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ORIGINAL RESEARCH

THE EFFECT OF FIXED ORTHODONTIC APPLIANCES ON BODY WEIGHT AND BODY MASS INDEX IN A SAMPLE OF ORTHODONTIC PATIENTS IN ERBIL CITY (A PILOT STUDY).

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Background: Fixed orthodontic appliances are widely used to manage malocclusion, yet their potential impact on body mass index remains unclear. The accessibility and adaptability of orthodontic brackets and wires, however, have nutritional implications that raise questions about body mass index (BMI). Patients with fixed appliances frequently have trouble chewing hard foods, which affects how many calories they consume and, in turn, their body mass index.

Objective: To evaluate changes in body mass index (BMI) during fixed orthodontic treatment in a cohort of orthodontic patients over 18 months.

Methods: This cohort study included 22 patients (12 males, 10 females; aged 18–24 years) with Class II division 1 malocclusion. Patients with an overjet between 0 and 6 mm and an overbite between 0 and 4 mm were included. The orthodontic treatment was performed by a single clinician using standardized brackets and arch wires. Body mass index (BMI) was measured at four time points: baseline (T1), six months (T2), twelve months (T3), and eighteen months (T4). Pairwise (post hoc) tests and repeated-measures ANOVA were used to analyze the data; $p < 0.05$ was considered significant.

Results: At baseline (T1), the mean BMI was 23.43 (± 5.17), which decreased to 23.24 (± 4.51) at T2; and then slightly increased to 23.64 (± 4.63) at T3; and ultimately reached 24.45 (± 4.61) at T4. BMI values showed significant changes over the course of the study, according to a repeated-measures ANOVA ($F=4.318$, $p=0.022$). Compared to T1 ($p = 0.048$), T2 ($p = 0.002$), and T3 ($p < 0.001$), the BMI at T4 was significantly higher. At T2 and T3, the BMI changes were not statistically significant ($P>0.05$). Additionally, the BMI patterns of male and female patients did not differ significantly.

Conclusion: According to this pilot study, BMI values decreased slightly at 6 months, then peaked significantly at 18 months relative to baseline. These findings emphasize the potential for long-term weight gain, though the lack of a control group prevents establishing direct causality.

Keywords: Body mass index, class II division I malocclusion, fixed orthodontic appliance, cohort study, orthodontic treatment.

INTRODUCTION

A range of malocclusions are treated with fixed, removable, and functional orthodontic appliances to produce long-lasting functional and aesthetic results. These devices have also been shown to enhance biting performance and speech articulation[1]. Wearing fixed appliances may cause short-term problems like chewing difficulties, the need to modify one's diet, and reluctance to eat certain foods. These issues can impact anthropometric measures like body weight and body mass index (BMI) as well as nutritional intake. Recent research indicates that eating habits, cultural factors, and the type of appliances used can all affect results, even though the systemic effects of orthodontic treatment have been disputed [2,3]. The type of appliance, the force used, past pain experiences, emotional states,

and environmental and cognitive influences are some of the variables that can cause discomfort during orthodontic treatment. In order to reduce pain and discomfort during the early stages of treatment, orthodontists frequently advise patients to follow certain dietary recommendations, such as eating soft foods[4]. Orthodontic appliances can have a significant impact on patients' everyday activities, potentially changing or limiting their eating habits[5]. The main cause of this is difficulties chewing and swallowing hard foods; patients usually observe a decrease in their ability to chew efficiently within 24 hours of receiving a fixed appliance. Patients frequently adopt a soft food diet to reduce pain and discomfort, which may result in a reduction in their overall food intake. Arch wires may restrict access to different kinds of food, which would make eating less pleasurable [6].

Body weight is significantly influenced by diet [7]. Patients experiencing oral discomfort may limit their food intake due to their increased dependence on nutritional supplements, potentially leading to unintended weight loss [8]. Numerous factors influence a patient's weight, such as behavioral dietary strategies like low glycemic index diets or orthodontic and functional appliances, as well as surgical procedures for intestinal or gastric conditions. By modifying patient weight, which depends on a number of variables, including health status, basal metabolic rates, diet quality, physical activity levels, hormonal balance, racial heritage, and genetic predispositions, fixed orthodontic treatments can affect overall health. As pointed out by Scott and Ludwig [9], dietary habits involving removable appliances may reduce food intake; therefore, orthodontists have the potential to actively contribute to the management of patient weight.

