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<td><strong>Author(s)</strong></td>
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The Chinese version of the pelvic pain and urgency/frequency symptom scale: a useful assessment tool for street-ketamine abusers with lower urinary tract symptoms

Objective
To investigate the use of a translated Chinese version of the pelvic pain and urgency/frequency symptom scale as an assessment and prognostic tool to evaluate the severity of street-ketamine-associated lower urinary tract symptoms and their reversibility after abstinence.

Design
Cross-sectional study.

Setting
A special designated out-patient clinic in a regional hospital in Hong Kong.

Participants
There were 50 patients with street-ketamine–associated lower urinary tract symptoms and 20 healthy individuals.

Main outcome measures
Reliability and validity of the questionnaire; frequency of individual lower urinary tract symptoms, cystoscopic, urodynamic and radiological abnormalities, and their correlation with pelvic pain and the urgency/frequency score.

Results
The test-retest reliability coefficient was 0.755 (P<0.001). Cronbach's alpha was 0.974. Mann-Whitney U test proved the discriminatory ability of the questionnaire (P<0.001). Patients with specific lower urinary tract symptoms had a higher mean pelvic pain and urgency/frequency total score compared to those without them: frequency (23.8 vs 17.3), nocturia (22.4 vs 14.0), urgency (22.5 vs 15.1), dysuria (22.7 vs 13.3), and haematuria (24.8 vs 16.2). The number of daytime voids and nocturia episodes correlated well with pelvic pain and urgency/frequency scores. With an increasing score, the likelihood of having cystitis changes, urodynamic abnormalities and hydronephrosis increased, while the cystometrically determined bladder capacity decreased. None of the patients with a score of 16 or below had urodynamic abnormality or hydronephrosis. The mean score change in the abstinence group was -4.33, versus +3.33 in their counterparts.

Conclusions
The Chinese version of the pelvic pain and urgency/frequency questionnaire is reliable and valid for assessment in patients with street-ketamine–associated lower urinary tract symptoms. The pelvic pain and urgency/frequency score correlates well with symptom severity as well as endoscopic, urodynamic and radiological abnormalities in patients with street-ketamine–associated lower urinary tract symptoms. A cut-off total pelvic pain and urgency/frequency score of 17 may suggest more serious urological sequelae from ketamine abuse. Abstinence from ketamine reduced lower urinary tract symptoms, but the extent of reversibility of urinary tract damage is yet to be evaluated.

Key words
Ketamine; Lower urinary tract symptoms; Questionnaires; Sensitivity and specificity; Substance-related disorders

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New knowledge added by this study
• With an increasing pelvic pain and urgency/frequency (PUF) symptom score of above 16 in patients with lower urinary tract symptoms after ketamine abuse, the urological sequelae are more serious, with increasing likelihood of having cystitis changes, urodynamic abnormalities and hydronephrosis, while the cystometrically determined bladder capacity decreases.

Implications for clinical practice or policy
• The Chinese version of the PUF patient symptom scale can be adopted as an assessment tool in patients with lower urinary tract symptoms after ketamine abuse. This tool can be used by social workers, teachers, and medical personnel. Those with a score of 17 or above warrant more in-depth urological care.

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盆腔疼痛及尿急／频尿症状测量表（中文版）
作为侦测街头氯氨酮滥用者下尿道症状的一个有效工具

目的
探究使用盆腔疼痛及尿急／频尿症状测量表（中文版）作为氯氨酮滥用者下尿道症状的侦测工具是否有效。当他们停止滥药后，该测量表是否可以作为一个预后工具检测其逆转情况？

设计
横断面研究。

安排
香港一所分院医院的指定特别门诊。

参与者的测量
测量表的信度和效度：出现下尿道症状的频率；膀胱镜、尿动力学及影像学检查的异常情况；以及与上述有关的盆腔疼痛及尿急／频尿症状测量表得分。

主要结果
重测信度为0.755（P<0.001），Cronbach’s alpha系数为0.974。曼-惠特尼U检验证明测量表具辨别力（P<0.001）。与健康状况良好的一组比较，出现下尿道症状的频率；膀胱镜、尿动力学及影像学检查的异常情况；以及与上述有关的盆腔疼痛及尿急／频尿症状测量表得分。

