Predictive Correlation Between the International Index of Erectile Function (IIEF) and Sexual Health Inventory for Men (SHIM): Implications for Calculating a Derived SHIM for Clinical Use

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ABSTRACT

Introduction. Validated questionnaires are used to assess postoperative continence, sexual function, and other quality-of-life issues after radical prostatectomy. The International Index of Erectile Function (IIEF) is one such well-tested inventory that is routinely used. However, some centers use the Sexual Health Inventory for Men (SHIM) or the IIEF-6 to record erectile function, and comparison between the three can be difficult.

Aims. To define if there was a predictive correlation between IIEF (or IIEF-6) and SHIM, and to explore a strategy for the use of an abbreviated and rapid functional assessment of erectile function in patients.

Materials and Methods. Preoperative and postoperative IIEF questionnaires from the robotic prostatectomy program at our institution were included in the study. The total IIEF, IIEF-6, and SHIM scores were calculated and correlations between the three were sought. We also looked at the feasibility of using only two questions from the IIEF with an aim of calculating both the SHIM and IIEF scores.

Main Outcome Measures. The power to differentiate between patients with SHIM ≥ 22 from those with SHIM ≤ 21 for (i) the ratio allowing direct conversion of IIEF (or IIEF-6) to SHIM; and (ii) a two-question-based recalculation of SHIM.

Results. Two hundred seventy-five questionnaires were available for review. If the total IIEF score is known, the IIEF-derived SHIM score can be calculated by dividing the total IIEF score by a factor of 2.8 and then rounding off to a whole number. Furthermore, we have shown that an abbreviated questionnaire using Q5 and Q15 of the IIEF can be used to calculate the SHIM scores (two-question-SHIM).

Conclusions. We described an easy way to calculate the SHIM score when the IIEF (or IIEF-6) score alone is known. The two-question model can be used for a rapid assessment of the patients' sexual function. **Ramanathan R, Mulhall J, Rao S, Leung R, Salamanca Martinez JI, Mandhani A, and Tewari A. Predictive correlation between the International Index of Erectile Function (IIEF) and Sexual Health Inventory for Men (SHIM): Implications for calculating a derived SHIM for clinical use. J Sex Med 2007;4:1336–1344.**

Key Words. Erectile Dysfunction; International Index of Erectile Function; Sexual Health Inventory for Men

Introduction

Patient-reported objective assessment of erectile dysfunction (ED) using validated questionnaires has been shown to be easy and reliable [1,2]. The Massachusetts male aging study used a single question to define erectile function [3], and was designed for community-based epidemiologic studies. Multidimensional instruments are considered objective, psychometrically more valid, and provide greater potential for use in the clinical setting [4]. The International Index of Erectile Function (IIEF) is a multidimensional self-report instrument consisting of 15 items and five domains [4] and is commonly used at many centers [5], including ours, to assess treatment outcomes after robotic radical prostatectomy.

Based on a need to simplify patient-administered tools [6], an abbreviated version of the IIEF, using five questions with the highest discriminat-

ing power to diagnose ED, was developed and called the IIEF-5, or Sexual Health Inventory for Men [7] (SHIM; Appendix 1). The IIEF-6, a similar tool, uses six questions from the IIEF and is preferred by some centers. The questions in both inventories ask about sexual function in frequency terms, and each is scored on a 5-point Likert scale, with 5 indicating "always or almost always" and 1 "never or almost never." Responses to each of the questions are added to give the IIEF-6 (range 1–30) or SHIM (range 1–25) scores. Well-established IIEF-6 and SHIM score cutoffs exist that define the severity of ED. IIEF-6 cutoffs are: no ED ($\geq$26), minimal ED (18–25), moderate ED (11–17), and severe ED ($\leq$10); SHIM cutoffs are: no ED ($\geq$22), mild (17–21), moderate (8–16), and severe ED ($\leq$7) [7].

