ORIGINAL ARTICLE

CROSS-CULTURAL ADAPTATION OF MODIFIED DENTAL PAIN SCREENING QUESTIONNAIRE (M-DEPAQ) IN A PRIMARY DENTAL CARE CLINIC IN KUALA LUMPUR

Amy Kia Cheen Liew[1], Dalia Abdullah[1], Seong Jin Shiu[1], Chiang San Chan[1] and Allan Pau[2]

[1] Faculty of Dentistry, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur, Malaysia
[2] School of Dentistry, International Medical University, No.126, Jalan Jalil Perkasa 19, Bukit Jalil, 57000 Kuala Lumpur, Malaysia

Corresponding author:
Dalia Abdullah
E-mail addresses: daliaabdullah@ukm.edu.my , daliaabdullah@gmail.com

ABSTRACT

A validated screening tool for patient triage based on the pain symptoms, could potentially optimize the resources and expertise available in dental pain management. The aim of this study was to translate and validate the Modified Dental Pain Questionnaire (M-DePaQ) for use in categorizing patients with pain into three groups of common dental conditions. Forward Malay and Chinese translation was performed, followed by backward English translation. The translation was reviewed by an expert panel and pre-tested on patients who are native speakers. Consecutive patients aged 18 years and older experiencing pain and attending the primary dental care clinic completed the questionnaires. Four calibrated dentists made clinical diagnoses independent of the questionnaire responses. For data analysis, the cases were split randomly into Random Sample 1 (RS1) and Random Sample 2 (RS2). Discriminant analysis was performed on RS1 to develop a model for classifying dental pain cases into three groups. The model was applied to cases in RS2, and a cross-validated accuracy rate was obtained. Criterion validity was assessed using measures such as sensitivity, specificity, positive predictive value, and kappa. Of the 234 questionnaires distributed, 216 (92.3%) were returned. Classification rates were recorded at 73.8% for RS1, 75.0% for RS2, and 71.1% for all cases. The sensitivity values were 0.72, 0.39, and 0.43 for Groups 1, 2, and 3, respectively. The corresponding specificity values were 0.42, 0.87, and 0.94. The discriminant validity of the adapted questionnaire was satisfactory, but the criterion validity could not be established because of biases incorporated in the study.
Key words: Dental pain; pulpitis; periodontitis; pericoronitis; questionnaires; validation

INTRODUCTION

Management of dental pain is the core business of most dental practices. Complaints of dental pain often are odontogenic, originating from the pulpal tissues or periodontal structures[1]. Although odontogenic pain can be controlled with appropriate treatment, obtaining a clinical diagnosis of dental pain requires a clinician to take a detailed history, conduct an objective assessment of the oral cavity, and interpret pulp tests and radiographs[2]. This procedure can be time consuming and resource intensive, and many dentists report that time and patient management are the main reasons for work-related stress, especially when running behind schedule[3-6]. As patients who are experiencing dental pain are more likely to visit the dentist[7], one way to address this problem is to have an effective triage in place based on the symptoms. The initial assessment and categorization prior to the comprehensive examination facilitate the allocation of limited resources and expertise so that patients with the most urgent needs can be prioritized[8].

The challenge, therefore, is to identify a measure sensitive enough to distinguish the origins of dental pain but not cumbersome in implementation. While a self-administered questionnaire could be suitable[9], most existing questionnaires are developed and validated in English[10]. Although it is possible to develop a new measure, clinicians and researchers often opt for modifying an existing questionnaire to suit their current contexts[11]. This entails forward translation, expert panel back-translation, pre-testing, and cognitive interviewing followed by validation to ensure accuracy of the measure[12].

Several screening questionnaires could be used to categorize dental pain. The McGill Pain Questionnaire contains an exhaustive list of pain descriptions and is frequently used by those who suffer pain, including odontogenic pain[13-15]. However, its main drawback is that not all pain descriptors listed are relevant to dental pain[16]. The developers of the Dental Pain Questionnaire (DePaQ) attempted to overcome this by focusing on three groups of commonly presenting oral conditions: (1) acute apical periodontitis and irreversible pulpitis, (2) reversible pulpitis and dentine sensitivity, and (3) pericoronitis[17]. The

modified version of this questionnaire (M-DePaQ) retained twelve of the sixteen items and simplified the Likert scale to a 3-point instead of a 5-point version[18]. Although it had been used on adolescents, this questionnaire was developed in an adult population[19].

