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Cross-cultural Adaptation and Validation of the Hong Kong-Chinese version of Vocal Fatigue Index (VFI(HK))

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Abstract

Purpose. This study aimed to cross-culturally adapt and validate the Hong Kong-Chinese version of the Vocal fatigue index (VFI(HK)).

Method. The original English version of the Vocal fatigue index (VFI) was translated and adapted to the VFI(HK). A total of 206 subjects (87 in the Fatigue group and 119 in the Control group) completed the VFI(HK) and validity, reliability and receiver operating characteristic (ROC) were analysed.

Result. The VFI(HK) exhibited satisfactory psychometric properties. It showed good content validity (scale-level content validity indices $\geq$ 0.842) and excellent internal consistency (Part 1: α = 0.945, Part 2: α = 0.914, Part 3: α = 0.951). Parts 1 and 2 of the questionnaire showed good construct validity (Part 1: $t(204) = 5.743$, $p < 0.001$; Part 2: $t(204) = 5.049$, $p < 0.001$). Test-retest reliability ranged from acceptable (Part 3: ρ = 0.702) to good (Part 1: ρ = 0.885, Part 2: ρ = 0.827). ROC curves showed acceptable and close-to-acceptable intrinsic accuracies for Parts 1 (Aera under curve (AUC) = 0.712) and 2 (AUC = 0.694) respectively. Cutoff scores of 25 and 10 are suggested for Parts 1 and 2 respectively.

Conclusion. The VFI(HK) is a valid and sensitive assessment tool. It may be adopted to identify individuals with vocal fatigue in the Hong Kong-Chinese population.

Keywords

Vocal fatigue; Voice disorders; Vocal fatigue index (VFI); Self-reported questionnaire

1. Introduction

Vocal fatigue is a major complaint in occupational voice users. The prevalence of reporting frequent-to-persistent vocal fatigue was as high as 60.7% in a group of Spanish teachers [1]. In addition to its association with functional and/or organic voice disorders [2-3], vocal fatigue is also associated with voice activity limitation and participation restrictions [4]. Early identification of vocal fatigue is, therefore, of paramount importance in the clinical management of voice disorders.

Vocal fatigue is a multifaceted problem with a variety of definitions raised in the literature. Welham and Maclagan [3] suggested that vocal fatigue is a kind of negative vocal adaptation that manifests acoustically and physiologically as a result of prolonged voice use. However, identification of acoustic, aerodynamic and laryngoscopic changes that could reliably indicate vocal fatigue had been unsuccessful [5]. Vilkman [6] suggested that vocal fatigue refers to some negative sensations, which are subjective in nature, experienced by the speaker. McCabe and Titze [7] defined vocal fatigue as some progressive changes in phonatory effort (e.g. increase in perceived tightness and dryness in the larynx, painful sensation during phonation) and phonatory capabilities (e.g. change in phonatory pitch, reduced pitch and loudness ranges, change in voice quality). More importantly, they proposed a conceptual model which states that vocal fatigue consists of both peripheral and central components which interact with each other. Whereas peripheral vocal fatigue is comprised of changes at the neuromuscular and tissue levels, central vocal fatigue is measured with one's self-perception of phonatory effort.

The vocal fatigue index (VFI) was developed to measure the self-perceived phenomena exhibited by individuals with vocal fatigue [8]. It is a reliable and valid assessment tool that is capable of identifying individuals with vocal fatigue and measuring treatment effects in this

group of individuals [8]. The VFI is a 19-item questionnaire that consists of three parts that are designed to measure three factors; namely, “tiredness of voice and avoidance of voice use” (Factor #1, 11 items), “physical discomfort” (Factor #2, 5 items), and “improvement of symptoms with rest (Factor #3, 3 items); that are found to predict vocal fatigue. Despite that all items are rated using a Likert scale (with “0” refers to “never” and “4” refers to “always”), higher scores in Parts 1 and 2 indicate more severe vocal fatigue whereas higher scores in Part 3 indicate less severe vocal fatigue. This is due to the negative wordings used in the items of Parts 1 and 2 and, contrastively, the positive wordings used in the items of Part 3. The scores of the three parts should, therefore, be interpreted separately. In light of its significant clinical implication and satisfactory psychometric properties, the VFI has been cross-culturally adapted and validated to a number of versions; such as the Malayalam version [9], the Croatian version [10], the Persian version [11], the Spanish version [12], the German version [13], the Japanese version [14], the Tamil version [15], and the Brazilian version [16].

Despite that all the published versions of VFI reported good psychometric properties and may be applied to the respective populations, differences in cutoff scores among the original [8], German [13], Brazilian [16] and Malayalam [9] versions were observed and also anticipated in the Hong Kong-Chinese version. Omission of the subject “I” was observed in some items from the original VFI (e.g. Items #4, #5, #9, #11, #15, #18 and #19) [8]. Such omissions may make formulating sentences in Chinese difficult. Some sayings in the original version were also difficult to be translated directly to Hong Kong-Chinese (e.g. “feels like work” in Item #5, “with voice use” in Items #4 and #16). The above justified the need of cross-cultural adaptation and validation in the local context. Further, all the published versions were validated by comparing the VFI scores between dysphonic subjects and vocally-healthy subjects [8-16]. Considering vocal fatigue is a phenomenon that may occur in non-dysphonic individuals who

have high vocal demands [17], the present study was designed to address this by including non-dysphonic vocally-fatigued individuals in the experimental group.

