The Diagnostic Criteria of Gambling Disorder of DSM-5 in Chinese Culture: By Confirmatory Factor Analysis (CFA) and Item Response Theory (IRT)

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Abstract Problem and pathological gambling are currently known as gambling disorder as listed in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorder* (DSM-5; American Psychiatric Association in Diagnostic and statistical manual of mental disorders. American Psychiatric Association, Washington, DC, 2013). Nevertheless, in Hong Kong, the development of gambling disorder treatment and research is still at an infant stage (Shek, Chan & Wong in Int J Child Health Hum Dev 6(1):125–144, 2013). This article will discuss the diagnostic criteria gambling disorder listed in DSM-5 in Hong Kong context. With confirmatory factor analysis (CFA) and item response theory (IRT), the diagnostic criteria of gambling disorder listed in DSM-5 were found to be a reliable and valid assessment. With differential item function (DIF) analysis, it was found that the diagnostic criteria of gambling disorder listed in DSM-5 could discriminate those who experience and demonstrate gambling disorder. Hence, the aforementioned criteria could serve as a screening tool differentiating those who have or do not have

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gambling disorder. To facilitate the clinical procedure, the IRT results suggested a procedure of interviewing potential clients with the diagnostic criteria of gambling disorder for screening purpose.

1 Introduction

Problem and pathological gambling are currently known as gambling disorder as listed in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorder* (DSM-5; American Psychiatric Association, 2013). The prevalence rate of gambling disorder was found between 0.2 and 5.3% (Hodgins, Stea, & Grant, 2011). In Hong Kong, a study conducted in 2011 (Ho, Chung, Hui-Lo, & Wong, 2012) indicated that the prevalence rate of possible gambling disorder was 1.4–2.2%, respectively. Gambling disorder could have various adverse effects on individuals, families and society. The undesirable consequences would entail debt problems, marital conflicts, criminal behaviour, family violence and breakdown as well as severe emotional and mental health problems (Abbott, 2001; Krishnan & Orford, 2002; Black, Monahan, Temkit, & Shaw, 2005). Therefore, a reliable and valid assessment tool screening individuals with gambling disorder for pre-emptive treatment is of paramount importance. Nevertheless, in Hong Kong, the development of gambling disorder treatment and research is still at an infant stage (Shek, Chan, & Wong, 2013). This article will discuss the diagnostic criteria gambling disorder listed in DSM-5 in Hong Kong context.

1.1 Gambling in Chinese Culture

Social-cultural influences can determine an individual's health-related behaviours (Stokols, 1996). In Chinese culture, it is convinced that small betting is fun, but excessive betting ruins the mind (Wu & Lau, 2014). Gambling with small wagers is acceptable and conceptualized as "game-playing" or "gaming" for entertainment rather gambling. Some traditional games such "mah-jong" and "pai-ju" are even deemed as cultural assets (Wu & Lau, 2014). In Chinese context, although high-stakes gambling is inappropriate and greed for money is thought to be unethical, "gaming" is widely socially acceptable. "Gaming" serves different social functions (Steinmuller, 2011; Wu, Tao, Tong, & Cheung, 2012). Playing mah-jong is an essential part of celebrations such as during a wedding reception. Even children are allowed to bet on games with their adult family members during Chinese New Year. It is believed to be an opportunity to foster interpersonal connections (Steinmuller, 2011).

1.2 Diagnostic Criteria of Gambling Disorder in DSM-5

According to the DSM-5, there are in total of nine diagnostic criteria for gambling disorder, namely preoccupation with gambling; tolerance; loss of control; withdrawal; escape gambling; chasing losses; lying about gambling behaviour; significant social, employment or education consequences; and seeking financial bailouts (Weinstock et al. 2013). The threshold value is 4 out of 9 criteria. The severity levels are classified into being: mild (4–5 criteria), moderate (6–7 criteria) and severe (8–9 criteria). DSM-5 is a Guttman scale and a worldwide diagnostic guideline for the helping professionals. On the other hand, as mentioned above, gambling is culturally specific. At least, gambling exists with its unique features in Chinese culture. The researchers were interested in how the DSM-5 gambling disorder diagnostic criteria can be applied to Hong Kong Chinese context. Moreover, the researchers were curious of the reliability and validity of the DSM-5 gambling disorder diagnostic criteria in Hong Kong Chinese context where the corresponding diagnostic criteria could function as an accurate clinical assessment screening individuals with gambling disorder.

