# Expanded Prostate Cancer Index Composite-26 (EPIC-26) Online: Validation of an Internet-Based Instrument for Assessment of Health-Related Quality of Life After Treatment for Localized Prostate Cancer

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**OBJECTIVES** To test the validity of an Internet-based version of Expanded Prostate Cancer Index Composite (EPIC-26) versus the phone-based version. Most men will survive for years after treatment for localized prostate cancer (PCa) and may experience lasting treatment-related toxicities affecting health-related quality of life. The EPIC-26 is a validated instrument that measures health-related quality of life across 5 PCa-specific domains. Previously, EPIC-26 was administered via phone in a large multicenter clinical trial.

**METHODS** We developed an Internet-based version of EPIC-26. We recruited subjects from two prospective longitudinal study cohorts of PCa patients undergoing local therapy: PROST-QA, and PROSTQA-RP2. Subjects were randomized to either an "Internet-first" or "phone-first" group. Subjects were offered the alternate questionnaire modality 2 weeks after completing the initial modality.

**RESULTS** 181 subjects were offered enrollment; 133 agreed to participate. 65 subjects were randomized to the "Internet- first" group and 68 subjects to the "phone-first" group. Of these, 37 and 26 subjects respectively completed both questionnaire versions (response rate: 44.4%). Test-retest analysis showed significant intraclass correlations in all 5 domains of EPIC-26: urinary incontinence ($r = 0.96$), urinary irritation ($r = 0.85$), bowel function ($r = 0.61$), sexual function ($r = 0.94$), and hormonal function ($r = 0.89$). There was no effect of order of questionnaire administration.

**CONCLUSION** This study demonstrates excellent correlation of responses between Internet-based and phone-based EPIC-26 administration. All domains demonstrated test-retest reliability between modalities, without ordering effect. This validates the use of internet-based EPIC-26 in international registries as part of the International Consortium for Health Outcomes Measurement effort, and may facilitate its use in clinical practice and quality improvement. UROLOGY 127: 53–60, 2019.


Most men will survive for years after treatment for localized prostate cancer, and they may experience lasting treatment-related toxicities. Thus, health-related quality of life (HRQoL) is a critical outcome in assessing prostate cancer therapies. In addition, integration of HRQoL assessment is encouraged by health policy initiatives promoting patient-centered care, including the Health Information Technology for Economic and Clinical Health Act and the Affordable Care Act.[1] Several validated patient-reported outcome (PRO) questionnaires have been developed to measure HRQoL in men with localized prostate cancer.[2-5] The National Cancer Institute has recommended that PRO instruments for localized prostate cancer

**Financial Disclosure:** *The authors declare that they have no relevant financial interests.*
**Funding:** *PROST-QA Consortium Funded by National Institutes of Health Grants R01 CA95662, RC1 CA146596, and RC1 EB011001.The source of funding had no involvement in this study design, data collection, data analysis, manuscript writing, or decision to submit manuscript for publication.http://dx.doi.org/10.13039/100000002.*

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*Submitted: October 12, 2018, accepted (with revisions): February 6, 2019*

include 5 disease-specific domains: urinary incontinence, urinary obstruction and irritation, bowel-related symptoms, sexual dysfunction, and hormonal symptoms.[6]

The Expanded Prostate Cancer Index Composite (EPIC-26) is a validated instrument that measures quality of life across all recommended domains.[4] It is the recommended prostate-cancer-specific PRO instrument in NCI-sponsored clinical trials[6] and is recommended by the International Consortium for Health Outcomes Measurement.[7]

The PROST-QA cohort is a prospective, longitudinal cohort of 1201 men treated for localized prostate cancer at 9 university-affiliated institutions enrolled from 2003-2006 who completed EPIC-26 at pretreatment baseline and at 2 months, 6 months, 1 year, 2 years and yearly thereafter. Analysis of these results has showed distinct patterns of change in quality-of-life domains depending on prostate-cancer treatment modality.[8] The PROSTQA-RP2 cohort is a prospective, longitudinal cohort of men treated for localized prostate cancer with either open or robotic-assisted laparoscopic prostatectomy enrolled from 2010 to 2012 who completed EPIC-26 on a similar schedule. For both studies, EPIC-26 was administered via phone by Michigan State University Office for Survey Research. The longevity of these studies, now in their 12th and 5th year of follow-up, respectively, demonstrates the effectiveness of phone-based administration of EPIC-26 in clinical studies or large registry efforts.

