Original Article

Distribution of Global Health Measures From Routinely Collected PROMIS Surveys in Patients With Breast Cancer or Prostate Cancer

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BACKGROUND: The collection of patient-reported outcomes (PROs) is an emerging priority internationally, guiding clinical care, quality improvement projects and research studies. After the deployment of Patient-Reported Outcomes Measurement Information System (PROMIS) surveys in routine outpatient workflows at an academic cancer center, electronic health record data were used to evaluate survey completion rates and self-reported global health measures across 2 tumor types: breast and prostate cancer. **METHODS:** This study retrospectively analyzed 11,657 PROMIS surveys from patients with breast cancer and 4411 surveys from patients with prostate cancer, and it calculated survey completion rates and global physical health (GPH) and global mental health (GMH) scores between 2013 and 2018. **RESULTS:** A total of 36.6% of eligible patients with breast cancer and 23.7% of patients with prostate cancer completed at least 1 survey, with completion rates lower among black patients for both tumor types ($P < .05$). The mean T scores (calibrated to a general population mean of 50) for GPH were 48.4 ± 9 for breast cancer and 50.6 ± 9 for prostate cancer, and the GMH scores were 52.7 ± 8 and 52.1 ± 9, respectively. GPH and GMH were frequently lower among ethnic minorities, patients without private health insurance, and those with advanced disease. **CONCLUSIONS:** This analysis provides important baseline data on patient-reported global health in breast and prostate cancer. Demonstrating that PROs can be integrated into clinical workflows, this study shows that supportive efforts may be needed to improve PRO collection and global health endpoints in vulnerable populations. ***Cancer* 2018;0:1-9**. © *2018 American Cancer Society.*

KEYWORDS: breast, global health, patient-centered outcomes, prostate, real-world evidence.

INTRODUCTION

Patient-reported outcomes (PROs), including metrics such as quality of life, functional status, and mental health, have emerged as a priority in cancer care internationally.[1,2] By providing a unique insight into the patient experience, PROs may help to inform treatment choices at patient and population level and are increasingly being used to benchmark quality of care.[3,4]

PROs were first collected in the context of prospective research studies, often as secondary endpoints in clinical trials. Recently, PROs have started to be integrated into routine care delivery and captured in the electronic health record (EHR).[5] Systematic reviews in oncologic settings have found that PRO collection facilitates patient-clinician communication by increasing the patient's awareness of symptoms and providing a stimulus for discussion, and this results in improved patient satisfaction.[6,7] Recently, randomized evidence demonstrated that routine collection of PROs, combined with clinician feedback loops, where nurses were able to intervene when PROs suggested deterioration, conferred a survival benefit.[8]

The Patient-Reported Outcomes Measurement Information System (PROMIS) was a collaboration launched in 2004 by the National Institutes of Health with the goal of developing PRO measures that could be standardized and shared across sites and disease states.[9] In oncology, PROMIS item banks (typically the Adult Global Health 10 [Global-10] survey or PROMIS-29) are used to monitor symptoms and quality of life for both research and clinical practice.[10,11] Consequently, there have been several recent efforts to establish baseline data and reference ranges for PROMIS responses in cancer populations. Past studies indicate that the use of PROs is lower population-wide in cancer patients and declines further in patients with advanced disease.[12,13]

Although PROMIS is gaining more widespread use in oncology practice, limited work has been done to evaluate the implementation of PROMIS measures into routine clinical workflows. Specifically, the value and variability of

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PROMIS scores over time in real-world patient populations are poorly understood, especially across different tumor types. This is despite previous literature showing important variations in quality of life between ethnic and socioeconomic subgroups during treatment and survivorship.[14]

In this study, we analyze EHR data since the integration of PROMIS Global-10 surveys into clinical workflows at a tertiary academic cancer center and assess PROs across 2 tumor types: breast and prostate cancer. We evaluate survey completion rates and PROMIS global health scores (physical and mental) across different demographic and clinical subgroups with a view toward establishing baseline data on the burden of cancer symptoms during treatment and survivorship. We identify population subsets that can be targeted in future PRO initiatives and quality improvement efforts.