Meticulous cancer control and excellent nerve sparing during robotic prostatectomy for prostate cancer are competing goals, and it is possible to compromise one at the expense of the other. Therefore, some treatment decisions including certain operative steps, prognostication of patients' recovery of sexual function, and reporting of postoperative results after surgery take into account, among other parameters, the patients' preoperative sexual function. However, measure of this sexual function is done using different tools at different centers. The IIEF, because of its multi-dimensional nature, provides for a more detailed evaluation and, is often the tool used by most institutions. Many clinicians wanting to assign scores to erectile function, however, prefer the IIEF-6 or SHIM, which are subsets of the IIEF. The first aim of our study, thus, was to define a predictive correlation between the three scores, which would thus enable easy conversion of one to the other, without the need to refer to the patients' charts, while retaining the accuracy to classify patients as "with" or "without ED."

Patients' compliance with questionnaires in clinical research poses a problem, and irrespective of the methodology used, only 49–76% of patients complete questionnaires [8,9]. Multidimensional questionnaires are more robust, but are also elaborate instruments that are difficult to complete in a reasonable time frame and may result in poorer compliance. Also, patients reporting to an ED clinic are more motivated to fill out a questionnaire relating to ED [10], but this may not be the case for a patient who is part of a large, prospective, postrobotic prostatectomy study and has to complete multiple questionnaires. The second aim of our study, thus, was to see if we could use the

pattern of correlation within the SHIM domain of the IIEF, to produce a shorter version of the SHIM that would be easy to use in the outpatient office by a practicing clinician, without compromising accuracy.

Methods

Patient Population

Between January 2005 and December 2006, 522 patients underwent robotic radical prostatectomy. All patients were evaluated with self-administered questionnaires in the preoperative as well as postoperative periods at 1, 3, 6, 12, and 24 months.

Questionnaire Analysis

Three hundred fifteen consecutive patient charts were reviewed and their preoperative and postoperative IIEF questionnaires evaluated. IIEF questionnaires with a total score of 75 were excluded from the study as they would have produced a perfect SHIM score of 25; similarly, incompletely filled questionnaires were also excluded from the study, as unanswered questions in our institution are assigned a default score of 0 when the IIEF score is calculated, and this may not reflect the true response to the question.

We looked at the records of patients included in the study, and looked for patterns in the correlation between IIEF and SHIM scores. The SHIM scores were calculated by adding the responses to questions 2, 4, 5, 7, and 15 of the IIEF, and patients with a SHIM of $\geq$22 were classified as "without ED (potent)." All the rest were classified as "with ED (impotent)."

We first examined the feasibility of converting the total IIEF score directly to SHIM without the need for going into the patients' chart to get the responses to individual questions. We started our analysis by first calculating the ratios of IIEF to SHIM (IIEF/SHIM ratios) for each patient and then obtaining the mean, modal, and median values of these ratios for the whole group. Dividing the IIEF of each patient by these ratios-for-the-group resulted in a new SHIM score for each patient, which we called the "IIEF-derived SHIM" (ID-SHIM) score. We kept working down from a higher IIEF/SHIM ratio (which yielded a very low sensitivity but high specificity) to lower ratios (with higher sensitivities and lower specificities), until we were able to identify the most optimal ratio that had the highest discriminatory power to identify patients correctly. Similarly, we looked at

Table 1 Showing the correlation between the "quartet" questions of the Sexual Health Inventory for Men (Q2, 4, 5, 7 of the International Index of Erectile Function)

Number of patients	With all four of four quartet questions having 100% concordance	With only three of four quartet questions having 100% concordance
Overall (N = 275)	168/275 (61%)	25/275 (9%)
When Q5 is scored 4 or 5 (N = 173)	105/173 (61%)	32/173 (18%)

the capacity to convert the IIEF-6 scores to SHIM by calculating the IIEF-6 to SHIM score ratios.

