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RESEARCH ARTICLE

# Investigation of the Effects of Teeth Clenching Due to Weight Training on Oral Health

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**Background:** As interest in health increases, the number of people engaging in weight training to enhance muscle strength and muscle mass is on the rise. High-intensity weight training has been reported to induce tooth clenching habits, leading to tooth damage and temporomandibular joint (TMJ) abnormalities. Consequently, it is essential to investigate the impact of weight training accompanied by tooth clenching on oral health and to develop guidelines based on these findings.

**Methods:** The study included male participants aged 25 years and older, comprising 15 non-exercisers and 15 professional fitness trainers who have been engaged in weight training for over 5 years. Data were collected using a self-administered questionnaire to gather information on age, exercise experience, total weight lifted in three major weight training exercises (deadlift, bench press, and squat), and teeth clenching habits. Additionally, examinations for tooth cracks and fractures, TMJ noise and pain, maximum mouth opening, occlusal force, and occlusal contact area were conducted.

**Results:** Compared to non-exercisers, professional fitness trainers who have been engaged in weight training for over 5 years exhibited a higher prevalence of teeth clenching habits. While there were no significant differences between the two groups in occlusal contact area and the extent of tooth fractures, there were significant differences in occlusal force and the degree of tooth cracks. Furthermore, unlike joint noise and TMJ pain, the maximum mouth opening was significantly reduced in professional fitness trainers compared to non-exercisers.

**Conclusion:** Our study suggests that the continuation of high-intensity exercise, which induces teeth clenching habits, may cause tooth damage and TMJ disorders.

**Key Words:** Bite force, Bruxism, Tooth fractures, Tooth wear, Weight lifting

## Introduction

### 1. Background

With the COVID-19 pandemic heightening people's interest in health, there has been an increase in individuals exercising not only in public sports facilities but also through home training. According to a 2022 survey conducted by the Sports Promotion Department of the Ministry of Culture, Sports and Tourism, the participation rate in daily sports activities in 2023 was 62.4%[1]. Although this is lower than the 66.6% in 2019 before the pandemic, it shows a recovery trend. The most frequently participated regular activities were walking (37.2%), hiking (17.3%), and bodybuilding (16.3%). Among these activities, bodybuilding experienced the largest increase in participation rate (9.2 percentage points) compared to the previous year among individuals in their 30s. Bodybuilding is a category of weight training. In 2023, the fitness population in Seoul and the metropolitan area is estimated to be around 14.5%[2]. According to the National Statistics Portal, approximately 9,900 fitness centers (health facilities) were in operation nationwide as of 2022, reflecting a steady increase in recent years[3]. Weight training is primarily aimed at increasing muscle strength and muscle mass, but its effectiveness in managing body fat has led to a growing number of participants. Weight training involves applying load to

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the muscles to enhance their resistance, thereby improving muscle strength and endurance[4]. This is achieved by progressively overloading the muscles with weights heavier than those encountered in daily activities. Representative exercises include deadlifts, bench presses, bent-over rows, abdominal exercises, squats, standing curls, and pull-ups.

According to the 2015 Sports Safety Accident Survey, 40.5% of respondents who engaged in weight training in the past year reported injuries, with an average of 2.4 injuries per year[5]. Among those who sustained injuries, 7 out of 10 individuals (68.9%) attributed the injuries to "excessive movement," followed by injuries caused by barbells and dumbbells (33.1%), the bench press (25.4%), and the treadmill (17.1%). Sprains, which involve damage to muscles and ligaments, can lead to chronic issues and joint damage if not treated promptly, resulting in increased pain. Weight training often involves teeth clenching, which applies abnormal forces to the teeth and temporomandibular joints (TMJs). Teeth are composed of hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$), a calcium phosphate compound that provides hardness and strength. During tooth formation, small amounts of organic material, such as collagen, aid in the mineralization process, promoting tooth growth. Repeated teeth clenching due to weight training can lead to tooth wear, attrition, and fractures[6]. The TMJ consists of the mandibular condyle and mandibular fossa (articular bones), along with the articular disc, joint capsule, ligaments (temporomandibular, sphenomandibular, and stylomandibular ligaments), and muscles (masseter, temporalis, medial pterygoid, and lateral pterygoid)[7]. The TMJ functions in movements such as opening, closing, lateral movement, protrusion, retraction, chewing, speech, and swallowing. Physical stress and damage to the jawbones, articular disc, surrounding muscles, and ligaments from weight training can lead to TMJ disorders, causing jaw pain, joint noises, and restricted mouth opening.

