

Perceptions and utilization of the Index of Orthodontic Treatment Need (IOTN) among final year dental students: a qualitative study

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Abstract

The Index of Orthodontic Treatment Need (IOTN) is widely used to assess malocclusion severity and prioritize orthodontic treatment. However, its perception and utilization among undergraduate dental students remain unclear. This qualitative study aimed to explore the perceptions and utilization of the IOTN among 13 final-year dental students at AIMST University, Malaysia. Participants were recruited using convenience sampling, and data were collected through semi-structured interviews conducted via Zoom. The interviews were transcribed verbatim and analysed using thematic analysis until data saturation was achieved. Five main themes emerged: subjectivity in perception of criteria, neglect of patients' psychological well-being, time-consuming application, lack of training and exposure, and potential facilitators for improvement. Although the participants acknowledged the IOTN as a valuable standardized tool, its consistent application in clinical practice was perceived to be limited by variability in interpretation and practical constraints. These findings highlight the need for improved undergraduate training, greater standardization, and the incorporation of digital technologies to enhance the reliability and clinical applicability of the IOTN. Strengthening these aspects may better prepare future dental practitioners for effective orthodontic assessment and treatment prioritization. Future research should consider multi-centre studies involving both public and private universities to improve generalisability and to better understand variations in training exposure, curriculum structure, and clinical experience across institutions.

Received:

3 October 2025

Revised:

13 April 2026

Accepted:

27 April 2026

Published Online:

31 July 2026

How to cite this article:

Ng, C. H., Tan, W. W., Law, A. C. H., Ang, S. R., Beh, H. Y., & Chan, W. S. (2026). Perceptions and utilization of the Index of Orthodontic Treatment Need (IOTN) among final year dental students: a qualitative study. *IIUM Journal of Orofacial and Health Sciences*, 7(2), 131–143.

<https://doi.org/10.31436/ijoh.v7i2.448>

Article DOI:

<https://doi.org/10.31436/ijoh.v7i2.448>

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Keywords: dental students, index, perception, utilization

Introduction

Efficient administration of the public healthcare system necessitates evaluating both demand and the requirement for orthodontic treatment. It is crucial to prioritize patients, ensuring that treatment is allocated to those with the most pressing needs, particularly in nations facing constraints in manpower and financial resources (Salzmann, 1968).

Therefore, Index of Orthodontic Treatment Need (IOTN) by (Brook & Shaw, 1989) in the 1989 marks an important milestone in orthodontic index development. The IOTN aimed to provide a standardized method for assessing malocclusions and determining the need for orthodontic treatment based on both dental health and aesthetic considerations. It consisted of two components: the Dental Health Component (DHC) and the Aesthetic Component (AC), which together provided a comprehensive evaluation of orthodontic treatment need (Järvinen, 2001).

The IOTN stands out for its holistic approach, encompassing clinical and patient-centered factors. This system has been embraced and recommended for integration into orthodontic education programs for undergraduate dental students in various countries as a standard for epidemiological and clinical research. Clinical decision-making may be significantly influenced by IOTN due to its substantial correlation with orthodontic treatment necessity.

Despite being recommended for inclusion in dental education programs, there is insufficient data to confirm its reliability in routine clinical settings (Ferguson, 2006). As a result, there is uncertainty about its utility and impact on treatment decisions among dentists. Over the past several decades, orthodontic research has shown that dentists often hold inconsistent views when assessing the need for orthodontic treatment. Concerns have been raised that dental school training may not adequately equip graduates to diagnose malocclusion or to appropriately refer patients who may require orthodontic care (Bentele *et al.*, 2002).

Therefore, assessing the perception of final-year dental students regarding the IOTN becomes necessary to understand their views, concerns, and experiences with its use in practice. This assessment can help identify any challenges or limitations associated with the implementation of the IOTN and inform future efforts to improve its application in dental practice.

Previously published data on IOTN has mostly centred on establishing the index's reliability, reproducibility, validity, and accuracy. In a study on the perspectives and experiences of dental practitioners in Scotland (Puri *et al.*, 2015), the IOTN was not used or applied in their dental practice for several reasons, including that it is only considered to be suitable for secondary dental care, was not included in their undergraduates training program, while some claimed that IOTN is only suitable for use after referral.

Another research conducted on UK dental students' ability in applying IOTN index (Bouskandar *et al.*, 2023), suggested that dental students demonstrated insufficient proficiency and confidence in accurately utilizing the IOTN Dental Health Component and determining the suitable referral pathway.