According to recent research, dietary restrictions brought on by the discomfort of orthodontic appliances—such as avoiding foods that are hard or fibrous—may cause brief changes in body weight. Adolescents may, for example, consume fewer fruits and vegetables and more soft, high-calorie carbohydrates which may lead to long-term changes in their body mass index [10].

The majority of research on BMI changes during orthodontic treatment has been restricted to short time periods (1-3 months), and there is a dearth of information on long-term BMI assessments [11-13]. The primary research question of this study is: What is the 18-month effect of fixed orthodontic treatment on the BMI of young adults with Class II division 1 malocclusion? In addition to addressing patients' concerns about potential weight changes during treatment, this cohort study sought to examine BMI variations.

The objective of this study is to investigate changes in body weight and BMI in orthodontic patients during an 18-month treatment duration. By investigating the connection between eating habits and fixed appliances, the study will shed light on the systemic effects of orthodontic treatment. It will also improve the current conversation about nutrition counseling in orthodontics, a practice that is being pushed more and more to guarantee healthy eating while undergoing treatment.

MATERIALS AND METHODS

This prospective single-arm pilot cohort study was conducted to explore longitudinal changes in BMI during fixed orthodontic treatment. As a pilot study, a formal sample size calculation was not performed; instead, the sample size was determined by the number of eligible patients available during recruitment. A total of 22 patients were included, allowing the collection of preliminary data on long-term changes in body mass index (BMI). Given the exploratory nature of pilot studies, the findings should be interpreted with caution and considered hypothesis-generating rather than confirmatory.

Inclusion and Exclusion Criteria

Participants had Class II Division 1 malocclusion with mild to moderate dental crowding, and their overjet and overbite were ($0\ mm \leq overjet \leq 6\ mm$)($0 \leq overbite \leq 4\ mm$). Throughout the course of treatment, the eligible subjects, aged 18 to 24 years old, demonstrated cooperation and motivation. Every participant had good oral hygiene and periodontal health, was medication-free, and was in overall good health. The study included only participants with all their permanent teeth, excluding third molars. Patients were eligible for inclusion if they presented with a Class II Division 1 incisor relationship and ($0\ mm \leq overjet \leq 6\ mm$)($0 \leq overbite \leq 4\ mm$).

Patients who presented with significant oral hygiene issues or missing teeth (excluding third molars) were excluded. Subjects who showed a lack of cooperation or who used drugs during the study period that could affect body weight were also not allowed to participate. Furthermore, patients with any systemic disease were ineligible to participate in the study. Pregnant women and patients with diagnosed eating disorders were also excluded to minimize potential confounding effects on BMI measurements.

Measurement Standardization

Weight was recorded using standard bathroom scales (accurate to 0.5 kg) with patients barefoot and in light clothing. Height was measured to the nearest centimeter to calculate BMI (kg/m^2). Measurements were taken at T1, T2, T3, and T4. Measurements were performed by the same clinician to ensure consistency, though the use of non-calibrated bathroom scales is noted as a limitation.

One limitation of this study was the use of standard bathroom scales with an accuracy of 0.5 kg. Future studies should employ calibrated medical-grade scales and more precise height measurements (to the nearest 0.1 cm) to improve measurement accuracy and data reliability.

This prospective cohort study was conducted at the Department of Orthodontics, College of Dentistry, Hawler Medical University. The study protocol was discussed by the scientific committee of the orthodontic department. Reviewed and approved by the Scientific and Ethical Committee of the College of Dentistry, Hawler Medical University, Erbil, Iraq (Reference Number: HMUD,2425007, assigned by the dean of the college, and followed recognized international rules for the protection of participants in human research as listed in the Declaration of Helsinki. Written informed consent for participation and publication of anonymous data was obtained from all participants included in this study.

The recruitment period for this study was from 1/2/2024 to 1/8/2025. Each patient was given information about the study's nature and goal prior to starting treatment, along with the freedom to discontinue participation at any moment. A single clinician from the same clinic treated all of the patients using the same orthodontic brackets and standard procedures. Arch wires were positioned and secured with the same elastic ligature following bracket bonding. Mild to moderate crowding that was treated without dental extractions was a common feature of the treated malocclusions. The subjects received instruction in proper oral hygiene and underwent full-mouth scaling and prophylaxis before the start of treatment.