MATERIALS AND METHODS

PROMIS Implementation

The cancer center is affiliated with an academic medical institute and serves as a tertiary referral center for patients with all cancer diagnoses. In 2011, a team consisting of oncologists, oncology nurses, administrators, social workers, and hospital chaplains convened to develop PRO reporting protocols for the cancer center under the oversight of the patient and family advisory committee. The team chose to use Global-10 (version 1.0/1.1), which contains 10 multiple-choice questions about physical and mental health with responses on a 1 to 5 scale (except for a 1-10 scale for pain), because of the ease of delivery and comprehensiveness of the tool. The survey was augmented with the following question: "Would you like help with any issue noted above?" After pilot testing with a paper-based instrument,[15] 2 further questions from another PROMIS scale were added: "My life lacks meaning—how true was this before your illness?" and "My life lacks meaning—how true was this after your illness?" The surveys were deployed into routine clinical workflows for oncology outpatients as follows: at the time of clinic appointments, patients were given a paper survey, which was transcribed directly into the EHR by the medical assistant. In May 2013, this process was supplemented by an electronic one, so patients could access the survey through the EHR patient portal before an appointment. Approximately 75% of the patients at the academic cancer center were enrolled in the EHR patient portal and could receive electronic reminders to complete a survey. If no survey was completed electronically, paper surveys were available at the time of the visit. The rollout of PROMIS surveys in different clinics was staggered. For patients with breast cancer, surveys were routinely collected from March 2013 onward; for patients with prostate cancer, they were routinely collected from June 2015 onward.

Data Set and Study Population

We used data from Oncoshare (a breast cancer outcomes research database) and a prostate cancer research warehouse.[16,17] These are both clinical research data warehouses that combine data extracted from the EHRs of an academic medical center with registry-level data from the California Cancer Registry, a statewide Surveillance, Epidemiology, and End Results Program registry. Each warehouse contains information on patient demographics clinical characteristics and detailed treatment information. Patient demographics and clinical variables were identified at the time of diagnosis. Retrospective data use was approved by the local institutional review board.

The total populations for breast and prostate cancer were defined as all subjects in the research data warehouse with at least 1 outpatient encounter recorded in the EHR after the date of PROMIS implementation (March 2013 for breast cancer and June 2015 for prostate cancer). This cohort included patients across various stages of treatment and survivorship.

Index Dates

For all patients, the index date was set as the date of first treatment to provide a relative marker of when a survey was completed in a patient's care pathway. For breast cancer, the following treatment categories were defined: surgery, surgery/radiotherapy, systemic therapy, surgery/systemic therapy, surgery/radiotherapy/systemic therapy, and other/unknown. Multitreatment categories were defined if multiple treatments were commenced within 12 months of the earliest treatment date. Patients with breast cancer with no primary treatment listed in either the EHR or the registry had the index date set as the diagnosis date and were classed as other/unknown. For patients with breast cancer and multiple distinct tumors, we used the tumor with the index date in closest proximity to the survey to stratify that survey into time bins. For prostate cancer, the following treatments were included: surgery, active surveillance, radiotherapy, hormone therapy, chemotherapy, and other/unknown. A large number of patients (n = 4347) did not receive

primary treatment at the cancer center, and the primary treatment modality was unknown; they were categorized together in the other/unknown category. For active-surveillance patients and those with no primary treatment listed, the index date was set as the diagnosis date.

On the basis of the aforementioned index date, 3 time windows were defined: before treatment, 0 to 12 months after treatment initiation, and more than 12 months after treatment initiation. Surveys were stratified into these time windows retrospectively. For each time window, only 1 survey per patient was used in calculating the average T score. For the pretreatment window, the survey with the later date (ie, closest to the treatment date) was used for analysis. For the time windows after treatment initiation, the earliest survey in each bin was used. A given patient may, therefore, have had a PROMIS score recorded between 0 and 3 time windows.

Survey Completion Rates

We calculated survey completion rates by taking the ratio of the number of distinct patients with at least 1 PROMIS survey to the total number of eligible patients with at least 1 outpatient encounter in the EHR during the study period. Rates were separately calculated for a range of demographic and clinical parameters, including primary treatment, age, race, and stage at diagnosis.

Global Physical Health (GPH) and Global Mental Health (GMH) Scores

All PROMIS responses were mapped to a 1 to 5 scale, with 1 being poor and 5 being excellent. GPH and GMH were each calculated as the sum of 4 response items. GPH was the sum of physical health (Global03), activities of daily living (Global06), pain (Global07), and fatigue (Global08). GMH was the sum of quality of life (Global02), mental health (Global04), satisfaction with social activities and relationships (Global05), and anxiety/depression/irritability (Global10).[18]

Raw GPH and GMH scores were converted into T scores for each patient with standard conversion tables.[18,19] T scores have previously been calibrated to have a mean of 50 and a standard deviation of 10 on the basis of a random sample of the US population.[20] A higher T score represents better global health. A 3-point difference in the T score was considered clinically meaningful, as in previous descriptive studies of PROMIS tools in oncology populations.[13]

Statistical Analysis

Within each time window, the subgroups in each demographic or clinical category were compared with the Kruskal-Wallis test because the GPH and GMH scores were not normally distributed on the basis of the Shapiro-Wilk test ($P < .001$). Within each demographic/clinical category, the reference group (the first listed group) was compared against all other subgroups with 2-sided Dunn tests. Significance levels were reported with respect to the reference category. Bivariate analyses of categorical variables were performed with chi-square tests followed by pairwise tests with the Bonferroni correction. Significance levels were reported with respect to the reference category. Analyses were performed with R (version 3.4.2), and P values less than .05 were considered significant.

