Research Article

Anatomical Positions of Mesially/Horizontally Impacted Mandibular Third Molars are Significant Predictors for Distal Caries in Adjacent Second Molars

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Background. Prevalence of distal caries in mandibular second molars (M2Ms) and its relationship with impacted condition of the adjacent mandibular third molars (M3Ms) have been reported in some studies. The results, however, were ambiguous because of including all impaction types and using univariate analysis for statistics. Aim. This study aimed to determine anatomical features of mesially/horizontally impacted mandibular third molars (M3Ms) that could predict distal caries in the adjacent mandibular second molars (M2Ms) using multivariable analysis. Materials and Methods. The study sample consisted of 300 digital panoramic radiographs of patients who underwent impacted M3Ms extraction. Two independent researchers collected the following variables from 446 pairs of M2M-M3M: sex, age, status of distal caries in M2Ms, mesial angulation, and Pell–Gregory classification of M3Ms. Results. The prevalence of distal caries was 50.67%. Multivariable Firth’s logistic regression analysis showed that age (β = 0.066, 95% CI = 0.023–0.113), mesial angulation (<30°: β = −1.205, 95% CI = −1.955 to −0.499; >70°: β = −0.730, 95% CI = −1.184 to −0.282), vertical position (level B: β = 2.275; 95% CI = 0.015–7.175; level A: β = 3.008; 95% CI = 0.755–7.905), and horizontal position (level II: β = 1.515; 95% CI = 0.444–2.874; level I: β = 1.423; 95% CI = 0.283–2.825) were significant variables after adjusting for sex in the final model for predicting distal caries (p < 0.05). Conclusions. In conclusion, anatomical positions of impacted M3Ms, such as mesial angulation and Pell–Gregory classification were significant predictors of distal caries in M2Ms.

1. Introduction

Impacted mandibular third molars (M3Ms) are a popular oral condition, with an average prevalence of 24.4% in adults [1]. They cause numerous pathological problems in the surrounding structures, such as dental caries, periodontal pockets, pericoronitis, dental tumors, or cysts. These lesions are usually mild symptomatic or asymptomatic, and challenging to diagnose with conventional radiographs [2, 3]. Among them, distal caries in mandibular second molars (M2Ms) is one of the most common M3Ms-associated complications which range from 12.2% to 39.0% [4, 5].

Distal caries is not only popular in M2Ms but also frequently unnoticed. It has been reported that nearly one-fourth of M2Ms with distal caries are unrestorable and must be removed [6]. Consequently, it has received great attention from researchers with the aim of identifying predictors of distal caries in M2Ms adjacent to impacted M3Ms. Determining predictors would help dental clinicians anticipate the risk of distal caries and make appropriate decisions to prevent it.

There have been a number of studies regarding this topic. Most of the studies highlighted the importance of anatomical positions of the adjacent impacted M3Ms in prevalence of distal caries in M2Ms. However, the current results are limited because of the following two issues. First, majority of previous studies included all the impacted directions of M3Ms. However, the prevalence of distal caries was significantly higher in M2Ms adjacent to mesially/horizontally impacted M3Ms [7]. Second, previous studies used univariate analysis to examine the relationships between distal caries and potential factors. Because dental caries is the
consequence of numerous factors, including tooth, time, bacteria, and other sociodemographic characteristics, it would be more accurate to use multivariable analysis to adjust for their contributions [8]. One study showed that the correlation between age and distal caries became insignificant after adjusting for other factors using multivariable analysis [9]. Therefore, this study was conducted using a different approach to avoid these limitations.

This study aimed to determine anatomical features of the mesially/horizontally impacted M3M that could predict distal caries in the adjacent M2M, using multivariable statistical analysis.

2. Materials and Methods

This cross-sectional study was conducted on 300 digital oral panoramic radiographs stored at the Department of Oral Surgery, Faculty of Odonto-Stomatology, University of Medicine and Pharmacy at Ho Chi Minh City. Radiographs were obtained from patients who underwent impacted M3Ms extraction from January 2019 to April 2021. All radiographs were taken by a sole radiographic technician using the same X-ray machine (Sirona, Germany) and technical parameters to reduce variation.

