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Occlusal Features and TMJ Clicking: A 30-Year Evaluation from a Cohort Study

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Abstract

Occlusal features that deviate from normative values have been historically considered risk factors for temporomandibular joint (TMJ) disorders. Nowadays, a putative association between dental occlusion and TMJ disorders remains controversial, with research findings on associations being inconsistent and inconclusive. We hypothesized that putative occlusal features identified during adolescence are associated with TMJ clicking later in life. The Dunedin Multidisciplinary Health and Development Study is a longitudinal birth cohort study investigation of 1,037 children (48.4% female) born in Dunedin, New Zealand, between April 1, 1972, and March 31, 1973, and assessed repeatedly since then. Associations between posterior crossbite, overbite, and overjet at age 15, as well as both self-reported and clinically assessed TMJ clicking sounds at age 45, were studied. Data were analyzed using multivariate logistic regression, after controlling for sex, emotional style, self-reports of tooth clenching and sleep bruxism, and history of orthodontic treatment. Self-reported and examiner-reported TMJ clicking at age 45 affected 18.3% and 23.8% of the study sample, respectively, and were not associated with the presence of a posterior crossbite or abnormal overjet/overbite values during adolescence. Self-reported history of tooth clenching and emotional style were associated with self-reported TMJ clicking later in life. In addition, there is a suggestion that high overbite during adolescence is negatively associated with TMJ clicking later in life. A history of orthodontic treatment was not associated with TMJ clicking. Abnormal occlusal features, such as posterior crossbite and high and low overjet/overbite in adolescence, are not associated with higher prevalence of TMJ clicking later in life. Personality also appears to influence self-reports of TMJ clicking later in life.

Keywords: temporomandibular joint disorders, malocclusion, orthodontics, bruxism, cohort studies, epidemiology

Introduction

Temporomandibular disorders (TMDs) can present with symptoms of pain, limited jaw movement, and clicking or grating sounds in the joint (Schmitter et al. 2005) and have been historically associated with dental malocclusions (Ramfjord 1961). However, no occlusal feature has been consistently found to be associated with TMDs, and considerable controversy persists with respect to occlusal treatment for TMD (Manfredini et al. 2017). For example, over half of a sample of Swedish and Japanese dentists believed that TMD-related symptoms, including temporomandibular joint (TMJ) clicking, are best treated through occlusal adjustment or "selective grinding" (Tegelberg et al. 2007; Kakudate et al. 2017), indicating that an evidence-practice gap persists (Kakudate et al. 2017).

Posterior crossbite is thought to cause functional shifts and asymmetrical jaw muscle activity, thus negatively affecting the masticatory system (Farella et al. 2007). The proposed chain of causal events suggests that asymmetries in the condyle-fossa relationship alter the disc-condyle relationship, which, in turn, is responsible for disc displacement and TMJ clicking (McNamara et al. 1995). In support to this hypothesis, a positive association between posterior crossbite and TMDs has been reported (Pullinger et al. 1993; Thilander et al. 2002; Egermark et al. 2003). Frequency of TMJ clicking due to disc displacement with reduction, for example, has been reported to be 3 times greater among those with a unilateral posterior crossbite than where no crossbite is present (Pullinger et al. 1993). Conversely, other studies have reported no association between TMJ clicking and posterior crossbite (Mohlin et al. 2004; Farella et al. 2007). A recent systematic review on this topic was inconclusive (Iodice et al. 2013).

As with posterior crossbite, abnormal overjet and overbite can also influence jaw function and have been reported to be associated with TMDs among children, adolescents, and adults, with conflicting findings (John et al. 2002; Hirsch et al. 2005). Thus, their putative role in the etiology of TMDs remains unclear.

Recent well-designed cohort studies have identified a number of risk factors for first-onset TMDs; these included somatic

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symptoms, overall health, oral parafunction, and several genetic markers (Maixner et al. 2011; Slade et al. 2013). Conversely, findings from cross-sectional studies have been limited by small sample sizes, lack of control groups, unclear case definitions, and the use of convenience or clinical samples with limited external validity (Palla and Farella 2009).