Next, we looked for a pattern in the patients' responses. On analysis, a pattern of correlation seemed to exist between questions 2, 4, 5, and 7, which prompted us to group these four questions as the "quartet" questions of SHIM. We found that the pattern of responses to the quartet group of questions was identical or very similar in many patients, and we used this feature to replace the "quartet" group with one representative question from the group. We tested IIEF Q4 and Q5 independently in this model: for each patient, the response (score) to Q4 was multiplied by 4 and the result added to the score from Q15, thus generating a two-question-SHIM (2Q-SHIM). The same procedure was then repeated with question 5.

Main Outcome Measures

We looked at the ability of ID-SHIM (calculated by using different IIEF/SHIM ratios) and that of the 2Q-SHIM (calculated by using Q4 or Q4 of the IIEF) to identify patients correctly as "without ED" or "with ED." Sensitivity, specificity, and positive and negative predictive values were computed. We classified the capacity to pick out patients without ED (potent patients) as true positives, and the capacity to pick out patients with ED (impotent patients) as true negatives. Thus, patients without ED that were incorrectly identified as having ED were classified as false negatives, and patients with ED that were identified as having no ED were classified as false positives.

All analysis was done using the statistical package included with Microsoft Excel 2003 (Microsoft Corp, Redmond, WA, USA).

Results

After the exclusion of 18 (5.7%) IIEF questionnaires with scores of 75, and 22 (6.9%) incomplete ones, 275 IIEF questionnaires were available for study. Our findings are summarized in Tables 1–5. Of the 275 patients, 130 (47.3%) were classified as having no ED based on their SHIM scores.

Table 1 shows the pattern of correlation between the "quartet" questions for the whole group. It was seen that in 61%, the responses to the four questions were identical (that is, if the response to IIEF Q4 had been scored as 4, the responses to Q2, Q5, and Q7 were also scored as a 4 by 61% of the patients). The responses to three of the four quartet questions were identical in another 9% of patients, and this increased to 18% when the response to IIEF Q5 was a 4 or a 5.

The average IIEF/SHIM ratios are shown in Table 2, and the highest accuracy was obtained with an optimal ratio between 2.82 and 2.80 at which the sensitivity, specificity, and positive and negative predictive values were all around 95%. This ratio was also closest to the mean IIEF/SHIM ratio for the group of patients classified as "without ED" (Tables 2 and 3).

We thus believe that for the most accurate estimation of the SHIM score from the IIEF, the total IIEF score should be divided by 2.81 (2.8 for convenience) and the quotient be rounded up to the nearest whole number to get the ID-SHIM score. Using this ratio, the calculated score matched the actual score most closely: 57 patients had no change in the score and another 95 patients had a change of only one point. (Table 4).

In the two-question model, Q5 of the IIEF allowed for the most accurate calculation of 2Q-SHIM. The calculated 2Q-SHIM score was identical to the actual score in 168 (61%) patients (Table 4) and the sensitivity and positive predictive values were higher when Q5 was used than with Q4 (Table 5).

Table 2 International Index of Erectile Function (IIEF)/Sexual Health Inventory for Men (SHIM) ratios

	IIEF to SHIM ratios
All patients (N = 275)	
Mean ratio ± SD	4.39 ± 3.65
Median ratio	2.95
Mode	3.0
Patients with SHIM ≥22 (N = 130)	
Mean ratio ± SD	2.82 ± 0.15
Median ratio	2.84
Mode	2.84

Table 3 Diagnostic accuracy of ID-SHIM

	ID-SHIM (2.82)	ID-SHIM (2.80)	ID-SHIM (2.78)
	IIEF/2.82	IIEF/2.80	IIEF/2.78
Potent patients classified as impotent	7/130 (5.3%)	7/130 (5.3%)	5/130 (3.8%)
Impotent patients classified as potent	7/145 (4.8%)	7/145 (4.8%)	9/145 (6.2%)
Sensitivity	94.7%	94.7%	96.2%
Specificity	95.2%	95.2%	93.8%
Positive predictive value	94.6%	94.6%	93.2%
Negative predictive value	95.2%	95.2%	96.4%

ID-SHIM = IEEF-derived SHIM; IIEF = International Index of Erectile Function; SHIM = Sexual Health Inventory for Men.