The present study set out to cross-culturally adapt the VFI to a Hong Kong-Chinese version, that is, the VFI(HK). Further, the psychometric properties of the VFI(HK) were examined and the questionnaire was validated. Specifically, the present study addressed the following research questions: 1) Is VFI(HK) a valid and reliable tool to measure the extent of vocal fatigue; and 2) Can VFI(HK) discriminate individuals with vocal fatigue from their non-vocal fatigue counterparts? Upon confirmation of its validity and reliability, the VFI(HK) would be the first assessment tool that measures self-perceived vocal fatigue in Hong Kong.

2. Method

2.1 Participants

The present study was approved by the Human Subjects Ethics Sub-committee, the Hong Kong Polytechnic University (Ref. HSEARS20190521005). All participants were self-referred and informed consents were obtained from each of them. Ten subjects with vocal fatigue and ten without vocal fatigue who first enrolled in the study and fulfilled the inclusionary/exclusionary criteria listed below participated in the pre-testing part of the VFI(HK) development process. An additional group of 206 subjects participated in the validation process. They were allocated by the first author (E.K., a speech therapist who had specialized in voice disorders for over 15 years) to either the Fatigue or Control group according to the presence of some self-reported symptoms related to vocal fatigue (see Appendix 1 for the list of symptoms). Subjects were asked to indicate if they had experienced the symptoms in the past two weeks and whether or not they regard themselves as having vocal fatigue. Subjects were interviewed further on their vocal demand, voice use pattern and other relevant case history if the self-reported symptoms

were not affirmative for group allocation. Other inclusionary/exclusionary criteria included: 1) subjects should age 18 years or above, 2) they should be native Cantonese speakers, 3) should be proficient in reading and comprehending written Chinese, and 4) all Control group subjects should not have any history of voice disorders. Table 1 summarizes the demographics of subjects in the two groups.

Table 1 Demographic characteristics of subjects in the Fatigue and Control groups

	Fatigue group	Control group
Total	87	119
Male	28	47
Female	59	72
Presence of vocal pathology		
With vocal pathology	9	0
Without vocal pathology	78	119
Level of voice user[a]		
First level voice user	0	1
Second level voice user	55	30
Third level voice user	16	20
Fourth level voice user	16	68
Mean age in years (SD)	33.1 (10.24)	32.9 (12.57)

Note. SD = standard deviation; [a]Levels of voice users as defined by Koufman and Issaacson [18]

2.2 Procedures

Development of the VFI(HK). The original English version of the VFI was forward translated to Hong Kong-Chinese by a professional Chinese/English bilingual translator to give Version

1 of the questionnaire. It was subsequently back-translated by another independent professional Chinese/English bilingual translator. The translations were reviewed and synthesized by the first and the second authors (C.T., a final year Master of Speech Therapy student who was trained to manage voice disorders) to give Version 2 of the questionnaire (See Appendix 2 for the translations). Pre-testing was conducted on 20 subjects. They were instructed to complete Version 2 of the VFI(HK) followed by an interview to identify any ambiguity in the items and wordings of the questionnaire. Modifications, based on the pre-testing subjects' comments, would be made if necessary.

Validation of the VFI(HK). The VFI(HK) was sent to an expert panel for content validity rating. The three panel members were all English-Chinese bilingual speech therapists and each of them had over 15 years of experience in managing voice disorders. They were required to rate the questionnaire components; namely, the questionnaire title, the instructions, the rating descriptors, and the 19 questionnaire items; for their relevance. Components were rated by each panel member as 1) not relevant, 2) quite relevant, 3) very relevant or 4) absolutely relevant. These relevance ratings allowed the computation of content validity indices.

The subjects summarized in Table 1 completed the VFI(HK) electronically. All subjects spent no more than ten minutes to complete the questionnaire. One hundred and thirty subjects (63.1% of the total number of subjects) completed the VFI(HK) again (i.e. second attempt), also electronically, one week after their first completion for test-retest reliability measurement. Subjects were reminded to maintain their usual voice use pattern during the one-week period. Among those who had undertaken a second attempt, 59 of them were from the Fatigue group and 71 of them were from the Control group.

2.3 Statistical analyses

All statistical analyses were conducted using the IBM SPSS Statistics 25 software. Construct validity was analyzed by comparing the Subtotal scores of the VFI(HK) between the Fatigue and Control groups using independent *t*-tests. Internal consistency was analyzed by obtaining the Cronbach's alpha coefficient and test-retest reliability was analyzed by obtaining the Spearman's rho correlation coefficient of the corresponding parts. Sensitivity and specificity of individual parts of the VFI(HK) were estimated from the receiver operating characteristic (ROC) plots. Alpha levels were set at 0.05 for all statistical tests.