The inclusion criteria for panoramic radiographs were as follows: (1) being qualified with clear details; (2) having at least one mesially/horizontally impacted M3M; and (3) containing all of the following information: sex, birthday, and the day taken. The exclusion criteria were as follows: (1) loss of the adjacent M2M, (2) severe destruction of M2M or M3M morphology that mesial angulation and Pell-Gregory classification could not be assessed, and (3) presence of uncommon pathological signs, such as radiolucent lesions with diameter ≥2.5 mm or radiopaque lesions in the mandibular angle region.

Two independent researchers (S. H. L. and N. M. N.) assessed the digital radiographs to obtain the required variables: age, sex, side (left/right), mesial angulation, Pell–Gregory classification of impacted M3Ms, and status of distal caries in M2Ms. Demographic variables (age, sex, and side) were collected from digital panoramic radiographs. The mesial angulation of impacted M3Ms was measured on a computer screen using the IC Measure software version 2.0. The researchers traced the line of the occlusal planes of M2M and M3M. The mesial angulation of the impacted M3Ms was defined as the angle formed at the intersection of the traced lines. The final mesial angulation was calculated as the mean of the values measured by the two researchers (Figures 1 and 2). The Pell–Gregory classification contained two perspectives of the impacted M3M position, including the mandibular occlusal surface (vertical position) and ramus (horizontal position). Each position has three impacted levels described and illustrated in the original article [10].

For mesial angulation, the intraclass correlation coefficient (ICC) was calculated to confirm interexaminer reliability (ICC = 0.904, 95% CI = 0.881–0.923). For the other variables (nominal variables), if there were any disagreements in the obtained values, the third researcher (L. T. B. N.) would be asked for discussion to obtain the final ones.

All data were analysed using IBM SPSS Statistics for Windows, version 25.0. Shapiro–Wilk test showed that age was not normally distributed (p < 0.001). A chi-squared test was employed to test differences in the prevalence of distal caries between sexes, sides, mesial angulation, and horizontal and vertical positions of impacted M3Ms. Mann–Whitney U test was used to examine differences in age between the caries and noncaries groups. Previous studies have shown that distal caries in M2Ms is correlated with multiple factors, such as sex, mesial angulation, and Pell–Gregory classification [9, 11, 12]. Therefore, multivariable Firth’s logistic regression analysis was conducted to determine the correlation between potential factors and distal caries in M2Ms. Statistical significance was set at p value < 0.05.

3. Results

In this study, there were 446 pairs of M2M-M3M, with an average age of the samples as 24.63 years old (SD = 4.98). The prevalence of distal caries in M2Ms was 50.67%. The frequencies and prevalence of collected variables are shown in Table 1. Significant difference was found in age between the
caries and noncaries group (25.35 ± 5.62 vs. 23.88 ± 4.11, respectively) with \( U = 21997.00 \) and \( p = 0.007 \). The prevalence of distal caries in M2Ms was significantly different between the groups with mesial angulation, vertical and horizontal impaction (Table 1). Notably, dental caries in M2Ms was more frequent if the mesial angulation was 30°–70°. The prevalence of distal caries tended to increase in the less impacted M3Ms, both vertically and horizontally.

Univariate regression showed that age, mesial angulation, and vertical and horizontal impaction were significant factors for predicting distal caries in multivariable analysis. Although sex was not a significant factor, the statistical results showed that sex was suitable for inclusion as a potential predictor in the multivariable regression test (Table 2).

Multivariable regression showed that age, mesial angulation, and vertical and horizontal impaction were significant predictors of distal caries in the final model. M2Ms adjacent to mesially/horizontally inclined M3Ms in participants of older age were more likely to suffer from distal caries. The M3Ms mesially inclined at 30°–70° increased the prevalence of distal caries in M2Ms. For vertical impaction, M3Ms level C was less related to distal caries in M2Ms than levels B and A. For horizontal impaction, M3Ms levels I and II significantly increased the probability of distal caries in M2Ms compared to level III (Table 3).