Our aim is to translate the M-DePaQ into Malay and Chinese and validate it so that it can be used for patient triage at a dental teaching hospital in the metropolitan area of Kuala Lumpur. This study describes the adaptation and validation processes, focusing on discriminant validity and criterion validity.

METHODOLOGY

The study was carried out at the primary care clinic of a dental teaching hospital in Kuala Lumpur, Malaysia. A cross-sectional study design was applied, and ethical approval was granted by the Research Ethics Committee, Universiti Kebangsaan Malaysia [UKM 1.5.3.5/244/DD/2013/013(2)].

Adaptation of M-DePaQ

First, the researchers (CC, SS) translated the English version of the Modified Dental Pain Questionnaire (M-DePaQ) into Malay and Chinese. Then, final year dental students who are also native speakers of the languages back translated each of the translated versions into English; confusing and misleading words were identified during the process. The expert panel (AL, AP, and DA) reviewed the translations, and disagreements were discussed to achieve consensus. For each translated version, the questionnaire was pre-tested on ten dental patients who are native speakers of the language, and cognitive interviews were conducted to scrutinize each item. The final versions were derived after minor adjustments.

Collection of data

Adult patients aged 18 years and older attending the clinic with dental pain as the chief complaint were eligible for inclusion in the study, but patients who did not understand any of the languages in the questionnaire and non-Malaysian citizens were excluded from the study. Participating patients, who were informed of the conduct of the study and agreed to take part, provided written consent before answering the questionnaire in their preferred languages. The researchers (CC, SS) were available to provide explanation and assistance for patients who had difficulty understanding the questions.

Four dentists were employed in this study to perform clinical examination and diagnosis. Prior to the commencement of the study, the dentists were trained and calibrated against a consultant in Endodontics (DA). After completing the questionnaire, the patients were examined by the calibrated dentists. Radiographs and pulp sensibility tests were carried out where indicated. The dentists then provided the clinical diagnoses, blind to the questionnaire responses throughout the entire process.

Statistical analysis

The data collected were analyzed using SPSS version 21.0 (IBM Corp., Armonk, NY). The clinical diagnoses were coded into three groups of oral conditions: (1) acute periapical periodontitis (including apical abscess) and irreversible pulpitis, (2) reversible pulpitis and dentine hypersensitivity, and (3) pericoronitis. The samples were divided randomly using the same software into Random Sample 1 (RS1) and Random Sample 2 (RS2). Frequency distributions for sociodemographic factors, clinical diagnoses, and M-DePaQ items were reported for the RS1 and RS2. The percentage of cases correctly classified was computed for the entire sample, RS1, RS2, and according to the languages in which the questionnaires were completed.

Moreover, discriminant analysis was carried out for RS1, and Fisher's classification coefficients were derived for each group of clinical conditions. A discriminate model in the form of linear equations was created using three sets of Fisher's classification coefficients for each M-DePaQ item. The linear equation can be represented as

$$d_i = \beta_0 + \beta_{i1}x_1 + \beta_{i2}x_2 + \cdots + \beta_{ip}x_p$$

where the discriminant function score d_i for each group was obtained by calculating the sum of the constant β_0 and the product of each classification coefficient β_i with its response score x_i. As a result, a classification equation was constructed for each of the three clinical conditions.

The classification equations were used to classify cases in RS2, and Fisher's scores were calculated for each case. Among the three scores for each patient case computed with the three equations, the highest score was used to classify the case into the corresponding clinical condition. The percentage of cases correctly classified (i.e., the cross-validated accuracy rate) was determined and compared to the proportional-by-chance accuracy rate, which was computed by squaring and calculating the sum of the proportion of cases in each group from the table of prior probabilities for the group. This model is considered successful if the percentage of cases correctly classified is 25% more than the calculated chance accuracy rate.

Grouping based on the equations and grouping based on clinical diagnoses were then compared in cross-tabulation to determine the criterion validity, using measures such as sensitivity, specificity, positive predictive value, and kappa.