The IIEF-6 could be converted to SHIM by dividing by a factor of 1.2, and there was excellent correlation. The IIEF-6 initially classified six patients without ED as having ED and seven patients with ED as "without ED," and this discordance persisted for the same patients even after conversion to SHIM.

The question most commonly left unanswered was IIEF-Q6 ("How many times have you attempted sexual intercourse?") We also noted seven questionnaires where the patients had scored a response and then changed their minds to mark a new response to the question. Patients who were undecided with responses tended to do it in more than one question.

Discussion

The IIEF is a multidimensional instrument for diagnosing and grading ED and following up patients on treatment. The IIEF was developed for use in clinical trials after consultation with experts and an exhaustive review of literature. Existing self-report instruments were considered lengthy and complex, or with restrictive focus [4]. The IIEF has five domains (erectile function, orgasmic function, sexual desire, intercourse satisfaction, and overall satisfaction) and is comprised of 15 questions, which can be completed in less than 15 minutes [4,5]. The IIEF has been extensively validated. Studies assessing the efficacy of treatment of ED using other measures of sexual function, such as the quality-of-erection questionnaire [11] and the erection-hardness score [12], have used the IIEF for comparison and correlation [11–13].

The IIEF has questions, which are functionally interlinked. Our study shows that there are patterns of response for the questions. For example, a patient who scored Q5 ("During sexual intercourse, how difficult was it to maintain your erection to complete intercourse?") as a 4 (slightly difficult) implicitly has stated that he is having erections hard enough (Q2) and that he was able to maintain the erection after penetrating the partner (Q4). As male sexual function and satisfaction are related to erectile function [14], and there is a positive correlation ($r = 0.76$) between erectile function and intercourse satisfaction [4], the response to Q7 is also likely to be similarly graded. In fact, in our study, many patients who scored Q5 as a 4 or 5 scored questions 2, 4, and 7 in an identical fashion. This cluster effect for these four questions prompted us to call these the "quartet" questions of the SHIM.

Table 4 Calculated and actual Sexual Health Inventory for Men (SHIM) scores

	Derived SHIM		
Actual SHIM	ID-SHIM (2.81)	4 × Q4 + Q15	4 × Q5 + Q15
Patients with SHIM ≤21			
No change in SHIM (actual vs. derived)	13 (8.9%)	72 (49.6%)	74 (51.0%)
Change of 1	32 (22.1%)	20 (13.7%)	19 (13.1%)
Change of 2	23 (15.8%)	22 (15.1%)	21 (14.4%)
Change of 3 or more	77 (53.1%)	31 (21.3%)	31 (21.5%)
Patients with SHIM ≥22			
No change in SHIM (actual vs. derived)	44 (33.8%)	95 (73.1%)	95 (73.1%)
Change of 1	63 (48.4%)	18 (13.8%)	23 (17.7%)
Change of 2	15 (11.5)	9 (6.9%)	9 (6.9%)
Change of 3 or more	8 (6.1%)	8 (6.2%)	3 (2.3%)

ID-SHIM = IEEF-derived SHIM; IIEF = International Index of Erectile Function.

Table 5 Diagnostic accuracy of two-question-Sexual Health Inventory for Men

	4 × Q4 + Q15	4 × Q5 + Q15
Potent patients classified as impotent	13/130 (10%)	7/130 (5.3%)
Impotent patients classified as potent	10/145 (6.8%)	10/145 (6.8%)
Sensitivity	90.0%	94.7%
Specificity	93.2%	93.2%
Positive predictive value	92.1%	92.4%
Negative predictive value	91.2%	95.0%