The aim of this study was to investigate the association between posterior crossbite, overjet, and overbite present during adolescence, as well as temporomandibular joint clicking sounds 30 y later in a birth cohort of New Zealanders. We hypothesized that putative occlusal features, such as posterior crossbite and abnormal overjet/overbite identified during adolescence, are associated with signs and symptoms of TMJ disorders later in life.

Materials and Methods

Sample

The Dunedin Multidisciplinary Health and Development Study is a longitudinal study of human health and development of a birth cohort born in Dunedin, New Zealand (Poulton et al. 2015). The cohort comprises children born at Queen Mary Maternity Hospital in Dunedin, New Zealand, between April 1, 1972, and March 31, 1973. Perinatal data were collected at the time of birth, and the cohort for the longitudinal study was defined at age 3. The cohort of 1,037 children was assessed within a month of their third birthdays and then at ages 5, 7, 9, 11, 13, 15, 18, 21, 26, 32, 38, and 45 y. Over 90% of study members self-identify as being of New Zealand European origin. The study protocol was approved by the Health and Disability Ethics Committees, Ministry of Health, New Zealand and conforms to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for human observational studies. Study members gave informed consent before participating.

Occlusal Features

Age 15 was the earliest assessment age at which examination of the occlusion of the permanent dentition was conducted. Occlusal and other dental examinations were undertaken in accordance with Oral Health Surveys: Basic Methods (World Health Organization 1997). For analysis, overjet and overbite values at age 15 were categorized as "low" (≤1 mm), "normal" (2 to 4 mm), or "high" (≥5 mm). Each participant was categorized as having "no posterior crossbite at age 15," "unilateral crossbite at age 15," or "bilateral crossbite at age 15." Crossbites were limited to full cusp relationships or more, and overjet/overbite values were measured to the nearest millimeter.

Temporomandibular Joint Clicking Sounds

Age 45 TMJ data were collected using a standardized dental questionnaire and a clinical examination. The questionnaire asked study members to self-report ("During the past 12 mo, have you heard any jaw joint noise(s) when you moved or used your jaw?"). Responses were coded as "yes" or "no" for both the left and right sides. The clinical examination was performed by 3 trained and calibrated examiners and involved each study member being asked to self-report any clicking, crepitus, or pain that occurred (left side, right side, or both) during 3 repetitions of jaw opening and closing. In addition, the clinical examiner would record whether they detected clicking or crepitus during the opening/closing cycles with palpation. Based on the questionnaire and clinical examination at age 45, those with clicking of the TMJ were categorized as having "self-reported TMJ click (last 12 mo)," "self-reported TMJ click during dental examination (upon opening/closing 3 times)," and/or "examiner-detected TMJ click during dental examination (upon opening/closing 3 times)." A fourth category of "disc displacement with reduction at age 45" was also used if a study member's history and examination fulfilled the Diagnostic Criteria for Temporomandibular Disorder (DC/TMD) (Schiffman et al. 2014).

Orthodontic Treatment History

Orthodontic treatment history was investigated using a self-report questionnaire at age 45 y. Any form of orthodontic treatment (including removable or fixed appliances, orthodontic extractions, and orthognathic surgery) was recorded.

Personality Traits

At age 26, study members completed a 177-item modified version ("Form NZ") of the Multidimensional Personality Questionnaire (MPQ), a self-report personality instrument examining a broad range of individual differences in emotional and behavioral style (Tellegen 1982). The tool has 10 independent MPQ subscales that define the 3 superfactors of "constraint," "negative emotionality," and "positive emotionality." The *constraint* superfactor is most strongly associated with control, harm avoidance, and traditionalism scales. The *positive emotionality* superfactor is primarily associated with well-being, social potency, achievement, and social closeness scales and has clear extraverted features. The *negative emotionality* superfactor is associated with stress-reaction, alienation, and aggression scales. (Tellegen et al. 1988; Thomson et al. 2011). Personality profiles were constructed by standardizing the MPQ superfactors and scale scores (which are continuous variables) into *z* scores with a mean of zero and standard deviation (SD) of 1.