However, computer-based HRQoL questionnaires may offer several advantages: they may increase clinicians' discussions of HRQoL issues,[9] they may be favored by patients,[10,11] and they may be faster and less costly as they rely on established infrastructure.[10,11] Indeed, Sharma and colleagues tested a computerized version of EPIC-26 against a paper version in a cohort of preoperative prostate cancer patients and found comparable results between questionnaire versions as well as substantial patient preference for the computerized version.[12] In this study, we tested the validity of an Internet-based version of EPIC-26 in comparison to the phone-based version in a cohort of men previously treated for localized prostate cancer.

## MATERIALS AND METHODS

We developed an Internet-based version of EPIC-26 using Qualtrics (www.qualtrics.com) with the same wording and scale of the validated phone version. Item responses were recorded via radial buttons, which represented the 4- or 5-point Likert scales used in EPIC-26. Individual item responses were converted from Likert scale to a linear scale of 0-100 scale (higher scores representing higher satisfaction) to maintain same direction and scale of all the responses for scoring, as per standard EPIC-26 scoring. Domain analysis was performed on raw scaled variables prior to conversion to the linear scale.

With Institutional Review Board approval, we solicited participation from subjects in the PROST-QA and PROSTQA-RP2 cohorts who were already completing phone questionnaires per protocol during May to September 2014. Participation in this sub-study was solicited during previously scheduled phone calls, before the phone questionnaire was to be administered.

The PROST-QA inclusion criteria were men with previously untreated stage T1 to T2 prostate cancer who had elected prostatectomy, brachytherapy, or external-beam radiotherapy as primary treatment and who were able to complete the phone interviews, which were conducted in English. Characteristics of the study group have been previously reported.[8] The PROSTQA-RP2 study includes men with previously untreated stage T1 to T2 prostate cancer who were scheduled to undergo open or robotic assisted laparoscopic radical prostatectomy; 36 months of follow-up or more were required in order for participants in this cohort to be eligible for the present study. The exclusion criterion specific to this study was lack of computer or Internet access outside of the clinic.

After consenting, participants were randomly assigned to 1 of 2 groups. The "Internet First" group was asked to complete the Internet-based questionnaire within 2 weeks of study enrollment and was given written instructions to access the questionnaire. Two weeks after completion of the Internet-based version, a phone-based questionnaire was conducted. Participants received follow-up phone calls if they were unavailable. The "Phone First" group was asked to respond to the phone-based questionnaire at the time of enrollment. The group was given written instructions to access the Internet-based questionnaire and was asked to complete it within 2 weeks of the phone version. Participants received an e-mail reminder if the Internet-based questionnaire was not completed within 2 weeks.

For analysis of internal consistency of each questionnaire version, responses were included from all participants who completed at least one questionnaire and more than 80% of the items within each domain. For test-retest analysis to validate the Internet-based version, responses were included from participants who completed both versions in the allocated order. Sensitivity analysis was performed to compare participants who were included in the analysis versus those excluded, validating the exclusion and verifying that non-completion occurred at random. We used generalized chi-square tests for categorical variables and Wilcoxon rank-sum tests for continuous variables. For included participants, the mean score and standard deviation along with median (min-max) for individual items and for each domain were calculated separately for (1) phone questionnaires alone, (2) Internet-based questionnaires alone, and (3) all questionnaires.

To evaluate the presence of ceiling effect in questionnaires, the percentage of participants scoring the maximum (100) on each item and domain was calculated. In order to evaluate internal consistency, Cronbach's $\alpha$ was calculated for each domain.

For assessment of validity of the Internet-based questionnaire, we conducted test-retest analysis for each domain for all participants completing both questionnaire versions. Intraclass correlation coefficient was calculated with 95% confidence intervals; a CI that excluded zero was considered as statistically significant. Analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC) and R (www.r-project.org).