However, research examining the obstacles clinicians and researchers encounter in utilizing the IOTN remains limited in the literature. In private dental practices, patients frequently receive treatment from multiple dentists. The implementation of a standardized orthodontic assessment tool like IOTN facilitates the monitoring of patients' progress by various dentists and enables them to address any subsequent complications more efficiently.

Hence, it's crucial to evaluate the challenges, perspectives, and opinions of current fifth-year dental undergraduates regarding the IOTN, given its widespread use as a prioritization tool in government dental services. With limited resources available, it becomes paramount to allocate treatment priority to those with greater needs. The assessment and management of malocclusions play a significant role across various domains, including epidemiology, diagnosis, communication among clinicians, patient interactions, and the assessment of treatment efficacy. This ensures that they are equipped to effectively navigate and contribute to the orthodontic treatment landscape upon entering their professional careers.

The objective of this research is to investigate the perceptions of year 5 dental undergraduates regarding the use of the IOTN. To the best of our knowledge, no comparable study has been conducted in Malaysia. Hence, a qualitative study was conducted to explore the students' attitudes, views, and experiences in utilizing the IOTN index for orthodontic treatment need assessment within their dental practice.

By gaining insights into the students' perceptions, this research seeks to identify any barriers, challenges, or enablers that

may influence their understanding and utilization of the IOTN index. Ultimately, the findings of this study aim to contribute to the enhancement of dental education and training programs by addressing any educational gaps and improving the integration of orthodontic assessment tools like the IOTN index into the curriculum.

Materials and Methods

Study design

This qualitative study explored the perceptions of final-year dental students in Malaysia regarding the use of the IOTN. Ethical approval was obtained from the AIMST University Research Ethics Committee (Reference: AUHEC/FOD/05/08/2024/G1). In this study, final-year dental students referred to undergraduate dental students in their fifth year of training who had been exposed to the IOTN during their curriculum.

Participants' recruitment and interview process

A semi-structured interview guide was developed based on a review of existing literature (Bouskandar *et al.*, 2023, Hsu *et al.*, 2014, Shahrul AI *et al.*, 2024) and was content-validated by an experienced qualitative researcher in the faculty. Eligible participants were final-year dental students from AIMST University who had prior exposure to the IOTN. Convenience sampling was used, and potential participants were invited via email.

Participant information sheets were provided, outlining the study objectives, voluntary nature of participation, confidentiality measures, and the right to withdraw at any time prior to data publication. Students who expressed interest were enrolled in the study.

One-on-one semi-structured interviews were conducted to explore participants' experiences and perceptions of the IOTN in depth. Verbal and written consent were

obtained prior to participation. Participants were given the opportunity to clarify any questions before the interviews commenced. The interviews were conducted via Zoom Video Communications Software and lasted approximately 20–30 minutes. Each session was facilitated by two researchers, with one leading the discussion and the other providing support. The facilitators had no prior relationship with the participants. All interviews were audio-recorded with consent and later transcribed verbatim for analysis.

Data analysis

All audio recordings were anonymized and transcribed verbatim. Data collection and analysis were conducted concurrently. Regular meetings were held among the research team to discuss emerging patterns and themes. Data collection was discontinued when all researchers agreed that no new themes were identified, indicating that data saturation had been achieved.

Data were gathered from interviews and meticulously transcribed into a password-secured Google Docs™ (Google LLC, Mountain View, CA, USA), solely accessible to the designated research team.

A phenomenological approach was adopted to explore participants' lived experiences with the IOTN. The data were analysed using thematic analysis as described by Braun and Clarke (2006), which is commonly applied in phenomenological research.

Initial coding was performed independently by two researchers using NVivo 12 software. The researchers identified meaningful segments of text and generated preliminary codes. Any discrepancies in coding were resolved through discussion with a third researcher.

The codes were subsequently grouped into categories, and themes were developed iteratively to reflect patterns within the data. All themes were reviewed, refined, and agreed upon by the entire research team to

ensure consistency, credibility, and trustworthiness of the findings.

Results

A total of 13 students participated in the study. Most participants were female, constituting 69.2%, while male participants accounted for 30.8% (Figure 1). Five main themes were developed inductively through the coding process namely, subjectivity in

perception of criteria, neglect of patients' psychological well-being, time-consuming application, lack of training and exposure, and potential facilitators for improvement.