结果
测量表的信度和效度：出现下尿道症状的频率；膀胱镜、尿动力学及影像学检查的异常情况；以及与上述有关的盆腔疼痛及尿急／频尿症状测量表得分。

结論
结論
盆腔疼痛及尿急／频尿症状测量表（中文版）作为侦测街头氯氨酮滥用者下尿道症状的一个有效工具

Introduction
Ketamine is a N-methyl-D-aspartate receptor antagonist developed in 1962 as an anesthetic agent.¹ It is less potent and shorter-acting than phencyclidine and is used as a dissociative anesthetic.² However, it has been increasingly used as a recreational drug by youngsters in clubs and parties, including raves. This global phenomenon involves countries/regions like China (including Hong Kong), Taiwan, Indonesia, Malaysia, Japan, Korea, the United Kingdom, Netherlands, Belgium, Russia, Canada, and the United States.³ A significant proportion of street ketamine abusers develop lower urinary tract symptoms (LUTS), which have been reported in many different countries.⁴⁻⁶ This new clinical entity, first termed ketamine-associated ulcerative cystitis,⁷ or ‘street-ketamine’ associated bladder dysfunction,⁸ is characterised by symptoms of lower urinary tract irritation related to ketamine use among young adults.⁹⁻¹⁰ With more studies of this entity, it is now known that not only the bladder is involved, since it actually comprises a spectrum of urinary tract damage ranging from mild cystitis changes on endoscopy¹⁰ to obstructive uropathy and kidney injury.¹¹ This condition is considered to be a classical LUTS syndrome (frequency, urgency, nocturia, dysuria and/or haematuria) with cystitis and contracted bladder that is associated with ketamine abuse, which ensues without other known causes (bacterial infection, stone disease, or neurogenic problem). Cystoscopic or pathological evidence of cystitis is not a prerequisite for diagnosing this syndrome.

The pathophysiology of this syndrome is not clear. A previous study by our group has examined urinary bladder biopsies in these patients, which yielded inflammatory changes (polymorph and eosinophil infiltration in the urothelium, and presence of granulation tissue and congested vessels in the lamina propria).¹² Under electron microscopy, queratiphiloid muscle cells with vacuoles at the periphery of muscle cells were identified, mimicking those in interstitial cystitis.¹³ These bladder biopsy features are, therefore, not solely pathognomonic of ketamine-associated cystitis.⁴

Currently, there is no established diagnostic tool to assess LUTS severity in ketamine-induced cystitis. In view of its clinical and pathological consistency with interstitial cystitis, existing symptom scales for assessing interstitial cystitis may be adopted for that purpose. There are several assessment tools available for interstitial cystitis, including the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) criteria,¹⁶ the University of Wisconsin Symptom Instrument (UWI),¹⁷ the O’Leary-Sant instrument (OSI),¹⁸ and the pelvic pain and urgency/frequency (PUF) patient symptom scale.¹⁹ Among these, the PUF patient symptom scale is a more efficient screening tool for interstitial cystitis.²⁰⁻²¹ Developed by Parsons et al, the PUF score comprises eight questions giving rise to two scores, the symptom score and the bother score, with a maximum total score of 35.²² It was proven to be an accurate method for detecting interstitial cystitis, and was validated by intravesical potassium sensitivity testing in more than 5000 patients.²³ We proposed adoption of the PUF score as a useful non-invasive diagnostic tool to assess ketamine-induced cystitis patients.

In this study, we translated and validated the Chinese version of the PUF symptom scale (Fig
1) and investigated the feasibility of using it as an assessment and prognostic tool to evaluate the severity of ketamine-associated cystitis. Anticipating good correlation between the PUF score and the symptomatology, a cut-off value suggestive of more serious urological sequelae was also looked for. Furthermore, the reversibility of the symptomatology of ketamine-associated cystitis after abstinence from ketamine was evaluated.

**Methods**

This study consisted of two components: (1) the validation of a Chinese version of PUF symptom scale, and (2) the investigation of its use as an assessment and prognostic tool in evaluating the severity of street-ketamine–associated LUTS as well as symptom reversibility after abstinence.

