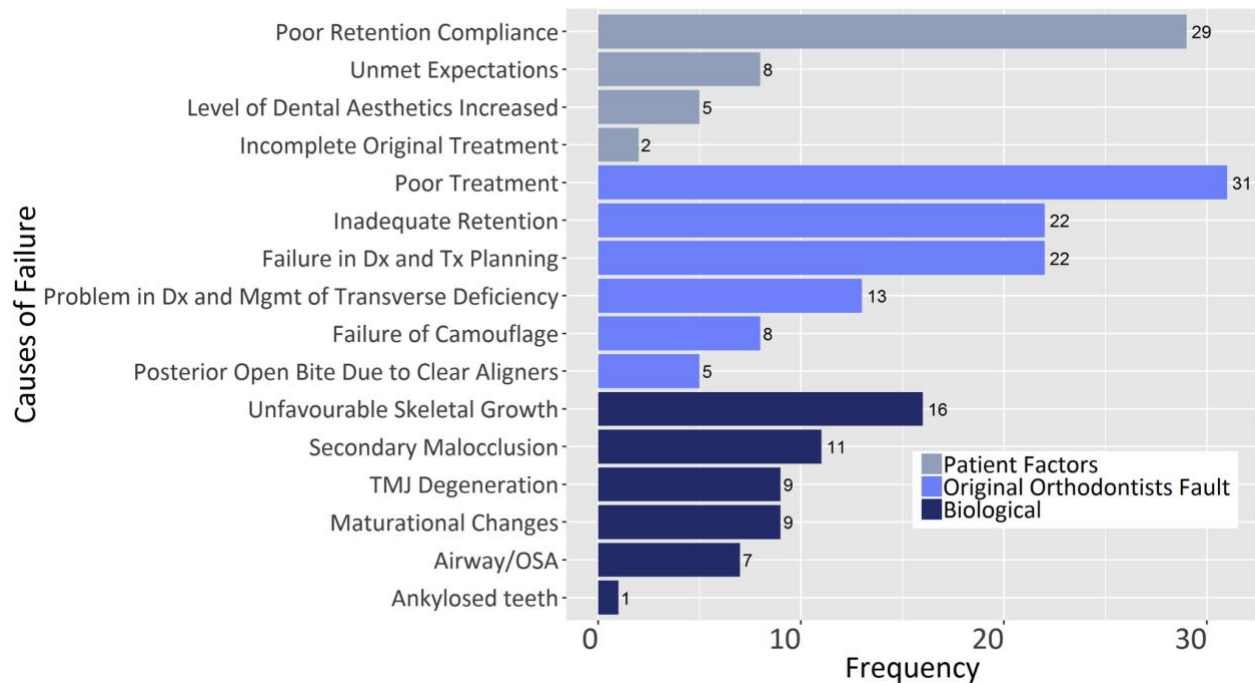


Figure 9: Reasons of failure of orthodontics treatment [Source: (Chow et al., 2020)]

## 6.2 Equilibrating Aesthetics and Function in Adult Orthodontics

Another factor that should be considered in adult orthodontic treatment is the aesthetic and fundamental functions (Jang et al., 2024). Although most adults choose orthodontic treatment for aesthetic purposes, it is important not to lose sight of function (Schneider and Moser, 2024). Morley (2023) insists on a more comprehensive treatment, which focuses on both aesthetics and functionality. This broad understanding acknowledges the fundamental fact that a perfect smile entails both aesthetics and function and the health of an individual.

Key considerations in balancing aesthetics and function include (Hung et al., 2023):

- Treatments are used in Aligning crowded teeth and jaws to enhance the mechanical efficiency of the bite.
- Treatments for temporomandibular joint (TMJ) disorders
- Improving the quality of the oral tissues and the health of the mouth in general
- Facial beautification: enhancing facial structure and features
- Sustaining stability for the results

### 6.2.1 Addressing Multiple Pathologies & Medications in Adults Undergoing Orthodontic Treatment

Adult patients are characterized by different medical and dental histories when compared to children and adolescents, which may complicate the process of orthodontic treatment (Ronsivalle et al., 2024). Such complexities call for a multi-factorial approach, which can guarantee the safety of the patients and their treatment success (Jang et al., 2024).

Pre-existing dental conditions that may impact treatment include (Hodges et al., 2024):

- Imbalances occurring from previous extractions or congenital dental deficits
- Periodontal disease
- Any major work (crowns, dental bridges, implants)

Medical conditions that can affect orthodontic treatment include (Gassem et al., 2022):

- Osteoporosis – diseases which affect the hardness of bones and tooth mobility
- Diabetes affected the healing process and exerts the Periodontal disease risk
- Cardiovascular diseases, wherein treatment stress plays an important role
- Medications can also affect orthodontic treatment, especially through various degrees of blood thinning that come with their use. For instance, bisphosphonates that are used to treat osteoporosis might influence tooth translation and other aspects of orthodontic treatment.