RESULTS

A total of 234 questionnaires were distributed; 216 were returned with the M-DePaQ questions completed, thus the response rate was 92.3%. Not all respondents answered the questions on sociodemographic details. Most respondents chose to answer the questionnaire in Malay (n=192, 82.1%), followed by English (n=26, 11.1%) and Chinese (n=16, 6.8%).

The demographic distribution is listed in Table 1. About half of the respondents were younger than 35 years and about half were males. The educational level attained was mostly at secondary (n=99, 43%) and tertiary (n=117, 50.9%) levels. However, 52 respondents (22.8%) were unemployed. Only 7.8% (n=18) of the respondents had never visited a dentist before. No marked difference was noted in sociodemographic variables between RS1 and RS2. The responses to questions in the M-DePaQ are summarized in Table 2, while the frequency distributions of clinical diagnoses between RS1 and RS2 are listed in Table 3.

Table 1: Socio-demographic and economic characteristics comparing RS1 and RS2

		RS1 n (%)	RS2 n (%)	Total n (%)
Age	<35 years	64 (53.8)	57 (49.6)	121 (51.7)
	≥ 35 years	55 (46.2)	58 (50.4)	113 (48.3)
	Total	119 (100)	115 (100)	234 (100)
Gender	Male	59 (49.6)	53 (46.1)	112 (47.9)
	Female	60 (50.4)	62 (53.9)	122 (52.1)
	Total	119 (100)	115 (100)	234 (100)
Marital Status	Single	45 (38.1)	45 (39.5)	90 (38.8)
	Married	67 (56.8)	66 (57.9)	133 (57.3)
	Widowed	2 (1.7)	1 (0.9)	3 (1.3)
	Separated	4 (3.4)	2 (1.8)	6 (2.6)
	Total	118 (100)	114 (100)	232 (100)
Employment status	Full-time	77 (67.0)	63 (55.8)	140 (61.4)
	Part-time	7 (6.1)	12 (10.6)	19 (8.3)
	Retired	11 (9.6)	6 (5.3)	17 (7.5)
	Not employed	20 (17.4)	32 (28.3)	52 (22.8)
	Total	115 (100)	113 (100)	228 (100)
Level of education	None	0 (0.0)	2 (1.8)	2 (0.9)
	Primary	6 (5.2)	6 (5.3)	12 (5.2)
	Secondary	51 (44.0)	48 (42.1)	99 (43.0)
	Tertiary	59 (50.9)	58 (50.9)	117 (50.9)
	Total	116 (100)	114 (100)	230 (100)
Have you ever been to a dentist before?	Yes	108 (93.1)	105 (91.3)	213 (92.2)
	No	8 (6.9)	10 (8.7)	18 (7.8)
	Total	116 (100)	115 (100)	231 (100)
Apart from your current pain, have you had pain in your mouth or face regions in the past?	Yes	54 (46.6)	43 (38.1)	97 (42.4)
	No	62 (53.4)	70 (61.9)	132 (57.6)
	Total	116 (100)	113 (100)	229 (100)
Apart from coming here today, where else have you been for advice, medication or treatment?	None	37 (32.2)	51 (45.1)	88 (38.6)
	My own dentist	64 (55.7)	49 (43.4)	113 (49.6)
	My doctor	5 (4.3)	1 (0.9)	6 (2.6)
	Hospital casualty	2 (1.7)	6 (5.3)	8 (3.5)
	Others	7 (6.1)	6 (5.3)	13 (5.7)
	Total	115 (100)	113 (100)	228 (100)

The proportional-by-chance accuracy rate was calculated as $0.559^2+0.243^2+0.197^2=0.410$. The benchmark for a success model was therefore at least 51.25% of cases correctly classified. Table 4 contains the cross-tabulation of predicted group membership using questionnaire responses and group membership according to clinical diagnosis. Most of the clinical Group 1 cases (n=71, 83.5%) were correctly predicted, followed by clinical Group 3 cases (n=20, 66.7%). Less than half of clinical Group 2 cases (n=17, 45.9%) were correctly predicted. The cross-validated accuracy rates were recorded at 73.8% for RS1, 75.0% for RS2, and 71.1% for all cases. Analysis by language revealed 69.1% correctly classified cases for the responses in Malay, while 100% was achieved for the English and Chinese versions, respectively.