## RESULTS

Study enrollment is shown in Figure 1. 98 participants from the PROST-QA and 83 participants from the PROSTQA-R2 cohorts (181 total) were offered study enrollment. Of these, 133 agreed to participate (29 from PROST-QA and 30 from PROSTQA-R2).

68 participants were randomized to the Phone First group, and 65 participants to the Internet First group. 24 subjects in the Phone First group completed both questionnaire versions, and 35 subjects in the Internet First group completed both versions (response rate: 44.4%). The 73 subjects who did not complete

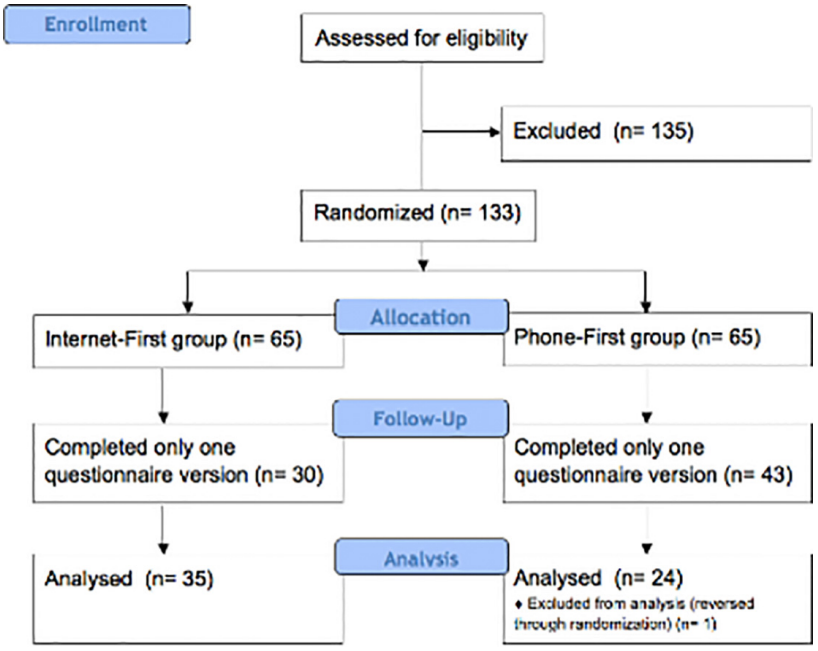


**Figure 1.** CONSORT diagram (Color version available online).

both versions were excluded from further analysis, as was one subject from the Phone First group who accidentally reversed through the randomization order. As Q53 (Bloody stools) was answered same by every participant, it was not considered in intraclass correlation coefficient calculations.

Pretreatment demographic variables including marital status, race, and education were evenly balanced between the 2 groups, as were disease-related variables including D'Amico risk level, primary therapy, age at treatment, BMI at treatment, and pretreatment PSA (Table 1). In this study, the median age at treatment was 61.8 years. The large majority of participants were white (93.1%). A slight majority (57.6%) had low-risk disease by D'Amico criteria. Most participants had undergone radical prostatectomy (71.2%); a minority (22%) received brachytherapy and a small minority (6.8%) received external radiation.

Although participants were requested to complete the second questionnaire version within 2 weeks, the median time between completion of the first and second questionnaires was 18 days.

For completed phone- and Internet-based questionnaires, median scores ranged from 40 to 100 (Table 2). Median scores