3. **Results**

3.1 Development and cross-cultural adaptation of the VFI(HK)

During the translation process, the subject "我" (meaning "I") was added to Items #4, #5, #9, #11, #15 and #18. The word order was revised and an additional clause was included in Items #1, #2, #6, #8, #9, #11, #12, #13, #14, #18 and #19. Some sayings were modified as follows: 1) "with voice use" was translated as "運用聲線後", meaning "after using my voice" in Items #4, #15 and #16; 2) "with talking" was translated as "說話時", meaning "when I talk" in Item #2; and 3) "feels like work" was translated as "吃力", meaning "feels difficult" in Item #5. Subjects participated in the pre-testing did not report any ambiguity in the items and found the wordings of the questionnaire comprehensible. No change had been made to the questionnaire after the pre-testing.

3.2 Validity

The item-level content validity index (I-CVI), scale-level content validity index based on the average method (S-CVI/Ave), and scale-level content validity index based on the universal agreement method (S-CVI/UA) were computed as suggested by Yusoff [19]. Table 2 summarizes the I-CVIs based on the relevance ratings obtained from the expert panel. Universal agreement on relevance (i.e. all members of the panel rated the component as very relevant or absolutely relevant and I-CVI equals 1.00) was found in all components of VFI(HK) except for the questionnaire title, Items #1, #4 and #15 (I-CVI = 0.67). Scale-level CVIs were computed based on the relevance rating of the 19 items. S-CVI/Ave and S-CVI/UA were found to be 0.948 and 0.842 respectively.

Table 2 Results of item-level content validity indices

Components	Item-level content validity index
Title	0.67
Instruction	1.00
Rating descriptors	1.00
Items	
#1	0.67
#2	1.00
#3	1.00
#4	0.67
#5	1.00
#6	1.00
#7	1.00
#8	1.00
#9	1.00
#10	1.00
#11	1.00
#12	1.00
#13	1.00
#14	1.00
#15	0.67
#16	1.00
#17	1.00
#18	1.00
#19	1.00

Construct validity of the VFI(HK) was obtained by comparing the Subtotal scores between the Fatigue and Control groups. Table 3 summarizes the descriptive data and results of the independent *t*-tests on the Subtotal scores. The Fatigue group was significantly higher than the Control group in the Subtotal scores of Part 1 ($t(204) = 5.743$, $p < 0.001$) and Part 2 ($t(204) = 5.049$, $p < 0.001$). The effect sizes of the differences were close-to-large and medium for Parts 1 ($d = 0.814$) and 2 ($d = 0.716$) respectively. For the Subtotal score of Part 3, nevertheless, the Fatigue group (mean = 9.06, standard deviation (SD) = 2.616) was slightly lower than the Control group (Control group: mean = 9.27, SD = 3.209). The difference was statistically non-significant ($t(206) = -0.504$, $p = 0.615$, $d = 0.071$).

Table 3 Results of descriptive statistics and independent t-tests for Parts 1, 2 and 3 of the VFI(HK).

	Fatigue group (n = 87)		Control group (n = 119)				
	Mean	**SD**	**Mean**	**SD**	***t***	***p***	**Cohen's *d***
Subtotal scores							
Part 1 (items 1 – 11)	28.31	8.654	21.26	8.737	5.743	< 0.001*	0.814
Part 2 (items 12 – 16)	11.02	4.066	8.21	3.862	5.049	< 0.001*	0.716
Part 3 (items 17 – 19)	9.06	2.616	9.27	3.209	-0.504	0.615	0.071

Note. VFI(HK) = Vocal fatigue index (Hong Kong-Chinese version), SD = standard deviation, *significant at $p < 0.05$ level

3.3 Reliability

Internal consistency analyses suggested that Parts 1, 2 and 3 of the VFI(HK) exhibited Cronbach's alpha coefficients of 0.945, 0.914 and 0.951 respectively. Table 4 summarizes the Cronbach's alpha coefficients if any of the item is deleted from its corresponding part of the questionnaire.

Table 4 Summary of Cronbach's alpha coefficients if an individual item is deleted from its corresponding part of the VFI(HK)

	Cronbach's alpha if item is deleted
Part 1 (Cronbach's alpha = 0.945)	
Item #1	0.939
Item #2	0.940
Item #3	0.937
Item #4	0.940
Item #5	0.939
Item #6	0.941
Item #7	0.947
Item #8	0.941
Item #9	0.936
Item #10	0.940
Item #11	0.936
Part 2 (Cronbach's alpha = 0.914)	
Item #12	0.905
Item #13	0.894
Item #14	0.892
Item #15	0.878
Item #16	0.901
Part 3 (Cronbach's alpha = 0.951)	
Item #17	0.912
Item #18	0.926
Item #19	0.948

Note. VFI(HK) = Vocal fatigue index (Hong Kong-Chinese version)

Table 5 summarizes the test-retest reliability data of the questionnaire. Spearman's rho analyses on Parts 1, 2 and 3 of the VFI(HK) gave correlation coefficients of 0.885, 0.827 and 0.702 respectively. All of the above analyses showed significant correlation in the Subtotal scores obtained from the two questionnaire attempts.

