



## **Competency of Primary Care Officers in Referring Patients for Orthodontic Treatment using IOTN (Index of Orthodontic Treatment Need)**

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### **ABSTRACT**

The Index of Orthodontic Treatment Need (IOTN) assesses need for orthodontic treatment based on dental health (DHC) and aesthetic (AC) concerns. Competency in appropriate referrals will reduce redundancy and improve equity in treatment. This study aims to evaluate IOTN competency of dental officers in referrals. Orthodontic referral forms from dental officers in primary care to Bandar Botanik orthodontic clinic (2011-2014) were analysed for compliance and accuracy in scoring DHC/AC. Scores from the orthodontist was the control. Kappa statistic was applied to test the strength of agreement of scores between officer and orthodontist. There were 166 referrals with DHC scored; but only 137 cases had a corresponding score by both officer and orthodontist. Thus 137 was our sample size for IOTN analysis. Compliance with scoring was low for DHC grade (82%) and DHC traits (67%) and very low for AC (20%) in contrast to good compliance with assessing malocclusion type (97%). The overall strength of agreement was only 'slight' for DHC ( $\kappa=0.17$ ),

although senior officers ( $\kappa=.34$ ) were better than junior officers ( $\kappa=.10$ ). DHC traits grading was varied and agreement was low with Cronbach's alpha of .55. Of the DHC traits, 'overjet' was the most consistently scored with 98.2% accuracy. Agreement was 'moderate' for malocclusion type ( $\kappa=.58$ ) with senior officers in 'substantial' agreement ( $\kappa=.67$ ) compared to 'moderate' agreement in junior officers ( $\kappa=.54$ ). There was no statistical significance in DHC agreement between referrals from Bandar Botanik, Banting and the other peripheral clinics. Diagnostic accuracy and compliance of dental officers using IOTN was low. Generally, officers were more compliant in scoring DHC than AC and senior officers were slightly more accurate in scoring DHC.

Keywords: IOTN, Referral, Competency, dental officers

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## INTRODUCTION

In Malaysia, the high demand for free or heavily subsidized orthodontic treatment in government orthodontic clinics has resulted in long waiting lists for orthodontic treatment<sup>1,2,3,4</sup>. Therefore, prioritization and selective eligibility for orthodontic treatment are needed for a more equitable delivery of orthodontic service to the public and to ensure the sustainability of specialist health service in the future<sup>2</sup>. Due to the limited financial and human resources for government orthodontic clinics, referral guidelines and protocols for dental officers were developed and implemented to address this issue<sup>1,2,3,4</sup>. Thus, dental officers in primary care dental clinics are the front-liners to screen and refer appropriate patients for orthodontic treatment. Inaccurate and inappropriate orthodontic referrals will result in some patients attending unnecessary orthodontic evaluation and others missing out on timely referral for treatment<sup>1,2,5</sup>.

The Index of Orthodontic Treatment Need (IOTN) has been validated and widely used as a screening tool for orthodontic treatment need in many countries including Malaysia<sup>1,2,5,6,10,11,12,13,14,15,16,17</sup>. Various studies showed that non-orthodontists like dental nurses, dental students and dental officers can be trained to use IOTN and it will significantly improve the agreement of their orthodontic evaluation with orthodontists after training and calibration<sup>1,2,5,8,11,18,19,20</sup>. Bentele<sup>5</sup> reported that IOTN is an effective educational resource to improve the orthodontic diagnostic abilities and Loke<sup>2</sup> reported that IOTN training for dental officers was beneficial and it was feasible to train them with a combination of lectures and 'hands-on' training in a limited time frame. Loke<sup>1</sup> also found that dental officers were better in identifying malocclusions with definite need than the 'little need' or 'borderline cases'.

The IOTN (Fig. 1, Table 1) has been used to plan the provision of orthodontic treatment in countries in which dental health services are subsidized by the government as part of the national health service or national health insurance system<sup>3,4,6,7</sup>. In Malaysia, those with moderate to definite need (DHC 4-5; AC 8-10) are eligible for orthodontic treatment in government orthodontic clinics. Dental officers are required to grade treatment need using the IOTN prior to referring to orthodontists.