Self-Reported Tooth Clenching and Grinding

Self-reported data on bruxism were collected at age 45 y. Study members were asked about daytime clenching ("During the past 12 mo, how often did you clench your teeth during waking hours?" with the following response options: "none of the time," "a little of the time," "some of the time," "most of the time," or "all of the time"). They were also asked about

Table 1. Temporomandibular Joint Clicking at Age 45[a] by Occlusal Features at Age 15 and Sex.

	No Posterior Crossbite	Unilateral Posterior Crossbite	Bilateral Posterior Crossbite	Overjet ≤1 mm	Overjet 2 to 4 mm	Overjet ≥5 mm	Overbite ≤1 mm	Overbite 2 to 4 mm	Overbite ≥5 mm	Overall
Self-reported click at age 45 (last 12 mo) (n = 715)										
No	510 (82.4)	53 (76.8)	21 (77.8)	90 (84.9)	410 (80.2)	84 (85.7)	97 (85.1)	352 (80.6)	135 (82.3)	584 (81.7)
Yes	109 (17.6)	16 (23.2)	6 (22.2)	16 (15.1)	101 (19.8)	14 (14.3)	17 (14.9)	85 (19.5)	29 (17.7)	131 (18.3)
Yes (male)	57 (18.6)	10 (27.0)	5 (41.7)	11 (23.4)	53 (20.9)	8 (14.6)	12 (24.0)	41 (19.1)	19 (20.9)	72 (20.2)
Yes (female)	52 (16.7)	6 (18.8)	1 (6.7)	5 (8.5)	48 (18.7)	6 (14.0)	5 (7.8)	44 (19.8)	10 (13.7)	59 (16.4)
Self-reported click during age 45 dental examination (upon opening and closing 3 times) (n = 709)										
No	472 (77.0)	51 (73.9)	23 (85.2)	86 (83.5)	388 (76.2)	72 (74.2)	90 (79.0)	325 (74.5)	28 (17.6)	546 (77.0)
Yes	141 (23.0)	18 (26.1)	4 (14.8)	17 (16.5)	121 (23.8)	25 (25.8)	24 (21.1)	111 (25.5)	28 (17.6)	163 (23.0)
Yes (male)	64 (21.2)	9 (24.3)	3 (25.0)	9 (20.0)	51 (20.1)	16 (30.2)	12 (23.5)	51 (23.9)	13 (14.8)	76 (21.6)
Yes (female)	77 (24.8)	9 (28.1)	1 (6.7)	8 (13.8)	70 (27.5)	9 (20.5)	12 (19.1)	60 (26.9)	15 (21.1)	87 (24.4)
Examiner-detected click during age 45 dental examination (upon opening and closing 3 times) (n = 709)										
No	466 (76.0)	52 (75.4)	22 (81.5)	80 (77.7)	390 (76.6)	70 (72.2)	86 (75.4)	322 (73.9)	132 (83.0)	540 (76.2)
Yes	147 (24.0)	17 (24.6)	5 (18.5)	23 (22.3)	119 (23.4)	27 (27.8)	28 (24.6)	114 (26.2)	27 (17.0)	169 (23.8)
Yes (male)	62 (20.5)	9 (24.3)	4 (33.3)	10 (22.2)	50 (19.7)	15 (28.3)	13 (25.5)	49 (23.0)	13 (14.8)	75 (21.3)
Yes (female)	85 (27.4)	8 (25.0)	1 (6.7)	13 (22.4)	69 (27.1)	12 (27.3)	15 (23.8)	65 (29.2)	14 (19.7)	94 (26.3)
Disc displacement with reduction (DC/TMD) at age 45 (n = 709)										
No	493 (80.4)	53 (76.8)	23 (85.2)	86 (83.5)	409 (80.4)	74 (76.3)	93 (81.6)	341 (78.2)	135 (84.9)	569 (80.3)
Yes	120 (19.6)	16 (23.2)	4 (14.8)	17 (16.5)	100 (19.7)	23 (23.7)	21 (18.4)	95 (21.8)	24 (15.1)	140 (19.8)
Yes (male)	54 (17.8)	9 (24.3)	3 (25.0)	9 (20.0)	43 (16.9)	14 (26.4)	11 (21.6)	43 (20.2)	12 (13.6)	66 (18.8)
Yes (female)	66 (21.3)	7 (21.9)	1 (6.7)	8 (13.8)	57 (22.4)	9 (20.5)	10 (15.9)	52 (23.3)	12 (16.9)	74 (20.7)