The Chinese version of the pelvic pain and urgency/frequency scale

Although health care professionals can use the original English version of the PUF scale for assessment of patients, we developed the Chinese version with a view to popularise the use of the questionnaire by local paramedics, domestic researchers, social workers, and even ketamine abusers themselves. The translation and linguistic validation process was similar to that of the Korean version of the PUF scale, with evaluated face and content validity. It involved (1) forward translation by bilingual urologists (two of the authors), (2) reconciliation of the two versions into one after detailed discussion, (3) back-translation of the reconciled Chinese version to English by an independent nurse with a bachelor’s degree in translation, (4) debriefing and cognitive debriefing.

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>症狀分數</th>
<th>困擾分數</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>你在日間上廁所多少次？</td>
<td>3-6</td>
</tr>
<tr>
<td>2a</td>
<td>你不時在夜間上廁所多少次？</td>
<td>0</td>
</tr>
<tr>
<td>b. 若你在夜間起來排便，這情況困擾你嗎？</td>
<td>從不</td>
<td>間中</td>
</tr>
<tr>
<td>3a</td>
<td>你現在/以往曾否在性行為時或之後感到痛楚/不適？</td>
<td>從不</td>
</tr>
<tr>
<td>b. 你曾否因為痛楚或尿急不適而避免性行為？</td>
<td>從不</td>
<td>間中</td>
</tr>
<tr>
<td>4</td>
<td>你有沒有膀胱或盆腔（陰道、陰唇、下腹、會陰、睾丸、或陰囊）位置的痛楚？</td>
<td>從不</td>
</tr>
<tr>
<td>5a</td>
<td>決定症狀，程度是：</td>
<td>輕微</td>
</tr>
<tr>
<td>b. 這些痛楚困擾你嗎？</td>
<td>從不</td>
<td>間中</td>
</tr>
<tr>
<td>6</td>
<td>尿急的情況困擾你嗎？</td>
<td>從不</td>
</tr>
<tr>
<td>7a</td>
<td>你有恆常的性行為嗎？</td>
<td>有/沒有</td>
</tr>
<tr>
<td>b. 尿急的情況困擾你嗎？</td>
<td>從不</td>
<td>間中</td>
</tr>
</tbody>
</table>

症狀分數 (1, 2a, 3a, 4, 5a, 6, 7a) =

困擾分數 (2b, 3b, 5b, 7b) =

總分（症狀分數 + 困擾分數） =

**FIG 1.** Chinese version of the pelvic pain and urgency/frequency symptom scale
Involving five ketamine-associated cystitis patients and five healthy individuals expressing feedback to the questions, and (5) formulation of the finalised Chinese version of PUF scale (Fig 1). The test-retest reliability of the questionnaire was tested on health care workers with a negative history of ketamine use. The translated Chinese version of the questionnaire was filled in by them twice with a 2-week interval and the test-retest reliability was analysed. Further analysis of results from questionnaires filled in by both health care workers and patients with street-ketamine-associated LUTS attending our institution before January 2009 was then carried out. This entailed split-half reliability and internal consistency by Cronbach’s alpha, which aimed to evaluate the construct validity of the questionnaire. The discriminatory ability of the questionnaire was then evaluated by the Mann-Whitney U test of the scores of the healthy individuals and the patients.

**Patient assessment**

In Princess Margaret Hospital, a special ‘ketamine clinic’ was launched dedicated to evaluating street-ketamine abusers presenting with LUTS from February 2009 to May 2010. All the patients attended the clinic were recruited into the study. Exclusion criteria were LUTS before starting ketamine use, other known causes of LUTS (bacterial cystitis with positive urine culture), use of urological/neurological medications like anti-cholinergic or antipsychotic medications, and neurological disorders that might result in voiding dysfunction and recent instrumentation of the urinary tract.

Data on the duration and amount of ketamine abuse, monthly expenditure on ketamine, LUTS (in terms of frequency, nocturia, urgency, dysuria, and haematuria according to the 2002 International Continence Society definition) were prospectively collected. Each patient also completed the PUF symptom scale questionnaire during every clinic visit. Investigations including blood tests (routine renal and liver function tests), urine tests (culture and toxicology), renal ultrasonography, flexible cystoscopy, and video urodynamic study were performed. All patients were assessed, counselled, and followed up by urologists from the centre.