Weight and height measurements were taken to calculate body mass index (BMI). Patients stood barefoot and in their normal clothes, and their weight was recorded using standard bathroom scales accurate to 0.5 kg. To the closest centimeter, height was measured. The BMI was then computed by dividing weight (kg) by height squared (m^2). Four time points were measured: baseline (pre-treatment), six months, twelve months, and eighteen months (T1, T2, T3, and T4).

GraphPad (version 10), R statistical programming (version 4.4.2), and IBM SPSS Statistics (version 26.0) were used for data analysis. Data normality was evaluated using the Shapiro-Wilk test. Repeated-measures ANOVA was used to assess changes in BMI over time. Pairwise (post hoc) comparisons were performed to identify specific time-point differences. Gender differences in BMI were assessed using independent-samples t-tests. The threshold for statistical significance was set at $p < 0.05$.

RESULTS

As shown in Table 1, the mean BMI of the 22 participants remained largely stable during the early stages of the study, with only minor fluctuations observed across the first three assessment points. At baseline (T1), the mean BMI was 23.43 (SD = 5.17). This value showed a slight decrease at 6 months (T2: 23.24), followed by a modest increase at 12 months (T3: 23.64). In contrast, a more pronounced increase in mean BMI was observed at the final assessment (T4), where it reached 24.45. The standard deviations were relatively consistent across all time points, indicating stable variability within the study population. Notably, the 95% confidence interval at T4 (22.89–26.01) shifted toward the higher end of the normal BMI range compared with earlier measurements, suggesting a trend toward increased body weight over time. The changes of BMI at T2 and T3 were not statistically significant ($P>0.05$).

Table 1. Descriptive Statistics of BMI at Four Time Intervals (N=22)

Time	Mean	Std. Deviation	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
T1	23.43	5.17	0.86	21.68	25.18
T2	23.24	4.51	0.75	21.71	24.76
T3	23.64	4.63	0.77	22.07	25.20
T4	24.45	4.61	0.77	22.89	26.01

The repeated measures ANOVA revealed a significant change in BMI over the course of the 18-months treatment period (F = 4.318, p = 0.022). The partial eta squared value (0.110) indicates a small to moderate effect size, meaning that approximately 11% of the variation in BMI can be explained by the timing of orthodontic treatment (Table 2).

Table 2. Repeated Measures ANOVA for BMI Changes Over Time.

Source	Type III Sum of Squares	Df	Mean Square	F	P-Value	Partial Eta Squared	
Time	30.606	1.751	17.478	4.318	0.022	0.110	
Error (Time)	248.105	61.290	4.048				

Particular variations between time points are shown by post-hoc pairwise comparisons (Table 3):
Comparing T1 and T4, the BMI at T4 was significantly higher than the baseline (mean difference = 1.016, p = 0.048). Comparing T2 and T4, the BMI at T4 was significantly higher than at 6 months (mean difference = 1.212, p = 0.002). Comparing T3 and T4, the BMI at T4 was significantly higher than at 12 months (mean difference = 0.809, p < 0.001). The most significant changes in BMI occurred in the later stages of treatment, especially leading to T4, as no significant differences were observed between T1-T2, T1-T3, or T2-T3.

Table 3. Pairwise Comparisons of BMI at Different Time Points (Post-hoc Test)

(I) Time		Mean Difference (I-J)	Std. Error	P-Value	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
T1	T2	0.196	0.386	0.615	-0.588	0.980
	T3	-0.207	0.418	0.623	-1.055	0.641
	T4	-1.016*	0.496	0.048	-2.023	-0.010
T2	T3	-0.403	0.244	0.107	-0.897	0.092
	T4	-1.212*	0.363	0.002	-1.949	-0.475
T3	T4	-.809*	0.165	0.000	-1.145	-0.474

The BMI values of the male and female participants at each time point are shown in Table 4. At T1, the mean BMI of females was slightly higher (23.93) than that of males (22.74). As treatment progressed, BMI values for all genders followed similar patterns, with both showing increases by T4 (males: 24.38; females: 24.49). There were no statistically significant differences in BMI between males and females at any time point (Table 5). This suggests that treatment effects on BMI are not gender-specific because the pattern of BMI changes during orthodontic treatment was similar for all genders.