Currently, dental officers working in government dental clinics are comprised of local and foreign graduates and most have limited levels of exposure to IOTN<sup>2</sup>. Although IOTN training courses are carried out sporadically in most states, many new graduates and junior officers did not have the opportunity to be trained. Random observation of orthodontic referrals to Bandar Botanik orthodontic clinic revealed that some referrals did not adhere to the local referral guidelines and IOTN scores were missing or inaccurate. Some patients with severe malocclusion were scored low and conversely referrals with very low IOTN score were referred for treatment.

There is a lack of local published literature on the accuracy of referrals using IOTN from primary care dentists to orthodontists. This study aims to evaluate the competency and compliance of dental officers in recording the IOTN in the referral forms.

**Figure 1. Aesthetic Component (AC) of the IOTN**

Photographs	Indication for treatment
1 - 4	No need
5 - 7	Borderline / moderate need
8 - 10	Definite need



**Table 1. Dental Health Component (DHC) of the IOTN**

<p><b>Grade 5 (Need treatment)</b></p> <p><b>5.i</b> Impeded eruption of teeth (except for third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any pathological cause.</p> <p><b>5.h</b> Extensive hypodontia with restorative implications (more than 1 tooth missing in any quadrant) requiring pre-restorative orthodontics.</p> <p><b>5.a</b> Increased overjet greater than 9 mm.</p> <p><b>5.m</b> Reverse overjet greater than 3.5 mm with reported masticatory and speech difficulties.</p> <p><b>5.p</b> Defects of cleft lip and palate and other craniofacial anomalies.</p> <p><b>5.s</b> Submerged deciduous teeth.</p> <p><b>Grade 4 (Need treatment)</b></p> <p><b>4.h</b> Less extensive hypodontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis.</p> <p><b>4.a</b> Increased overjet greater than 6 mm, but less than or equal to 9 mm.</p> <p><b>4.b</b> Reverse overjet greater than 3.5 mm with no masticatory or speech difficulties.</p> <p><b>4.m</b> Reverse overjet greater than 1 mm but less than 3.5 mm with recorded masticatory and speech difficulties.</p> <p><b>4.c</b> Anterior or posterior crossbites with greater than 2 mm discrepancy between retruded contact position and intercuspal position.</p> <p><b>4.l</b> Posterior lingual crossbite with no functional occlusal contact in one or both buccal segments.</p> <p><b>4.d</b> Severe contact point displacements greater than 4 mm.</p> <p><b>4.e</b> Extreme lateral or anterior open bites greater than 4 mm.</p> <p><b>4.f</b> Increased and complete overbite with gingival or palatal trauma.</p> <p><b>4.t</b> Partially erupted teeth, tipped and impacted against adjacent teeth.</p> <p><b>4.x</b> Presence of supernumerary teeth.</p> <p><b>Grade 3 (Borderline need)</b></p> <p><b>3.a</b> Increased overjet greater than 3.5 mm, but less than or equal to 6 mm with incompetent lips.</p> <p><b>3.b</b> Reverse overjet greater than 1 mm, but less than or equal to 3.5 mm.</p> <p><b>3.c</b> Anterior or posterior crossbites with greater than 1 mm, but less than or equal to 2 mm discrepancy between retruded contact position and intercuspal position.</p> <p><b>3.d</b> Contact point displacements greater than 2 mm, but less than or equal to 4 mm.</p> <p><b>3.e</b> Lateral or anterior open bite greater than 2 mm, but less than or equal to 4 mm.</p> <p><b>3.f</b> Deep overbite complete on gingival or palatal tissues, but no trauma.</p> <p><b>Grade 2 (Slight)</b></p> <p><b>2.a</b> Increased overjet greater than 3.5 mm, but less than or equal to 6 mm with competent lips.</p> <p><b>2.b</b> Reverse overjet greater than 0 mm but less than or equal to 1 mm.</p>
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- 2.c** Anterior or posterior crossbite with less than or equal to 1 mm discrepancy between retruded contact position and intercuspal position.
- 2.d** Contact point displacements greater than 1 mm but less than or equal to 2 mm.
- 2.e** Anterior or posterior open bite greater than 1 mm but less than or equal to 2 mm.
- 2.f** Increased overbite greater than or equal to 3.5 mm without gingival contact.
- 2.g** Pre- or post-normal occlusions with no other anomalies (includes up to half a unit discrepancy).

**Grade 1 (None)**

- 1** Extremely minor malocclusions including contact point displacements less than 1 mm

## **MATERIALS AND METHODS**

This is a retrospective cross-sectional study of all new referrals using the standard orthodontic referral form from dental officers in primary care to the orthodontic specialist clinic in Bandar Botanik, Klang. This is a convenience sampling (2011 to 2014) since this clinic was established only in mid-2011. Exclusion criteria included referral letters from medical officers, specialists, private dentists or referrals not in the standard referral form.