Table 1 presents a comprehensive summary of the themes and subthemes derived from the qualitative analysis of participants' perceptions of the IOTN system. Each theme is accompanied by a description and illustrative quotes to provide contextual depth and support the findings.

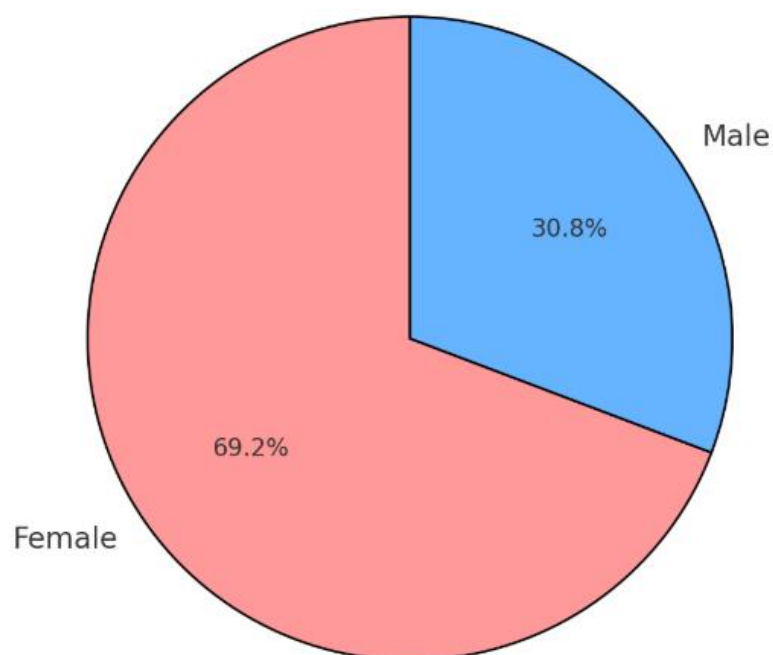


Figure 1. Gender composition of the study sample: distribution of male and female participants.

Table 1. Thematic analysis of participants' perceptions of the IOTN: themes, subthemes, and supporting quotes.

Theme	Subtheme	Description	Supporting Quotes
Theme 1: Subjectivity in perception of criteria	• Variability in clinician judgement	• Despite standardized criteria, clinicians interpret malocclusion differently, leading to inconsistent scoring.	• <i>"IOTN itself is quite a subjective assessment... different people have different perspectives on it."</i> (Participant 2)
	• Subjectivity in aesthetic component	• Aesthetic evaluation varies between clinician and patient, contributing to inconsistency.	• <i>"It's the subjectivity in the aesthetic component because the patient's and clinician's perceptions may be varied."</i> (Participant 1)
	• Patient's limited self-awareness	• Patients may not fully understand their dental condition, affecting aesthetic scoring.	• <i>"The esthetic component is very subjective... some patients do not know about their dental condition very well."</i> (Participant 3)
	• Differences in severity perception	• Clinicians differ in judging severity levels of malocclusion.	• <i>"Some may feel that it's more severe. Some may feel that it's less severe."</i> (Participant 4)
Theme 2: Neglect of patient's psychological well-being	• Lack of psychosocial consideration	• IOTN does not incorporate psychosocial or emotional factors.	• <i>"...the system does not incorporate patient psycho-social content..."</i> (Participant 1)
	• Focus on clinical over patient concerns	• Emphasis on clinical need overlooks patient-reported concerns.	• <i>"It doesn't fully capture functional issues or patient-reported concerns."</i> (Participant 6)
	• Limited reflection of patient priorities	• Patients prioritize aesthetics, but this may not align with clinician-based scoring.	• <i>"It does not fully consider the patient's emotional and psychological concerns..."</i> (Participant 7)
Theme 3: Time-consuming application	• Complexity of assessment criteria	• Multiple components and severity levels require detailed measurements.	• <i>"There are many things to measure."</i> (Participant 3)