Table 5 Test-retest reliability data of Parts 1, 2, and 3 of the VFI(HK)

	Spearman's rho	*p*	Level of reliability
Part 1 (items 1 – 11)	0.885	< 0.001*	good
Part 2 (items 12 – 16)	0.827	< 0.001*	good
Part 3 (items 17 – 19)	0.702	< 0.001*	acceptable

Note. VFI(HK) = Vocal fatigue index (Hong Kong-Chinese version), *significant at $p <$ 0.05 level

3.4 Area under curve (AUC) values of the receiver operating characteristic (ROC) curves, sensitivity and specificity

The ROC plots of the Subtotal scores of Parts 1 and 2 are illustrated in Figure 1 and that of the Subtotal score of Part 3 is illustrated in Figure 2. Table 6 summarizes the AUCs of ROC, recommended cutoff scores and their corresponding sensitivity and specificity values for each of the Subtotal scores. The AUCs of Part 1 and Part 2 were 0.712 and 0.694 respectively. Optimal sensitivity and specificity matches resulted from scores of 25 (Part 1) and 10 (Part 2) or above. The AUC of Part 3 was found to be 0.530 and the optimal sensitivity and specificity match resulted from score 9 or below.

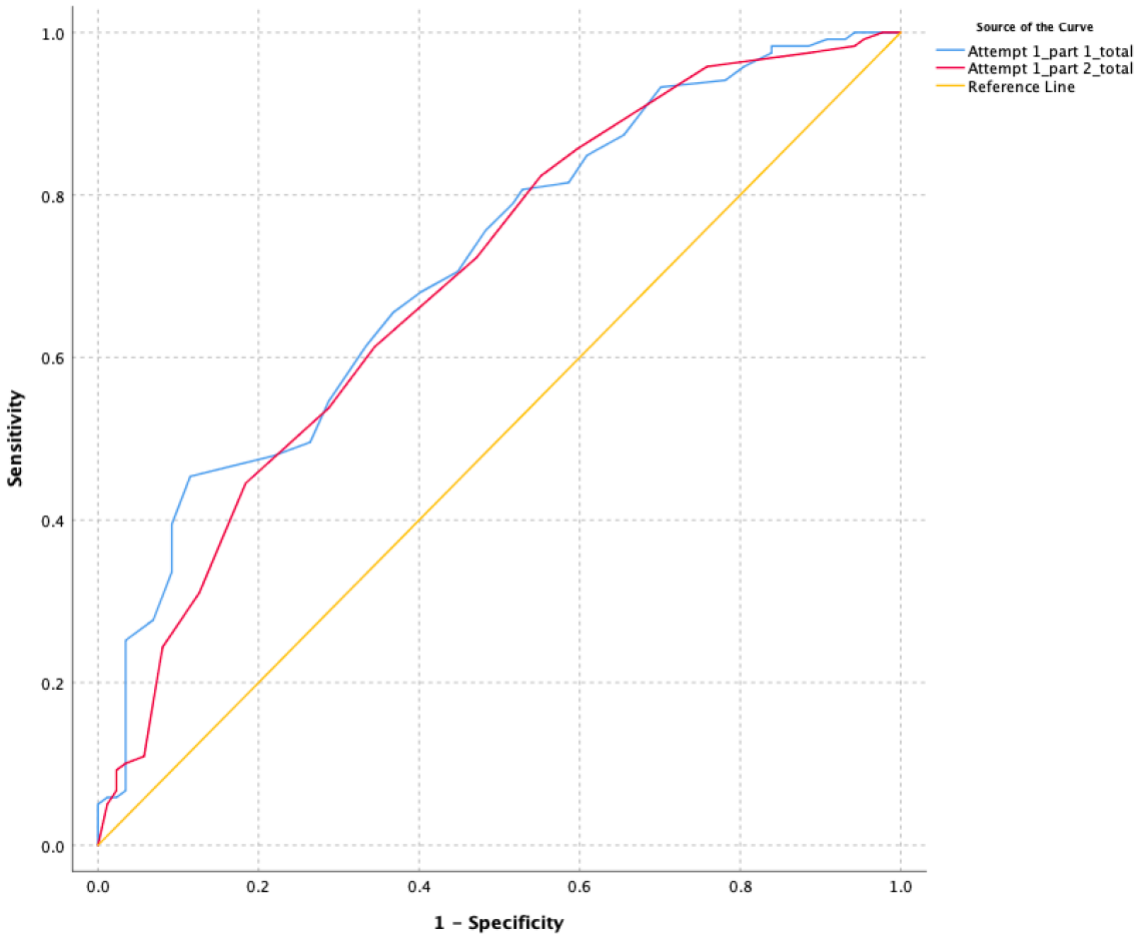

Figure 1. Receiver operating characteristic (ROC) plots of Parts 1 and 2 of the VFI(HK)