2 Current Study

The current study aimed at investigating the reliability and the validity of the DSM-5 gambling disorder diagnostic criteria using confirmatory factor analysis (CFA) with weighted least square (Byrne, 1998; Kline, 2010) and item response theory (IRT) by 2-parameter logistic regression Rasch model (2-PL model; Smith, 2004; Bond & Fox, 2007). Later on, the differential item functioning (DIF) between samples with and without gambling disorder would be investigated. Descriptive statistics were analysed using SPSS 22.0; CFA was investigated utilizing Lisrel 8.51; and the item parameter statistics and DIF were examined utilizing IRTPRO 2.1.

3 Methods

3.1 Participants

Data ($N = 1694$) for the analyses of the current study were retained from a total 2066 respondents to the street intercept survey. Among the 1694 respondents, 875 respondents (51.65%) were male while there were female; 593 respondents (35.01%) were or below 17 years old while 1101 respondents (64.99%) were or above 18 years old; 1085 respondents (64.05%) were students while 609 respondents (35.95%) were not students; and 1574 respondents (92.92%) reported not

having gambling disorder while 120 respondents (7.08%) reported having gambling disorder, i.e. the respondents' accumulative scores in reference of the DSM-5 gambling disorder were equal to or higher than the threshold of four.
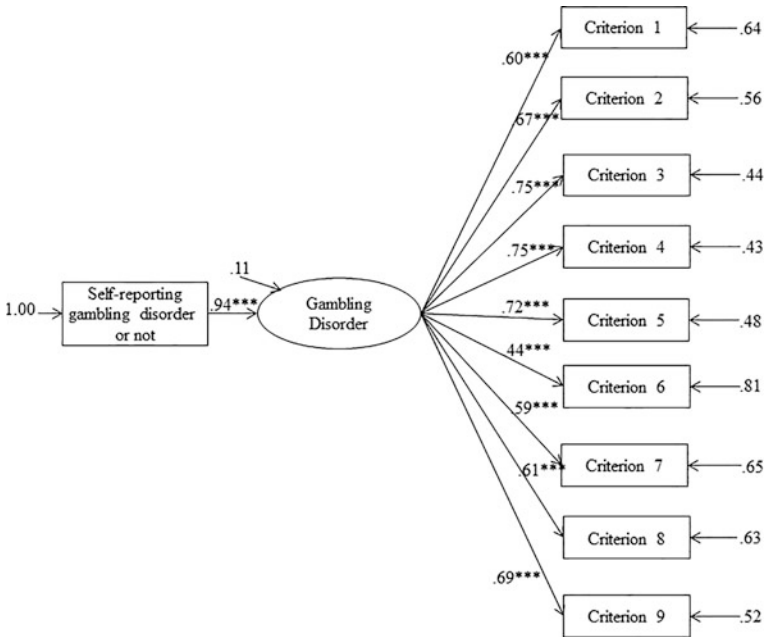
3.2 Measure

The survey was grounded on the nine diagnostic criteria for gambling disorder of DSM-5 which is a dichotomous Guttman scale. "Yes" referred to presence of the symptoms while "no" referred to absence of the symptoms. According to DSM-5, the threshold number of symptoms is four. The severity levels are determined as follows: mild (4–5 symptoms), moderate (6–7 symptoms) and severe (8–9 symptoms).

