

# Relationship between impacts attributed to malocclusion and psychological stress in young Japanese adults

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**SUMMARY** Identifying risk factors is important to prevent a wide range of health-damaging behaviours and to improve the quality of life of young people. The aim of this study was to investigate the relationship between impacts on daily performance attributed to malocclusion and psychological stress in healthy young Japanese adults.

Medical and oral health data were collected during a cross-sectional examination conducted by the Health Service Center of Okayama University. Systemically healthy non-smoking students aged 18 and 19 years ( $n = 641$ ; 329 males and 312 females) were included. Malocclusion was defined using a modified version of the Index of Orthodontic Treatment Need (IOTN). The impacts on daily performance attributed to malocclusion and psychological stress were assessed using self-reported questionnaires, the condition-specific oral impacts on daily performances (CS-OIDP), and the Hopkins Symptoms Checklist. Mann–Whitney *U*- and chi-square tests and structural equation modelling (SEM) were used for statistical analysis.

Forty per cent of subjects had a malocclusion ( $n = 255$ ). Subjects with impacts on daily performance had a significantly higher prevalence of malocclusion than those without impacts ( $P < 0.001$ ). SEM showed that psychological stress, especially interpersonal sensitivity and depression, was significantly correlated with CS-OIDP and malocclusion. Negative impacts on daily performance attributed to malocclusion may contribute to psychological stress in young Japanese adults.

## Introduction

Adolescents experience rapid physiological, social, and cognitive changes (Baker, 2007). Approximately 16 per cent of adolescents worldwide suffer from mental health problems (Roberts *et al.*, 1998), with wide ranges (2.6–35.6 per cent), such as in the USA, Europe, Canada, India, and the United Arab Emirates (Kessler *et al.*, 1994; Spady *et al.*, 2001; Eapen *et al.*, 2003; Remschmidt and Belfer, 2005; Pillai *et al.*, 2008). Major depression and anxiety disorders are the most common forms of mental illness, and the prevalence of these increases significantly in late adolescence or young adulthood (Hankin *et al.*, 1998; Kessler *et al.*, 2005). Poor mental health during this period has been linked to mental health problems in adulthood (Hofstra *et al.*, 2002). Therefore, it is very important for young adults to prevent health-damaging behaviour and to improve their quality of life (QoL; Walker and Townsend, 1998).

Malocclusion has physical, psychological, and social effects on QoL (Bernabé *et al.*, 2009). In an animal model, the placement of acrylic caps on the lower incisors of rats increased plasma corticosterone levels (Yoshihara *et al.*, 2001). In recent studies using accelerated senescence-prone mice, the bite raising in aged mice increased plasma

corticosterone levels (Kubo *et al.*, 2007). It is possible that occlusal dysfunction caused by bite raising induces hormone-related stress. On the other hand, in a human study, patients who underwent non-surgical correction of a malocclusion had lower disease-specific QoL based on the orthognathic QoL questionnaire compared with subjects with normal occlusion (Tajima *et al.*, 2007). In female subjects with an Angle Class III malocclusion in whom surgical treatment was indicated, a significant reduction in the number of depressive symptoms was observed after surgery (Nicodemo *et al.*, 2008). Patients with a severe malocclusion requiring surgical correction showed improvement in disease-specific oral health-related (OHR) QoL and anxiety after jaw surgery (Azuma *et al.*, 2008). These findings suggest that a relatively severe malocclusion may lead to psychological stress. However, there is little information on how mild or moderate malocclusions affect psychological stress.

The aim of this study was to investigate the relationship between impacts attributed to malocclusion and psychological stress in healthy young Japanese students. OHRQoL measures are commonly used in oral health surveys, oral health needs assessment, clinical trials, and studies evaluating the outcomes of dental care intervention (Allen, 2003;

Locker *et al.* 2004). This study used the condition-specific oral impacts on daily performances (CS-OIDP) because CS-OIDP is the only OHRQoL measure designed to link specific oral conditions, such as malocclusion to impacts on daily performance (Adulyanon and Sheiham, 1997; Gherunpong *et al.*, 2004, 2006). The Hopkins Symptoms Checklist (HSCL), which has been found to be a psychometrically valid and reliable indicator of anxiety and depression symptomatology (Derogatis *et al.*, 1974), was also utilized since anxiety and depression are common stress-related disorders and are closely related to medical conditions and attributed behaviours (Sandanger *et al.*, 1999).