Table 2: Frequency distributions for M-DePaQ items comparing RS1 (n=113) and RS2 (n=103)

		RS1 n (%)	RS2 n (%)	Total n (%)
Pain in the…	Gums only	15 (13.3)	13 (12.6)	28 (13.0)
	Tooth/teeth only	34 (30.1)	48 (46.6)	82 (38.0)
	Both gums and tooth/teeth	64 (56.6)	42 (40.8)	106 (49.1)
Pain for…	Less than one week	59 (52.2)	57 (55.3)	116 (53.7)
	One week or longer	54 (47.8)	46 (44.7)	100 (46.3)
Pain is…	Mild	18 (15.9)	20 (19.4)	38 (17.6)
	Discomforting and distressing	84 (74.3)	74 (71.8)	158 (73.1)
	Horrible and excruciating	11 (9.7)	9 (8.7)	20 (9.3)
Pain has been…	Episodic	76 (67.3)	73 (70.9)	149 (69.0)
	Continuous	37 (32.7)	30 (29.1)	67 (31.0)
Pain radiates to the surrounding area	No, not at all	36 (31.9)	30 (29.1)	66 (30.6)
	Yes, a little	63 (55.8)	61 (59.2)	124 (57.4)
	Yes, completely	14 (12.4)	12 (11.7)	26 (12.0)
Pain worse when chewing or eating	No, not at all	8 (7.1)	14 (13.6)	22 (10.2)
	Yes, a little	68 (60.2)	57 (55.3)	125 (57.9)
	Yes, very much so	37 (32.7)	32 (31.1)	69 (31.9)
Eating or drinking something cold makes pain worse	No	37 (32.7)	35 (34.0)	72 (33.3)
	Yes	76 (67.3)	68 (66.0)	144 (66.7)
Gums swollen	No, not at all	31 (27.4)	51 (49.5)	82 (38.0)
	Yes, a little	70 (61.9)	47 (45.6)	117 (54.2)
	Yes, very much so	12 (10.6)	5 (4.9)	17 (7.9)
Painful tooth feels like it is loose	No, not at all	64 (56.6)	59 (57.3)	123 (56.9)
	Yes, a little	46 (40.7)	42 (40.8)	88 (40.7)
	Yes, very much so	3 (2.7)	2 (1.9)	5 (2.3)
Difficult to swallow	No, not at all	67 (59.3)	65 (63.1)	132 (61.1)
	Yes, a little	35 (31.0)	32 (31.1)	67 (31.0)
	Yes, very much so	11 (9.7)	6 (5.8)	17 (7.9)
Painful tooth feels like it is sticking out	No, not at all	80 (70.8)	79 (76.7)	159 (73.6)
	Yes, a little	29 (25.7)	21 (20.4)	50 (23.1)
	Yes, very much so	4 (3.5)	3 (2.9)	7 (3.2)
Difficulties sleeping	No, not at all	32 (28.3)	30 (29.1)	62 (28.7)
	Yes, a little	51 (45.1)	49 (47.6)	100 (46.3)
	Yes, very much so	30 (26.5)	24 (23.3)	54 (25.0)

Table 3: Frequency distributions for clinical diagnosis comparing RS1 (n=113) and RS2 (n=103)

		RS1 n (%)	RS2 n (%)	Total n (%)
Group 1	Acute periradicular periodontitis and irreversible pulpitis	46 (40.7)	39 (37.9)	85 (39.4)
Group 2	Reversible pulpitis and dentine hypersensitivity	15 (13.3)	22 (21.4)	37 (17.1)
Group 3	Pericoronitis	23 (20.4)	7 (6.8)	30 (13.9)
Group 4	Others	29 (25.7)	35 (34.0)	64 (29.6)
Total		113 (100)	103 (100)	216 (100)

The classification function coefficients and the corresponding classification equations derived from RS1 are presented in Table 5. Using the equations, group membership of cases in RS2 was determined and verified against the true clinical diagnosis (Table 6). The sensitivity values were 0.72, 0.39, and 0.43 for Groups 1, 2, and 3 respectively. The corresponding specificity values were 0.42, 0.87, and 0.94.