## 2. Objectives

Repeated high-intensity weight training negatively impacts dental and TMJ health. Weightlifters and bodybuilders, due to their repetitive and intense training, often suffer from tooth damage, TMJ disorders, and injuries to the oral and facial soft tissues[8]. The most common dental issues observed in these athletes are tooth damage and TMJ disorders. High-intensity training, which increases the tension and rigidity of the masticatory muscles, suggests the need for consideration of mouthguard use[9]. Contact sports such as boxing and taekwondo, which have a high incidence of trauma, mandate the use of mouthguards during competitions[10]. Reports indicate that the occlusal wear rate of Korean athletes is higher and progresses more rapidly than that of the general population[11]. Despite this, awareness of sports dentistry and mouth protectors among these athletes is very low, with less than 50% being aware[11]. Considering the low awareness of the necessity of oral protective devices among physical education majors and professional athletes, the general public's awareness is expected to be even lower. With increasing life expectancy, there is a growing interest in healthy lifespans. While this has led to the promotion of recreational sports, it has also resulted in the indiscriminate practice of high-intensity weight training due to the popularity of body profile photography. Therefore, it is urgently necessary to establish guidelines for safe recreational sports and provide evidence-based data to prevent irreversible dental issues caused by high-intensity weight training.

Continuous teeth clenching can damage the enamel layer due to tooth wear and may cause temporomandibular disorders (TMD) by placing excessive tension on the muscles, articular discs, and ligaments around the jaw. Studies on athletes have shown that most of them exhibit teeth-clenching habits, with a high proportion of subjects experiencing tooth damage and TMJ pain due to tooth wear[12-14]. Therefore, this study aims to determine the impact of teeth clenching associated with weight training on oral health by comprehensively exploring the dental and TMJ health of fitness trainers who have engaged in weight training for many years. Based on these findings, we aim to propose guidelines for maintaining oral health during weight training.

# Materials and Methods

## 1. Study participants

A total of 30 male adults aged 25 and older residing in Seongnam, Gyeonggi-do, participated in this study. The participants were divided into two groups: Fifteen participants were individuals with no weight training experience, while another fifteen were professional health trainers with over 5 years of weight training experience. Individuals undergoing orthodontic treatment or diagnosed with TMD were excluded. All participants understood the purpose of the study and agreed to measurements to identify dental and TMJ abnormalities. The present study was approved by the Institutional Review Board of Eulji University. Written informed consent was obtained from all participants.

## 2. Methods

### 1) Self-administered questionnaire

All study participants completed a self-administered questionnaire covering the following items: age, exercise experience, total weight lifted in the three major weight training exercises (deadlift, bench press, squat), and teeth clenching habits.

### 2) Measurement of tooth wear

Tooth wear was assessed using the Tooth Wear Index developed by Smith and Knight, which categorizes wear into grades (Score 0∼4) based on visual inspection of enamel and dentine wear[15]. In our study, teeth with a score of 2 or higher, indicating distinct enamel wear and exposure of dentine, were considered as having wear.

### 3) Examination for tooth cracks and fractures

Tooth crack examinations were conducted based on the five categories of cracked tooth syndrome classified by the American Association of Endodontists[16]. The categories inspected included Craze Lines (small cracks limited to the enamel), Fractured Cusp (fracture of the pointed part of the tooth), Cracked Tooth (a crack extending vertically from the chewing surface towards the root), and Split Tooth (a crack progressing to the point where the tooth is divided into two distinct segments). Tooth fracture examinations were conducted using the classification by Pagadala and Tadikonda[17]. The categories are as follows: Class I: enamel fracture, Class II: enamel and dentin fracture, Class III: enamel, dentin, and pulp fracture, Class IV: loss of crown, Class V: root fracture, Class VI: fracture of the root with exposure of the pulp, Class VII: displacement of the tooth without fracture, Class VIII: fracture of the crown en masse and its replacement. Participants applied a staining agent after standardized tooth brushing. Visual inspection was then conducted to assess the presence of tooth cracks and fractures. All tests were evaluated by a single researcher, and the results were reviewed and approved by all researchers.

### 4) Measurement of temporomandibular joint noise and pain

The presence of joint noise and pain originating from the TMJ during mouth opening and closing was measured using a Likert 5-point scale. The scale items were: Not at all (1), Slightly not (2), Neutral (3), Slightly yes (4), Very much yes (5). Participants were asked to lightly place their fingers on the TMJ area and move their jaw to check for any joint sounds. Additionally, a modified numerical rating scale was used to assess the intensity of pain experienced by participants while moving their jaw. The scale ranged from 0 to 5, with 0 indicating “no pain” and 5 indicating “the worst pain.”