	Workflow constraints in practice	Busy clinical settings limit feasibility of using IOTN.	<i>"...for private practice, they don't really have the time to do all this."</i> (Participant 4) <i>"...you have to ask the patient to open very wide for a long time. It is quite time consuming."</i> (Participant 13)
Theme 4: Lack of training and exposure	- Insufficient undergraduate training - Limited clinical exposure - Difficulty mastering the index	- Limited formal training reduces confidence in using IOTN. - Students encounter few and less complex cases. - Limited patient numbers hinder skill development.	<i>"The training of IOTN system is really insufficient..."</i> (Participant 2) <i>"...we still see quite limited cases for us back in university time."</i> (Participant 2) <i>"...you can't expect yourself to master... just from seeing 10 to 11 patients."</i> (Participant 9)
Theme 5: Potential facilitators for improvement	- Standardization of aesthetic assessment - Enhanced scoring system - Use of photographic comparison - Improving reliability of assessment	- Use of visual aids or reference tools can reduce subjectivity. - Refinement of aesthetic component scoring may improve reliability. - Visual comparison methods may support patient involvement. - Greater standardization can enhance consistency across clinicians.	<i>"...we can use some improved visual tools to reduce the subjectivity..."</i> (Participant 1) <i>"...maybe we can integrate a more scoring part in aesthetic component..."</i> (Participant 2) <i>"...take a photo of the patient and let the patient compare side by side."</i> (Participant 3) <i>"...the aesthetic component should be more standardized and less subjective..."</i> (Participant 6)

Theme 1: subjectivity in perception of criteria.

The IOTN index provides a standardized set of criteria for the clinician to score the patient's presented malocclusion. Hence,

this system that makes the criteria advocates for objectivity from the practitioner. However, every practitioner may have different perception and view every patient's malocclusion in a different way. As

a result, this breeds inconsistency in scoring despite viewing the same criteria.

Variability in clinician judgement

Participants reported that individual clinicians interpret malocclusion traits differently despite standardized guidelines. The variability introduces inconsistency in scoring and may compromise inter-examiner reliability.

Participant 1: But for the limitation of IOTN, I will say that IOTN itself is quite a subjective assessment to be honest. So different people have different perspectives on it.

Subjectivity in the aesthetic component

The aesthetic component (AC) of the IOTN was particularly identified as a course of inconsistency. Participants emphasized that aesthetic judgement are inherently subjective and influenced by both clinician bias and patient perception.

Participant 2: For the limitation, I think it's the subjectivity in the aesthetic component because the patient's and clinician's perceptions may be varied.

Patient's limited self-awareness

Another contributing factor to subjectivity is patients' limited understanding of their own dental conditions. Participants noted that patients often lack the knowledge to accurately assess their malocclusion, which can lead to underestimation or overestimation of aesthetic concerns.

Participant 3: However, the esthetic component is very subjective because it is based on how the patients see themselves and some patients do not know about their dental condition very well.

Differences in severity perception

Variations were also observed in how clinicians perceive the severity of malocclusion. Participants acknowledged that identical clinical presentations could be

graded differently depending on the assessor.

Participant 4: it's actually quite subjective. Some might think that it falls in it falls indifferent stages. Some may feel that it's more severe. Some may feel that it's less severe.

Theme 2: neglect of patient's psychological well-being

The IOTN index only focuses on the dental and aesthetic components. If clinician only focuses on treating the malocclusion, they end up neglecting the patient's mental health and psychological well-being.

Lack of psychosocial consideration

A recurring observation was that the IOTN does not incorporate psychological or social factors, such as self-esteem, social confidence, or emotional distress related to dental appearance.

Participant 1: ... the system does not incorporate patient psycho-social content...

Focus on clinical over patient concerns

The findings suggest that the IOTN prioritizes objective clinical indicators over subjective patient experiences. Participants noted that functional and patient-reported concerns may be overlooked if they do not align with the index's scoring criteria.

Participant 6: However, a limitation is that it doesn't fully capture functional issues or patient-reported concerns.

Limited reflection of patient priorities

Participants highlighted a disconnect between clinician-driven assessments and patient priorities. While patients often place high importance on aesthetics and psychosocial outcomes, these factors are not fully captured within the IOTN scoring system.

Participant 7: Additionally, it does not fully consider the patient's emotional and

psychological concerns, which can be important in determining treatment necessity.

Theme 3: time-consuming application

The IOTN index comprised of various sets of criteria to be scored when evaluating the patient's malocclusion. The practitioner has to measure each component to discover its severity for the final score to be determined. For a clinician to utilise this index in a government setting or private practice can be time consuming as they are operating on a heavy workflow.

Complexity of assessment criteria

Participants described the IOTN as requiring multiple measurements and detailed evaluations, which can be cumbersome, particularly for inexperienced users. The need to assess both dental health and aesthetic components adds to the complexity and duration of the assessment.