Table 4. Descriptive statistics of BMI in males and females at different time points

Time	Gender	N	Mean	Std. Deviation	Std. Error Mean
T 1	Male	12	22.737	6.053	1.748
	Female	10	23.928	4.534	1.434
T 2	Male	12	23.364	5.569	1.608
	Female	10	23.143	3.722	1.177
T 3	Male	12	23.687	5.704	1.647
	Female	10	23.604	3.836	1.213
T 4	Male	12	24.384	5.489	1.585
	Female	10	24.493	4.013	1.269

Table 5. Independent-samples t-test for BMI differences between genders

Time	t	df	P-Value	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
T 1	-0.521	20	0.608	-1.191	-5.660	3.278
T 2	0.108	20	0.915	0.221	-4.043	4.485
T 3	0.040	20	0.969	0.083	-4.326	4.492
T 4	-0.053	20	0.959	-0.109	-4.394	4.176

DISCUSSION

BMI remained relatively stable during the early study period, with a slight decrease from T1 to T2 and minimal change through T3. In contrast, a more pronounced increase was observed at T4 (mean BMI = 24.45). Although mean values remained within the normal range, the upward shift of the 95% confidence interval upper bound to 26.01 suggests that a subset of participants may have transitioned into the overweight category by the final assessment.

These findings indicate a potential late-phase trend toward weight gain; however, given the exploratory nature of this pilot study, such observations should be interpreted with caution. Further well-controlled studies are needed to determine whether lifestyle, behavioral, or treatment-related factors contributed to the increase in BMI observed between T3 and T4.

A significant change in BMI was observed over the study period, with a notable increase at 18 months. Although the increase in mean BMI from 23.43 to 24.45 was statistically significant, its clinical relevance for overall health remains uncertain and warrants further investigation.

This study investigated the effects of fixed orthodontic appliances on BMI in a small cohort of young adult patients over 18 months. To preserve sample homogeneity and account for potential confounding variables associated with various forms of malocclusion, this study only examined Class II division 1 malocclusion. This limitation restricts generalizability even though it allows for a more precise assessment of treatment effects within a particular patient population.

In this study, significant changes in BMI were noted at different stages of treatment. These findings are in line with earlier studies that examined the effects of orthodontic treatment on eating patterns and anthropometric measurements. Orthodontists should be aware of how patients' eating habits change during treatment in order to improve treatment quality and patient satisfaction [14]. Numerous studies have examined the relationship between orthodontic treatment and weight changes [15–16], and evidence suggests that orthodontic treatment may influence dietary intake [17]. Prevalence rates range from 70% to 95% in some settings, and patients frequently experience pain and discomfort when biting or chewing, especially in the early stages [18].

This study used pairwise comparisons and repeated measures ANOVA to show a statistically significant change in BMI over time ($p = 0.022$). Remarkably, when compared to time 1 (pre-treatment), BMI decreased negligibly at time 2 (early treatment) and time 3 (mid-treatment). In contrast to baseline and previous time points, the BMI was considerably higher at time 4 (18 months). Patients who have trouble chewing hard or fibrous foods may experience temporary discomfort and food-related restrictions due to fixed appliances, which may account for the initial, negligible decreases in caloric intake [19]. However, dietary patterns returned to normal as patients adjusted to their appliances and treatment, and their BMI rose above baseline levels.

Early treatment outcomes showed modest fluctuations in BMI at first, followed by increases later on. This pattern differs from earlier research that was mainly concerned with short-term effects. Oral discomfort, dietary changes, and decreased appetite are most noticeable when patients are first getting used to their appliances, according to research [19]. Johal et al.[20] demonstrated that patients reduced their food intake following appliance placement during the initial phase compared with a control group, consistent with the early-phase findings. Azaripour et al.[21] highlighted the variability in dietary responses by finding no significant differences in snack consumption.

Patients likely adjusted by eating soft foods, which are often high in calories, even though they initially felt uncomfortable and ate less (as shown by the T2 decrease). Orthodontic patients are often advised to eat foods such as ice cream, smoothies, mashed potatoes, pasta, bread, and processed carbohydrates; however, these foods are typically high in calories and low in fiber. Regular consumption of these foods may have increased calorie intake over time, which in turn may have increased BMI.

During the first few months of the study, participants experienced discomfort when biting and chewing, prompting them to temporarily alter their diet and limit their food intake. Shah et al. [22] connected eating disorders to weight loss and a decreased BMI in patients who had Hyrax expanders. Mahajan [23] pointed out that fixed appliances can alter dietary preferences, especially during the early stages of treatment. The specific patterns of nutrient intake vary among studies with conflicting data. Riordan et al. [15] reported a decrease in carbohydrate intake after appliance placement, while Ozdemir et al. and Shirazi et al. found no changes in protein or carbohydrate intake [24,25]. Ozdemir et al. [24] reported short-term reductions in fat intake, whereas Shirazi et al. [25] reported reductions in cholesterol, saturated fat, and monounsaturated fat intake following treatment. However, Riordan et al. [15] and Sharma et al. [26] reported higher fat intake, which could be partially attributed to differences in regional dietary cultures.