Patient demographics were obtained from clinical records. Data collected included patient's age, gender, race, date of referral, name of primary care dental clinic, seniority of referring dental officer, IOTN (DHC and AC) and malocclusion type scored by both dental officer and orthodontist. The orthodontist's score was used as control to determine the accuracy of the officer's score. At any one time, only one orthodontist served the specialist clinic and during this period the corresponding IOTN scores were collected from two orthodontists' charting. However, the scoring was not carried out consistently for every new referral, especially in AC. Calibration was not possible since no study casts or photographs of new referrals were taken routinely.

### **Aesthetic Component (AC) score**

The AC consists of a ten-point scale, illustrated by ten photographs of the labial aspect of different malocclusions (fig. 1). The AC scores are grouped into 3 categories where scores 1-4 indicate that there is 'no/slight need', 5-7 a 'borderline need', and 8-10 a 'definite need' for treatment.

**Dental Health Component (DHC) score**

The DHC quantifies malocclusion objectively by assessing the occlusal factors that may be detrimental to dental health (Table 1). The DHC consists of five grades of treatment need; grade 1 (“no need treatment”), grade 2 (“slight need for treatment”), grade 3 (“borderline need for treatment”), grade 4 (“need treatment”) and grade 5 (“need treatment”). Each Grade comprises detailed occlusal traits in a hierarchy of dental health severity and importance.

**Malocclusion Type**

Malocclusion is a misalignment or incorrect relation between the teeth of the two dental arches when they approach each other as the jaw close. Depending on the sagittal relations of teeth and jaws, malocclusion can be divided mainly into three types; that is Class I, Class II Division 1 or Division 2, Class III according to either Angle’s or Incisor Classification. The Incisor Classification is adopted in the Ministry of Health Malaysia.

**Seniority of dental officers**

Dental officers’ seniority was graded based on the years of service (Grade U41-54). Grade U41 officers are within 2 years of service and categorized as ‘junior officer’. Service of Grade U44 are within 5 years, U48 within 9 years, U52 within 12 years and U54 more than 12 years. Grades U44-54 are categorized as ‘senior officer’.

## DATA ANALYSIS

Reliability tests of DHC, AC scores and malocclusion type between officers and orthodontists were done using the Kappa coefficient or K statistic<sup>5,21,22</sup> (Table 2). K statistic is designed specifically to look at agreement beyond chance<sup>5,21,22</sup>. Before K analysis was carried out, the actual DHC grades was categorized into 3 groups (Group 1= Grade 1 and 2 with ‘no/little need’ treatment, Group 2= Grade 3 with ‘borderline need’ treatment, Group 3= Grade 4 and 5 with ‘definite need’ treatment). AC was also categorized into 3 groups (Group 1= AC score 1-4, Group 2= AC score 5-7, Group 3= AC score 8-10). This categorization of DHC and AC is in accordance with the definition and grading of IOTN. However, dental health occlusal traits were too varied to use Kappa for reliability analysis. They were assigned numerical scores and Internal Consistency Reliability (ICR) was carried out with the Cronbach’s alpha to test for strength of agreement.

Grade U41 are junior officers and categorized as group 1 and Grade 44-48 are senior officers regrouped into Group 2 before carrying out kappa statistic for accuracy in assessing DHC and malocclusion type. Referrals were broadly regrouped into 3 source clinics; namely Bandar Botanik, Banting and ‘other clinics’ based on the number of referrals before chi-square test or Fisher’s exact test was performed. Statistical analysis was carried out using Statistical Package for Social Science (SPSS) version 16.0.