## Subjects and methods

### Subjects

Among 2374 first-year students who had undergone a general health examination in April 2009 at the Health Service Center of Okayama University, 1017 students (18.8 ± 2.2 years, mean ± SD) volunteered to undergo an oral examination. The study was approved by the Ethics Committee of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences. After verbal consent was obtained from the participants during the oral examination, the subjects completed questionnaires regarding their personal health. The oral examination was carried out by dentists and the general examination by physicians and public health nurses. Exclusion criteria were: a previous or current smoking habit, pregnancy, systemic diseases, consumption of any drugs within the previous 2 months, or failure to provide written informed consent. A total of 654 subjects satisfied the inclusion criteria. For these, questionnaires with no missing values from subjects aged 18–19 years ( $n = 641$ ; 329 males and 312 females) were analysed.

### Oral examination

A modified version of the Index of Orthodontic Treatment Need (IOTN) was used for each student. A previous study suggested that the modified IOTN is useful for the screening of malocclusion by non-specialists in oral health surveys

(Burden *et al.*, 2001). The dental health component of the modified IOTN consists of a two-grade scale (0 = no definite need for orthodontic treatment and 1 = definite need for orthodontic treatment) with no subcategories (Table 1). Four calibrated dentists (DE, MF, KI, and TA) performed the screening and an orthodontist (TM) confirmed the modified IOTN score. In a preliminary check, intra- and inter-concordance rate for diagnosis of malocclusion was more than 90 per cent. The number of missing and decayed teeth in each subject was also determined.

### Self-reported questionnaire

The OIDP index was used to evaluate serious oral impacts on eight daily activities: eating, speaking, cleaning the mouth, relaxing, smiling, studying, emotion, and social contact (Gherunpong *et al.*, 2006; Bernabé *et al.*, 2009). If no impact was reported, then a score of zero was allocated. If a subject reported an impact on any of these eight activities, the frequency of the impact (scale from 1 to 3) and the severity of its effect on daily life (scale from 1 to 3) were scored. Subjects with impacts were subsequently asked to choose from a list of oral problems that, in their opinion, impacted on their daily performance. Three problems ('bad position of teeth', 'space between teeth', and 'deformity of the mouth or face') were considered in the analysis as CS-OIDP attributed to malocclusion (Gherunpong *et al.*, 2006; Bernabé *et al.*, 2009). Subjects with one or more affirmative responses were considered to have malocclusion-related impacts. The percentage of subjects with a CS-OIDP score higher than zero was calculated.

The HSCL is a psychometrically valid and reliable indicator of anxiety and depression (Derogatis *et al.*, 1974) and is a well-validated self-report instrument in Japanese subjects (Nakano and Kitamura, 2001). Fifty-four questions measuring the frequency and intensity of symptoms during the previous week were scored on a scale from 1 (not bothered) to 4 (extremely bothered). Scale scores were determined for each of the five primary symptom dimensions (somatization, obsessive-compulsive, interpersonal sensitivity, depression, and anxiety; Petersen *et al.*, 2005).

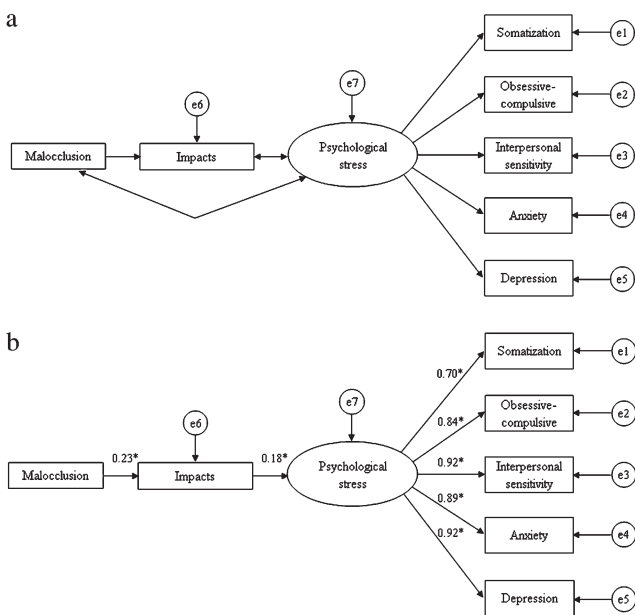
**Table 1** Modified dental health components of Index of Orthodontic Treatment Need [reproduced with kind permission from Burden *et al.* (2001)].

Missing teeth	Hypodontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need of a prosthesis.
Overjet	Impeded eruption of teeth. Presence of supernumerary teeth, and retained deciduous teeth. Increased overjet greater than 6 mm. Reverse overjet greater than 3.5 mm with no masticatory or speech difficulties. Reverse overjet greater than 1 mm but less than 3.5 mm with recorded masticatory and speech difficulties.
Crossbites	Anterior or posterior crossbites with greater than 2 mm discrepancy between retruded contact position and intercuspal position.
Displacement of contact points (crowding)	Contact point displacements greater than 4 mm.
Overbite	Lateral or anterior open bites greater than 4 mm. Deep overbite with gingival or palatal trauma.