4   Result

The validity and reliability would be investigated in this session. Before CFA analysis was conducted, the respondents had been classified into two groups: group 1—those who reported not having gambling disorder and group 2—those who reported having gambling disorder. With the dichotomy of the dummy variable having gambling disorder (0 = no, 1 = yes), multiple-indicator-multiple-cause (MIMIC; Kline, 2010) modelling approach was employed. The model fitness of a MIMIC-CFA model would be appropriate given that comparative-fitness index (CFI) $\geq$ 0.95, goodness-of-fit index (GFI) $\geq$ 0.90 and standard root mean error of approximation (RMSEA) $\leq$ 0.080 (Byrne, 1998; Hu & Bentler, 1999; Kline, 2010). The estimated model of the gambling disorder demonstrated acceptable model fitness to the data, χ^2 (df = 35) = 521.13, RMSEA = 0.084, CFI = 0.95, GFI = 0.95. The composite reliability (ρ; Fornell & Larcker, 1981; Raykov, 2009) was 0.87 which illustrated the appropriate reliability. The CFA model is depicted in Fig. 1.

As for item response theory (IRT), unidimensionality is an underlying assumption (Bjorner, Kosinski, & Ware, 2003; Brown, 2006; Cook et al., 2007). The aforementioned CFA result indicated that the nine diagnostic criteria of gambling disorder would belong to a single factor model. The diagnostic criteria of gambling disorder were analysed by IRT by using 2-PL Rasch model (Smith, 2004; Bond & Fox, 2007). IRT utilizes probabilistic model to construct a questionnaire based on the relationship between an individual's response to a question and the individual's level on the construct (θ) being measured by the scale. This relationship is conditional in those individuals with higher probability of endorsing response categories that are consistent with higher trait levels (Hambleton, Swaminathan, & Rogers, 1991; Bond & Fox, 2007). IRT also allows the responses (raw scores) from different items representing different severity. Therefore, IRT model is that an individual's

Fig. 1 MIMIC-CFA model of the diagnostic criteria of gambling disorder of DSM-5

response to any given item reveals a level of ability in the trait being measured. The Rasch model aims at looking beyond a logistic function that relates the respondent's underlying traits and item difficulty to the probability of endorsing an item (Smith, 2004). Furthermore, item information function (IIF) is imperative to describing and evaluating an assessment (Hambleton & Swaminathan, 1985). IIF highlights the contribution of each item to the total assessment information and the consequences of selecting a particular item independently from other items in the assessment independently from other items in the assessment (De Ayala, 2009).

There were two groups classified for IRT analysis: group 1 referred to the respondents reporting no gambling disorder. The goodness-of-fit indices are illustrated in Table 1. The item parameter statistics of group 1 and group 2 are tabulated in Tables 2 and 3, respectively. The item information curves of every single criterion of group 1 and group 2 are visualized in Figs. 2 and 3 correspondingly. The total information curves of group 1 and group 2 are illustrated in Fig. 4.

Table 1 Table of the likelihood-based values and goodness-of-fit statistics

	−2loglikelihood	Akaike information criterion (AIC)	Bayesian information criterion (BIC)
Gambling disorder	5421.16	5493.16	5688.81

Table 2 Item parameter estimates and fit statistics of 2-PL model of gambling disorder (group 1—normal samples)

Item	a	c	b	χ^2	df	p
Criterion 1	1.80	−4.16	2.31	15.48	2	0.0004
Criterion 2	2.37	−5.06	2.14	25.05	2	0.0001
Criterion 3	1.13	−4.71	4.18	15.05	2	0.0005
Criterion 4	2.01	−6.48	3.23	11.08	2	0.0039
Criterion 5	1.29	−4.23	3.28	13.01	2	0.0015
Criterion 6	1.52	−2.15	1.42	21.75	2	0.0001
Criterion 7	1.06	−4.03	3.79	12.45	2	0.0020
Criterion 8	0.74	−3.98	5.38	7.29	2	0.0261
Criterion 9	1.50	−6.20	4.14	11.63	2	0.0030

Table 3 Item parameter estimates and fit statistics of 2-PL model of gambling disorder (group 2—samples reported having gambling disorder)

Item	a	c	b	χ^2	df	p
Criterion 1	0.56	−1.01	1.81	12.77	4	0.0124
Criterion 2	−0.80	4.06	5.08	14.66	4	0.0055
Criterion 3	1.59	−4.43	−4.43	28.11	4	0.0001
Criterion 4	1.33	−3.90	2.94	23.45	4	0.0001
Criterion 5	2.57	−7.19	2.79	22.74	4	0.0001
Criterion 6	−0.27	2.45	9.22	17.74	4	0.0014
Criterion 7	3.81	−12.41	3.26	32.95	4	0.0001
Criterion 8	1.35	−4.27	3.17	39.21	4	0.0001
Criterion 9	4.42	−14.83	3.35	5.80	3	0.1215