Participant 3: The main concern is the difficulty in interpretation because there are many things to measure.

Workflow constraints in practice

In busy clinical environments, especially private practice settings, time efficiency is critical. Participants indicated that the comprehensive nature of the IOTN makes it less feasible for routine use. Unlike government funded settings where resources are limited, the IOTN serves little purpose in private practice, as the practitioner are paid and will treat cases regardless of IOTN.

Participant 4: It's just maybe time consuming, because you need to count all the displacement count overjet or maybe for private practice, they don't really have the time to do all this.

Participant 13: when you want to score something right inside the patients, you have to ask the patient to open very wide for a long time. It is quite time consuming.

Theme 4: lack of training and exposure

Many practitioners encountered difficulties when aiming to fully utilise the index in a consistent and efficient manner due to lack of exposure and training during their undergraduate programme.

Insufficient undergraduate training

Participants consistently reported that formal training in the use of IOTN was limited during their undergraduate education. This lack of structured teaching contributes to uncertainty and reduced confidence in applying the index accurately.

Participant 2: To be honest, as a year, as a graduated year 5 student and still waiting for posting, I feel that the training of IOTN system is really insufficient Then, cases that we have received in uni and those cases that they will be given to us to assess will be more likely more simple cases to be honest, instead of more severe cases. So, to be honest, I just feel that we still see quite limited cases for us back in university time.

Limited clinical exposure

Students noted that their clinical exposure to orthodontic cases was relatively limited, both in quantity and complexity. As a result, opportunities to practice and refine IOTN scoring were insufficient.

Participant 5: we only have limited ortho clinic sessions due to the need of prioritising other clinic sessions as well.

Difficulty mastering the index

Due to limited case exposure and practice opportunities, participants found it challenging to achieve proficiency in using the IOTN. Mastery of the index requires repeated application across a diverse range of cases, which many students felt was lacking in their training.

Participant 9: we started at the end of year four till year five. So within this period, we probably have seen a maximum 10 to 11 patient. So there's very limited clinical exposure, and then you can't expect yourself

to master and truly understand and truly be able to apply IOTN just from saying 10 to 11 patient.

Theme 5: potential facilitators for improvement

Despite the challenges identified, participants proposed several strategies to enhance the usability and reliability of the IOTN.

Standardization of aesthetic assessment

Participants suggested that incorporating standardized visual aids or reference tools could help reduce subjectivity in the aesthetic component. Improved calibration methods may enhance inter-examiner agreement and scoring consistency.

Participant 1: I think the aesthetic component can be refined where we can combine the patient and clinician's ratings and also maybe we can use some improved visual tools to reduce the subjectivity in aesthetic component.

Enhanced scoring system

Refinement of the scoring system, particularly within the aesthetic component, was proposed as a means to improve clarity and reliability. Participants indicated that a more detailed or structured scoring framework could reduce ambiguity.

Participant 2: ...maybe we can integrate a more scoring part in aesthetic component itself. This is one of the parts that I think can improve IOTN.

Use of photographic comparison

The use of photographic records and side-by-side comparisons was identified as a practical tool to support both clinician assessment and patient understanding. This approach may also facilitate shared decision-making by involving patients more actively in the evaluation process.

Participant 3: The esthetic component should be made less subjective, maybe we can take a photo of the patient and let the patient compare and choose side by side

Improving reliability of assessment

Overall, participants emphasized the need for greater standardization and calibration in applying the IOTN. This includes improved training, clearer guidelines, and possibly digital or technological aids to enhance consistency across users.

Participant 6: I believe the aesthetic component should be more standardized and less subjective to improve its reliability.

Discussion

The aim of the present study was to explore the perceptions of the use of the IOTN among final-year dental students in Malaysia. The IOTN is widely used as an objective measure to determine the requirement for orthodontic treatment, taking into account both dental health and aesthetic factors, and serves as a guide for treatment prioritization and resource allocation within Ministry of Health facilities in Malaysia (Loke & Tan 2017) reported that the diagnostic accuracy of dental officers in the Malaysian Ministry of Health in applying the IOTN was low. They recommended training and calibration to enhance proficiency. This study highlights the underlying reasons why even graduate dentists may not have fully mastered the use of the IOTN and offers strategies to improve this competency.