**Data analyses**

Mean PUF scores of patients with or without certain symptoms were compared. A correlation analysis of quantitative parameters and PUF scores was performed. Significance was defined at a P value of less than 0.05. Mean PUF scores of patients with positive investigation results were compared to those without such results. Investigation results of patients with different PUF total scores were compared and analysed to identify the best cut-off value. Correlation analysis between bladder capacity and PUF score was also performed. Patients with ketamine abstinence on follow-up were selected and the change in their PUF scores with time was reviewed. All the data analyses were performed with the Statistical Package for the Social Sciences (Windows version 17.0; SPSS Inc, Chicago [IL], US), except the use of MedCalc (version 11.6.1.0; MedCalc software, Mariakerke, Belgium) for identifying the best cut-off PUF score.

**Results**

**Validation of the Chinese version of pelvic pain and urgency/frequency scale score**

Twenty health care workers with a negative history

| TABLE 1. (a) Reliability and (b) internal consistency of the pelvic pain and urgency/frequency questionnaire
<table>
<thead>
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<tbody>
<tr>
<td><strong>(a) Reliability statistics</strong></td>
<td><strong>Data</strong></td>
</tr>
<tr>
<td>Cronbach’s alpha</td>
<td>0.936</td>
</tr>
<tr>
<td>No. of items</td>
<td>6*</td>
</tr>
<tr>
<td>Part 1</td>
<td></td>
</tr>
<tr>
<td>Value</td>
<td>0.966</td>
</tr>
<tr>
<td>No. of items</td>
<td>6†</td>
</tr>
<tr>
<td>Part 2</td>
<td></td>
</tr>
<tr>
<td>Total N of items</td>
<td>12</td>
</tr>
<tr>
<td>Correlation between forms</td>
<td>0.949</td>
</tr>
<tr>
<td>Spearman-Brown coefficient</td>
<td>0.974</td>
</tr>
<tr>
<td>Equal length</td>
<td>0.974</td>
</tr>
<tr>
<td>Unequal length</td>
<td>0.974</td>
</tr>
<tr>
<td>Guttman split-half coefficient</td>
<td>0.972</td>
</tr>
<tr>
<td><strong>(b) Item-total statistics</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scale mean if item deleted</td>
</tr>
<tr>
<td>Q1</td>
<td>12.3939</td>
</tr>
<tr>
<td>Q2a</td>
<td>11.7576</td>
</tr>
<tr>
<td>Q2b</td>
<td>12.3030</td>
</tr>
<tr>
<td>Q3a</td>
<td>13.0303</td>
</tr>
<tr>
<td>Q3b</td>
<td>12.7879</td>
</tr>
<tr>
<td>Q4</td>
<td>12.5758</td>
</tr>
<tr>
<td>Q5a</td>
<td>12.4545</td>
</tr>
<tr>
<td>Q5b</td>
<td>12.5152</td>
</tr>
<tr>
<td>Q6</td>
<td>12.5455</td>
</tr>
<tr>
<td>Q7a</td>
<td>12.2121</td>
</tr>
<tr>
<td>Q7b</td>
<td>12.3636</td>
</tr>
<tr>
<td>Q8</td>
<td>12.7273</td>
</tr>
</tbody>
</table>
of ketamine use and 15 patients with street-ketamine associated LUTS filled out the questionnaire. Of the former 20 individuals, 18 (9 males and 9 females) completed the questionnaire the second time 2 weeks after the initial assessment. Their mean age was 24 (range, 19-31) years. The mean PUF (± standard deviation [SD]) total score was 2.1 ± 2.4 (mean symptom score, 1.6 ± 1.5; mean bother score, 0.6 ± 2.0). Regarding the patients, eight were male and seven were female. Their mean age was 26 (range, 18-31) years. Their mean PUF (± SD) total score was 27.4 ± 7.3 (mean symptom score, 18.3 ± 4.7; mean bother score, 9.1 ± 2.8).