Differential item functioning (DIF) refers to a psychometric difference in how an item functions across groups. An item that performs differently must necessarily be less valid, in some senses, for at least one of the groups. As a result, an effort to detect and eliminate DIF from tests seeks to increase the validity of the test for all groups (De Ayala, 2009). With respect to the detection of DIF, the expected value curve (EVC) of the responses groups to an item was employed (Hagquist & Andrich, 2015). DIF across different groups implies that for the same values of the variable, and the EVC of the response to an item for members of the groups is different. If the differences along the variables are homogenous, then the DIF is referred to as uniform; otherwise, it is said to be as non-uniform (Hagquist & Andrich, 2015), i.e. uniform DIF appears when responses to an item vary consistently according to the respondents' characteristic after allowing for the level of the scale score. Non-uniform DIF emerges when the magnitude of such response differences vary according to the level of the matching variable. The DIFs of all the diagnostic criteria between two groups were examined by Wald test (Lord, 1980; as cited in Cohen, Kim, & Baker, 1993). The DIF statistics are illustrated in Table 4. The DIFs of all the corresponding items are visualized by the item characteristic curves (ICCs) of Fig. 5. The item information curves of all the criteria demonstrating DIF are visualized in Fig. 6.
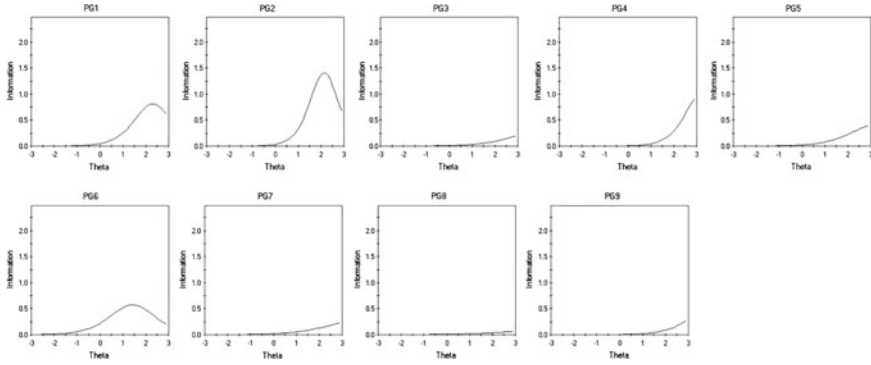
Fig. 2 Item information curves of group 1 those who reported not having gambling disorder
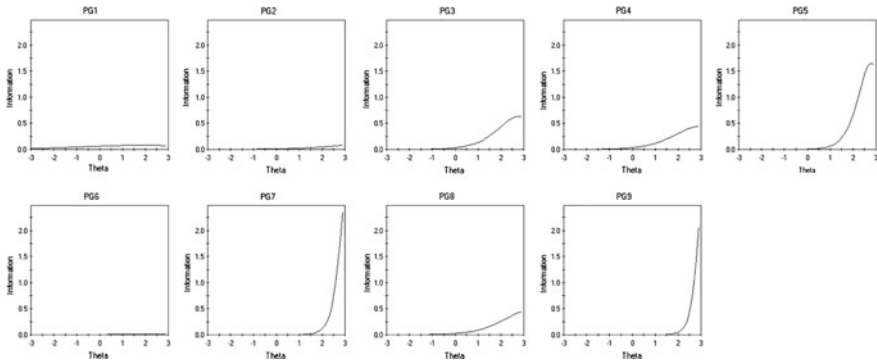