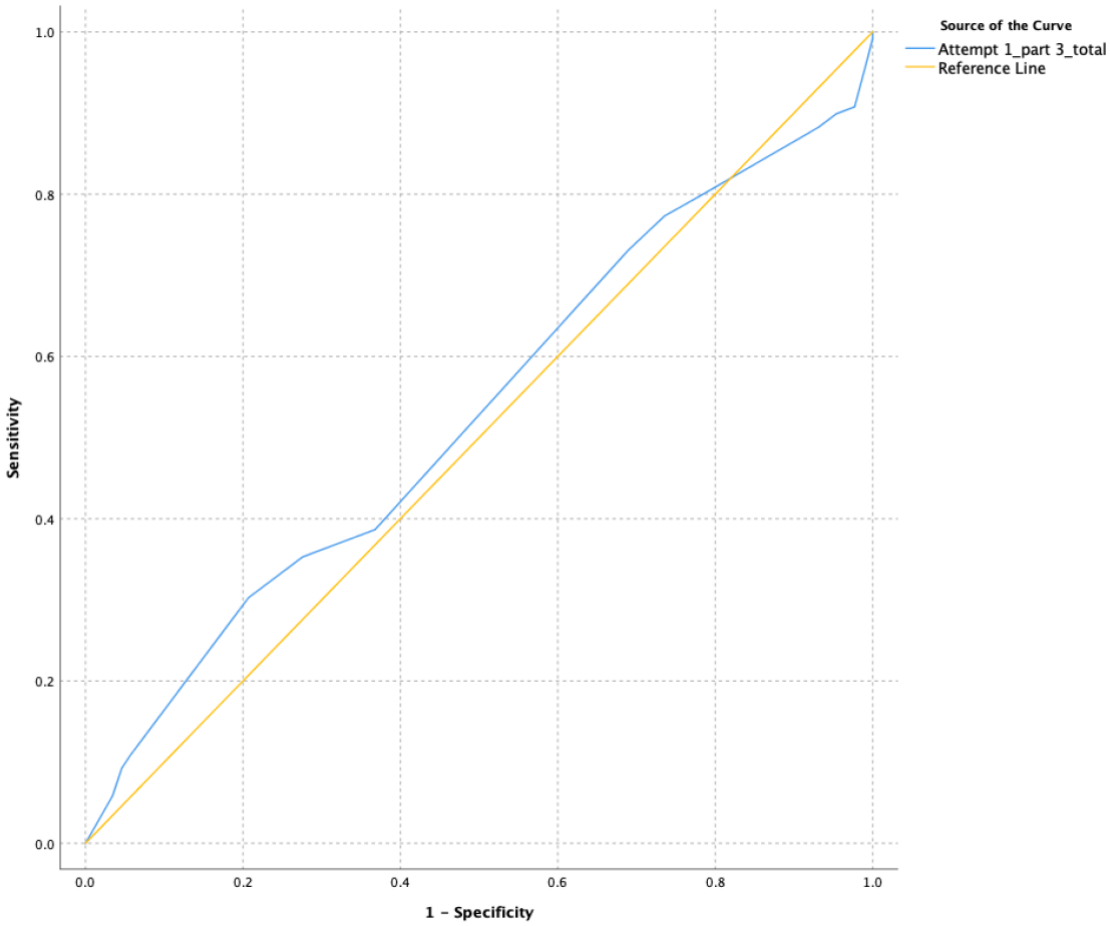

Figure 2. Receiver operating characteristic (ROC) plot of Part 3 of the VFI(HK)

Table 6 Summary of Area under curve (AUC) values of the receiver operating characteristic (ROC) curves, cutoff values, sensitivity and specificity data of Parts 1, 2, and 3 of the VFI(HK).

	AUC of ROC	Cutoff value	Sensitivity	Specificity
Part 1 (items 1 – 11)	0.712	≥ 25	0.655	0.632
Part 2 (items 12 – 16)	0.694	≥10	0.613	0.655
Part 3 (items 17 – 19)	0.530	≤ 9	0.731	0.310

Note. VFI(HK) = Vocal fatigue index (Hong Kong-Chinese version), AUC = area under curve, ROC = Receiver operating characteristic curve

4. Discussion

The present study set out to develop and validate the Hong Kong-Chinese version of the VFI. The VFI(HK) was adapted from the original English version cross-linguistically and cross-culturally in the local context. Modifications in sentence structure, word order and wordings were made to the questionnaire items to make them syntactically sound and semantically acceptable to Cantonese-speaking individuals in Hong Kong.

4.1 Validity, sensitivity and specificity

The VFI(HK) showed good content validity at the scale-level (i.e. the S-CVIs). The Instruction, Rating descriptors and 16 out of 19 items of the VFI(HK) also exhibited excellent item-level content validity (I-CVI = 1), suggesting that these components are relevant to what the assessment tool is intended to measure [19]. For the remaining questionnaire components; namely, the Title, Items #1, #4 and #15; they were rated by one of the panel members as “quite relevant” (the Title, Items #1 and #4) and “irrelevant” (Item #15). It was commented by the

panel member that the concerns lied in the "translation accuracies" of the terms "index" (in the Title), "voice use" (in Items #1 and #4) and "aches" (in Item #15), instead of the actual relevance of these components. The VFI(HK) is, therefore, considered to possess good content validity.