**Table 1.** Demographic distribution of cohort (pretreatment data)

| | | Experiment Group | | | |
|---|---|---|---|---|---|
| Covariate | Level | Phone First (N = 24) n (%) | Internet First (N = 35) n (%) | Total (N = 59) n (%) | Parametric *P* Value* |
| Marital status | Single | 2 (8.33) | 1 (2.86) | 3 (5.08) | .654 |
| | Married | 21 (87.5) | 32 (91.43) | 53 (89.83) | |
| | Living with a partner | 1 (4.17) | 1 (2.86) | 2 (3.39) | |
| | Unknown | 0 (0) | 1 (2.86) | 1 (1.69) | |
| Race** | White | 22 (91.67) | 32 (94.12) | 54 (93.1) | .471 |
| | Black | 2 (8.33) | 1 (2.94) | 3 (5.17) | |
| | Asian | 0 (0) | 1 (2.94) | 1 (1.72) | |
| College Graduate/ Postgraduate | No | 15 (62.5) | 16 (45.71) | 31 (52.54) | .205 |
| | Yes | 9 (37.5) | 19 (54.29) | 28 (47.46) | |
| D'Amico risk level | 1 | 16 (66.67) | 18 (51.43) | 34 (57.63) | .508 |
| | 2 | 7 (29.17) | 15 (42.86) | 22 (37.29) | |
| | 3 | 1 (4.17) | 2 (5.71) | 3 (5.08) | |
| Primary therapy | RP | 19 (79.17) | 23 (65.71) | 42 (71.19) | .522 |
| | XRT | 1 (4.17) | 3 (8.57) | 4 (6.78) | |
| | BT | 4 (16.67) | 9 (25.71) | 13 (22.03) | |
| Age at treatment | Mean ± Std | 62 ± 6.2 | 61.6 ± 8.1 | 61.8 ± 7.4 | .855 |
| | Median (Min-Max) | 62 (47.9-74.2) | 59.2 (41.8-78.1) | 61.8 (41.8-78.1) | |
| BMI ($kg/m^2$) | Mean ± Std | 27.2 ± 3.8 | 29.4 ± 4.9 | 28.5 ± 4.6 | .075 |
| | Median (Min-Max) | 26.9 (21.1-36.5) | 28.6 (21.3-40.4) | 27.7 (21.1-40.4) | |
| Baseline PSA (ng/mL) | Mean ± Std | 5.3 ± 2.7 | 6.1 ± 3.4 | 5.8 ± 3.1 | .356 |
| | Median (Min-Max) | 4.8 (1.5-12.8) | 5.4 (1.8-19.6) | 5.2 (1.5-19.6) | |

* The parametric *P* value is calculated by ANOVA for numerical covariates and chi-square test for categorical covariates.
** Data was missing for one patient.