4. Discussion

Some studies have examined the relationship between distal caries in M2Ms and impacted M3Ms. Notably, the prevalence of distal caries in M2Ms adjacent to mesially/horizontally impacted M3Ms was usually reported as the highest among all types of impaction and could be up to nearly 10 times more than others [7, 13]. A few studies have focused on mesially/horizontally impacted M3Ms; however, multivariable analysis was not employed to adjust for contribution of independent factors [11, 14, 15]. The study results revealed that anatomical positions of mesially/horizontally impacted M3Ms, such as mesial angulation, and vertical and horizontal levels were significant predictors of distal caries in M2Ms.

The study used panoramic radiographs to assess distal caries in M2Ms and the anatomical position of M3Ms. It was also the most common radiographic technique chosen in previous studies [7]. Panoramic radiography is a reliable method for examining the anatomical characteristics of M3Ms and surrounding structures, but it is not as accurate as bitewing radiography for diagnosing proximal caries [16, 17]. However, it has been proven that the accuracy of panoramic radiography when examining proximal caries in the mandibular molar region is clinically useful and suitable [18, 19]. Therefore, panoramic radiography is appropriate for assessing distal caries in M2Ms and the anatomical position of M3Ms in this study.

Dental caries is the consequence of four direct contributors, including tooth, diet, bacteria in the biofilm, and time. Notably, bacteria in biofilms play a critical role because the acidic by-products of fermentation initiate carious lesions [8]. Evidence revealed the frequent detection of Streptococcus, Lactobacillus, Actinomyces, and certain species in the development of dental caries [20, 21]. Additionally, the number of dental caries-associated bacterial clusters gradually reduced when dental plaque was located in deeper positions [22, 23]. Therefore, the authors assumed that dental plaque located more apically was less able to initiate a carious lesion.

In this study, mesial angulation was divided into three groups: < 30°, 30°–70°, and >70°. The result of the effect of mesial angulation was in line with previous studies. When

| Variables                  | Caries | Noncaries | Total | \( \chi^2 \) | Df  | \( p \) value |
|----------------------------|-------|-----------|-------|-------------|-----|--------------|
| Sex                        |       |           |       |             |     |              |
| Female                     | 92    | 47.18     | 103   | 52.82       | 195 | 43.72        |
| Male                       | 134   | 53.39     | 117   | 46.61       | 251 | 56.28        |
| Side                       |       |           |       |             |     |              |
| Left                       | 102   | 48.57     | 108   | 51.43       | 210 | 47.09        |
| Right                      | 124   | 52.54     | 112   | 47.46       | 236 | 52.91        |
| Mesial angulation          |       |           |       |             |     |              |
| <30°                       | 13    | 29.55     | 31    | 70.45       | 44  | 9.86         |
| 30°–70°                    | 159   | 61.63     | 99    | 38.37       | 258 | 57.85        |
| >70°                       | 53    | 36.81     | 90    | 63.19       | 144 | 32.29        |
| Vertical impaction         |       |           |       |             |     |              |
| A                          | 167   | 60.95     | 107   | 39.05       | 274 | 61.44        |
| B                          | 59    | 36.42     | 103   | 65.58       | 162 | 36.32        |
| C                          | 0     | 0         | 10    | 100         | 10  | 2.24         |
| Horizontal impaction       |       |           |       |             |     |              |
| I                          | 64    | 56.63     | 49    | 43.37       | 113 | 25.34        |
| II                         | 159   | 52.30     | 145   | 47.70       | 304 | 68.16        |
| III                        | 3     | 10.34     | 26    | 89.66       | 29  | 6.50         |

A chi-squared test was conducted to compare differences between caries and noncaries groups, except for the vertical impaction groups. Owing to the appearance of expected values less than 5, Fisher’s exact test was conducted. F-value of Fisher’s exact test.