The significant differences in the Subtotal scores of Parts 1 and 2 between the Fatigue and Control groups suggest that these parts of the VFI(HK) possess good construct validities and are capable of discriminating individuals with and without vocal fatigue. The two groups, nevertheless, exhibited comparable Subtotal score in Part 3. Such finding was not observed in the original (i.e. English) and a number of other translated versions of the VFI (e.g. German [13], Persian [11], and Croatian [10]), where between group differences in all parts were found. This may reflect that subjects of the two groups regarded their vocal fatigue and the associated voice problems can be relieved similarly by voice rests.

The discriminating power of the VFI(HK) is further substantiated by the ROC curves. The AUCs of Parts 1 and 2 showed acceptable and close-to-acceptable intrinsic accuracies respectively [16]. From the coordinates of the ROC plots, cutoff scores of 25 (out of 44) and 10 (out of 20) are indicated for Parts 1 and 2 of the questionnaire. The cutoff score of Part 1 resembles that of the original English version, where a cutoff score of 24 was suggested [8]; but notably higher than the German (≥ 15.5) [13] and Malayalam (≥ 16.5) [9] versions. The cutoff score of Part 2 of the VFI(HK) is higher than the above-mentioned versions (original: ≥ 7, German: ≥ 2.5, and Malayalam: ≥ 6.5) [8-9, 13] and the Brazilian version (≥ 1.5) [16]. These among-version discrepancies in cutoff scores may be attributed to the differences in culture in the corresponding populations. The items in Part 2, especially Items #12, #13, and #14, are not

specific to vocal fatigue in Hong Kong. The raw scores from the Control group showed that subjects in Hong Kong, who did not have persistent vocal fatigue, also perceived that they would experience these physical discomforts after prolonged voice use. This is also suggested by the relatively high mean total score (i.e. 8.21) of Part 2 of VFI(HK) in the Control group as compared to that in the original (i.e. 1.44) [8], Malayalam (i.e. 9.26) [9] and German (i.e. 1.55) [13] versions. The necessity of cross-cultural validation before an assessment tool could be applied clinically to any local population is therefore reiterated. It is noteworthy that the AUC of the ROC of Part 3 in the present study was only slightly above 0.5 and suggests very little discriminating power for this particular part of the VFI(HK) [20]. This finding echoes with the Spanish study by Contreras-Regatero et al. [12], in which the AUC of Part 3 failed to reach 0.5. Despite that this part of the VFI(HK) may not be applicable to discriminate individual with vocal fatigue from their non-fatigue counterparts, it is recommended to remain in the questionnaire as it may shed lights on how an individual's vocal fatigue reacts and responds to voice rest [12, 8].

4.2 Reliability

The VFI(HK) showed excellent internal consistency as all its parts exhibited Cronbach's alpha coefficients that are greater than 0.9 [21]. The items are considered to be representative of the corresponding factors intended to be measured; they are, "tiredness of voice", "physical discomfort in related to voice use" and "improvement of vocal fatigue symptoms with rest" [8]. Although Cronbach's alpha coefficient higher than 0.9 may suggest possible redundancy of items in a questionnaire, deletion of item(s) is not recommended. It is because deleting any of the items from the questionnaire would only have a limited effect on Cronbach's alpha coefficient and the numbers of items in each of the three parts of the VFI(HK) are considered minimal (e.g. number of items in Part 1 = 11). The excellent internal consistency of VFI(HK)

resembles that of the Malayalam version [9] and individual parts of other versions (e.g. Part 1 of the English [8] and the Persian version [11], Parts 1 and 3 of the Spanish version [12], Parts 1 and 2 of the German version [13]). Other parts of the above versions also possessed good internal consistencies (i.e. $\alpha \geq 0.82$) [7, 10-12]).

When the VFI(HK) was repeated in seven days by the same group of subjects, the Subtotal scores of the two attempts for Parts 1 and 2 showed strong correlations. This suggests that these two parts of the VFI(HK) are capable of resulting in stable responses. Subtotal score of Part 3, on the other hand, only exhibited acceptable test-retest reliability. A similar pattern was also found in the original English version of the VFI, that is, Parts 1 and 2 showed good whereas Part 3 showed notably poorer test-retest reliabilities [8]. The acceptable-only test-retest reliability for Part 3 of the present study may be attributed to a relatively indirect or non-exclusive linkage between "vocal fatigue" and "improvement of symptoms with rest", the factor intended to be measured by this part of the VFI(HK). This might result in relatively less stable responses provided by the subjects in this part of the questionnaire.

4.3 Clinical implication

The VFI(HK) is the first assessment tool designed to measure the self-perceived phenomenon of vocal fatigue in Hong Kong. It is also the first study to date that validates the questionnaire on non-dysphonic vocally-fatigued subjects and non-fatigued controls. The satisfactory psychometric properties revealed in the present study confirm its clinical application to the vocal-fatigued and/or dysphonic population in Hong Kong (Research question #1). The significant differences in Subtotal scores of Parts 1 and 2 between the Fatigue group and Control group, the acceptable (for Part 1) and close-to-acceptable (for Part 2) AUCs of the

ROC, and the cutoff scores obtained for Parts 1 and 2 suggests that the VFI(HK) may be used as a tool to identify individuals who are vulnerable to vocal fatigue (Research question #2). Through easy and early identification of those who are suffering from and/or at risk of vocal fatigue, intervention (e.g. voice therapy and vocal training) may be implemented in a timely manner and other associated voice problems may be prevented. It is noteworthy that Part 3 of the questionnaire did not show adequate construct validity and discriminating power in the present study, and thus, is not recommended for the measurement of the extent of one's vocal fatigue. This part, however, is not excluded from the questionnaire as it may provide clinical information about one's reactions and responses to voice rest. Clinicians adopting the VFI(HK) should be aware of such.