Common causes for suboptimal compliance may include length of the questionnaires and the sensitive nature of the questions [10]. Cultural differences may be responsible for potential ambiguity of words [15] and this could indirectly influence compliance. Irrespective of the methodology used, questionnaires with missing data continue to be a problem and in one study, only 76% were returned with complete responses [8]. Though a questionnaire that yields a graded measure of ED is preferable, a single item self-assessment is likely to have a higher compliance rate than a multiple item assessment in community-based epidemiologic studies [15]. The average patient undergoing robotic prostatectomy at our institution completes a set of five questionnaires at every visit. These include the Expanded Prostate Cancer Index Composite with 32 main questions, the IIEF (15 questions), the International Prostate Symptom Score (seven questions), and post-trobotic surveys (34 questions). Many of these questions also have up to eight subquestions. We have seen many patients turn in questionnaires with missing information. We feel that the benefits of using an abbreviated questionnaire could possibly be seen in such situations.

Our study was undertaken with two specific aims. First, we used a predictive correlation between the IIEF and SHIM scores, which allowed for easy and accurate conversion of one to the other without the need to refer to the patients' charts. The utility of this, we feel, is twofold. First, if any one of these scores is available as a stand-alone figure, then the other two can be derived easily. The derived score will have a good discriminatory power to differentiate between patient with and without ED. Second, it also allows for comparisons between ED reported from different centers using different tools (IIEF, SHIM, or IIEF-6). We found the IIEF score to be linked to the SHIM score most accurately by a factor of 2.81, and this conversion can be conveniently carried out by dividing the IIEF score by 2.8, and then rounding up the quotient to a whole number. The SHIM and IIEF-6 scores are also comparable: the IIEF-6 divided by a factor of 1.2 corresponds to SHIM.

Our second aim was to see if we could use a more abbreviated questionnaire. A 2Q-SHIM derived by multiplying the response to Q5 of the IIEF by 4, and adding the result to the response to Q15 of the IIEF was found to be accurate in our study, and could replace the regular SHIM for a quick and convenient assessment.

The strengths of this study include a large patient number and rigorous inclusion criteria. We also feel that the study has future utility: results from a larger series could be used to construct assigned scores for each question based on the association between that question and others in the same domain. This way, a patient who has turned in an incomplete questionnaire could still have an accurate total score calculated based on assigned scores, and this would be useful in clinical trials. The greatest utility would be in helping to design shorter questionnaires, thus making the assessment of ED easier and accurate in situations where a very detailed assessment may not be required. Furthermore, the use of question 2 in its original form across cultures has been questioned [16,17], and cultural differences may have an impact on how terms are viewed [18]. As our study bypasses the use of Q2 of the IIEF, it may allow easier use of this technique for the assessment of ED across cultural barriers.

Although our study population comprised of patients with prostate cancer, either waiting for surgery or having undergone surgery, the association that seems to exist between the various questions in a given domain of the IIEF may make the results of our study reproducible for other patient groups, too. We also feel that though the ID-SHIM has good discriminatory power to accurately differentiate patients with ED from those without ED, the same level of accuracy may not extend to the various grades of ED. The two clinical limitations of the IIEF are its sole focus on current sexual function and lack of information provided about the etiology of the ED [19]; these limitations continue to exist with our study.

Our study was undertaken as a preliminary investigation to look at the strength of association between questions assessing erectile function, and the relationship between the IIEF, SHIM, and IIEF-6. More evaluation and external validation of our findings are indicated. We feel that our technique can be an easy, accurate, and quick assess-

ment of patient's sexual function. It cannot (and should not) replace the use of the more detailed and thoroughly validated IIEF questionnaire-based assessment in clinical trials. Benefits of reducing the size of questionnaires need to be extensively evaluated, given the multiple underlying the etiologies of ED. We do agree that spending more time, rather than less, while evaluating the underlying etiology will be, without a doubt, very useful for the patient presenting ED as a main complaint to a specialist.