*International Journal of Dentistry* 3
the mesial angulation ranged from 30° to 70°, the risk of
distal caries was statistically higher than when it was <30° or
>70° [9, 11, 14, 24]. To the authors’ knowledge, there has
been no explanation for this difference. The authors assumed
that when the mesial angulation was <30°, the position of the
contact point was closer to the occlusal surface; hence, it
would be easier to remove dental plaque. On the other hand,
when the mesial angulation was >70°, the contact point was
more apical. This was not favoured for the growth of dental
caries-associated bacteria [22, 23]. Perhaps, these conditions
resulted in a lower prevalence of distal caries when the
mesial angulation was out of the range of 30°–70°.

The Pell–Gregory classification is one of the most
common predictors of distal caries in M2Ms adjacent to
impacted M3Ms. The multivariable statistics revealed that in
comparison with levels C and III, the other levels signifi-
cantly increased the prevalence of distal caries in M2Ms. The
majority of previous studies also showed the same corre-
lations between impacted levels of M3Ms and prevalence of
distal caries in M2Ms [5, 12, 25, 27]. Additionally, the authors assumed that the bacterial complex would shift to a smaller number of acid-
producing bacterial clusters along with an increase in im-

Table 2: Univariate logistic regressions of associations between distal caries in M2Ms and demographic/radiographic characteristics
(N = 446).

| Variables                  | Coefficient | SE  | 95% CI         | p value |
|----------------------------|-------------|-----|----------------|---------|
| Sex*a                     | 0.247       | 0.191 | −0.126−0.623 | 0.194   |
| Age                       | 0.063       | 0.021 | 0.023−0.106  | 0.002   |
| Mesial angulationb         |             |     |                |         |
| <30°                       | −1.319      | 0.353 | −2.033−0.653  | <0.001  |
| >70°                       | −0.979      | 0.214 | −1.402−0.563  | <0.001  |
| Vertical impactionc        |             |     |                |         |
| B                          | 2.491       | 1.527 | 0.410−7.354   | 0.013   |
| A                          | 3.488       | 1.523 | 1.421−8.349   | <0.001  |
| Horizontal impactiond      |             |     |                |         |
| II                         | 2.116       | 0.590 | 1.102−3.445   | <0.001  |
| I                          | 2.289       | 0.609 | 1.229−3.646   | <0.001  |

SE, standard error; CI, confidence interval; *0 = female; 1 = male; b1 = 30°–70°; 2 = <30°, 3 = >70°; c1 = C; 2 = B; 3 = A; d1 = III; 2 = II; 3 = I.

Table 3: Multivariable logistic regression of associations between distal caries in M2Ms and demographic/radiographic characteristics
(N = 446).

| Variables                  | Coefficient | SE  | 95% CI         | p value |
|----------------------------|-------------|-----|----------------|---------|
| Sex*a                     | 0.057       | 0.212 | −0.358−0.470  | 0.788   |
| Age                       | 0.066       | 0.023 | 0.023−0.113   | 0.002   |
| Mesial angulationb         |             |     |                |         |
| <30°                       | −1.205      | 0.373 | −1.955−0.499  | 0.001   |
| >70°                       | −0.730      | 0.231 | −1.184−0.282  | 0.001   |
| Vertical impactionc        |             |     |                |         |
| B                          | 2.275       | 1.613 | 0.015−7.175   | 0.048   |
| A                          | 3.008       | 1.611 | 0.755−7.905   | 0.005   |
| Horizontal impactiond      |             |     |                |         |
| II                         | 1.515       | 0.606 | 0.444−2.874   | 0.004   |
| I                          | 1.423       | 0.637 | 0.283−2.825   | 0.013   |