4.4 Limitations and recommendations

Since there is no "gold standard" assessment for vocal fatigue, particularly the self-perceived component, available in Hong Kong; criterion validity was not analyzed for the VFI(HK). Further, it is recommended that the subjects might be diagnosed on their laryngeal structures and/or vocal function, such that group allocation of subjects could be carried out based on information in addition to their self-reported vocal fatigue symptoms.

5. Conclusion

Findings of the present study confirms the psychometric properties of the VFI(HK). It is the first questionnaire that is available to measure the self-perceived vocal fatigue in Hong Kong. Parts 1 and 2 of the VFI(HK) may be used to identify individuals with vocal fatigue and/or those who are at risk and thus early intervention may be provided to this population. Part 3 of

the questionnaire may provide valuable insights on how one's vocal fatigue reacts and responses to voice rests.

Word count: 3980

6. Reference

[1] Bermúdez De Alvear, R. M., Barón, F. J., & Martínez-arquero, A. G. (2011). School teachers' vocal use, risk factors, and voice disorder prevalence: Guidelines to detect teachers with current voice problems. *Folia Phoniatr Logop*, 63(4), 209-215

[2] Koufman, J. A., & Blalock, P. D. (1988). Vocal fatigue and dysphonia in the professional voice user: Bogart-Bacall syndrome. *Laryngoscope, 98(5)*, 493-498.

[3] Welham, N. V., & Maclagan, M. A. (2003). Vocal fatigue: current knowledge and future directions. *J Voice, 17(1)*, 21-30

[4] Ilomäki, I., Kankare, E., Tyrmi, J., Kleemola, L., & Geneid, A. (2017). Vocal fatigue symptoms and laryngeal status in relation to vocal activity limitation and participation restriction. *J Voice*, 31(2*)*, 248.e247-248.e210.

[5] Solomon, N. (2008). Vocal fatigue and its relation to vocal hyperfunction. *Int. J. Speech-Lang*, 10(4), 254-266.

[6] Vilkman, E. (2004). Occupational safety and health aspects of voice and speech professions. *Folia Phoniatr Logop, 56(4)*, 220-253.

[7] McCabe, D. J., & Titze, I. R. (2002). Chant therapy for treating vocal fatigue among public school teachers: A preliminary study. *Am J Speech Lang Pathol*, 11(4), 356.314p.

[8] Nanjundeswaran, C., Jacobson, B., Gartner-Schmidt, J., & Verdolini Abbott, K. (2015). Vocal Fatigue Index (VFI): Development and validation. *J Voice*, 29(4), 433-440.

[9] Athira, U., & Devadas, U. (2019). Adaptation and validation of vocal fatigue index (VFI) to malayalam language. *J Voice, In Press*. doi:10.1016/j.jvoice.2019.03.002.

[10] Bonetti, A., Bonetti, L., & Čipčić, O. (2019). Self-assessment of vocal fatigue in muscle tension dysphonia and vocal nodules: a preliminary analysis of the discriminatory potential of the croatian adaptation of the VFI (VFI-C). *J Voice, In Press*.

[11] Naderifar, E., Moradi, N., Farzadi, F., Tahmasebi, N., Soltani, M., Latifi, S., & Nanjundeswaran, C. (2018). Cross-cultural adaptation and validation of the VFI into Persian. *J Voice,* 33(6*)*, 947.e935-947.e944.

[12] Contreras-Regatero, S., Vila-Rovira, J., & Verdejo, C. (2019). Validity and reliability of spanish version of two questionnaires of vocal fatigue in female teachers. *J Voice, In press*. doi:10.1016/j.jvoice.2019.07.008.

[13] Latoszek, B. B. v., Auner, M., & Graf, S. (2021). Cross-Cultural Adaption and Validation of the Vocal Fatigue Index in German, *J Voice,* 35(1), 161.e1-161.e13.

[14] Osamu, S., & Miho, S. (2020). Reliability and validity of Vocal Fatigue Index (VFI) in Japanese version:—study of patients with dysphonia and healthy young to middle-aged adults. *Japan J. of Logop. Phoniatr.*, 61(1), 50-60.

[15] Srinivas, S., Mahalingam, S., & Boominathan, P. (2020) Cultural and Linguistic Adaptation of Vocal Fatigue Index for Tamil-Speaking Population (VFI-T), *J Voice,*10.1016/j.jvoice.2020.01.002.