**Table 2.** Instrument summary and internal validity

| Question | | Internet Survey | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N | Mean (SD) | Median (min, max) | Missing (%) | Max (%) | Min (%) | Cronbach's Alpha |
| **EPIC: Urinary incontinence** | | | | | | | | |
| Q23 | Frequency of leaked urine | 62 | 67.1 (33.6) | 80 (20, 100) | 3.1 | 40.6 | 25 | **0.91** |
| Q26 | Urinary control | 62 | 82.7 (17.3) | 75 (25, 100) | 3.1 | 40.6 | 1.6 | |
| Q27 | Pads or adult diaper use | 62 | 86.1 (26.6) | 100 (0, 100) | 3.1 | 68.8 | 6.3 | |
| Q28 | How big a problem: dripping or leaking urine | 62 | 78.6 (23.9) | 75 (0, 100) | 3.1 | 42.2 | 1.6 | |
| **EPIC: Urinary irritation** | | | | | | | | |
| Q29 | Pain or burning on urination | 62 | 99.2 (4.5) | 100 (75, 100) | 3.1 | 93.8 | 3.1 | **0.69** |
| Q30 | Bleeding with urination | 60 | 99.6 (3.2) | 100 (75, 100) | 6.3 | 92.2 | 1.6 | |
| Q31 | Weak urine stream or incomplete emptying | 62 | 91.1 (18.2) | 100 (25, 100) | 3.1 | 73.4 | 3.1 | |
| Q33 | Need to urinate frequently | 62 | 77.8 (25.6) | 75 (0, 100) | 3.1 | 43.8 | 1.6 | |
| Q34 | How big a problem: urinary function | 62 | 85.2 (18.4) | 90 (20, 100) | 3.1 | 48.4 | 1.6 | |
| **EPIC: Bowel function** | | | | | | | | |
| Q49 | Urgency to have a bowel movement | 62 | 93.5 (14.3) | 100 (50, 100) | 3.1 | 78.1 | 6.3 | **0.67** |
| Q50 | Increased frequency of bowel movements | 62 | 96.4 (10) | 100 (50, 100) | 3.1 | 84.4 | 1.6 | |
| Q52 | Losing control of stools | 62 | 98.4 (7.7) | 100 (50, 100) | 3.1 | 92.2 | 1.6 | |
| Q53 | Bloody stools *(not included in analysis)* | 58 | 100 (0) | 100 (100, 100) | 9.4 | 90.6 | 90.6 | |
| Q54 | Abdominal/Pelvic/Rectal Pain | 62 | 98.8 (5.4) | 100 (75, 100) | 3.1 | 92.2 | 4.7 | |
| Q55 | How big a problem: Bowel function | 62 | 95.8 (9.7) | 100 (60, 100) | 3.1 | 79.7 | 3.1 | |
| **EPIC: Sexual function** | | | | | | | | |
| Q57 | Ability to have an erection | 62 | 47.1 (28.3) | 40 (20, 100) | 3.1 | 9.4 | 39.1 | **0.93** |
| Q58 | Ability to reach orgasm (Climax) | 61 | 58.7 (30.3) | 60 (20, 100) | 4.7 | 17.2 | 28.1 | |
| Q59 | Quality of erections | 62 | 69 (29.6) | 75 (25, 100) | 3.1 | 34.4 | 23.4 | |
| Q60 | Frequency of erections | 62 | 56.8 (33.6) | 60 (20, 100) | 3.1 | 25 | 35.9 | |
| Q64 | Ability to function sexually | 61 | 49.5 (29.6) | 40 (20, 100) | 4.7 | 12.5 | 35.9 | |
| Q68 | How big a problem: Sexual function | 62 | 65.8 (27) | 60 (20, 100) | 3.1 | 26.6 | 10.9 | |
| **EPIC: Hormonal function** | | | | | | | | |
| Q74 | Hot flashes | 62 | 94.4 (16.6) | 100 (0, 100) | 3.1 | 82.8 | 1.6 | **0.69** |
| Q75 | Breast tenderness/Enlargement | 62 | 99.2 (6.4) | 100 (50, 100) | 3.1 | 95.3 | 1.6 | |
| Q77 | Feeling depressed | 61 | 89.3 (21.1) | 100 (25, 100) | 4.7 | 70.3 | 6.3 | |
| Q78 | Lack of energy | 59 | 86.9 (19.3) | 100 (25, 100) | 7.8 | 56.3 | 3.1 | |
| Q79 | Change in body weight | 61 | 95.1 (15.7) | 100 (0, 100) | 4.7 | 82.8 | 1.6 | |