RESULTS

A total of 11,485 patients with breast cancer and 8936 patients with prostate cancer were included in the study cohort: patients with at least 1 outpatient encounter after the rollout of PROMIS surveys for each tumor type. Within this cohort, there were 11,657 surveys from 4199 distinct patients with breast cancer and 4411 surveys from 2118 distinct patients with prostate cancer (Table 1); 36.6% of the patients with breast cancer and 23.7% of the patients with prostate cancer had at least 1 survey. Of the patients with at least 1 survey, the median number of surveys completed was 2. The percentage of surveys completed electronically via the EHR patient portal was approximately 20% to 35% and was trending upward over time, with the remainder completed on paper forms during the clinic appointment.

Table 2 shows the percentage of eligible patients (with at least 1 outpatient encounter) who completed at least 1 survey during the study period as well as the

TABLE 1. Number of PROMIS Surveys and Distinct Patients in Breast and Prostate Cancer Populations

	Breast	Prostate
Total patients in database, No.	11,485	8936
No. of surveys	11,657	4411
Distinct patients with survey, No. (% of total)	4199 (36.6)	2118 (23.7)
Surveys per patient, median (range)	2 (1-12)	2 (1-12)
Age at first survey, mean ± SD, y	58.1 ± 15	70.1 ± 9

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; SD, standard deviation.

TABLE 2. Survey Completion Rates by Demographic and Clinical Subgroups

Breast Cancer			Prostate Cancer		
Subpopulation (Total Patients)	Patients With Survey, %	Outpatient Encounters, Median	Subpopulation (Total Patients)	Patients With Survey, %	Outpatient Encounters, Median
First line of treatment			First line of treatment		
Surgery (2371)	29.5	9	Surgery (1796)	32.1	7
Surgery + radiotherapy (1175)	29.3	10	Active surveillance (478)	**49.8**[a]	8
Systemic (223)	**50.7**[a]	16	Radiation (968)	**19.6**[a]	8
Surgery + radiotherapy + systemic (4598)	**37.8**[a]	11	Hormone (1171)	31.2	9
Radiotherapy + systemic (78)	34.6	14	Chemotherapy (176)	39.8	18
Surgery + systemic (2828)	**41.2**[a]	12	Other/unknown (4347)	**15.6**[a]	7
Other/unknown (212)	**52.8**[a]	8			
Age			Age		
<45 y (2592)	36.8	10	<55 y (780)	26.0	5
45-59 y (4832)	36.9	11	55-75 y (6113)	25.8	7
60-75 y (3275)	37.0	11	>75 y (2043)	**16.5**[a]	9
>75 y (786)	31.8	10			
Race			Race		
White (7451)	33.8	10	White (6415)	24.4	7
Black (403)	**21.8**[a]	11	Black (508)	**13.4**[a]	9
Hispanic (867)	**42.7**[a]	13	Hispanic (384)	24.2	7
Asian (2380)	**45.4**[a]	12	Asian (940)	**29.0**[b]	9
Other/unknown (384)	37.5	10	Other/unknown (689)	**17.4**[a]	5
Insurance status			Insurance status		
Private (7660)	37.5	10	Private (2167)	28.1	5
Public (3212)	38.0	12	Public (6004)	**23.1**[a]	8
None/unknown (613)	**17.0**[a]	10	None/unknown (765)	**16.2**[a]	7
Stage at diagnosis			Stage at diagnosis		
0 (1901)	28.5	9	I (941)	33.9	8
I (4108)	**37.5**[a]	10	II (3193)	**26.3**[a]	8
II (3222)	**36.3**[a]	11	III (649)	36.5	7
III (999)	**37.6**[a]	13	IV (452)	35.2	8
IV (340)	**36.8**[b]	10	Unknown (3701)	**15.2**[a]	7
Unknown (915)	**48.6**[a]	15			

Percentages of all patients who completed at least 1 Patient-Reported Outcomes Measurement Information System survey are shown. Bolded values are significant according to a corrected pairwise chi-square test with respect to the reference category within that time bin (the first listed group).
[a]$P < .001$.
[b]$P < .05$.

median number of outpatient encounters in that subgroup. In breast cancer, patients with systemic therapy had higher completion rates (up to 50.7% for patients who received systemic therapy alone), whereas in prostate cancer, the highest rates were observed among active-surveillance patients (49.8%). The survey completion rate among elderly patients with prostate cancer (>75 years old) was significantly lower than the rate among patients younger than 55 years (16.5% vs 26.0%; $P < .001$), although this age dependency was not as pronounced in breast cancer.