DISCUSSION

The demographic distribution reflects an educated urban Malaysian population. Because the study was conducted at a teaching institution, a higher number of patients who are students was expected. In addition, this skewed the unemployment rate. In this sense, generalizability of the findings of this study is limited to a patient pool with similar characteristics. However, the questionnaire was made available in three commonly used languages of the Malaysian population. Hence, we were able to validate the questionnaire in this multicultural setting. The prevalence of toothache was reported at 1.7% in the Malaysian population in 2010[20].

Table 4: Classification rates of questionnaire-determined cases against clinically determined cases

	Group	Group membership according to clinical diagnosis			
		1	2	3	Others
		n (%)	n (%)	n (%)	n (%)
Predicted group membership	1	39 (84.0)	6 (40.0)	6 (26.1)	19 (65.5)
according to questionnaire	2	4 (8.7)	7 (46.7)	1 (4.3)	6 (20.7)
responses for RS1 (n=113)	3	3 (6.5)	2 (13.3)	16 (69.6)	4 (13.8)
	Total	46 (100)	15 (100)	23 (100)	29 (100)
Predicted group membership	1	31 (79.5)	6 (27.3)	2 (28.6)	17 (48.6)
according to questionnaire	2	6 (15.4)	16 (72.7)	1 (14.3)	16 (45.7)
responses for RS2 (n=103)	3	2 (5.1)	0 (0.0)	4 (57.1)	2 (5.7)
	Total	39 (100)	22 (100)	7 (100)	35 (100)
Predicted group membership	1	71 (83.5)	18 (48.6)	10 (33.3)	44 (68.8)
according to questionnaire	2	10 (11.8)	17 (45.9)	0 (0.0)	14 (21.9)
responses for whole sample	3	4 (4.7)	2 (5.4)	20 (66.7)	6 (9.4)
(n=216)	Total	85 (100)	37 (100)	30 (100)	64 (100)

Table 5: Classification Function Coefficients derived from discriminant analysis using RS1

	Group		
Questionnaire items	1	2	3
Pain in the gums only, tooth/teeth only or gums and tooth/teeth?	2.820	2.544	2.675
Pain for less than one week, or more than one week?	8.442	8.186	7.463
Pain is mild, discomforting/distressing, or horrible/excruciating?	10.754	9.146	10.334
Pain has been episodic or continuous?	-1.142	-1.768	-1.859
Pain radiates to the surrounding area	-2.079	-2.108	-2.664
Pain worse when chewing or eating	4.625	5.860	5.755
Eating or drinking something cold makes pain worse	5.474	6.633	4.932
Gums swollen	-2.467	-2.078	-0.191
Painful tooth feels like it is loose	4.129	4.162	3.060
Difficult to swallow	-1.924	-1.308	-1.126
Painful tooth feels like it is sticking out	3.307	2.351	1.789
Difficulties sleeping	1.260	-0.410	1.003
Constant	-31.087	-29.535	-30.619

Derived from formula:
*Group1=2.820*Q1+8.442*Q2+10.754*Q3+(-1.142)*Q4+(-2.079)*Q5+4.625*Q6+5.474*Q7+(-2.467)*Q8 +4.129*Q9+(-1.924)*Q10+3.307*Q11+1.260*Q12+(-31.087).*
*Group2=2.544*Q1+8.186*Q2+9.146*Q3+(-1.768)*Q4+(-2.108)*Q5+5.860*Q6+6.633*Q7+(-2.078)*Q8 +4.162*Q9+(-1.308)*Q10+2.351*Q11+(-0.410)*Q12+(-29.535).*
*Group3=2.675*Q1+7.463*Q2+10.334*Q3+(-1.859)*Q4+(-2.664)*Q5+5.755*Q6+4.932*Q7+(-0.191)*Q8 +3.060*Q9+(-1.126)*Q10+1.789*Q11+1.003*Q12+(-30.619).*
(Q1 denotes question number 1 in M-DePaQ, etc)