*Statistical analysis and the structure of modelling*

Mann–Whitney *U*- and chi-square tests were used to determine whether there were any significant differences ( $P < 0.05$ ) between subjects with a CS-OIDP greater than 0 or without impacts (CS-OIDP = 0) on daily performance attributed to malocclusion.

Structural equation modelling (SEM) was used to test the relationship between impacts on daily performance attributed to malocclusion and psychological stress. The hypothesized model is shown in Figure 1a. It was hypothesized that impacts attributed to mild or moderate malocclusions may contribute to psychological stress by impacting on the performance of daily activities and there may be interaction between malocclusion and stress. SEM gives the analysis of the cross-sectional study with many of the benefits of a longitudinal study, allowing for exploration of the complex causal pathways involved in disease processes (Chukmaitov *et al.*, 2008). Confirmatory factor analysis was used to estimate the proposed model that described the unobserved variables or hypothetical constructs from the observed variables. Path analysis was used to describe the direct dependencies among a set of the observed variables. These included dichotomous or three-category variables. Therefore, Bayesian estimation with Markov chain Monte Carlo algorithm was also performed. To test the fit of the model, a comparative fit index (CFI), a goodness-of-fit index (GFI), and a root mean square error of approximation (RMSEA) were used (Bentler, 1990; Han *et al.*, 2001; Chukmaitov *et al.*, 2008). The fit indices range from 0 to 1 and measure the amount of variances and covariances that are jointly accounted for by the model.



**Figure 1** Malocclusion, impacts on daily performance, and psychological stress. (a) Hypothesized model and (b) Final model with standardized estimates. \* $P < 0.001$  e1–e7: unique variables.

Higher values (closer to one) are typically desirable. RMSEA measures the degree of model adequacy based on population discrepancy in relation to degrees of freedom. A RMSEA value less than 0.05 is preferred (Chukmaitov *et al.*, 2008). The better model was selected by Akaike information criterion (AIC; Kletting and Glatting, 2009). The Statistical Package for Social Sciences (15.0J for Windows; SPSS Japan, Tokyo, Japan) and AMOS (17.0J for Windows; SPSS Japan) were used for statistical analyses.

**Results**

None of the subjects had a severe malocclusion requiring surgical treatment. Forty per cent of subjects were classified as having a malocclusion ( $n = 255$ ; 129 males and 126 males) according to the modified IOTN. The prevalence of each activity of CS-OIDP attributed to malocclusion is shown in Table 2.

Table 3 shows the characteristics of subjects with (CS-OIDP greater than 0) and without (CS-OIDP = 0) impacts on daily performance. Subjects with impacts on daily performance had significantly higher HSCL scores and prevalence of malocclusion ( $P < 0.01$ ). There were no significant differences in HSCL scores between subjects with a normal occlusion or with a malocclusion or between males and females (data not shown).

The best model as presented in Figure 1b fitted the data well: GFI = 0.989, CFI = 0.995, RMSEA = 0.041, and AIC = 301.2. These results suggest that the model fitted the empirical data. Malocclusion was found to contribute to impacts on daily performance (standardized regression coefficient,  $\beta = 0.23$ ,  $P < 0.001$ ). The impacts on daily performance were conducive to psychological stress ( $\beta = 0.18$ ,  $P < 0.001$ ), especially interpersonal sensitivity ( $\beta = 0.92$ ,  $P < 0.001$ ) and depression ( $\beta = 0.92$ ,  $P < 0.001$ ).

**Discussion**

This appears to be the first study to assess the relationship between impacts on daily performance (CS-OIDP) attributed to mild or moderate malocclusions and psychological stress using SEM. Because SEM gives analysis of cross-sectional studies, including many of the virtues of a longitudinal study, it was used to investigate possible pathways that impacts attributed to malocclusion may contribute to psychological stress. Subjects with impacts on daily performance had a significantly higher prevalence of malocclusion and psychological stress (Table 3). According to SEM, the impacts attributed to malocclusion contributed to psychological stress, especially interpersonal sensitivity and depression. The finding is in agreement with studies demonstrating a relationship between malocclusion and CS-OIDP score (Gherunpong *et al.*, 2006; Bernabé *et al.*, 2009). In cases of severe malocclusion, the anxiety of patients improves after orthognathic surgery (Azuma *et al.*,

2008). Even if subjects do not have a severe malocclusion, it is possible that the improvement in, or treatment of, a malocclusion reduces psychological stress, such as interpersonal sensitivity and depression, in young adults.