[16] Zambon F, Moreti F, Ribeiro VV, Nanjundeswaran C, & Behlau M. (2020) Vocal Fatigue Index: Validation and Cut-off Values of the Brazilian Version. *J Voice*. Jul 18:S0892-1997(20)30235-6. doi: 10.1016/j.jvoice.2020.06.018.

[17] Hunter, E. J., & Banks, R. E. (2017). Gender Differences in the Reporting of Vocal Fatigue in Teachers as Quantified by the Vocal Fatigue Index. *Ann. Otol. Rhinol. Laryngol, 126*(12), 813–818.

[18] Koufman, J. A., & Isaacson G. (1991)The spectrum of vocal dysfunction. *Otolaryngol Clin North Am*. Oct;24(5):985-8. PMID: 1754226.

[19] Yusoff, M. S. B. (2019). ABC of Content Validation and Content Validity Index Calculation. *Med. Educ.* , 11(2*)*, 49-54.

[20] Mandrekar, J. N. (2010). Receiver operating characteristic curve in diagnostic test assessment. *J Thorac Oncol*, 5(9), 1315-1316.

[21] George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference 11.0 update* (4th ed.). Boston: Ally & Bacon.

Appendix 1. Self-reported symptoms related to vocal fatigue

- Excessive effort for phonation.
- Tightness in neck, throat and lower jaw muscles.
- Soreness in throat.
- The urge to throat-clear.
- Powerlessness in phonation.
- Strained voice.
- Hoarse voice.
- Breathy voice.
- Reduction in pitch range.
- Reduction in loudness range.

Appendix 2. The original, backward translation and Hong Kong-Chinese version of the Vocal Fatigue Index (VFI(HK))

Questionnaire components	Original	Backward Translation	VFI(HK)
Title	Vocal Fatigue Index – VFI version 2	Vocal Fatigue Index – VFI version 2	聲線疲勞指標 – 第二版
Instruction	These are some symptoms usually associated with voice problems. Circle the response that indicates how frequently you experience the same symptoms (0 – never, 1 – almost never, 2 – sometimes, 3 – almost always, and 4 – always).	Listed below are some related symptoms of voice problems, please indicate how often you experience these symptoms by circling your answer. (0 – never, 1 – almost never, 2 – sometimes, 3 – quite often, 4 – very often)	以下是一些與聲線問題相關的症狀，請圈出回應，顯示你有多經常經歷這些症狀。 (0 – 從不, 1 – 近乎沒有, 2 – 有時, 3 – 頗經常, 4 – 極經常)
Items			
#1	I don't feel like talking after a period of voice use.	After using my voice for a period of time, I don't want to talk.	運用聲線一段時間後，我便不想說話。
#2	My voice feels tired when I talk more.	When I talk more, my voice gets tired.	當我說話多了，我感到聲線疲勞。
#3	I experience increased sense of effort with talking.	I feel that I need more and more effort when I talk.	我感到說話時越來越費力。
#4	My voice gets hoarse with voice use.	After using my voice, it gets hoarse.	運用聲線後，我的聲音變得沙啞。
#5	It feels like work to use my voice.	I feel difficult in using my voice.	我感到用聲很吃力。
#6	I tend to generally limit my talking after a period of voice use.	After using my voice for a period of time, I tend to talk less.	運用聲線一段時間後，我一般會傾向減少說話。
#7	I avoid social situations when I know I have to talk more.	I try to avoid social occasions in which a lot of conversations are required.	我會避免出席那些需要我說很多話的交際場合。
#8	I feel I cannot talk to my family after a work day.	At the end of a day's work, I feel that I cannot talk to my family.	當我完成一整天工作後，我覺得自己不能跟家人說話。
#9	It is effortful to produce my voice after a period of voice use.	After using my voice for a period of time, I feel effortful to produce voice.	運用聲線一段時間後，我感到發聲十分費力。

#10	I find it difficult to project my voice with voice use.	I feel particularly difficult to project my voice while using it.	我感到用聲時很難放大聲線。
#11	My voice feels weak after a period of voice use.	After using my voice for a period of time, I feel it gets weaker.	運用聲線一段時間後，我感到聲線變弱。
#12	I experience pain in the neck at the end of the day with voice use.	After a whole day with voice use, I feel pain in the neck.	用聲一整天後，我感到頸部疼痛。
#13	I experience throat pain at the end of the day with voice use.	After a whole day with voice use, I have a sore throat.	用聲一整天後，我感到喉嚨痛。
#14	My voice feels sore when I talk more.	When I talk more, my voice feels hurt.	當我說話多了，便出現嗓子痛。
#15	My throat aches with voice use.	When I use my voice, my throat aches	我用聲時喉嚨會隱隱作痛。
#16	I experience discomfort in my neck with voice use.	When I use my voice, I feel discomfort in my neck.	我用聲時頸部會感到不適。
#17	My voice feels better after I have rested.	After rest, I feel a bit better with my voice.	我休息後便會感到聲線好一些。
#18	The effort to produce my voice decreases with rest.	After rest, I feel less effortful to use my voice.	休息後，我感到用聲不用那麼費力。
#19	The hoarseness of my voice gets better with rest.	After rest, the problem of hoarseness gets better.	休息後，我的聲音沙啞問題會好一些。