*Continued*

**Table 2.** Continued

| | | Phone Survey | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Question** | **N** | **Mean (SD)** | **Median (min, max)** | **Missing (%)** | **Max (%)** | **Min (%)** | **Cronbach's Alpha** |
| **EPIC: Urinary incontinence** | | | | | | | | |
| Q23 | Frequency of leaked urine | 62 | 68.7 (34.5) | 80 (20, 100) | 3.1 | 45.3 | 23.4 | **0.89** |
| Q26 | Urinary control | 62 | 83.9 (17.6) | 75 (25, 100) | 3.1 | 45.3 | 1.6 | |
| Q27 | Pads or adult diaper use | 62 | 85.5 (26) | 100 (0, 100) | 3.1 | 67.2 | 4.7 | |
| Q28 | How big a problem: dripping or leaking urine | 62 | 73 (28.7) | 75 (0, 100) | 3.1 | 42.2 | 3.1 | |
| **EPIC: Urinary irritation** | | | | | | | | |
| Q29 | Pain or burning on urination | 62 | 98.4 (7.7) | 100 (50, 100) | 3.1 | 92.2 | 3.1 | **0.49** |
| Q30 | Bleeding with urination | 62 | 98.4 (8.9) | 100 (50, 100) | 3.1 | 93.8 | 3.1 | |
| Q31 | Weak urine stream or incomplete Emptying | 62 | 89.1 (20.1) | 100 (25, 100) | 3.1 | 70.3 | 3.1 | |
| Q33 | Need to urinate frequently | 62 | 81.9 (29) | 100 (0, 100) | 3.1 | 64.1 | 3.1 | |
| Q34 | How big a problem: urinary function | 62 | 79.4 (21.4) | 80 (20, 100) | 3.1 | 40.6 | 1.6 | |
| **EPIC: Bowel function** | | | | | | | | |
| Q49 | Urgency to have a bowel movement | 62 | 90.7 (18.8) | 100 (25, 100) | 3.1 | 73.4 | 3.1 | **0.7** |
| Q50 | Increased frequency of bowel movements | 62 | 93.5 (16.9) | 100 (25, 100) | 3.1 | 82.8 | 1.6 | |
| Q52 | Losing control of stools | 62 | 98 (8.2) | 100 (50, 100) | 3.1 | 90.6 | 1.6 | |
| Q53 | Bloody stools *(not included in analysis)* | 61 | 100 (0) | 100 (100, 100) | 4.7 | 95.3 | 95.3 | |
| Q54 | Abdominal/Pelvic/Rectal pain | 62 | 97.6 (10.8) | 100 (25, 100) | 3.1 | 90.6 | 1.6 | |
| Q55 | How big a problem: Bowel function | 62 | 92.3 (15.1) | 100 (40, 100) | 3.1 | 73.4 | 1.6 | |
| **EPIC: Sexual function** | | | | | | | | |
| Q57 | Ability to have an erection | 60 | 48.3 (30.7) | 40 (20, 100) | 6.3 | 14.1 | 42.2 | **0.96** |
| Q58 | Ability to reach orgasm (Climax) | 60 | 57 (33.3) | 60 (20, 100) | 6.3 | 25 | 34.4 | |
| Q59 | Quality of erections | 60 | 66.3 (30.1) | 75 (25, 100) | 6.3 | 31.3 | 25 | |
| Q60 | Frequency of erections | 59 | 52.9 (33.8) | 40 (20, 100) | 7.8 | 23.4 | 37.5 | |
| Q64 | Ability to function sexually | 60 | 50.7 (30.2) | 40 (20, 100) | 6.3 | 15.6 | 35.9 | |
| Q68 | How big a problem: Sexual function | 62 | 64.2 (31.8) | 60 (20, 100) | 3.1 | 34.4 | 20.3 | |
| **EPIC: Hormonal function** | | | | | | | | |
| Q74 | Hot flashes | 62 | 93.5 (18.1) | 100 (25, 100) | 3.1 | 84.4 | 3.1 | 0.81 |
| Q75 | Breast Tenderness/Enlargement | 62 | 96.4 (14.9) | 100 (25, 100) | 3.1 | 90.6 | 3.1 | |
| Q77 | Feeling depressed | 62 | 91.5 (19.7) | 100 (0, 100) | 3.1 | 78.1 | 1.6 | |
| Q78 | Lack of energy | 62 | 87.9 (23.8) | 100 (0, 100) | 3.1 | 71.9 | 1.6 | |
| Q79 | Change in body weight | 62 | 94.8 (18.2) | 100 | 3.1 | 87.5 | 1.6 | |

**Table 3.** Intraclass correlation coefficients

| | Question | Internet First | Both (N = 59) | Phone First |
|---|---|---|---|---|
| **EPIC: Urinary incontinence** | | | | |
| Q23 | Frequency of leaked urine | **0.97 (0.94-0.98)** | **0.96 (0.93-0.98)** | **0.94 (0.87-0.97)** |
| Q26 | Urinary control | | | |
| Q27 | Pads or adult diaper use | | | |
| Q28 | How big a problem: Dripping or leaking urine | | | |
| **EPIC: Urinary irritation** | | | | |
| Q29 | Pain or burning on urination | **0.86 (0.74-0.93)** | **0.86 (0.77-0.91)** | **0.85 (0.69-0.93)** |
| Q30 | Bleeding with urination | | | |
| Q31 | Weak urine stream or incomplete emptying | | | |
| Q33 | Need to urinate frequently | | | |
| Q34 | How big a problem: urinary function | | | |
| **EPIC: Bowel function** | | | | |
| Q49 | Urgency to have a bowel movement | **0.68 (0.46-0.82)** | **0.70 (0.54-0.81)** | **0.73 (0.48-0.87)** |
| Q50 | Increased frequency of bowel movements | | | |
| Q52 | Losing control of stools | | | |
| Q53 | Bloody stools *(not included in analysis)* | | | |
| Q54 | Abdominal/Pelvic/Rectal pain | | | |
| Q55 | How big a problem: Bowel function | | | |
| **EPIC: Sexual function** | | | | |
| Q57 | Ability to have an erection | **0.96 (0.92-0.98)** | **0.94 (0.90-0.96)** | **0.90 (0.78-0.96)** |
| Q58 | Ability to reach orgasm (Climax) | | | |
| Q59 | Quality of erections | | | |
| Q60 | Frequency of erections | | | |
| Q64 | Ability to function sexually | | | |
| Q68 | How big a problem: sexual function | | | |
| **EPIC: Hormonal function** | | | | |
| Q74 | Hot flashes | **0.87 (0.76-0.93)** | **0.88 (0.81-0.93)** | **0.90 (0.79-0.95)** |
| Q75 | Breast tenderness/Enlargement | | | |
| Q77 | Feeling depressed | | | |
| Q78 | Lack of energy | | | |
| Q79 | Change in body weight | | | |