The diverse experiences of dental pain were demonstrated by the sufferers of different clinical conditions in terms of localization, intensity, continuity, response to cold stimuli, gingival swelling, swallowing, and sleep disturbances. Pau et. al. (2005) demonstrated that sixteen pain descriptors were able to classify 89.7% of dental cases accurately[17], while subsequent research using twelve of the pain descriptors obtained an 88% cross-validated accuracy rate[18]. A lower rate was observed in this study at 71.1%. The reduced rate could be explained by the use of different versions of DePaQ and the socio-cultural contexts of the study. The modified version[18] contained less items compared to the original version[17], excluding pain descriptors such as exhausting,

electric shocks, pulling and numb. Of these excluded descriptors, it is not uncommon for patients seen at this institution to complain of electric shock-like and pulling pain. On the other hand, patients were having a hard time trying to understand the item "painful tooth feels like it is sticking out" retained in the modified questionnaire. Because the modification was tailored to Vadakara population[18], so it fits the population much better than our samples. Also, the number of returned questionnaire and response rate were lower than previous studies[17, 18], this might reduce the overall fit of the model. Nevertheless, the model is considered successful because the cross-validated classification rate is at least 25% higher than the proportional chance accuracy rate.

Table 6: Validity of the questionnaire in classifying RS2 into the three groups of clinical conditions when compared to clinical diagnoses (gold standard)

	Group 1 (APP and IRP)	Group 2 (RP and DH)	Group 3 (PC)
True positive responses	31	9	3
False positive responses	42	12	6
True negative responses	30	80	102
False negative responses	12	14	4
Sensitivity (95% CI)	0.72 (0.56-0.84)	0.39 (0.20-0.61)	0.43 (0.12-0.80)
Specificity	0.42 (0.30-0.54)	0.87 (0.78-0.93)	0.94 (0.88-0.98)
Positive predictive value	0.42 (0.31-0.55)	0.43 (0.23-0.66)	0.33 (0.09-0.69)
Negative predictive value	0.71 (0.55-0.84)	0.85 (0.76-0.91)	0.96 (0.90-0.99)
Observed agreement	0.53 (0.43-0.62)	0.77 (0.70-0.86)	0.91 (0.86-0.96)
Kappa	0.12 (0.00-0.28)	0.27 (0.06-0.48)	0.33 (0.01-0.65)

The Malay version was most commonly used in this study, with the correct classification rate for this subset at 69.1%. The English and Chinese versions recorded 100% correct classification rates, but caution is warranted as few respondents selected these versions. The discrepancies between groups could also be explained by ethnic differences in pain experience. In a study among three major ethnic groups in Malaysia, more Indians reported knee pain than Malays and Chinese[21]. Ethnic differences were also found in the prevalence of neuropathic low back pain[22] and musculoskeletal pain[23], as well as pain complaints in primary care setting[24]. Furthermore, even when a common language was used, significant difference was found among different ethnic-culture groups in rating the intensity of pain terms[25]. Because pain threshold and pain expression varied considerably, the multi-ethnic groups in this study obfuscated the validity of the questionnaire.

Sensitivity and specificity were also lower than those obtained in previous studies[17,18]. Most of the acute periapical periodontitis and irreversible pulpitis cases were correctly predicted, with moderate sensitivity and low specificity. In clinical practice, this translates to a high number of false positive cases being referred for root canal treatment or extraction. This is not an unusual finding, as Linn et al. (2007) reported 44% of patients with orofacial pain had been wrongly treated with extractions or endodontic treatment[2]. Therefore, it is crucial for the dentist to carry out confirmatory investigations before initiating any invasive treatment, even in the presence of a screening questionnaire. In contrast, pericoronitis, reversible pulpitis, and dentine hypersensitivity cases were more likely to be overlooked when the questionnaire was used.