**Table 2. Evaluation of kappa ( $\kappa$ ) statistic<sup>3</sup>**

<b><math>\kappa</math> values</b>	<b>Strength of agreement</b>
<0	By chance / poor
0-0.2	Slight
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Substantial
0.81-1.0	Almost perfect

## RESULTS

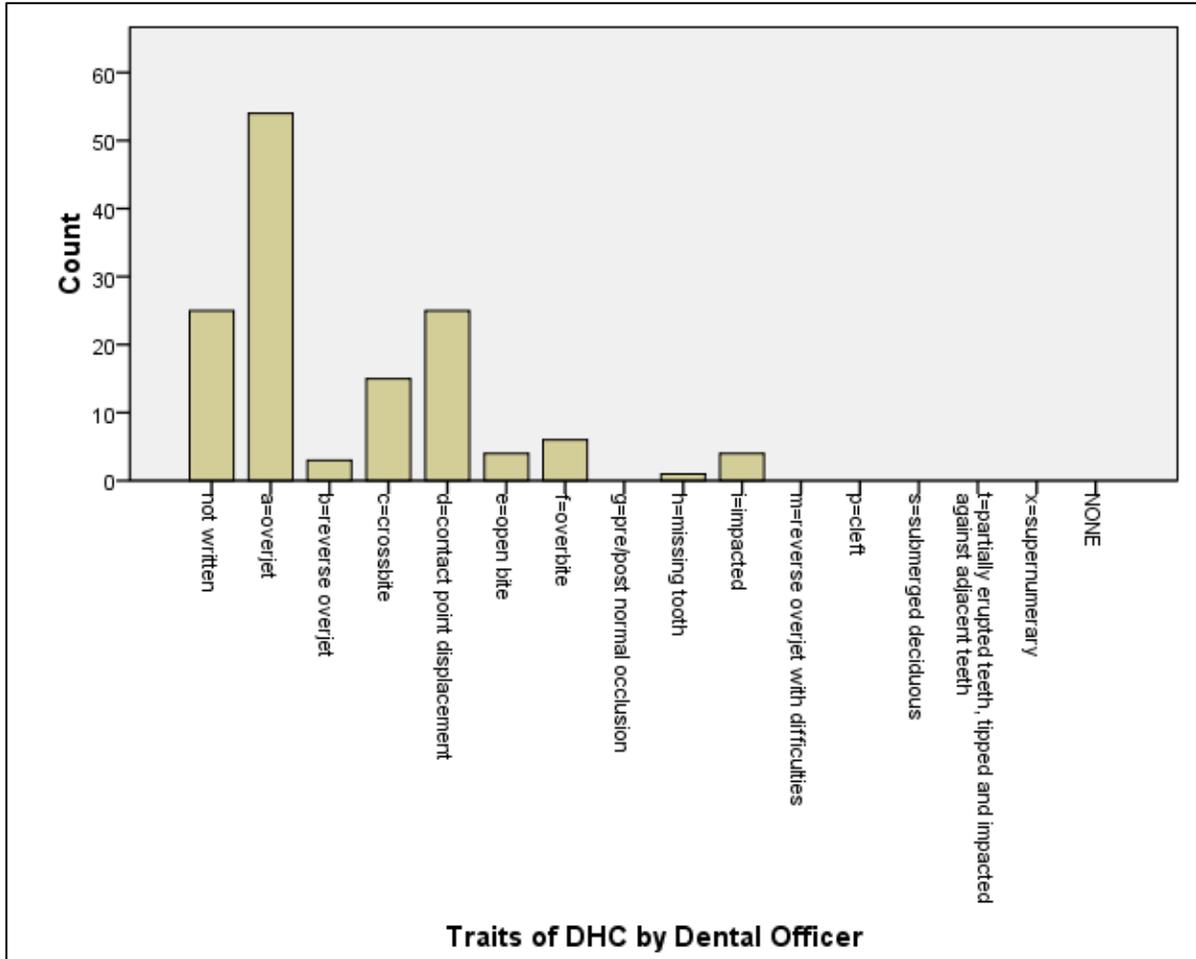
The sample comprised 166 referral forms from officers in primary care to the orthodontic clinic. Patient demographics showed 43 males and 123 females with 24.7% Class I, 54.3% Class II Division 1, 4.9% Class II Division 2 and 16% Class III malocclusions. Majority of the referrals were from the primary care unit in the same Botanik clinic (38.6%) and Banting (27.1%), with less from eight other clinics in the Klang district (23.4%). However, only 137 referrals had corresponding scores by both officer and orthodontist in the clinical records. Hence, the sample size of 137 was used to analyse IOTN agreement. Patient treatment need in terms of DHC assessed by orthodontists was 2.2% in Grades 1 and 2, 9.5% in Grade 3 and 88.3% in Grades 4 and 5 respectively.