Values are presented as n (%).
DC/TMD, Diagnostic Criteria for Temporomandibular Disorder.
[a]Age 45 data were missing for a small number of study members who were dentally examined at age 15 y.

nighttime clenching/grinding ("During the past 12 mo, how often did you clench or grind your teeth (based on any information you may have, for example, a partner or roommate)?" with the following response options: "none of the time," "less than 1 night per month, "1 to 3 nights per month," "1 to 3 nights per week" or "4 to 7 nights per week"). Those who self-reported "some of the time," "most of the time," or "all of the time" were considered to be cases of daytime clenching, and those who self-reported more than "1 to 3 nights per month" were considered cases of nighttime clenching/grinding.

Statistical Analysis

Data were analyzed using STATA/SE 15.1 (StataCorp), and the level of statistical significance was set as 0.05. The associations between specific occlusal risk factors (posterior crossbite, overjet, and overbite) present at age 15 y and TMJ outcomes at age 45 y were examined using cross-tabulations, with bivariate chi-square and Fisher's exact tests. A 2-sided t test was used for MPQ personality variables. A logistic regression model then estimated the odds ratios (ORs) and 95% confidence intervals (CIs) for the various age 45 TMJ outcome categories, after adjusting for sex, MPQ superfactors (categorical variable), history of orthodontic treatment by age 45 y (dichotomous variable), and self-reported parafunctional habits (categorical variable). The Hosmer-Lemeshow test was used to test model goodness of fit. Two study members self-reported "no" clicking on the left-hand side and "don't know" on the right-hand side at age 45 y. For the purposes of statistical analysis, this was coded as "no" for both sides.

Results

The age 45 dental questionnaire and age 45 dental examinations were completed by 903 (90.6%) and 892 (89.5%) of the surviving cohort, respectively. Those who had data collected at both age 15 and age 45 (dental questionnaire, n = 715; dental examination, n = 709) were included in the analysis.

Clicking of the TMJ at age 45 (during the last 12 mo) was reported by 162 (17.9%) study members. Self-reported clicking of the TMJ during the age 45 dental examination was reported by 197 (22.1%) study members. Examiner-detected TMJ clicking during the age 45 dental examination affected 206 (23.1%). Some 171 (19.2%) study members met the DC/TMD criteria for disc displacement with reduction. There were no associations observed between the occlusal features of interest and any of the TMJ outcomes (Table 1).

At age 15, posterior crossbite was present in 100 (12.8%). Overjet was classified as low for 114 (14.6%), normal for 556 (71.2%), and high for 111 (14.2%). Overbite was classified as low for 122 (15.6%), normal for 473 (60.6%), and high for 186 (23.8%).

A history of any orthodontic treatment was reported by 310 (33.1%) study members at age 45 y. Daytime clenching (at least some of the time) was reported by 134 (14.8%) and nighttime clenching/grinding (at least 1 to 3 nights per month) by 140 (15.7%).

Associations between self-reported daytime clenching (last 12 mo) and self-reported TMJ clicking (last 12 mo) were present among both males and females (Table 2). Nighttime clenching/grinding history (last 12 mo) was significantly associated with

Table 2. Temporomandibular Joint Clicking at Age 45 by Orthodontic Treatment History, Parafunctional Habits, and Personality Traits.