SE, standard error; CI, confidence interval; *0 = female; 1 = male; b1 = 30°–70°, 2 = <30°, 3 = >70°; c1 = C; 2 = B; 3 = A; d1 = III; 2 = II; 3 = I.
sociodemographic status, behaviour, attitude, and knowledge [8]. Sex has been proven to affect the status of dental caries due to differences in biological and sociodemographic factors [28]. Although females have some disadvantages related to biological factors, males are less likely to have adequate oral self-care and professional treatment [29, 30]. Previous studies have reported no correlation between DMF/DMFT and the prevalence of distal caries in M2Ms adjacent to impacted M3Ms [6, 15, 31]. These results suggest that common factors for predicting high-rated dental caries, such as sex, might not have critical effects on distal caries in M2Ms. The authors assumed that distal caries in M2Ms adjacent to mesially/horizontally impacted M3Ms was mainly caused by the frequent presence of the local dental plaque that was almost impossible to clean. Bacteria in dental plaque might relate to numerous clinical signs, which appear in about 60% of cases coming for surgical removal of mesially/horizontally impacted M3Ms, such as pericoronitis, pain, or periodontal pocket [24, 31]. The higher prevalence of distal caries in mesially/horizontally impacted M3Ms than in distally and vertically ones in previous studies also support this assumption [5, 9, 12, 13, 27, 31, 32].

Previous studies examined other parameters for predicting distal caries, such as the Leone classification and the position of the M2M-M3M contact point [11, 15, 31]. The Leone classification was determined based on the distance between the cementoenamel junctions of M2M-M3M, which seemed highly correlated with the mesial angulation of the M3Ms. The higher the mesial angulations, the greater the distance between the cementoenamel junctions of M2M-M3M. However, mesial angulation has been proven to be more reliable for predicting distal caries [9, 11, 24]. In previous studies, the position of the M2M-M3M contact point was classified as above, on, and under the M2M cementoenamel junction. The authors assumed that with a same mesial angulation of M3M, the position of the M2M-M3M contact point would likely correlated with vertical impaction of the Pell–Gregory classification, and was also a parameter of the vertical impacted level of M3M [14]. In cases of advanced distal caries, the authors found that it was difficult to determine the relationship between contact points and M2M cementoenamel junctions due to the severe destruction of the tooth structure. Therefore, the Leone classification and the position of the contact point were not employed for predicting distal caries in this study.

The study was conducted with an appropriate study design: assessing digital panoramic radiographs, collecting data by two independent researchers with high interexaminer reliability, and analysing data with multivariable statistics. Notably, multivariable analysis highlighted the outstanding point because it helped reduce the confounding effects of the predictive factors. However, there are a few limitations that should be considered in future studies. First, the prevalence of distal caries would have been more accurate if it had been assessed clinically or with a three-dimensional imaging technique to avoid superimposition [33]. Second, this study did not assess the bacterial component of dental plaque, which is the most convincing answer for some of the authors’ assumptions. Third, because M3M impaction, especially vertical position, can change with increasing age, a longitudinal study design would be more appropriate to predict distal caries [34]. Therefore, other researchers can consider eliminating these limitations when conducting studies to provide a better understanding.

5. Conclusions
This study revealed that distal caries in M2Ms could be predicted by anatomical positions of the adjacent M3Ms. Specifically, M2Ms were assessed as high-risk for distal caries if the anatomical position of the adjacent M3Ms had the following features: mesial angulation ranged from 30° to 70°, vertical impacted level A/B, and horizontal impacted level I/II. Additionally, the long presence of mesially/horizontally impacted M3M increases the likelihood of distal caries. These predictors were dependent on each other and summed up for predicting distal caries in M2Ms.

Data Availability
All the data used to support the findings of this study were supplied by Dr. Son Hoang Le under license and so cannot be made freely available. Requests for access to these data should be made to Dr. Son Hoang Le.

Ethical Approval
This study was approved by the Ethical Committee of the University of Medicine and Pharmacy at Ho Chi Minh City (no. 2142).

Conflicts of Interest
The authors declare no conflicts of interest.