Compliance with IOTN scoring was low in officers for the DHC grade/DHC traits and very low for AC in both officers and orthodontists in contrast to good compliance with assessment for malocclusion type (Table 3). With DHC scores categorized into 3 groups of 'no need', 'borderline need' and 'need' treatment, only 70.1% of Dental officers were accurate in assessment and a much lower 49.6% were agreed in assessing DHC Traits. 24.1% of officers were inaccurate by 1-grade difference and 5.8% by 2-grade difference in DHC assessment. Of all the DHC Traits 'overjet' was the most consistent scoring in officers with an accuracy of 98.2% (Fig. 2 and 3).

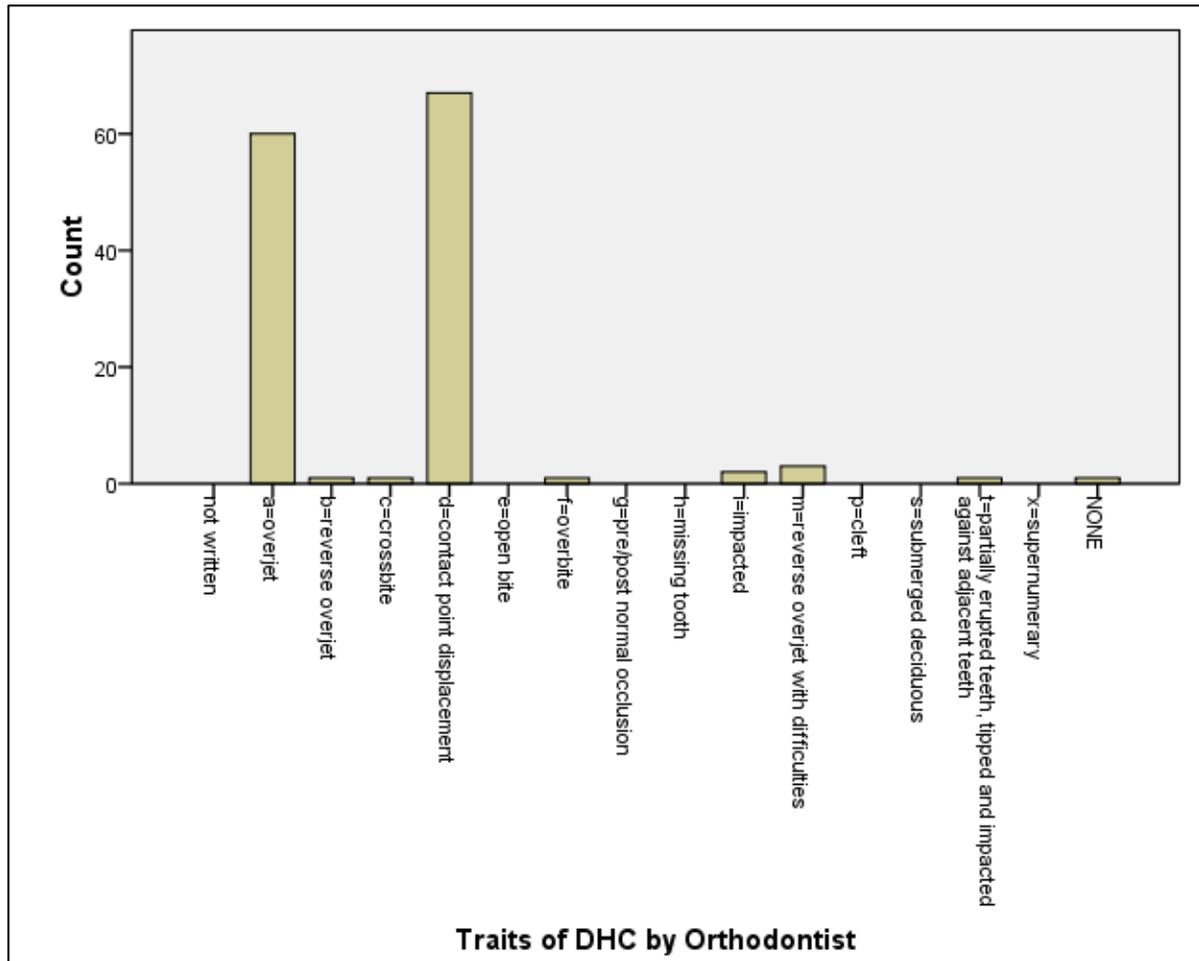
**Table 3. Compliance with scoring of IOTN and malocclusion type**