	No Self-Reported Orthodontic Treatment, *n* (%)	Self-Reported Orthodontic Treatment, *n* (%)	No Self-Report Clenching, *n* (%)	Self-Report Clenching, *n* (%)	No Self-Report Grinding, *n* (%)	Self-Report Grinding, *n* (%)	Positive Emotionality, Mean (SD)	Negative Emotionality, Mean (SD)	Constraint, Mean (SD)
Self-reported click at age 45 (last 12 mo) (*n* = 893)									
No	485 (82.5)	247 (81.0)	646 (85.0)	86 (64.2)	623 (83.5)	105 (76.1)	0.06 (0.97)	–0.08 (0.98)	0.03 (0.98)
Yes	103 (17.5)	58 (19.0)	114 (15.0)	48 (35.8)[a]	123 (16.5)	33 (23.9)[a]	–0.19 (1.12)[a]	0.20 (1.00)[a]	–0.06 (1.08)
Yes (male)	56 (18.7)	26 (17.7)	69 (17.2)	13 (30.2)[a]	68 (17.7)	10 (18.9)	–0.11 (1.22)[a]	0.26 (1.03)	0.46 (1.00)
Yes (female)	47 (16.3)	32 (20.2)	45 (12.6)	35 (38.5)[a]	55 (15.2)	23 (27.1)[a]	–0.28 (1.00)	0.15 (0.98)[a]	0.34 (1.00)
Self-reported click during age 45 dental examination (upon opening and closing 3 times) (*n* = 884)									
No	446 (77.2)	243 (79.4)	591 (79.1)	94 (71.8)	578 (79.2)	102 (73.9)	0.02 (0.99)	–0.73 (0.98)	0.29 (0.98)
Yes	132 (22.8)	63 (20.6)	156 (20.9)	37 (28.2)	152 (20.8)	36 (26.1)	0.00 (0.07)	0.08 (1.00)	–0.00 (1.06)
Yes (male)	59 (20.1)	26 (17.7)	72 (18.2)	11 (26.2)	70 (18.5)	12 (23.1)	0.93 (1.17)	0.16 (1.07)	–0.45 (0.97)
Yes (female)	73 (25.6)	37 (23.3)	84 (23.9)	26 (29.2)	82 (23.3)	24 (27.9)	–0.07 (0.91)	0.23 (0.95)	0.35 (0.99)
Examiner-detected click during age 45 dental examination (upon opening and closing 3 times) (*n* = 884)									
No	444 (76.8)	236 (77.1)	577 (77.2)	99 (75.6)	567 (77.7)	103 (74.6)	0.01 (1.00)	–0.47 (1.00)	0.02 (0.98)
Yes	134 (23.2)	70 (22.9)	170 (22.8)	32 (24.4)	163 (22.3)	35 (25.4)	0.02 (1.02)	–0.01 (0.94)	0.04 (1.06)
Yes (male)	58 (19.8)	25 (17.0)	73 (18.5)	8 (19.1)	70 (18.5)	10 (19.2)	0.22 (1.08)	0.04 (1.00)	–0.41 (1.00)
Yes (female)	76 (26.7)	45 (28.3)	97 (27.6)	24 (27.0)	93 (26.4)	25 (29.1)	–0.12 (0.96)	–0.04 (0.91)	0.36 (0.98)
Disc displacement with reduction (DC/TMD) at age 45 (*n* = 884)									
No	465 (80.5)	249 (81.4)	610 (81.7)	100 (76.3)	597 (81.8)	107 (77.5)	0.01 (0.99)	–0.06 (1.00)	0.03 (0.98)
Yes	113 (19.6)	57 (18.6)	137 (18.3)	31 (23.7)	133 (18.2)	31 (22.5)	0.03 (1.03)	0.06 (0.95)	0.01 (1.08)
Yes (male)	51 (17.4)	21 (14.3)	62 (15.7)	8 (19.1)	59 (15.6)	10 (19.2)	0.23 (1.11)	0.11 (0.98)	–0.47 (1.00)
Yes (female)	62 (21.8)	36 (22.6)	75 (21.3)	23 (25.8)	74 (21.0)	21 (24.4)	–0.12 (0.95)	0.01 (0.93)	0.34 (1.00)

DC/TMD, Diagnostic Criteria for Temporomandibular Disorder.
[a]$P < 0.05$.