Fig. 3 Item information curves of the gambling disorder diagnostic criteria for group 2 those who report having gambling disorder
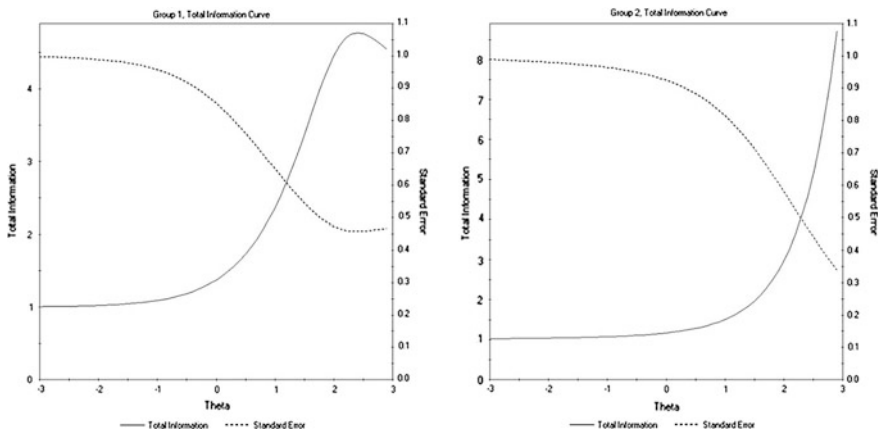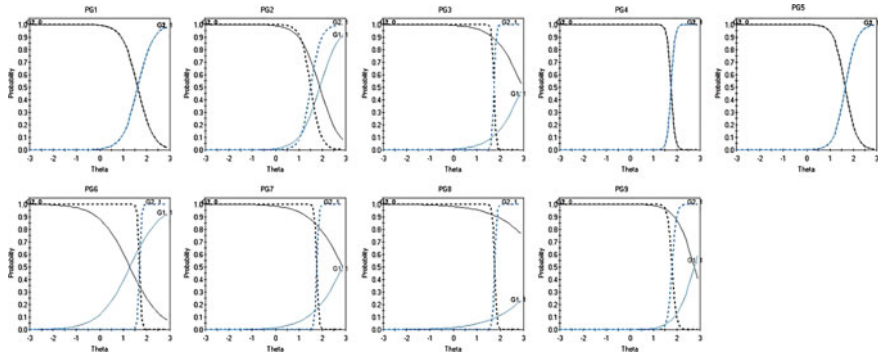

Fig. 4 Total information curves for group 1 and group 2

**Table 4** Differential item functioning statistics for graded items of gambling disorder

Item numbers in:		Total χ^2	df	p	χ^2_a	df	p	$\chi^2_{c|a}$	df	p
Group 1 (normal)	Group 2 (disordered gambler)									
Criterion 2	Criterion 2	9.2	2	0.0102*	1.8	1	0.1855	7.4	1	0.0065**
Criterion 3	Criterion 3	5674.8	2	0.0001***	2339.1	1	0.0001***	3335.7	1	0.0001***
Criterion 6	Criterion 6	196.8	2	0.0001***	193.0	1	0.0001***	3.8	1	0.0516
Criterion 7	Criterion 7	10,804.2	2	0.0001***	3800.0	1	0.0001***	7004.1	1	0.0001***
Criterion 8	Criterion 8	956.2	2	0.0001***	877.6	1	0.0001***	78.5	1	0.0001***
Criterion 9	Criterion 9	7.1	2	0.0283*	6.1	1	0.0138*	1.1	1	0.3020

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Fig. 5 Item characteristic curves of the diagnostic criteria demonstrating DIF between group 1 and group 2
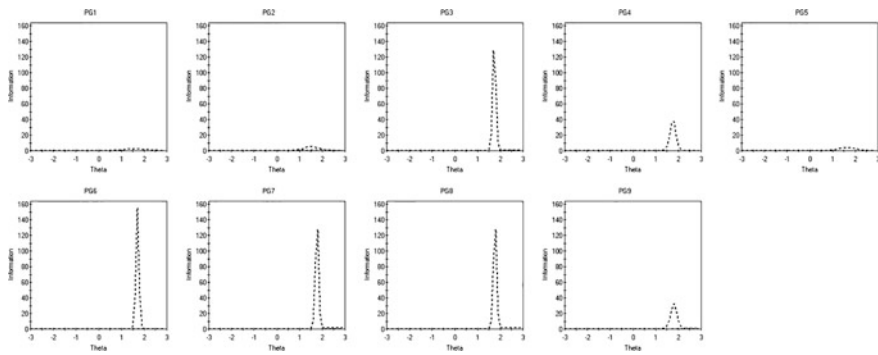
Fig. 6 Item information curves of the diagnostic criteria demonstrating DIF between group 1 and group 2