The test-retest reliability coefficients for symptom score, bother score, and total score were 0.753, 0.764, and 0.755, respectively (P<0.001 for all three). The equal-length Spearman-Brown coefficient for split-test reliability was 0.974, while the Guttman coefficient was 0.972. The overall Cronbach’s alpha was 0.974. The Cronbach's alpha for any one of the questions being deleted are shown in Table 1. The Mann-Whitney U test revealed significant differences between scores of the 20 health care workers and 15 street-ketamine abusers (U=1.50, Z= -4.96 for symptom score: U=0, Z= -4.92 for bother score: U=0, Z= -4.94 for total score; P<0.001 for all three). The respective mean (± SD) score differences were 12.3 ± 0.8, 7.2 ± 0.5, and 19.5 ± 1.2.

Assessment results
Fifty-four street ketamine abusers attended the clinic during the study period. Altogether four patients were excluded: two had LUTS before abusing ketamine, one had psychotic illness with active use of anti-psychotic medications, while the other had a history of childhood meningitis without definitive LUTS. As a result, 50 patients (20 males and 30 females) with a mean age of 24 (range, 14-48) years were eligible and included for analysis.

The mean (± SD) duration of ketamine abuse was 4.7 ± 2.8 years. The mean monthly amount spent on ketamine abuse was HK$5006 (range, $200-21 000). Common presenting LUTS included: urgency (46 patients, 92%), frequency (42 patients, 84%), nocturia (44 patients, 88%), dysuria (43 patients, 86%), and haematuria (34 patients, 68%). The mean (± SD) presenting PUF total score was 21.4 ± 7.5 and the corresponding symptom and bother scores were 13.6 ± 5.1 and 7.7 ± 3.0, respectively. The PUF score correlated well with the presence/absence of each individual LUTS component: urgency (mean PUF, 22.5 ± 7.3 vs 15.1 ± 5.5; P=0.002), frequency (mean PUF, 23.8 ± 7.4 vs 17.3 ± 5.2; P=0.009), nocturia (mean PUF, 22.4 ± 7.5 vs 14.0 ± 1.4, P=0.001), dysuria (mean PUF, 22.7 ± 7.0 vs 13.3 ± 6.2; P=0.002) and haematuria (mean PUF, 24.8 ± 7.2 vs 16.2 ± 5.6; P<0.001) (Fig 2). Quantitatively, the number of day-time voids (frequency episodes) was shown to correlate with symptom score (R=0.475, P=0.001) and total score (R=0.408, P=0.004), while the number of nocturia episodes was correlated with all three: symptom, bother, and total scores (R=0.651, 0.557, and 0.669, respectively; all P<0.001). The correlations between PUF total score and the amount of ketamine consumption or duration of abuse were not statistically significant (R=0.17, P=0.909 and R=0.234, P=0.239, respectively).

Of the 50 participants, 42 (84%) underwent flexible cystoscopy, 31 (62%) underwent urodynamic study, and 43 (86%) had renal ultrasonography. In all, 30/42 (71%) of the patients had cystitis revealed by cystoscopy, 10/31 (32%) had detrusor overactivity, 3/31 (10%) had vesico-ureteric reflux, 10/31 (32%) had poor bladder compliance, and 10/43 (23%) had hydronephrosis (8 unilateral and 2 bilateral).

Higher mean PUF total scores were noted in patients with positive cystoscopic, urodynamic and ultrasonographic investigation results, namely cystitis changes on flexible cystoscopy (mean PUF, 24.0 ± 6.4 vs 18.6 ± 7.4; P=0.024), detrusor overactivity (mean PUF, 25.3 ± 4.9 vs 19.4 ± 7.8; P=0.034), vesico-ureteric reflux (mean PUF, 30.0 ± 5.6 vs 20.3 ± 7.1, P=0.029), poor bladder compliance (mean PUF, 27.2 ± 5.0 vs 18.6 ± 6.9; P=0.001), and hydronephrosis (mean PUF, bilateral 30.0 ± 7.1 vs unilateral 22.5 ± 4.1 vs negative 20.6 ± 8.0; P=0.018) [Fig 3]. Biochemically, only four patients had mildly deranged serum creatinine levels (range, 105-118 μmol/L; upper limit normal, 100 μmol/L).