were overall quite high in the urinary incontinence, urinary irritation, bowel function, and hormonal function domains, indicating good HRQoL in these areas. Median scores were lower in the sexual function domain, as low as 40 for ability to have an erection and ability to function sexually.

For participants who completed both versions of the questionnaire, test-retest analysis showed strong correlations in all 5 domains of EPIC-26: urinary incontinence ($r = 0.96$; 95% CI 0.93-0.98), urinary irritation ($r = 0.86$; 95% CI 0.77-0.91), bowel function ($r = 0.7$; 95% CI 0.7), sexual function ($r = 0.94$; 95% CI 0.9-0.96), and hormonal function ($r = 0.88$; 95% CI 0.81-0.93) (Table 3). Ordering (Phone First versus Internet First) did not significantly change these results. A ceiling effect was present for some questions, meaning clustered responses at the upper end of the range; little floor effect was present, meaning there was no clustering of responses at the lower end of the range. Sensitivity analysis revealed no significant differences among the collected demographic and disease data between responders and incomplete or non-responders (Supplemental Table 1).

## DISCUSSION

This study demonstrates excellent correlation of responses to an Internet-based version of a previously validated phone instrument for assessing HRQoL in men treated for localized prostate cancer. All domains demonstrated test-retest reliability for the phone- and Internet-based versions. Sharma and colleagues found similar results when they compared a paper version to an electronic version of EPIC-26,[12] and studies of other PRO instruments have also demonstrated good correlation of responses between electronic and paper-based versions.[9,13-15]

Unlike Sharma and colleagues, we studied a population of men who had undergone primary therapy, between 36 months (PROSTQA-RP2 cohort) and 9-11 years earlier (PROSTQA cohort), and had been participating in yearly interviews. The follow-up period after primary therapy is particularly important given that many prostate cancer patients are asymptomatic at diagnosis and develop symptoms related to therapy. Additionally, we assessed for possible effects of the ordering of the questionnaire versions, which strengthens our findings by eliminating possible response-shift bias. Sharma and colleagues did use a satisfaction scale and were able to demonstrate patient preference for the electronic version, which is consistent with studies of other electronic PRO instruments.[9,10]

EPIC-26 was administered by a third-party phone-survey facility in a large study of HRQoL in prostate cancer,[8] but automated phone assessment has also been used to facilitate data collection.[16] The Internet-based version will significantly facilitate data collection compared to either phone-based method. In addition, the Internet-based version will enable international data collection, which by phone would be difficult. This will allow

investigators to initiate multi-center and multi-national collaborations for research and quality improvement using an internationally recommended instrument.[7] Such efforts are promoted by International Consortium for Health Outcomes Measurement and others, and they will become increasingly important not only for research and quality improvement but for value-based payment. In addition, electronic PRO instruments can be integrated into electronic health records to facilitate comparative effectiveness research[17] and clinical care.[18]