Referring to Table 4 and Fig. 5, the DIF analysis results indicated that group 2 respondents endorsed criteria 2, 3, 6, 7, 8 and 9 at significantly different baselines because p-values for total $\chi^2(df = 2)$ were smaller than 0.05. Except criterion 2, criteria 3, 6, 7, 8 and 9 of group 2 demonstrated significantly steeper slopes than those of group 1. The p-values of $\chi_a^2(df = 1)$ of those criteria with steeper slopes were smaller than 0.05. Integrating the DIF results and Fig. 5, it was found that those items could discriminate the latent traits (gambling disorder symptoms) more precisely for group 2 than for group 1 respondents. The results also illustrated that criterion 6 and criterion 9 embodied significant uniform DIF, and the p-values for $\chi_{c|a}^2(df = 1)$ were larger than 0.05. On the other hand, criteria 2, 3, 7 and 8 demonstrated significant non-uniform DIFs, and the p-values for $\chi_{c|a}^2(df = 1)$ were smaller than 0.01.

5 Discussion

Although CFA and IRT study latent variables (De Ayala, 2009; Kline, 2010), they offer us two different approaches to evaluate the scale, i.e. CFA provides us with particular factorial structure of the entire construct which a scale assesses (a top-down approach) while IRT evaluates an assessment on the item-by-item basis (a bottom-up approach). In a sense, CFA and IRT are deemed complementary to evaluate an assessment holistically.

Via CFA, the reliability and validity of the diagnostic criteria of gambling disorder of DSM-5 were examined. According to the aforementioned CFA results, the composite reliability (ρ) was 0.87 which was larger than the threshold value of 0.70 (Fornell & Larcker, 1981; Raykov, 2009). The diagnostic criteria of gambling disorder were found to be a set of reliable assessment tools. The validity of the diagnostic criteria of gambling disorder was found to be appropriate either, χ^2 ($df = 35$) = 521.13, RMSEA = 0.084, CFI = 0.95, GFI = 0.95. In accordance with the MIMIC-CFA results, a respondent reporting having gambling disorder or not could have a significant and positive contribution ($\gamma = 0.94$, $p < 0.001$) to the latent variable of "gambling disorder", i.e. a respondent reported experiencing and demonstrating four or more than four gambling disorder symptoms would be conceptualized to have gambling disorder.

At item level, as for group 1 (those reported having no gambling disorder), the item information curves of criteria 1, 2, 4 and 6 were relatively higher than other criterion. In addition, the item information curves of all the diagnostic criteria were negatively skewed, i.e. the means of the curves were larger than $\theta = 0.00$. It indicated that the highest probabilities of the respondents endorsing the items hinged upon those who rated themselves on the diagnostic criteria higher than the mean response when compared to the samples' normative response. In other words, the diagnostic criteria were effective in discriminating those who experienced and demonstrated some gambling symptoms, yet under the threshold. As for group 2 (those reported having gambling disorder), the item information curves of criteria 5, 7 and 9 were relatively higher than other criteria. Moreover, the researchers had similar findings to those of group 1 in terms of skewness. As for group 2, the item information curves of all the diagnostic criteria were negatively skilled. The total information curves depicted in Fig. 6 indicated that the diagnostic criteria were effective in discriminating respondents with more severe gambling disorder.