### 5) Measurement of maximum mouth opening

Participants were asked to place their heads in a neutral position and open their mouths as wide as possible without experiencing pain. A millimeter ruler was used to vertically measure the distance between the incisal edges of the maxillary central incisors and the mandibular central incisors.

### 6) Measurement of occlusal force and occlusal contact area

Occlusal force and occlusal contact area were measured using Dental Prescale II occlusal force sheets. The occlusal force sheet was inserted into the participant’s mouth to cover the entire dentition, and the participants were instructed to clench their teeth maximally for 3 seconds. The obtained sheet was then disinfected and analyzed using the Bite Force Analyzer software, a digital occlusal analysis program. Occlusal force was expressed in Newtons (N) and occlusal contact area in square millimeters ($mm^2$).

## 3. Statistical analysis

Statistical analysis was performed using IBM SPSS 29.0.1.0 (IBM Corp., Armonk, NY, USA). Age, exercise experience, and total weight lifted in the three major weight training exercises (deadlift, bench press, squat) were presented using frequency analysis. Maximum mouth opening, maximum occlusal force, and occlusal contact area were reported as means and standard deviations, with comparisons between the two groups conducted using the Mann–Whitney U test. Other variables were compared between the two groups using the chi-squared test. A p-value ≤ 0.05 was considered statistically significant.

# Results

## 1. Characteristics between non-exercisers and fitness trainers participating in the study

A total of 30 male adults aged 25 to 45 years participated in this study (Table 1). Fifteen participants were non-exercisers, while the other fifteen were professional fitness trainers who had engaged in weight training for more than 5 years. The age distribution was similar between the two groups (p=0.977). The distribution was as follows: 4 to 5 participants (26.7% to 33.35%) aged 25～30 years, 4 participants (26.7%) aged 31～34 years, 5 to 6 participants (33.35% to 40%) aged 35～39 years, and 1 participant (6.6%) aged 40～45 years. The average ages were 33.3±4.80 years for non-exercisers and 32.6±4.95 years for fitness trainers. Among the fitness trainers, the duration of exercise experience was distributed as follows: 5～6 years for 6 participants (40%), 7～8 years for 4 participants (26.7%), 9～10 years for 1 participant (6.6%), and over 11 years for 4 participants (26.7%). Regarding the weight lifted in the three major weight training exercises (deadlift, bench press, and squat), the weights lifted by the professional fitness trainers were distributed as follows: 200～300 kg by 2 participants (13.3%), 300～400 kg by 5 participants (33.35%), 400～500 kg by 7 participants (46.75%), and 500～600 kg by 1 participant (6.6%). The average weight lifted was 396.67±83.38 kg.

**Table 1.** Characteristics of Experimental Participants

| Category | Number (%) | p-value |
|---|---|---|
| Non-athletes (n=15) | | |
| Age (y) | | |
| 25～30 | 4 (26.7) | |
| 31～34 | 4 (26.7) | |
| 35～39 | 6 (40) | |
| 40～44 | 1 (6.6) | 0.977[a] |
| Fitness trainers (n=15) | | |
| Age (y) | | |
| 25～30 | 5 (33.35) | |
| 31～34 | 4 (26.7) | |
| 35～39 | 5 (33.35) | |
| 40～44 | 1 (6.6) | |
| Athletic experience (y) | | |
| 5～6 | 6 (40) | |
| 7～8 | 4 (26.7) | |
| 9～10 | 1 (6.6) | |
| ＞11 | 4 (26.7) | |
| Total weight lifted in the three major weight training exercises (kg) | | |
| 200～300 | 2 (13.3) | |
| 300～400 | 5 (33.35) | |
| 400～500 | 7 (46.75) | |
| 500～600 | 1 (6.6) | |

[a]Chi-squared test.

## 2. Comparison of occlusion and dental abnormalities between non-exercisers and fitness trainers

A survey on teeth clenching habits revealed that 7 non-exercisers (46.7%) reported having the habit, whereas 13 fitness trainers (86.7%) did (Table 2). The difference in teeth clenching habits between the two groups was significant (p=0.025). Occlusal force and occlusal contact area were compared between non-exercisers and fitness trainers using occlusal force sheets. The occlusal force of non-exercisers was 909±446 N, while that of fitness trainers was higher at 1,224±517 N. The difference in occlusal force between the two groups was significant (p=0.024). In contrast, the occlusal contact area of fitness trainers was 28±19 $mm^2$, which was larger than that of non-exercisers (23±10 $mm^2$), but the difference was not significant (p=0.054). Tooth cracks were observed in 2 non-exercisers (13.3%) and in 12 fitness trainers (80.0%), but the difference between the two groups was not significant (p=0.674). Tooth fractures were observed in 6 non-exercisers (40%) and in 8 fitness trainers (53.3%), and the difference was not significant (p=0.361). Tooth wear was found in 3 non-exercisers (20.0%) and in 7 fitness trainers (46.7%), but the difference between the two groups was not significant (p=0.123).