The discrepancy of criterion validity between studies could be explained by biases commonly seen in studies of diagnostic test accuracy. In particular, imperfect gold standard bias could lead to the underestimation of sensitivity and specificity. Although pathology and surgery were often considered as true gold standards, it is not uncommon to use the clinical diagnosis as the gold standard in testing the accuracy of a screening tool[26]. However, dentists could disagree with one another in diagnosing an oral condition[27]. Furthermore, the management of patients in a primary care setting typically focuses on pain relief while waiting to uncover the cause of pain[28]. This is also reflected in the current study, as one third of the total cases was not grouped, compared to 4% and 15% of previous studies[17,18]. Hence, this could further compromise the accuracy of the selected gold standard. Although the primary care setting and multiple clinicians were intentional arrangement to reflect the actual scenario for the use of the questionnaire as suggested by the developers[17], single examiner in a secondary care center would provide a more controlled setting for the purpose of questionnaire validation.

Another related threat to validity was workup bias[26]. After gathering information on pain history and oral examination, the examining dentists decided whether a particular patient needed further investigation such as radiographs, pulp tests, and periodontal probing. Although they were blind to the questionnaire responses, it is a

standard prerequisite to ask about pain symptoms. Thus, the decision of subsequent investigations and clinical diagnosis were not entirely independent of the questionnaire responses. Further investigations were more likely to lead to accurate diagnosis, but these were provided selectively to patients with indicative symptoms. This might again lead to underestimation of the accuracy of the screening questionnaire. To overcome these shortcomings, future validation study should depend on the consensus of an expert review panel for a less error-prone clinical diagnosis. Alternatively, clinical outcome information can be used to supplement the imperfect gold standard and selective indication of confirming tests[26].

As for DePaQ, suggestions for future research and development include using the original sixteen items version for higher accuracy, examining the pain descriptors by data mining of healthcare records or focus group study involving patients with dental pain in their first languages, and validating the questionnaire in different population. With further testing and validation, DePaQ could possibly be incorporated in practice management software, thereby easing appointment scheduling and patient management. The current surge of big data analytics also help healthcare organizations to customize care efficiently and effectively[29]. This would invariably reduce work-related stress for the dentists. Other than practice management software, the potential to incorporate such medical algorithm and discriminative models into gadgets and wearable technology which connect personal health information into cloud computing is huge, as we welcome the era of the Internet of Things.

CONCLUSIONS

The discriminant validity of the adapted questionnaire and the classification equations derived were satisfactory, with 71.1% cases correctly classified. However, the criterion validity could not be established because of biases incorporated in the study. Further testing against a better gold standard is required.

ACKNOWLEDGEMENTS

This research was supported by Fundamental Research Grant Scheme, Ministry of Higher Education Malaysia (FRGS/1/2015/SKK14/UKM/02/1).

REFERENCES

1. Setty, S., David, J. Classification and epidemiology of orofacial pain. In Vadivelu N, Vadivelu A, Kaye AD. (eds). Orofacial Pain: a Clinician's Guide. Switzerland: Springer International Publishing; 2014, p. 15–24.

2. Linn, J., Trantor, I., Teo, N., Thanigaivel, R., Goss, A. The differential diagnosis of toothache from other orofacial pains in clinical practice. *Aust Dent J* 2007;**52**:S100–4.

3. Myers, H.L., Myers, L.B. "It's difficult being a dentist": stress and health in the general dental practitioner. *Br Dent J* 2004;**197**:89–93.

4. Moore, R., Brødsgaard, I. Dentists' perceived stress and its relation to perceptions about anxious patients. *Community Dent Oral Epidemiol* 2001;**29**:73–80.

5. Möller, A.T., Spangenberg, J.J. Stress and coping amongst South African dentists in private practice. *J Dent Assoc S Afr* 1996;**51**:347–57.

6. Wilson, R.F., Coward, P.Y., Capewell, J., Laidler, T.L., Rigby, A.C., Shaw, T.J. Perceived sources of occupational stress in general dental practitioners. *Br Dent J* 1998;**184**:499–502.

7. Duncan, R.P., Gilbert, G.H., Peek, C.W., Heft, M.W. The dynamics of toothache pain and dental services utilization: 24-month incidence. *J Public Health Dent* 2003;**63**:227–34.

8. Wuerz, R.C., Milne, L.W., Eitel, D.R., Travers, D., Gilboy, N. Reliability and validity of a new five-level triage instrument. *Acad Emerg Med* 2000;**7**:236–42.

9. Steven, L., Halldén, K. Can we screen for problematic back pain? A screening questionnaire for predicting outcome in acute and subacute back pain. *Clin J Pain* 1998;**14**:209–15.