To the best of the authors' knowledge, the current study is the first of its kind to investigate the perceptions of Malaysian final-year dental students regarding the use of the IOTN. The present study has established five theme barrier categories: subjectivity in perception of criteria, neglect of patients' psychological well-being, time-consuming application, lack of training and exposure, and potential facilitators for improvement. This could help improve undergraduate dental education by identifying gaps in students' understanding and application of the index. It can guide

curriculum enhancements by integrating more case-based learning, hands-on workshops, and calibration exercises to improve clinical decision-making and standardization. Additionally, it can reinforce the role of IOTN in public health policy and evidence-based practice, ensuring students are better prepared for both private and government-funded orthodontic care. Insights from the study can help refine teaching methods, making orthodontic training more practical and relevant.

The IOTN is designed to provide a standardized method for assessing malocclusion severity and treatment necessity. However, findings from this study reveal a prevailing concern among participants regarding the subjectivity of the index, particularly in its Aesthetic Component (AC). While the IOTN aims to enhance objectivity in orthodontic treatment prioritization, differences in perception and interpretation among clinicians and patients introduce variability in scoring, leading to inconsistencies in assessment. This aligns with the findings of Loke and Tan, who reported that dental officers demonstrated greater accuracy in diagnosing the Dental Health Component compared to the Aesthetic Component (Loke & Tan 2017).

Participants highlighted variability in assessing malocclusion severity using the IOTN, as different practitioners may interpret cases differently despite following the same criteria. This inconsistency stems from differences in clinical experience, personal judgment, and case interpretation, making uniform scoring particularly challenging for borderline cases. This concern is supported by (Siddiqui *et al.*, 2014), who found significant variability between orthodontists' and patients' perceptions of malocclusion severity when using the IOTN-AC, indicating inconsistencies in assessments.

The subjectivity of the IOTN is most evident in its Aesthetic Component (AC), which relies on individual perceptions of dental attractiveness. Participants noted that both patients and clinicians may have differing

views on aesthetics, influenced by personal preferences and cultural factors. Previous study (Grzywacz, 2003) supports this view, stating that the AC of the IOTN moderately reflects subjective perceptions of dental aesthetics and the demand for orthodontic treatment, further highlighting its inherent subjectivity. These variations in perception can impact treatment decisions, as what is considered an aesthetic concern varies across individuals and communities.

The IOTN is a comprehensive tool used to assess malocclusion severity, encompassing various components such as missing teeth, overjet, crossbite, displacement of contact points, and overbite. Each of these elements requires precise measurement across multiple levels of severity, necessitating meticulous evaluation by practitioners. This detailed process can be particularly time-consuming in clinical settings, especially for practitioners managing heavy workloads.

In private practices, where efficiency is paramount, the extensive time required to assess each component of the IOTN may be impractical. Similarly, in government healthcare settings with limited resources, the thorough application of the IOTN can be challenging. However, despite these challenges, the IOTN remains valuable in prioritizing treatment for patients with significant orthodontic needs, thereby optimizing resource allocation.

To address the time-consuming nature of the IOTN, there is growing interest in integrating artificial intelligence (AI) into orthodontic assessments. AI has the potential to streamline the evaluation process by automating measurements and analyses, thereby reducing the time burden on practitioners. A review on the application of AI in orthodontics discusses current advancements and future perspectives, suggesting that AI could enhance efficiency in clinical assessments (Stetzel *et al.*, 2024, Liu *et al.*, 2023).

This study's findings underscore the final theme of discussion, which revolves around the key challenges faced by final-year dental students in Malaysia regarding the use of the

IOTN, namely lack of training (Loke, 2006). One of the primary concerns expressed by participants is the lack of adequate exposure and training during their undergraduate programme. The ability to consistently and efficiently utilise the IOTN relies heavily on repeated practice and familiarity with a diverse range of malocclusion cases. However, as noted by multiple participants, the clinical exposure provided during their studies was insufficient in terms of both quantity and variety.

A significant challenge is the limited number of patients seen during the orthodontic clinical sessions. Participant 9 mentioned that within the allocated training period, students were exposed to only 10 to 11 patients, which is a very small sample size to develop mastery of the IOTN. The complexity of the index, which requires an understanding of multiple severity levels and criteria, makes it difficult to memorise and apply correctly without extensive hands-on experience. This lack of exposure likely hinders students' confidence and ability to accurately use the IOTN in future clinical practice.