**Table 2.** Dental and Temporomandibular Joint Abnormalities in Non-Athletes and Fitness Trainers

| Category | Non-athletes (n=15) | Fitness trainers (n=15) | p-value |
|---|---|---|---|
| Bruxism habits (yes/no) | 7 (46.7)/8 (53.3) | 13 (86.7)/2 (13.3) | 0.025[a] |
| Dental crack (yes/no) | 5 (33.4)/10 (66.6) | 12 (80.0)/3 (20.0) | 0.013[a] |
| Tooth fractures (yes/no) | 6 (40.0)/9 (60.0) | 8 (53.3)/7 (46.7) | 0.358[a] |
| Tooth wear (yes/no) | 3 (20.0)/12 (80.0) | 7 (46.7)/8 (53.3) | 0.123[a] |
| TMJ sounds | 1.7±1.1 | 2.5±1.5 | 0.229[b] |
| TMJ pain | 1.5±0.9 | 2.1±1.5 | 0.469[b] |
| Maximum mouth opening (cm) | 6.1±0.6 | 5.5±0.6 | 0.010[b] |
| Occlusal force (N) | 909±446 | 1,224±517 | 0.024[b] |
| Occlusal contact area ($mm^2$) | 23±10 | 28±19 | 0.054[b] |

Values are presented as n (%) or mean±standard deviation.
TMJ: temporomandibular joint.
[a]Chi-squared test.
[b]Mann–Whitney U test.

### 3. Comparison of temporomandibular joint abnormalities between non-exercisers and fitness trainers

Three indicators related to TMJ abnormalities were assessed between non-exercisers and fitness trainers (Table 2). First, joint sounds and TMJ pain during mouth opening and closing were measured using a 5-point Likert scale. Non-exercisers reported a mean joint sound score of 1.7±1.1, while fitness trainers reported a higher score of 2.5±1.5. However, the difference in joint sound scores between the two groups was not statistically significant (p=0.229). Non-exercisers reported TMJ pain with a mean score of 1.5±0.9, whereas fitness trainers reported a higher mean score of 2.1±1.5. Nevertheless, the difference in TMJ pain between the two groups was not statistically significant (p=0.469). Measurement of the vertical distance between the upper and lower central incisors revealed that the maximum mouth opening for non-exercisers was 6.1±0.6 cm, while for fitness trainers, it was reduced to 5.5±0.6 cm. This difference in maximum mouth opening between the two groups was statistically significant (p=0.010).

## Discussion

### 1. Interpretation

Bruxism has a wide and varied impact on dental and TMJ health, making the prevention of this maladaptive habit critically important[18]. Bruxism can accelerate tooth wear and damage the enamel layer. Persistent pressure from bruxism may induce microfractures in teeth, leading to dentin and root surface caries, as well as tooth fractures. Additionally, enamel wear due to bruxism can increase tooth sensitivity to cold beverages and impose stress on the surrounding gums and bone, exacerbating periodontal disease. Excessive tension from bruxism can strain the muscles, articular discs, and ligaments around the jaw, potentially causing TMD[19]. This can affect the jaw, neck, and shoulders, leading to generalized musculoskeletal pain and, if severe, functional issues such as jaw asymmetry that hinder food intake. Excessive pressure on the TMJ may also trigger trigeminal neuralgia, which can result in chronic headaches and neck pain. Persistent tooth clenching and grinding (bruxism) cause various adaptive and morphological changes, including muscle hypertrophy, tooth mobility, tooth attrition and wear, thickening of periodontal ligaments, increased bone density, and TMJ remodeling[20]. These changes are well-documented to also induce neuromuscular and TMJ dysfunction, tooth and periodontal ligament sensitivity, pulp inflammation, and dental fractures. In implant-supported prosthetics, both mechanical failures (such as veneer fractures, screw loosening and fractures, and frame fractures) and biological failures (such as implant integration loss) have been reported. Given the increasing prevalence of physical activity across all age groups, particularly resistance training, there is a need for safety education and preventive measures to mitigate these outcomes among the general population.