Conclusions

The IIEF and SHIM are good screening aids for the evaluation of ED and also useful tools for the study of the effects of therapy in patients. Our two techniques of calculating the SHIM are easy to use and can serve as an effective rapid screening for ED. The simplified calculation of the SHIM from a known total IIEF score can be useful in situations where the patients' IIEF questionnaire is not available for review, and the two-question model is useful for a rapid yet accurate assessment of the patients' erectile function, while possibly contributing to improving compliance with questionnaires. The study may have a high utility in helping to grade incomplete IIEF forms using the "missing data procedures." More long-term studies with larger cases series are required to validate the results of our study.

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Statement of Authorship

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Appendix 1

INTERNATIONAL INDEX OF ERECTILE FUNCTION (IIEF)
Over the past 4 weeks:

Q1: How often were you able to get an erection during sexual activity?
0 No sexual activity
1 Almost never or never
2 A few times (less than half the time)
3 Sometimes (about half the time)
4 Most times (more than half the time)
5 Almost always or always

> **Q2: When you had erections with sexual stimulation, how often were your erections hard enough for penetration?**
> 0 No sexual activity
> 1 Almost never or never
> 2 A few times (less than half the time)
> 3 Sometimes (about half the time)
> 4 Most times (more than half the time)
> 5 Almost always or always

Q3: When you attempted intercourse, how often were you able to penetrate (enter) your partner?
0 Did not attempt intercourse
1 Almost never or never
2 A few times (less than half the time)
3 Sometimes (about half the time)
4 Most times (more than half the time)
5 Almost always or always

Q4: During sexual intercourse, how often were you able to maintain your erection after you had penetrated (entered) your partner?

0 Did not attempt intercourse
1 Almost never or never
2 A few times (less than half the time)
3 Sometimes (about half the time)
4 Most times (more than half the time)
5 Almost always or always

Q5: During sexual intercourse, how difficult was it to maintain your erection to completion of intercourse?

0 Did not attempt intercourse
1 Extremely difficult
2 Very difficult
3 Difficult
4 Slightly difficult
5 Not difficult

Q6: How many times have you attempted sexual intercourse?
0 No attempts
1 One to two attempts
2 Three to four attempts
3 Five to six attempts
4 Seven to ten attempts
5 Eleven or more attempts

Q7: When you attempted sexual intercourse, how often was it satisfactory for you?

0 Did not attempt intercourse
1 Almost never or never
2 A few times (less than half the time)
3 Sometimes (about half the time)
4 Most times (more than half the time)
5 Almost always or always

Q8: How much have you enjoyed sexual intercourse?
0 No intercourse
1 No enjoyment at all
2 Not very enjoyable
3 Fairly enjoyable
4 Highly enjoyable
5 Very highly enjoyable

Q9: When you had sexual stimulation or intercourse, how often did you ejaculate?
0 No sexual stimulation or intercourse
1 Almost never or never
2 A few times (less than half the time)

3 Sometimes (about half the time)
4 Most times (more than half the time)
5 Almost always or always

Q10: When you had sexual stimulation or intercourse, how often did you have the feeling of orgasm or climax?
1 Almost never or never
2 A few times (less than half the time)
3 Sometimes (about half the time)
4 Most times (more than half the time)
5 Almost always or always

Q11: How often have you felt sexual desire?
1 Almost never or never
2 A few times (less than half the time)
3 Sometimes (about half the time)
4 Most times (more than half the time)
5 Almost always or always

Q12: How would you rate your level of sexual desire?
1 Very low or none at all
2 Low
3 Moderate
4 High
5 Very high

Q13: How satisfied have you been with your overall sex life?
1 Very dissatisfied
2 Moderately dissatisfied
3 Equally satisfied & dissatisfied
4 Moderately satisfied
5 Very satisfied

Q14: How satisfied have you been with your sexual relationship with your partner?
1 Very dissatisfied
2 Moderately dissatisfied
3 Equally satisfied & dissatisfied
4 Moderately satisfied
5 Very satisfied

Q15: How do you rate your confidence that you could get and keep an erection?
1 Very low
2 Low
3 Moderate
4 High
5 Very high

Questions in the shaded text box: SHIM