Integrating the aforementioned points, the diagnostic criteria were sensitive to those with comparatively more gambling disorder symptoms. In clinical settings, particularly in clinical interviews, a therapist might first adopt criteria 5, 7 and 9 since they would serve as a screening tool effectively discriminating an individual with severe gambling disorder. If the individual reported "no" to criteria 5, 7 and 9, the therapist could continue the interview with criterion 2 first as it was found to have the highest item information function among criteria 1, 2, 4 and 6. Whenever the individual reported "no" to criterion 2, the therapist could move on with criteria 1, 4 and 6 correspondingly. If the individual reported "no" to the aforementioned

criteria, the remnants could be retained as the individual had already been asked for seven items. The individual would be diagnosed to be normal although the individual reported "yes" to criterion 3 and criterion 8. The aforementioned questioning procedure might serve as a quick screening test for normal population. With respect to an individual with gambling disorder, the individual could also undergo the aforementioned questioning procedure. Owing to the high item information functions of criteria 5, 7 and 9, it would probably be a reminder for a therapist of the client's possible gambling disorder. Therefore, the therapist would better be more attentive to the gambling disorder-related information whenever the client endorsed criteria 5, 7 and 9.

With regard to the criterion demonstrating DIF, the item characteristic curves visualized in Fig. 5 illustrated that the respondents reporting having gambling disorder endorsed the diagnostic criteria of 6 and 9 at significantly higher baselines when compared to the respondent reporting not having gambling disorder. However, the respondents with gambling disorder endorsed the diagnostic criteria of 2, 3, 7 and 8 at a significantly lower baseline when compared to the respondents reporting not having gambling disorder. The respondents with gambling disorder endorsed the corresponding diagnostic criteria with significantly higher likelihood than those who reported no gambling disorder (group 1). As for criteria 3, 6, 7, 8 and 9 for group 2, as reflected by the item characteristic curves illustrated in Fig. 3, they were more discriminant to respondents with gambling disorder than to those who reported no gambling disorder. According to the item information curves depicted in Fig. 6, the respondents within gambling disorder endorsed criteria 3, 6, 7, 8 and 9 to provide more information than the respondents reporting not having gambling disorder did. As for criteria 2, 3 7 and 8, non-uniform DIF appeared between respondents reporting having and not having gambling disorder. To elaborate, an individual with mild gambling disorder would be less possible than another individual without gambling behaviour to experience and demonstrate gambling disorder symptoms 2, 3, 7 and 8. Meanwhile, an individual with severe gambling disorder would be more prone to the aforementioned gambling disorder symptoms than an individual without gambling disorder. An individual with gambling disorder, regardless of the severity, would be more likely than another individual without gambling disorder to experience and demonstrate symptom 6 and symptom 9.

6   Conclusion and Implication

There are cultural differences in gambling behaviours across Western and Chinese cultures. DSM-5 is applied widely in Western context, and its diagnostic criteria for gambling disorder have never been studied in Hong Kong context. The current study examined the psychometric properties of the diagnostic criteria of gambling disorder of DSM-5 in Hong Kong context. MIMIC-CFA result indicated that the aforementioned diagnostic criteria were found to be a reliable and valid assessment

tool. IRT results illustrated that the aforementioned diagnostic criteria would be effective in screening individuals with gambling disorder. Meanwhile, they would be comparative less sensitive to individuals without gambling disorder. Although they would serve as a efficacious clinical screening tool for those who already have gambling disorder, they would not be an effective assessment tool for preventive purpose. They would be relatively insensitive to those who might be at risk, i.e. the total score is near but yet to reach the threshold. All in all, the diagnostic criteria of gambling disorder of DSM-5 were found to be reliable and valid in Hong Kong.

7 Limitations

Several limitations should be taken into account when evaluating the current study. First, the data collected in the current study were on the basis of self-report which was void of observations of behaviours. The sampling size ($N = 1694$) suggested that the potential biased errors were present and generalization to other samples might be limited. The current study was fundamentally a cross-sectional survey in Chinese culture. The research design was not a longitudinal study investigating the causal effects among the variables. Hence, the causal relationships among the currently studied variables might not be valid. Further interpretations must be made carefully and modestly in the current study. In the future, a causal model of the studied phenomenon should be established which could more elaborately portray the mechanism for devising further therapeutic interventions. Furthermore, empirical researches should be conducted to investigate the effectiveness of the aforementioned interventions in terms of their impacts on the diagnostic criteria of gambling disorder of DSM-5.

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