## 2. Comparison with previous studies

It has been found that a longer athletic career correlates with increased dental damage due to tooth wear[12]. Habitual bruxism during exercise has been shown to place abnormal stress on cervical restorations, leading to their failure[13]. Among athletes engaged in contact sports, 51.1% reported experiencing bodily and oral-facial trauma, with 37.4% having sustained injuries to the oral soft tissues of the maxillary incisors[14]. Additionally, 84.1% of these athletes exhibited bruxism habits, and 67.0% reported TMJ pain. To investigate the impact of high-intensity weight training on oral health, we compared the oral health of non-athletes who do not exercise with that of professional health trainers who have been weight training for more than 5 years. To minimize bias in oral condition due to age and gender, male participants of similar age were recruited for both groups. The analysis revealed that in our study of professional fitness trainers who had been weight training for over 5 years with weights of approximately 500 kg, 86.7% exhibited a pronounced tooth clenching habit. This percentage is significantly higher than the 46.7% reported among non-exercising individuals. Notably, professional fitness trainers who had engaged in weight training for over five years exhibited greater occlusal forces compared to non-athletes. Although our analysis did not find statistical significance in comparison to non-athletes, it is suspected that high bruxism habits among these trainers could be a contributing factor to increased dental cracks in 80.0% and more tooth fractures in 53.3% of them. There are limited reports on the effects of movements accompanied by clenching on dental health. However, considering our research findings and the fact that most athletes habitually clench their teeth, resulting in tooth damage and pain, long-term exercise accompanied by bruxism can abnormally increase occlusal force, leading to tooth damage, restricted mouth opening, and a heightened risk of referred pain.

Furthermore, signs of TMJ abnormalities, such as joint sounds and increased TMJ pain severity, were notably prevalent among professional fitness trainers who had engaged in weight training for over five years. Although statistically not significant compared to non-athletes, these findings clearly indicate an increased incidence of TMJ abnormalities among long-term weight trainers. Additionally, these trainers had significantly reduced maximum mouth opening compared to non-athletes, suggesting that prolonged weight training may contribute to TMJ abnormalities. These results underscore the need for preventive measures to address dental damage and TMJ abnormalities associated with weight training. The use of mouthguards to distribute stress on teeth and TMJs during habitual bruxism has been suggested[13]. However, only 50.2% of athletes consistently wear mouthguards during sports activities. The absence of mouthguard use is associated with a higher likelihood of oral-facial trauma, and a lack of regulations or recommendations for mouthguard use increases this risk[14]. Thus, there is a clear need for strategies to popularize mouthguard use to prevent oral-facial trauma, including dental and TMJ injuries, among the general population. Individuals who participate in sports or occupations that may negatively impact overall oral health, such as those involving bruxism, require specialized oral health education in addition to general oral hygiene instruction. Beyond the use of mouthguards, it is essential to provide information on the oral risks associated with bruxism and strategies to avoid these risks when potential triggers are recognized. Such education can help mitigate the adverse effects on oral health caused by activities associated with bruxism and promote overall oral health improvement.

## 3. Limitations

This study investigated dental damage and signs of TMJ abnormalities in trainers who have engaged in prolonged high-intensity weight training. The study observed significant differences in bruxism habits, dental cracks, maximum mouth opening, and occlusal force when compared to non-athletes, highlighting the substantial impact of high-intensity exercise on oral health. Although the study aimed to reduce bias by matching the gender and age distribution between the groups, it is limited by its small sample size. To generalize these findings, further research with a larger and more diverse sample, including broader gender representation, is required.

## 4. Conclusions

This study compared dental conditions and signs of TMJ abnormalities between non-athletes and trainers engaged in high-intensity weight training, confirming that high-intensity exercise, which induces bruxism habits, may contribute to dental damage and TMJ disorders. These findings provide a basis for recommending the use of mouthguards during exercise to prevent bruxism and protect oral health.

## Notes

### Conflict of interest

No potential conflict of interest relevant to this article was reported.

### Ethical approval

Human experiment was approved by the Institutional Review Board (IRB) of Eulji University (approval No. EU24-07).

### Author contributions

Conceptualization: Sang Min Lee, Eun Chae Lee, Juwon Gong, Chae Eun Jang, and Young Sun Hwang. Data acquisition: Sang Min Lee, Eun Chae Lee, Juwon Gong, Chae Eun Jang, and Young Sun Hwang. Formal analysis: Sang Min Lee, Eun Chae Lee, Juwon Gong, Chae Eun Jang, and Young Sun Hwang. Funding acquisition: Young Sun Hwang. Supervision: Young Sun Hwang. Writing-original draft: Sang Min Lee, Eun Chae Lee, Juwon Gong, Chae Eun Jang, and Young Sun Hwang. Writing-review & editing: Young Sun Hwang.


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### Data availability

The data and materials of this article are included within the article. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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