Table 3. Logistic Regression Adjusting for Personality Characteristics, Occlusal Risk Factors, Previous Orthodontic Treatment, and Parafunctional Habits.

Characteristic	Self-Reported Click at Age 45 (Past 12 mo), OR (95% CI)	Self-Reported Click during Age 45 Examination, OR (95% CI)	Examiner-Detected Click during Age 45 Examination, OR (95% CI)	Disc Displacement with Reduction (DC/TMD) at Age 45, OR (95% CI)
Female sex	0.8 (0.5–1.2)	1.2 (0.8–1.8)	1.4 (1.0–2.0)	1.3 (0.8–2.0)
MPQ superfactors				
Negative emotionality *z* score	**1.3 (1.1–1.6)**	1.2 (1.0–1.4)	1.1 (0.7–1.9)	1.1 (0.9–1.3)
Positive emotionality *z* score	**0.7 (0.6–0.9)**	1.1 (0.9–1.3)	1.1 (0.9–1.4)	1.1 (0.9–1.4)
Constraint *z* score	1.0 (0.8–1.3)	1.0 (0.8–1.2)	1.0 (0.8–1.2)	0.9 (0.7–1.1)
Posterior crossbite	1.7 (0.9–2.9)	1.2 (0.7–2.1)	1.1 (0.7–1.9)	1.3 (0.7–2.2)
Overjet (reference = normal, 2 to 4 mm)				
High, ≥5 mm	0.6 (0.3–1.1)	1.1 (0.6–1.9)	1.4 (0.9,2.4)	1.4 (0.8–2.3)
Low, ≤1 mm	0.6 (0.3–1.3)	0.6 (0.3–1.4)	0.9 (0.5–1.6)	0.8 (0.5–1.4)
Overbite (reference = normal, 2 to 4 mm)				
High, ≥5 mm	0.9 (0.6–1.5)	**0.6 (0.3–0.9)**	**0.5 (0.3–0.9)**	**0.6 (0.3–1.0)**
Low, ≤1 mm	0.9 (0.5–1.6)	0.9 (0.5–1.5)	0.8 (0.5–1.4)	0.8 (0.5–1.4)
Any previous orthodontic treatment	1.1 (0.7–1.7)	0.9 (0.6–1.3)	0.9 (0.6–1.3)	0.9 (0.6–1.4)
Self-reported daytime dental clenching, past 12 mo	**2.6 (1.5–4.5)**	1.1 (0.7–2.0)	0.7 (0.4–1.3)	1.0 (0.5–1.7)
Self-reported nighttime clenching/grinding, past 12 mo	1.1 (0.6–1.9)	1.2 (0.7–2.0)	1.3 (0.8–2.1)	1.2 (0.7–2.0)

DC/TMD, Diagnostic Criteria for Temporomandibular Disorder; MPQ, Multidimensional Personality Questionnaire; OR, odds ratio.
Boldface denotes statistical significance.

self-reported clicking of the TMJ among females but not males. Higher positive emotionality at age 26 was associated with less self-reported TMJ clicking at age 45; this was statistically significant for males but not females. Conversely, negative emotionality at age 26 was associated with more self-reported TMJ clicking at age 45; this was statistically significant among females but not males. No other associations were detected for any of the other TMJ outcomes at age 45.