Body mass index changed very little during the first two phases of treatment, but it increased significantly at 18 months (T4). This implies that patients eventually adapt and may even increase their food intake as treatment progresses, and that the initial dietary difficulties are temporary. As a result, people who receive orthodontic treatment shouldn't be considered to be permanently losing weight. The first few months of treatment were largely devoted to dietary modifications, during which patients' self-esteem increased considerably. Food patterns and BMI may change due to shifts in eating habits and self-esteem, according to a prospective study by Gnanasambandam and Gnaneswar [27]. Sandeep et al. [28] observed a decline in body fat percentage and BMI in the early stages, indicating that these changes are temporary as patients adapt. According to Ajmera et al. [29], poor or unbalanced diets can lead to a range of health issues. In patients with bite raiser, Shalchi et al. [30] found correlations among changes in BMI, pain, and nutrition, suggesting a range of physiological and psychological factors. According to Lee et al. [8], oral pain can interfere with nutrition and impact weight.

Conversely, von Bremen et al. [31] reported a complex reciprocal relationship between orthodontic treatment outcomes and BMI. Michelogiannakis et al. [32] noted in a systematic review that tooth movement efficiency may be influenced by an individual's BMI and nutritional status. This underscores the importance of tracking BMI changes during treatment, especially for younger patients. Arch wires usually cause discomfort and should be placed and activated with caution, especially during the first week, as this may reduce food intake and enjoyment [33]. To prevent short-term nutritional deficiencies, nutritional counseling should begin at the start of orthodontic treatment. During the first adjustment period, clinicians should advise patients to eat a balanced diet full of soft, nutrient-dense foods. Patients who are underweight or suffer from eating disorders require careful observation.

The Body Mass Index (BMI) trends among male and female participants in this research showed no significant differences. Research by Maeda et al. [34] and Mary et al. [35] suggests that the influence of orthodontic treatment on BMI is consistent across genders and is related to adaptation to the appliances, as both studies identified similar changes in diet and weight for males and females.

It is critical to acknowledge this study's numerous limitations. The absence of a non-orthodontic control group limits the ability to distinguish treatment-related effects from natural age-related weight changes in young adults. Additionally, dietary intake, caloric consumption, physical activity levels, stress, and psychosocial factors were not assessed. The relatively small sample size may also affect the generalizability and precision of the findings. Other factors, such as socioeconomic status, sleep patterns, hormonal status, and genetic predisposition, that could influence BMI were not included. Finally, measurement precision is another limitation. Using standard bathroom scales with 0.5 kg accuracy and height measurements recorded to the centimeter may be less sensitive than calibrated medical-grade equipment, potentially affecting the detection of subtle changes in BMI.

Future studies should employ longitudinal designs that include larger, more diverse groups and a variety of measurement techniques, such as body composition assessments, thorough dietary logs with frequency evaluations, and assessments of psychosocial factors. Using objective dietary assessment methods, such as 24-hour recalls or food diaries, may improve data accuracy. Research comparing various appliance types (e.g., fixed braces versus clear aligners) or treatment modalities (e.g., extraction versus non-extraction) may help clarify the mechanisms underlying BMI changes during orthodontic treatment. It is possible to distinguish between BMI changes caused by orthodontic treatment and those resulting from normal age-related weight changes by comparing the two groups with a control group of age-matched individuals not receiving orthodontic treatment.

CONCLUSIONS

This preliminary pilot study identified a distinct pattern of BMI change over time, characterized by a modest, non-significant decrease at 6 months followed by a significant increase by 18 months. These findings suggest that early dietary challenges associated with orthodontic treatment may be temporary, with patients gradually adapting their eating habits, potentially favoring soft, energy-dense foods.

Although the absence of a control group prevents definitive conclusions about causality, the observed trend highlights the importance of monitoring BMI, particularly in younger patients. Where meaningful weight changes are detected, incorporating nutritional guidance into orthodontic care may help support overall health during long-term treatment.

DECLARATION

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Ethical Considerations

All ethical principles were adhered to in conducting and writing this article.

Transparency of Data

All data are available upon request.

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Conflict of Interest

None to declare.

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