Managing these complex histories requires (Zhang, Sang and Tang, 2023):

- Medical and dental assessments before the intervention
- Inter-professional linkages with other specialists, such as periodontists and endodontists.
- Personalized treatment regimens that are based on bio-psycho-social-spiritual characteristics
- Frequency of check-ups and if necessary, changes to the treatment procedures

Thus, for these cases' successful management, it is possible to use some additional upcoming technologies, including 3D imaging and digital treatment planning (Liu, Sharpe and Volponi, 2023). All these tools assist in developing better informed personal treatment care plans for patients as well as in detailing the expectations of the patients concerning their conditions (Brown et al., 2022).

## **7. Emerging Trends and Future Directions:**

### **7.1 Advancements in Technologies**

Technological developments that are prevalent in the current society are vastly influencing orthodontic treatment. 3D printing is the latest advancement which has seen the fabrication of braces, retainers and some appliances all customized to suit the specific dental structures of patients (Kaitsas et al., 2021). Technological advancements including cone-beam computed tomography (CBCT) give orthodontists an enhanced view of the jaws and teeth of patients requiring treatment to assess the exact nature of a problem (K, B and V, 2022). Big data in orthodontic treatment is being incorporated into clear aligner treatment planning in which AI is applied to huge data sets in decision-making about the best processes for treatment path (Dipalma et al., 2023). Teledentistry has also been embraced whereby patients are checked and their progress followed through telephone calls, reducing the many densities that clients have to undertake in treating their teeth (Sahu et al., 2022).

## 7.2 Personalized Treatment Solutions

Now, the orthodontic field is quickly shifting in the direction of much more individualized treatment methods (Maaz and Fida, 2022). Using sophisticated imaging and treatment planning tools, orthodontists can develop individualized treatment plans based on each patient's specific needs and objectives (Leon-Valencia, Alarcon and Martin, 2024). It has also resulted in more efficient and effective approaches since it now obtains solutions that fit.

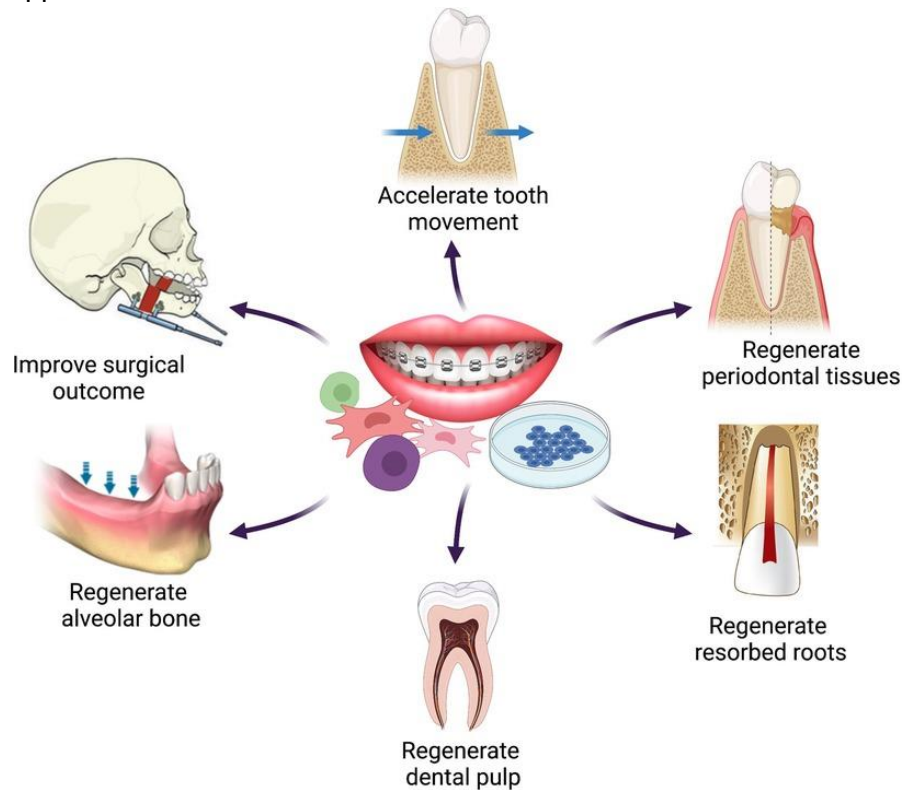


Figure 10: Modern techniques of orthodontics treatment [Source: (Liu, Sharpe and Volponi, 2023)]

Every client perfectly. CAD/CAM can be applied to the design of personalized orthodontic appliances such as braces, aligners, and other orthodontic appliances that can fit a patient's dentition perfectly (Y. Zhao et al., 2024). Furthermore, the use of AI in developing treatment plans is also accelerating the personalization step and potentially the overall treatment time (Mheissen et al., 2024). More so, this trend towards personalized orthodontics also applies the technique of precision orthodontic treatments that are tailored to the specific patient's biology and genetics (Schneider and Moser, 2024).