With a PUF total score of 14 or above, patients started to develop cystitis changes on flexible cystoscopy. Changes indicative of cystitis increased
None of the patients with PUF total scores of 16 or below had detrusor instability, vesico-ureteric reflux, poor bladder compliance, or hydronephrosis. With a higher PUF total score, the prevalence of detrusor instability, vesico-ureteric reflux, poor bladder compliance, and hydronephrosis increased. Receiver operating characteristics (ROC) curve analysis was performed. The area under the ROC curve was 0.723 (95% confidence interval, 0.578-0.840; P=0.0017) for using a PUF score to detect the presence of any urodynamic or radiological upper urinary tract abnormalities.

Table 2 summarises the sensitivity, specificity, positive likelihood ratios, negative likelihood ratios, positive predictive values, and negative predictive values for assessing urodynamic abnormalities and upper urinary tract damage when using different PUF total scores as the cut-off.

A higher PUF score was associated with smaller bladder capacity (correlation= –0.497, P=0.001; Fig 4).

Of the 50 patients, 24 attended one or more follow-up and 18 out of these patients had PUF scores documented during follow-up. Only those who stopped the medications prescribed (by self or by doctor) for symptomatic control were included in the analysis. Only nine patients were available for analysis (three were active ketamine abusers and six had quit the habit). The mean (± SD) abstinence period was 24 ± 12 months for the six patients who had quit ketamine. After stopping medications for symptomatic control, the post-treatment mean change in PUF total score in the abstinence group was -4.33 (range, -16 to +3), and mean change among those who were still abusing ketamine was +3.33 (range, +1 to +5).

Discussion

Ketamine abuse has been well reported by the Narcotics Division of the Hong Kong SAR Government. From 2007 to 2010, it was the most common type of drug abused by persons aged 21 years or under and the second most common among all ages (next to heroin). Local urologists and family physicians were involved in managing and treating ketamine abusers presenting with...
urological symptoms. While there had been no standardised assessment tool for this clinical entity, in 2007 we started using the PUF symptom scale in our patients and since then attained our objective, namely to obtain clinical information on the severity of urological sequelae in abusers. As investigations like flexible cystoscopy and urodynamic study are invasive and not readily accepted by ketamine abusers, a non-invasive diagnostic tool that can truly reflect the symptomatology of these patients is needed. An ideal scoring system should also predict the outcome of invasive investigations and help in counselling patients before they consent to those investigations. As in the entity of interstitial cystitis, Kushner and Moldwin\textsuperscript{20} revealed that questionnaires do not demonstrate sufficient specificity to serve as sole diagnostic indicators, but they can be used to screen patients with urinary tract symptoms to identify those who should be further examined or followed up if they had already been diagnosed.

Different assessment tools for interstitial cystitis have been considered. The NIDDK criteria for interstitial cystitis were established in 1987. They were intended to be used as a guideline for research.\textsuperscript{14} The criteria also involved invasive procedures, were purposely designed to be restrictive, and therefore were not widely applicable.\textsuperscript{21} While there were several other diagnostic tools for interstitial cystitis, including the UWI and the OSI,\textsuperscript{15} Parsons et al\textsuperscript{19} proposed the PUF scale as a non-invasive and accurate diagnostic tool in the assessment of patients with interstitial cystitis. A PUF score of 15 or higher was associated with an 84\% chance of a positive with the intravesical potassium sensitivity test.\textsuperscript{24}

Among the Chinese-speaking communities including those in mainland China and Taiwan, the Chinese version of PUF questionnaire was translated for individual use only, and no formal validation has been reported in the western literature. We therefore translated and validated the questionnaire locally, and tested its linguistic and cultural suitability in Hong Kong users. The test-retest reliability was demonstrated based on 18 pairs of PUF scores completed 2 weeks apart by healthy individuals, which resulted in a reliability coefficient of 0.755. Bias by memory of questionnaire answers was reduced by the 2-week interval between filling of the two questionnaires. As only healthy subjects were used for analysing test-retest reliability, its usefulness cannot be taken to reflect the full range of the scores. A more appropriate way of testing the test-retest reliability would be to do so in patients with street-ketamine–associated LUTS, which was not achieved because of the high default rate of the patients. For the construct validity of the questionnaire, the split-half reliability and the internal consistency were good. The Mann-Whitney $U$ test for the scores between healthy individuals and ketamine abusers confirmed the good discriminatory ability of the questionnaire in patients with different severity of LUTS.