<b>Compliance</b>	<b>DHC</b>	<b>DHC Trait</b>	<b>AC</b>	<b>Malocclusion type</b>
Dental officer	137 (82.0%)	112 (67.0%)	34 (20.0%)	162 (97.0%)
Orthodontist	166 (100%)	166 (100%)	92 (55%)	166 (100%)

**Figure 2. DHC Traits assessed by dental officers**



**Figure 3. DHC Traits assessed by orthodontist**



Although there is no universal agreement on interpreting the kappa value, the scale of Landis and Koch<sup>22</sup> is widely accepted as strength of agreement for categorical outcome (Table 2). From the 166 referrals, only 137 had DHC grades and 112 had DHC traits scored by both officers and orthodontists respectively. Only 20 referrals had AC scored by both officers and orthodontist. Table 4 shows overall agreement was only 'slight' for DHC in officers ( $\kappa = .17$ ) although senior officers ( $\kappa = .34$ ) were comparatively better than junior officers ( $\kappa = .10$ ). Agreement was poor for AC with k statistic in the negative ( $\kappa = -.06$ ). DHC traits assessment was very varied and agreement was low with Cronbach's alpha of .55 ( $p < .0001$ ). For acceptable reliability in inter-examiner variability, Cronbach's alpha should be in the range of 0.7 – 0.8.

Table 5 shows that as a group, agreement was 'moderate' for assessment in malocclusion type ( $\kappa = .58$ ) with senior officers in 'substantial' agreement ( $\kappa = .67$ ) compared to 'moderate' agreement in junior officers ( $\kappa = .54$ ). Distribution of the referrals from different source clinics shows proportionately more officers with DHC agreement from Banting (77%) and 'other clinics' (74%) and least from Botanik (63%) which had the most referrals (Table 6). However, Chi-square test showed no statistical significance ( $p = .26$ ) between the clinics although there were proportionately more senior officers in 'other clinics' compared with Banting and Botanik. Fischer's exact test showed no statistical significance difference in DHC agreement between junior and senior officers in each of the three groups of source clinics respectively. Botanik also had greater percentage of referrals which differed by more than 2-grades (8.9%) compared with Banting and other clinics (Table 6).

**Table 4. Agreement of DHC and AC between officers and orthodontist**

	<b>Junior officers n=118</b>	<b>Senior officers n=48</b>	<b>Junior + Senior officers n=166</b>	
	<b>DHC (grouped)</b>	<b>DHC (grouped)</b>	<b>DHC(grouped) n=137</b>	<b>AC(grouped) n=20</b>
Kappa	.10	.34	.17	-.06

**Table 5. Agreement of malocclusion type between officers and orthodontist**

	<b>Junior officers n=118</b>	<b>Senior officers n=48</b>	<b>Junior + Senior officers n=166</b>
Kappa	.54	.67	.58

**Table 6. DHC Agreement / Disagreement from source clinics**

Clinic	Grade of officer		Positive DHC agreement			DHC disagreement		
	Junior officers	Senior officers	Junior officers	Senior officers	Total	Chi square test	By 1-grade	By 2-grades
Botanik n=56	44 (78.6%)	12 (21.4%)	27 (61.4%)	8 (66.7%)	35 (63%)	<i>p</i> =.507	28.6%	8.9%
Banting n=38	30 (78.9%)	8 (21.1%)	21 (70%)	7 (87.5%)	28 (74%)	<i>p</i> =.306	21.1%	3.3%
Other clinics n=43	31 (72.1%)	12 (27.9%)	25 (80.6%)	8 (66.7%)	33 (77%)	<i>p</i> =.277	20.9%	2.3%

Statistical significance set at  $p < .05$

## DISCUSSION

Majority of referrals were 'definite need' for treatment (88.3%) and a small number in the 'borderline/ moderate need' (9.5%) which is appropriate and in accordance with the guidelines set by the Ministry of Health Malaysia. The surprisingly low compliance of scoring for AC in dental officers may be due to the misconception that only the DHC was required in the referral form. Emy<sup>23</sup> similarly observed that compliance with IOTN scoring was 92.1% (DHC only) and a low 7.9% (both DHC and AC included) from her study of 110 referrals (January to July 2015) to the Tanjong Karang orthodontic clinic in the Kuala Selangor District. DHC grading appears to be more important than AC for both officers and orthodontists since it is more objective. Only very recently were orthodontists required to enter IOTN scores of new referrals in the clinical records and annual data collected by the Ministry. This was probably the reason previous scoring by orthodontists was inconsistent.