Velikova and colleagues reported that routine measurement of HRQoL via an integrated electronic PRO instrument at the point of care impacted physician-patient communication and improved some patients' HRQoL and emotional functioning.[19] In addition, this intervention resulted in higher patient satisfaction and assessment of continuity of care.[9] However, collection of PROs need not be limited to the clinic. Internet-based PRO instruments allow patients to report symptoms from home between visits, streamlining clinic encounters and avoiding retrospective bias. Integrated into an online patient portal, patients and providers would be able to access PROs and track them over time. In addition, internet-based PRO instruments can be completed via mobile phone and can allow patients to immediately notify physicians about any severe symptoms.[20] New legislation may further encourage use of internet-based PRO instruments: Health Information Technology for Economic and Clinical Health Stage 3 Meaningful Use regulations proposed in October 2015 included a provision requiring providers to incorporate "patient-generated health data" into electronic health records from "non-clinical" settings.[1]

Our study is limited by its small sample size and low completion rate of both survey versions among those who agreed to participate. In addition, the subgroups receiving radiation therapy or brachytherapy were quite small due to patient sampling from the surgery-only PROSTQA-RP2 cohort, limiting conclusions about patients not treated with prostatectomy. However, EPIC-26 has previously been validated in patients treated with other modalities.

Our study focused on establishing the validity of the Internet-based version of EPIC-26 in comparison to the phone-based one. Nonetheless, external validity may be limited by the characteristics of the study population, which was overwhelmingly white, mostly with a college-level education or beyond, and had a mean age at time of treatment of 62. Rate of missing data was low in the Internet version and consistent with the Phone version, suggesting that these patients did not experience difficulty completing the Internet version. However, other studies have demonstrated validity of electronic PRO instruments in a wide range of demographic groups[10,21] and generally no effect of age, education level, or prior experience with computers on score stability across method of questionnaire administration.[21] Finally, we tested validity in a population of men who had already been exposed to the EPIC-26 instrument, limiting generalizability to patients not yet familiar with it. However, other studies have demonstrated consistency between electronic and non-electronic questionnaires even among patients not previously exposed to the instruments.[9,13-15,21]

EPIC-26 is primarily a research instrument, but the shorter EPIC-CP has been developed for clinical practice[4] and has been validated for post-treatment follow-up.[22] In the future, an Internet-based version of EPIC-CP should be developed in order to facilitate data collection in clinical practice.

## CONCLUSION

In sum, this study validates an Internet-based version of a recommended prostate-cancer HRQoL instrument, which will facilitate its broader and international use in future research, clinical practice, and quality improvement.

**Acknowledgments.** The PROSTQA Consortium includes contributions in cohort design, patient accrual and follow-up from the following investigators: Meredith Regan (Dana Farber Cancer Institute, Boston, MA); Larry Hembroff and Douglas Roberts (Michigan State University, East Lansing, MI); John T. Wei, Dan Hamstra, Rodney Dunn, Laurel Northouse, and David Wood (University of Michigan, Ann Arbor, MI); Eric A Klein and Jay Ciezki (Cleveland Clinic, Cleveland, OH); Jeff Michalski and Gerald Andriole (Washington University, St. Louis, MO); Mark Litwin and Chris Saigal (University of California—Los Angeles Medical Center, Los Angeles, CA); Thomas Greenfield, PhD (Public Health Institute, Emeryville, CA), Louis Pisters and Deborah Kuban (MD Anderson Cancer Center, Houston, TX); Howard Sandler (Cedars Sinai Medical Center, Los Angeles, CA); Jim Hu and Adam Kibel (Brigham and Women's Hospital, Boston, MA); Douglas Dahl and Anthony Zietman (Massachusetts General Hospital, Boston, MA); Peter Chang, Andrew Wagner, and Irving Kaplan (Beth Israel Deaconess Medical Center, Boston, MA) and Martin G. Sanda (Emory, Atlanta, GA).

The authors acknowledge PROSTQA Data Coordinating Center Project Management by Kyle Davis and Jill Hardy, MS (Michigan State University, East Lansing, MI), Erin Najuch and Jonathan Chipman (Dana Farber Cancer Institute, Boston, MA), Datta Patil, MBBS, MPH (Emory, Atlanta, GA) and Catrina Crociani, MPH (Beth Israel Deaconess Medical Center, Boston, MA), grant administration by Beth Doiron, BA (Beth Israel Deaconess Medical Center, Boston, MA), and technical support from coordinators at each clinical site. The authors would like to thank the study participants. Without them this study would not be possible.

## SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.urology.2019.02.004.

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