Our results demonstrated that the PUF score related well to symptom severity, both qualitatively (presence of frequency, nocturia urgency, dysuria, and haematuria) and quantitatively (number of day-time voids and number of nocturia events). It was closely related to investigation outcomes in all aspects: endoscopically, urodynamically and radiologically, and as a tool for assessing urological sequelae in patients with ketamine-induced cystitis. The sequence of progressive urodynamic changes with increasing PUF scores may provide hints to the cause of upper urinary tract damage, as it is suggested that the lower urinary tract is primarily affected before the upper tracts, which results from a small, shrunken bladder with time.\textsuperscript{7} Further studies to determine the actual pathophysiology of ketamine-induced cystitis are required. The persons performing the cystoscopic, radiological, and urodynamic investigations were not blinded to the history of ketamine use, LUTS and PUF score, which may have caused possible bias.

The cut-off value of 17 is suggestive of more severe disease status. A total PUF score of higher than 16 was associated with a significantly higher rate of urological sequelae: endoscopically confirmed cystitis (83\% vs 47\%), detrusor instability (48\% vs 0\%), vesico-ureteric reflux (14\% vs 0\%), poor bladder compliance (48\% vs 0\%), and hydronephrosis (37\% vs 0\%). This cut-off had a sensitivity of 100\%, specificity of 42\%, positive predictive value of 47\%, and negative predictive value of 100\% in assessing the presence of any urodynamic abnormalities and upper tract damage in patients with ketamine-induced cystitis. This cut-off value may spare patients with lower PUF scores from invasive investigations and those with higher scores may warrant more thorough investigation.

Our study failed to demonstrate any correlation of PUF score and the serum creatinine level as a result of prolonged abuse or progression of the disease. This was probably due to the small number of patients with renal impairment in our group of patients. The highest serum creatinine level among the recruited patients was 118 μmol/L only. The predictability of the PUF score for biochemical renal impairment is uncertain.

The frequency, amount, and monthly spending on ketamine did not show any significant correlation with PUF scores. This could be due to the difficulty in quantifying the actual amount of ketamine being consumed. For most of the patients, the frequency of ketamine consumption was irregular and the amount consumed each time varied. Furthermore, many abusers shared ketamine between friends, so
the analysis based on monthly spending on ketamine may be inaccurate. Besides, the street-ketamine powder obtained by abusers varied as to the degree of its purity. There is also the possibility of different susceptibility to street-ketamine metabolism in different abusers.

Abstinence from ketamine is thought to be associated with improved PUF scores but serial follow-up of a larger number of patients is needed for confirmation. Due to the high default rate in the current study, we failed to obtain a large cohort of ketamine abusers who abstained. The social and psychological complexity of ketamine abusers rendered them difficult to follow-up. Only nine patients without medical intervention were available to evaluate this aspect of the study. Our limited patients without medical intervention were available to evaluate this aspect of the study. Our limited results nevertheless showed a different trend for mean changes in PUF score in the abstinence group (-4.33) and the continuously abusing group (+3.33). This suggests reversibility of LUTS with abstinence and may motivate abusers to stop further use of ketamine. More concrete proof of recovery is required to document PUF score improvements together with follow-up urodynamic studies on patients with ketamine abstinence.

**Conclusion**

The Chinese version of PUF questionnaire is reliable and has good discriminatory ability for assessment in patients with street-ketamine–associated LUTS. The PUF score correlates well with symptom severity as well as endoscopic, urodynamic, and radiological abnormalities in patients with ketamine-induced cystitis. A cut-off PUF total score of 17 or more may suggest more serious urological sequelae from ketamine abuse. Abstinence from ketamine appears to help reduce urinary tract symptoms, but the reversibility of the urinary tract damage is yet to be evaluated.

**References**