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References
[1] K. Carter and S. Worthington, “Predictors of third molar impaction,” Journal of Dental Research, vol. 95, no. 3, pp. 267–276, 2016.
[2] S. Patil, A. Alkahtani, S. Bhandi et al., “Ultrasound imaging versus radiographs in differentiating periapical lesions: a systematic review,” Diagnostics, vol. 11, no. 7, p. 1208, 2021.
[3] L. W. McArldle, M. Andiappan, I. Khan, J. Jones, and F. McDonald, “Diseases associated with mandibular third molar teeth,” British Dental Journal, vol. 224, no. 6, pp. 434–440, 2018.
[4] K. B. Syed, F. S Alshahrani, W. S Alabsi et al., “Prevalence of distal caries in mandibular second molar due to impacted third molar,” Journal of Clinical and Diagnostic Research: Journal of Clinical and Diagnostic Research, vol. 11, no. 3, pp. ZC28–ZC30, 2017.
[5] Z. Haddad, M Khorasani, M Bakhshi, M Tofangchiha, and Z Shalli, “Radiographic position of impacted mandibular third molars and their association with pathological conditions,”
International Journal of Dentistry, vol. 2021, Article ID 8841297, 11 pages, 2021.

[6] V. Toedtling, P. Couthlard, and G. Thackray, "Distal caries of the second molar in the presence of a mandibular third molar - a prevention protocol," British Dental Journal, vol. 221, no. 6, pp. 297–302, 2016.

[7] J. C. R. Glória, C. C. Martins, A. C. V Armond, E. I. Galvão, C. R Dos Santos, and S. G. M Falcí, "Third molar and their relationship with caries on the distal surface of second molar: a meta-analysis," Journal of maxillofacial and oral surgery, vol. 17, no. 2, pp. 129–141, 2018.

[8] R. H. Schweitz, A. I. Ismaiel, and N. B. Pitts, "Dental caries," The Lancet, vol. 369, no. 9555, pp. 51–59, 2007.

[9] S. G. M. Falcí, C. R. de Castro, R. C. Santos et al., "Association between the presence of a partially erupted mandibular third molar and the existence of caries in the distal of the second molars," International Journal of Oral and Maxillofacial Surgery, vol. 41, no. 10, pp. 1270–1274, 2012.

[10] G. J. Pell and G. T. Gregory, "Impacted mandibular third molars: classification and modified technique for removal," Dental Digest, vol. 39, no. 9, pp. 330–338, 1933.

[11] S. W. Chang, S. Y. Shin, K. Y. Kum, and J. Hong, "Correlation study between distal caries in the mandibular second molar and the eruption status of the mandibular third molar in the Korean population," Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology & Endodontics, vol. 108, no. 6, pp. 838–843, 2009.

[12] V. K. Prajapati, R. Mitra, and K. M. Vinayak, "Pattern of mandibular third molar impaction and its association to caries in mandibular second molar: a clinical variant," Dental Research Journal, vol. 14, no. 2, pp. 137–142, 2017.

[13] R. T. Allen, H. Withrow, J. Collyer, R. Roper-Hall, M. A. Nazir, and G. Mathew, "The mesioanagular third molar - to extract or not to extract? Analysis of 776 consecutive third molars," British Dental Journal, vol. 206, no. 11, p. E23, 2009.

[14] I. Ozeç, S. Hergüner Siso, U. Taşdemir, S. Ezirganli, and G. Gökotlga, "Prevalence and factors affecting the formation of second molar distal caries in a Turkish population," International Journal of Oral and Maxillofacial Surgery, vol. 38, no. 12, pp. 1279–1282, 2009.

[15] L. W. Mc Ardle, F. McDonald, and J. Jones, "Distal cervical caries in the mandibular second molar: an indication for the prophylactic removal of third molar teeth? Update," British Journal of Oral and Maxillofacial Surgery, vol. 52, no. 2, pp. 185–189, 2014.

[16] G. L. Terry, M. Noujeim, R. P. Langlais, W. S. Moore, and T. J. Prihoda, "A clinical comparison of extraoral panoramic and intraoral radiographic modalities for detecting proximal caries and visualizing open posterior interproximal contacts," Dentomaxillofacial Radiology, vol. 45, no. 4, p. 20150159, 2016.

[17] S. Gupta, "Evaluation of impacted mandibular third molars by panoramic radiography," ISRN Dentistry, p. 406714, 2011.