## 7.3 Areas for Further Research

Further developments in the field of orthodontics may be expected to concern several aspects. Bioengineering and gene therapy pose chances of shifting new benchmarks of original therapy impressions that may lead to prevention as much as noninvasive treatments (Hodges et al., 2024). Another promising area for further research is the use of artificial intelligence in diagnosis improvement as well as in the optimization of the treatment process (Jang et al., 2024). Further,

there has been a recent shift in focus towards more green and environmentally friendly approaches to orthodontic treatment and materials which has to do with the environmental footprint of dental treatments (Kuo et al., 2024).

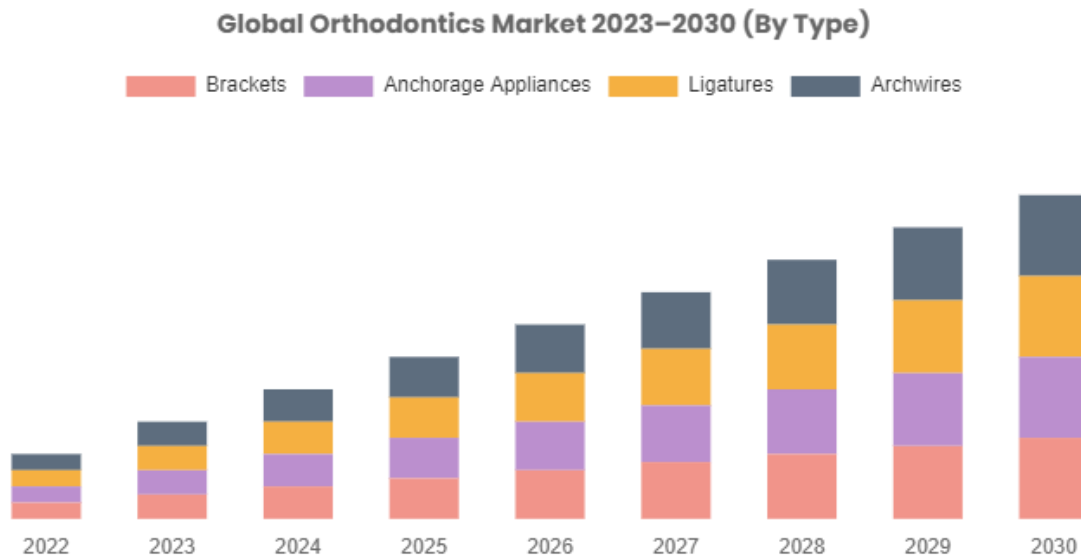


Figure 11: Global orthodontics market 2023-2030 [Source: (Global Orthodontics Market Size, Trends, Share, Forecast 2030, 2024)]

## Conclusion:

It has been established that adult orthodontics is an increasingly complicated area involving tasks like compliance management, aesthetic/functional trade-offs, and multifaceted medical histories. The enhanced use of technology in various improvements such as 3D printing and the use of artificial intelligence in treatment planning has gained significant credit. Gender differences and education level affect the outcome of the treatment in a major way. Looking at the previous literature, it is evident that there is generally an improved quality of life in the various domains tested for those accepting orthodontic treatment. However, there are major limitations in the generalizability, sample selection bias, and short-term follow-up, which raises the need for increased overall extensive studies in this developing specialty area.

The authors should call for comprehensive studies, although most of the reports contain informative suggestions and explanations.

Adult orthodontics may provide significant benefits from more extensive and methodologically rigorous research. The current limitations show that longer and larger studies are required to tackle these issues further in detail. Future studies should focus on:

- Multicenter data to increase external validity of results
- Methods that are distinct but easily comparable across the various surveys
- Integration of control groups to eliminate confounding effects of the treatment
- Prolonged follow-up durations to understand the durability of the results

- Cross-sectional studies involving more centers to recruit larger samples and diminish reference point predisposition
- Cross-sectional survey with qualitative supplement to ensure that the full experience of patients is ascertained
- Exploratory study of new technologies concerning patient treatment outcomes
- A review of how adult health is affected by orthodontic treatment

Nonetheless, the distinctive nature and variable requirements of orthodontic patients who are adults implore a tailored approach. Adults have different medical histories, lifestyles, and desired looks or expectations for the treatment results which make them require personal attention. More targeted strategies should consider not only the disease-related factors but also the psychosocial parameters of treatment outcomes. This makes it easy for orthodontists to fine-tune treatment plans to better serve the needs of the patient, increase adherence, and satisfy the patient. Adult orthodontics will also focus on blending available technologies and individual and societal needs and wishes to provide everyone with the appropriate and best solution available for their case.

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