10. Beaton, D., Bombardier, C., Guillemin, F., Ferraz, M. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine* 2000;**25**:3186–91.

11. Guillemin, F., Bombardier, C., Beaton, D. Cross-cultural adaptation of health-related quality of life measures: literature review and proposed guidelines. *J Clin Epidemiol* 1993;**46**:1417–32.

12. World Health Organization (WHO). Process of translation and adaptation of instruments. http://www.who.int/substance_abuse/research_tools/translation/en/. Accessed December 21, 2015.

13. Grushka, M., Sessle, B.J. Applicability of the McGill pain questionnaire to the differentiation of "toothache" pain. *Pain* 1984;**19**:49–57.

14. Hall, E.H., Terezhalmy, G.T., Pelleu, G.B. A set of descriptors for the diagnosis of dental pain syndromes. *Oral Surgery, Oral Med Oral Pathol* 1986;**61**:153–7.

15. Seymour, R.A., Charlton, J.E., Phillips, M.E. An evaluation of dental pain using visual analogue scales and the McGill Pain Questionnaire. *J Oral Maxillofac Surg* 1983;**41**:643–8.

16. Fernandez, E., Towery, S. A parsimonious set of verbal descriptors of pain sensation derived from the McGill Pain Questionnaire. *Pain* 1996;**66**:31–7.

17. Pau, A., Viswanath, K.P., Croucher, R. Validation of a dental pain screening questionnaire in a semi-urban hospital setting in South India. *Int Dent J* 2010;**60**:113–21.

18. Pau, A., Croucher, R., Marcenes, W., Leung, T. Development and validation of a dental pain-screening questionnaire. *Pain* 2005;**119**:75–81.

19. Pau, A, Khan, S.S., Babar, M.N., Croucher, R. Dental pain and care-seeking in 11-14-yr-old adolescents in a low income country. *Eur J Oral Sci* 2008;**116**:451–7.

20. Oral Health Division, Ministry of Health Malaysia. National Oral Health Survey of Adults 2010 (NOHSA 2010). Putrajaya: Ministry of Health Malaysia; 2013, p. 405.

21. Chia, Y.C., Beh, H.C., Ng, C.J., Teng, C.L., Hanafi, N.S., Choo, W.Y., Ching, S.M. Ethnic differences in the prevalence of knee pain among adults of a community in a cross-sectional study. *BMJ Open* 2016;**6**:1–7.

22. Kew, Y., Tan, C.Y., Ng, C.J., et al. Prevalence and associations of neuropathic pain in a cohort of multi-ethnic Asian low back pain patients. *Rheumatol Int* 2016 doi:10.1007/s00296-016-3633-x

23. Veerapen, K., Wigley, R.D, Valkenburg, H. Musculoskeletal pain in Malaysia: a COPCORD survey. *J Rheumatol* 2007;**34**:207–13.

24. Zailinawati, A.H., Teng, C.L., Kamil, M.A., Achike, F.I., Koh, C.N. Pain morbidity in primary care - preliminary observations from two different primary care settings. *Med J Malaysia* 2006;**61**:162–7

25. Gaston-Johansson, F., Albert, M., Fagan, E., Zimmerman, L. Similarities in pain descriptions of four different ethnic-culture groups. *J Pain Symptom Manage* 1990;**5**:94–100.

26. Zhou, X., Obuchowski, N.A., McClish, D.K. Statistical methods in diagnostic medicine. 2nd ed. New Jersey: John Wiley & Sons, Inc.; 2011, p. 57–95.

27. Bader, J.D., Shugars, D.A. Variation in dentists' clinical decisions. *J Public Health Dent* 1995;**55**:181–8.

28. Institute of Medicine (US) Committee on Advancing Pain Research, Care and Education. Care of People with Pain. Bethesda, MD: NIH, 2011. Available from: http://www.ncbi.nlm.nih.gov/books/NBK92517/ (accessed 21 December 2015)

29. Raghupathi, W., Raghupathi, V. Big data analytics in healthcare: promise and potential. *Health Inf Sci Syst* 2014;**2**:1–10.