[18] Z. Z. Akarslan, M. Akdevelioğlu, K. Güngör, and H. Erten, "A comparison of the diagnostic accuracy of bitewing, periapical, unfiltered and filtered digital panoramic images for proximal caries detection in posterior teeth," Dentomaxillofacial Radiology, vol. 37, no. 8, pp. 458–463, 2008.

[19] M. J. Fan, S. Upadhye, and A. Worster, "Understanding receiver operating characteristic (ROC) curves," Gyn, vol. 8, no. 1, pp. 19–20, 2006.

[20] P. D. Marsh, "Microbiology of dental plaque biofilms and their role in oral health and caries," Dental Clinics of North America, vol. 54, no. 3, pp. 441–454, 2010.

[21] N. Takahashi and B. Nyvad, "Ecological hypothesis of dentin and root caries," Caries Research, vol. 50, no. 4, pp. 422–431, 2016.

[22] S. S. Socransky, A. D. Haffajee, M. A. Cugini, C. Smith, and R. L. Keni, "Microbial complexes in subgingival plaque," Journal of Clinical Periodontology, vol. 25, no. 2, pp. 134–144, 1998.

[23] A. D. Haffajee, S. S. Socransky, M. R. Patel, and X. Song, "Microbial complexes in supragingival plaque," Oral Microbiology and Immunology, vol. 23, no. 3, pp. 196–205, 2008.

[24] F. Kang, C. Huang, M. K. Sah, and B. Jiang, "Effect of eruption status of the mandibular third molar on distal caries in the adjacent second molar," Journal of Oral and Maxillofacial Surgery, vol. 74, no. 4, pp. 684–692, 2016.

[25] N. Srivastava, "Incidence of distal caries in mandibular second molars due to impacted third molars: nonintervention strategy of asymptomatic third molars causes harm? A retrospective study," International journal of applied & basic medical research, vol. 7, no. 1, pp. 15–19, 2017.

[26] J. Marques, "Impacted lower third molars and distal caries in the mandibular second molar. Is prophylactic removal of lower third molars justified?" J Clin Exp Dent, vol. 9, no. 6, pp. e794–e798, 2017.

[27] A. Claudia, H. M. Barbu, L. Adi et al., "Relationship between third mandibular molar angulation and distal cervical caries in the second molar," Journal of Craniofacial Surgery, vol. 29, no. 8, pp. 2267–2271, 2018.

[28] E. A. Martinez-Mier and A. F. Zandona, "The impact of gender on caries prevalence and risk assessment," Dental Clinics of North America, vol. 57, no. 2, pp. 301–315, 2013.

[29] K. Fukai, Y. Takaesu, and Y. Maki, "Gender differences in oral health behavior and general health habits in an adult population," The Bulletin of Tokyo Dental College, vol. 40, no. 4, pp. 187–193, 1999.

[30] M. S. Lipsky, "Men and oral health: a review of sex and gender differences," American Journal of Men’s Health, vol. 15, no. 3, p. 15579883211016361, 2021.

[31] T. Pepper, P. Grimshaw, T. Konarzewski, and J. Combes, "Retrospective analysis of the prevalence and incidence of caries in the distal surface of mandibular second molars in British military personnel," British Journal of Oral and Maxillofacial Surgery, vol. 55, no. 2, pp. 160–163, 2017.

[32] A. Altan and N. Akbulut, "Doestheangulationofanimpactedmandibularthirdmolaraffecttheprevalenceofpreoperativepathoses?" Journal of Dentistry (Shiraz, Iran), vol. 20, no. 1, pp. 48–52, 2019.

[33] G. Perrotti, G. Baccaglione, T. Clauser et al., "Total face pathology," Radiology, vol. 37, no. 8, pp. 458–463, 2008.

[34] S. Ryalat, S. A. AlRyalat, Z. Kassob, Y. Hassona, M. H. Al-Shayyab, and F. Sawair, "Impaction of lower third molars and their association with age: radiological perspectives," BMC Oral Health, vol. 18, no. 1, p. 58, 2018.