In the multivariate model (Table 3), negative emotionality was associated with greater odds for self-reporting TMJ clicking (OR = 1.3), while positive emotionality was associated with lower odds for self-reporting TMJ clicking (OR = 0.7). Overbite at age 15 was the only occlusal feature that was associated with the TMJ outcomes of interest. Greater overbite at age 15 was associated with lower prevalence of self-reported clicking during examination (OR = 0.6), examiner-detected

TMJ clicking during examination (OR = 0.5), and DC/TMD-diagnosed disc displacement with reduction (OR = 0.6) at age 45 y. Self-reported history of daytime tooth clenching (during the last 12 mo) was associated with greater odds (OR = 2.6) for self-reported TMJ clicking at age 45. History of orthodontic treatment by age 45 was not associated with any of the TMJ outcomes of interest. A supplementary analysis investigated whether TMJ outcomes would be worse among those who had orthodontic treatment but had unsatisfactory overjet, overbite, and posterior crossbite at age 45 than among those who had successful orthodontic treatment. No differences were observed (Appendix 1).

Discussion

This long-term longitudinal study provides new evidence that abnormal occlusal features, such as posterior crossbite and high and low overjet/overbite in adolescence, are not associated with higher prevalence of TMJ clicking later in life. In addition, personality was shown to influence self-reports of TMJ symptoms, in both positive and negative directions.

This study, to our knowledge, is the first longitudinal investigation of an association between features of occlusion in adolescence and TMJ outcomes (both self-reported and clinically examined) 30 y later. Despite this, the limitations of this research should be considered. Although participation for the age 45 dental examination/questionnaire was around 90% of the original cohort, only 781 had been dentally examined at age 15 y, leaving a lower number available for the current analysis. An earlier timepoint in the full permanent dentition, before some study members had received orthodontic treatment, may have been more appropriate than age 15. Nonetheless, a supplementary analysis indicated that those who had orthodontic treatment but still had unsatisfactory overjet, overbite, and posterior crossbite at age 45 were no worse off than those who had successful orthodontic treatment. It is also acknowledged that there are factors other than overjet, overbite, and crossbite that contribute to the overall success and quality of orthodontic treatment.

Another limitation was that the assessment of clenching and grinding in the past 12 mo was based on self-reports. Although more accurate forms of assessment such as electromyographic monitoring are considered the gold standard, logistical constraints precluded using these on such a large population. It must also be acknowledged that, at age 45 and prior, dental questionnaires have sought a history of TMJ clicking sounds present during the previous 12 mo. This differs from the 30-d reference period used in the DC/TMD criteria. The study does, however, have a number of strengths. These include the prospective longitudinal design, complete birth cohort, large sample size, high retention rate, multiple outcome measures (including subjective, objective, and standardized TMD diagnostic criteria), and the use of multivariate modeling.

Most investigations of occlusal features and TMJ clicking have focused on clinical orthodontic samples of children or young adults. Both self-reported and clinically recorded signs and symptoms of TMD have been shown to substantially fluctuate over decades, without progression to severe pain or dysfunction (Magnusson et al. 2000). The overall prevalence for TMJ clicking and disc displacement with reduction (DC/TMD) at age 45 was around 20%, or 1 in 5. This rate is consistent with other studies of nonpatient adult populations (Lundh and Westesson 1991; Matsuka et al. 1996). The prevalence of self-reported TMJ clicking during examination (23.0%) and examiner-detected TMJ clicking during examination (23.8%) was higher than the prevalence of disc displacement with reduction (DC/TMD) (19.8%). Ideally, disc displacement with reduction would have been diagnosed through magnetic resonance imaging, but this information was not available to the authors. The lower frequency for DC/TMD is likely explained by the diagnostic criteria used to reach a diagnosis of disc displacement with reduction.

Posterior crossbite was observed among 12.8% of study members at age 15. This prevalence is consistent with those from similar studies of adolescents (Farella et al. 2007). Despite being an occlusal feature thought to have a strong impact on the functioning of the masticatory system, posterior crossbite at age 15 was not associated with higher odds of any of the TMJ outcomes later in life. Age 15 overjet and overbite groups appear to be well distributed, with 75.3% and 60.6% of study members falling within the "normal" range, respectively. These 3 occlusal features were chosen because they can be identified or measured accurately, in contrast to functional or dynamic occlusal features (such as functional shifts and occlusal interferences), which are difficult to assess reliably. A history of orthodontic treatment was self-reported by around one-third of study members by age 45, consistent with findings from other studies of orthodontic treatment uptake (Burden 1995). Despite the limitations, these findings do not lend support to the notion of the effectiveness of orthodontic treatment in the treatment or prevention of TMJ clicking later in life.