Furthermore, the prioritisation of other clinical sessions over orthodontic training has exacerbated the issue. As Participant 5 pointed out, the limited number of orthodontic sessions means that students do not have enough opportunities to practice applying the IOTN in real clinical settings. This reinforces the notion that while students may be introduced to the index in theory, their practical application remains inadequate due to time constraints and curriculum structure.

Another critical issue is the simplicity of cases that students encounter during their university training. Participant 2 expressed concern that most of the cases presented during training were relatively straightforward, whereas more severe and complex cases were rarely encountered. This lack of diversity in case severity prevents students from fully appreciating the breadth of the IOTN's application and limits their ability to assess and classify more challenging cases effectively. Without

exposure to severe cases, students may struggle when they enter professional practice and are required to make independent orthodontic treatment decisions.

The combination of these factors suggests a need for curriculum reform and enhanced training strategies. To improve competency in IOTN application, universities could consider increasing the duration and frequency of orthodontic clinical sessions, incorporating case-based discussions with a wider range of malocclusion severity, and implementing simulation-based training or digital learning tools. Additionally, structured workshops and refresher courses could be introduced post-graduation to reinforce knowledge and practical skills before students begin clinical practice.

Possible solutions & future directions

To enhance the consistent and effective use of the IOTN, structured and comprehensive training should be formally incorporated into the final-year of undergraduate dental curricula to ensure a uniform understanding and application of the index. This training should be supported by case-based learning, hands-on workshops, and real-life patient assessments to improve students' confidence and clinical competence in using the IOTN, as previously recommended in the literature. In parallel, the establishment of clear national and institutional guidelines for IOTN utilization is essential to minimize discrepancies in assessment and interpretation, with professional bodies playing a key role in issuing standardized recommendations for treatment prioritization based on the index. Greater interdisciplinary collaboration should also be encouraged through strengthened communication between orthodontic, general dentistry, and pediatric dentistry postgraduate trainees, facilitating appropriate referrals and improved case selection; this may be supported by continuing professional development programs and structured discussion forums focusing on the clinical relevance and interpretation of the IOTN. Additionally, the

integration of digital technologies, including electronic scoring systems (Murray, 2023) and AI-assisted tools, has the potential to enhance objectivity and reduce inter-examiner variability, warranting further research into machine learning applications to improve scoring accuracy and predict treatment outcomes.

Limitations of the study

This study is subjected to several limitations that should be considered when interpreting the findings. The relatively small sample size, comprising only current Year 5 undergraduate students, may restrict the applicability and generalisability of the results to a broader population. In addition, the study was conducted within a single university, which further limits the representativeness of the findings. Institutional differences in curriculum design, clinical exposure, and teaching approaches across dental schools in Malaysia may influence students' perceptions and experiences, and these factors were not captured in the present study. Future research should incorporate multi-centre designs involving multiple universities, including both public and private universities to enable more comprehensive comparisons and contextualise these findings within the wider Malaysian dental education landscape. In addition, the study relies on self-reported data, and participants' responses may have been shaped by individual experiences, personal biases, and differing levels of exposure to orthodontic cases, introducing subjectivity and variability in interpretation. The absence of objective measures to assess knowledge gaps or competency in the use of the IOTN further constrains the strength of the conclusions.

Finally, as the study captures perceptions at a single point in time, it does not reflect how understanding and application of the IOTN may evolve with continued training and clinical experience; a longitudinal design would offer more comprehensive insights into the development of IOTN-related knowledge and its influence on clinical decision-making.

Conclusions

The study highlights significant variability in how undergraduate dental students perceive and utilize the IOTN, underscoring the necessity for improved education, standardization, and integration with modern diagnostic tools. Enhancing undergraduate training in orthodontic indices can refine clinicians' ability to prioritize treatment more effectively, while a standardized approach to IOTN usage ensures fairness in resource allocation and treatment decisions.

While the IOTN remains a valuable tool for assessing orthodontic treatment needs, its inherent subjectivity, particularly in the Aesthetic Component and borderline case classification, poses a notable limitation. Differences in perception among clinicians and patients can lead to inconsistencies in scoring, affecting treatment decisions and prioritization.

Acknowledgements

The authors would like to thank Dr Hasnah Binti Hashim for her invaluable advice in the preparation of this manuscript.

Conflict of Interest

The authors declare that they hold no competing interests.

Funding

Not applicable

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