Anxiety and depression are common stress-related disorders (Sandanger *et al.*, 1999), and it is important to identify these symptoms at an early stage. Malocclusion is one of the most common oral disorders, and its prevalence is high in most countries (Takahashi *et al.*, 1995; Hensel *et al.*, 2003). Moreover, malocclusion traits remain remarkably stable if patients do not receive orthodontic treatment (Helm and Petersen, 1989). The present findings may provide new insights into the consequences of malocclusion. Therefore, evaluation or treatment of malocclusions might be required for young adults for early detection of stress-related disorders. In Japan, health examinations are implemented on a regular basis according to a school health law. As preventing mental health problems at an early stage by controlling risk factors in young people is important, regular screening for malocclusion as part of health examinations might be useful.

In the present research, 40 per cent of subjects had a definite orthodontic treatment need according to the modified IOTN. Other studies in countries using the original IOTN showed a wide range in the percentage of subjects in definite need of orthodontic treatment (i.e. 11–50 per cent; Otuyemi *et al.*, 1997; Akeel and Al-Jasser, 1999; Kerosuo *et al.*,

2000; Mugonzibwa *et al.*, 2004; Soh and Sandham, 2004; Hassan, 2006; Bernabé *et al.*, 2008a,b). Although the sample size, age, and definition of malocclusion differed between the current research and other studies, the prevalence of malocclusion observed was within this range.

The present study had several limitations. Firstly, although SEM was used as an analytical tool, the study design limited interpretation concerning temporal relationships. Intervention studies may provide additional information. Secondly, the number of subjects was small. Thirdly, other factors (e.g. genetic components, nutrition, level of education, academic factors, patient–child relationship) that have been shown to affect psychological stress were not considered (Hicks *et al.*, 2009). Fourthly, the present study inferred stresses from measures of psychological health because it may be a consequence of stress. However, this was a proxy measure of stress not the actual experience of stress. In addition, the measurements ignored the possible effects of coping. Individuals may experience high levels of stress but cope adequately with them and thus have no psychological ill health. Therefore, using HSCL as a proxy measure of stress has limitations. Fifthly, the validity and reliability of the modified IOTN have not been fully confirmed. It is suggested that the modified IOTN overcomes the reliability problems that often accompany the use of orthodontic indices by non-specialists in oral health surveys (Burden *et al.*, 2001). Therefore, the present study used the modified IOTN and checked the validity and reliability with the preliminary finding of the orthodontists. However, further research is required to confirm validity and reliability. Finally, the modified IOTN was used to identify malocclusion. There are other methods for defining malocclusion, such as Angle's classification (Bernabé *et al.*, 2008a,b) and classification based on the severity of malocclusion (Azuma *et al.*, 2008). Considering that the present subjects had malocclusions as defined by the modified IOTN, it is possible that malocclusion by other definitions may have effects on psychological stress other than those identified.

**Table 2** Prevalence of condition-specific oral impacts on daily performances attributed to malocclusion.

Prevalence	<i>n</i> (%)
Eating	114 (17.8)
Speaking	92 (14.4)
Cleaning mouth	159 (24.8)
Relaxing	53 (8.3)
Emotion	48 (7.5)
Smiling	143 (22.3)
Studying	41 (6.4)
Social Contact	41 (6.4)

**Table 3** Characteristics of subjects with and without impacts on daily performance.

Characteristics	Without impacts ( <i>n</i> = 365)	With impacts ( <i>n</i> = 276)	<i>P</i>
Number of decayed teeth	0 (0, 0)*	0 (0, 0)	0.960†
Number of teeth present	28 (28, 28)	28 (28, 28)	0.914†
Hopkins Symptoms Checklist			
Somatization	17 (15, 20)	19 (17, 21)	<0.001†
Obsessive–compulsive	16 (13, 20)	18 (13, 22)	0.003†
Interpersonal sensitivity	14 (12, 19)	17 (13, 20)	<0.001†
Anxiety	10 (8, 13)	11 (9, 14)	<0.001†
Depression	17 (14, 22)	20 (16, 24)	<0.001†
Proportion of malocclusion (%)	33	48	<0.001‡
Proportion of male students (%)	52	51	0.791‡

\*Median (25th and 75th).

†Mann–Whitney *U*-tests were performed.

‡Chi-square test was performed.



## Conclusion

Impacts on daily performance attributed to malocclusion contribute to psychological stress, especially interpersonal sensitivity and depression in young Japanese adults.

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