Nevertheless, it was surprising that agreement in AC was very poor in the current study in contrast to the previous study by Loke<sup>2</sup> that showed 'moderate' agreement ( $\kappa=.51$ ) in mostly first-year dental officers in Kedah and 'fair' agreement ( $\kappa=.32$ ) in the study by Norzakiah<sup>11</sup>. Certain common malocclusions like bialveolar proclination\_/protrusion, Class III malocclusions with reverse overjet and anterior crossbite are not depicted in the AC pictures as they are not a reflection of the general British population. Thus, inexperienced officers may have trouble grading aesthetics in patients as they may try to 'match' the malocclusions with the pictures.

Agreement in DHC grading overall was only 'slight' even with the DHC grades categorized into 3 main groups of 'no need', 'borderline' and 'need' treatment. Thus, it was not unsurprising that accuracy in DHC traits assessment was poor. A clear understanding of the definitions, terms

and measurement of the DHC traits is vital for accurate interpretation. Poor agreement was echoed in the study by Emy<sup>23</sup>, which showed only 33.6% correct scoring of both DHC and AC. Jawad et al.<sup>24</sup> had reported the DHC mean kappa of 0.22 from general dental practitioners (GDP) compared with mean kappa of 0.55 from student orthodontic therapist. The AC mean kappa scores ranged from 0.13-0.21, indicating poor to fair agreement. Reddy et al.<sup>25</sup> reported poor use and inappropriate IOTN scores in referrals from general practitioners despite implementation of an action plan to improve use of referral guidelines and feedback pathways<sup>25</sup>. Bentele et al.<sup>5</sup> showed 'substantial' improvement ( $\kappa=.62$ ) in referral decisions after IOTN training compared with 'moderate' agreement ( $\kappa=.45$ ) in undergraduates with no IOTN training. However, Loke<sup>2</sup> did not find improvement in dental officers after training probably due to the large variation within the group.

Jawad et al.<sup>24</sup> also observed that there was acceptable DHC agreement ( $\kappa>.60$ ) in the orthodontist, postgraduate orthodontic student and orthodontic therapist groups. These groups had orthodontic training and this may be the reason for the accuracy in scoring IOTN. The current study found that DHC agreement was slightly better in senior than junior officers. This suggests that work experience or frequent usage of IOTN may improve accuracy. The current study did not find statistically significant difference of referrals from different place of work in contrast to Jawad et al.<sup>26</sup> who reported that place of work, frequency of use of IOTN and registrant group were the main factors influencing accuracy of use of IOTN. These findings re-emphasize the need for IOTN training in undergraduate schools and repeated usage in-service with feedback pathways for self-improvement and accuracy. Referral guidelines alone were ineffective and more targeted training tools and verifiable continuing professional development (CPD) appear to improve accuracy,

especially on the AC kappa scores<sup>25,26</sup>. The British Orthodontic Society (BOS) similarly commented “IOTN assessment by individuals not trained in the use of the indices is unlikely to be as meaningful as when performed by those who have undergone associated training”<sup>27</sup>. Their quality assurance framework for the new orthodontic contract in NHS primary care orthodontics required mandatory usage of IOTN for assessment of treatment need and extensive efforts undertaken to train and calibrate all practitioners in IOTN.

Malocclusion classification is basic undergraduate knowledge whereas IOTN training is absent or very superficial in most dental undergraduate schools. Thus, it is unsurprising that agreement in malocclusion classification is much better than in IOTN. Emy<sup>23</sup> similarly showed 100% compliance with 73.6% accuracy in evaluating malocclusion type. The ‘substantial’ agreement of senior officers with orthodontists suggests that work experience improved accuracy.

### **Limitations of the study**

The inconsistent scoring of IOTN by officers and orthodontists especially in the AC resulted in a very small sample size that could not be analysed with meaningful outcomes. We were unable to assess whether competency was due to individual factors as this data was not collected due to many incompletely filled forms with no names of officers. Emy<sup>23</sup> similarly reported 29.1% of referrals with missing details of the referring practitioner’s name and workplace<sup>28</sup>. Previous level of exposure to IOTN could not be determined from the referral forms.

## **CONCLUSION**

Diagnostic accuracy of dental officers in IOTN was low although compliance in scoring DHC was better than in AC. Senior officers were slightly better than juniors in scoring IOTN. Training and calibration in IOTN are highly recommended for all dental officers to improve their accuracy in orthodontic referrals.

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