Tooth clenching and grinding have been considered risk factors for TMDs (Michelotti et al. 2010). Daytime clenching was self-reported by approximately 15% of study members at age 45, consistent with other findings in adult populations (Strausz et al. 2010). Our modeling revealed that self-reported clenching was associated with greater odds of self-reported TMJ clicking, but no such association was found between clenching and objective/examiner-detected TMJ outcomes. Self-reported sleep-time clenching/grinding was not associated with any of the TMJ outcomes.

The study questionnaire used separate items for daytime tooth clenching and nighttime tooth clenching/grinding, although it has been suggested that laypeople may not be able to make such a distinction (Okeson et al. 1991). This is especially true when the self-report is reliant on information from a partner or roommate. In addition, the validity of self-reports has been questioned because these may reflect distress, rather than actual masticatory muscle activity (Lobbezoo et al. 2018). Future research on the relationship between clenching and TMDs should include an objective assessment of parafunction.

In agreement with previous longitudinal study findings (Mohlin et al. 2004), high (≥4 mm) overbite values at age 15 were negatively associated with age 45 TMJ outcomes, except self-reported clicking in the last 12 mo. High overbite is a feature common to individuals with hypodivergent facial patterns, who generally have larger TMJ condyles than their hyperdivergent counterparts (Ma et al. 2018). It is possible that large condyles are less susceptible to mechanical stress than small condyles, thus protecting against the subsequent onset of disc derangements (Nickel et al. 2018). This hypothesis appears consistent with the findings of a systematic review indicating that facial hyperdivergence (which contrary to hypodivergence is associated with small condyles) is a risk factor for TMJ disc displacement and degenerative disorders (Manfredini et al. 2016). Consideration should therefore be given to the vertical growth pattern of participants in future TMD studies if overbite is used as a variable.

Self-reported TMJ clicking at age 45 was more frequent among those scoring higher on negative emotionality and lower among those with high positive emotionality. These findings are consistent with earlier observations of the cohort, which demonstrated that personality characteristics appear to influence self-reports of oral health (Thomson et al. 2011). Personality characteristics have the potential to influence care-seeking behavior or self-reports of TMJ noises. Although this study assessed personality traits only at age 26, there is general acceptance for the stability of personality traits over the life course (Livesley 2001). An association between psychological traits and self-reported TMJ clicking sounds appears to be already well established during early adolescence (Ukra et al. 2017). Associations for personality shown in this study are consistent with modern etiological concepts of TMD that include psychological influences (Ohrbach and Dworkin 2016). Although no specific psychological profile has been identified, many patients with TMD report stressful life events, catastrophizing behavior, depression, and anxiety (Auerbach et al. 2001; Pallegama et al. 2005). A stronger association exists between psychological factors and muscle-related TMDs than joint-related TMDs, such as disc displacement (Pallegama et al. 2005). The effect of personality found in this study may act as a source of bias that deserves consideration when interpreting research based on self-reports of TMD.

Conclusions

Posterior crossbite and abnormal overjet/overbite values during adolescence are not associated with greater risk for TMJ clicking later in life. Personality characteristics and self-reported history of daytime tooth clenching appear to be associated with self-reported TMJ clicking.

Author Contributions

S.J. Olliver, contributed to conception, design, data acquisition, and analysis, drafted and critically revised the manuscript; J.M. Broadbent, contributed to design, data acquisition, and analysis, critically revised the manuscript; W.M. Thomson, contributed to design, critically revised the manuscript; M. Farella, contributed to conception, design, data analysis, and interpretation, critically revised the manuscript. All authors gave final approval and agree to be accountable for all aspects of the work.

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