There were significant differences between ethnic groups, with completion rates consistently lower among black patients across both tumor types (Table 2). Patients with prostate cancer with public insurance or an unknown insurance status had lower completion rates (a trend not observed in breast cancer). Rates were comparable across stage categories except for patients with stage 0 breast cancer and patients with stage II prostate cancer. For subjects with breast cancer, high completion rates were often associated with a high median number of appointments (eg, patients undergoing systemic therapy); however, this correlation was not as pronounced in prostate cancer.

Across all surveys, the mean T scores for GPH and GMH were 48.4 ± 9 and 52.7 ± 8, respectively, for breast cancer (n = 11,657) and 50.6 ± 9 and 52.1 ± 9, respectively, for prostate cancer (n = 4411). The percentages of surveys with GPH and GMH T scores lower than 40 (1 standard deviation below the population mean of the general US population) were 21.4% and 4.9%, respectively, for breast cancer and 16.3% and 8.4%, respectively, for prostate cancer.

Table 3 shows the GPH scores across demographic and clinical subgroups stratified by the timing of the survey with respect to the patient's index date (the treatment start date or the diagnosis date in the absence of treatment), with only 1 survey per patient in each

TABLE 3. Global Physical Health Scores for Demographic and Clinical Subgroups

	Breast, Mean T Score ± SD (No.)		
	Before Treatment (n = 218)	0-12 mo (n = 1026)	>12 mo (n = 3869)
First line of treatment			
Surgery	47.9 ± 9 (56)	47.9 ± 10 (190)	48.7 ± 10 (611)
Surgery + radiotherapy	53.1 ± 7 (26)	49.2 ± 9 (97)	49.0 ± 9 (305)
Systemic	51.5 ± 9 (16)	44.2 ± 10 (57)	45.7 ± 10 (98)
Surgery + radiotherapy + systemic	48.8 ± 10 (40)	47.9 ± 10 (287)	49.2 ± 9 (1656)
Radiotherapy + systemic	—	—	**42.7 ± 9**[a] (23)
Surgery + systemic	49.1 ± 10 (72)	47.5 ± 9 (356)	48.2 ± 9 (1072)
Other/unknown	—	50.0 ± 11 (31)	45.5 ± 10 (104)
Age			
<45 y	48.6 ± 9 (43)	47.1 ± 10 (201)	48.8 ± 9 (874)
45-59 y	49.3 ± 8 (89)	47.5 ± 10 (453)	48.9 ± 9 (1650)
60-75 y	50.2 ± 10 (68)	48.8 ± 10 (299)	48.4 ± 9 (1123)
>75 y	46.0 ± 12 (18)	44.5 ± 11 (73)	**47.7 ± 9**[b] (222)
Race			
White	49.9 ± 9 (118)	48.6 ± 10 (597)	49.6 ± 9 (2318)
Black	—	44.5 ± 11 (21)	**45.3 ± 9**[c] (78)
Hispanic	45.5 ± 8 (15)	44.6 ± 11 (99)	**46.1 ± 10**[c] (338)
Asian	50.1 ± 9 (66)	47.3 ± 9 (269)	**47.6 ± 9**[c] (1004)
Other/unknown	—	46.2 ± 10 (40)	47.0 ± 10 (131)
Insurance status			
Private	49.9 ± 8 (139)	48.0 ± 10 (683)	49.4 ± 9 (2657)
Public	47.7 ± 11 (68)	**46.8 ± 10**[a] (309)	**46.8 ± 9**[c] (1118)
None/unknown	—	49.4 ± 8 (34)	47.6 ± 9 (94)
Stage at diagnosis			
0	49.7 ± 8 (50)	49.3 ± 11 (91)	50.3 ± 9 (500)
I	49.3 ± 9 (54)	48.7 ± 9 (279)	49.6 ± 9 (1458)
II	48.5 ± 10 (41)	46.9 ± 10 (234)	**48.3 ± 9**[c] (1103)
III	—	46.3 ± 10 (85)	**46.2 ± 10**[c] (358)
IV	45.0 ± 8 (18)	**42.6 ± 11**[b] (39)	**45.2 ± 10**[c] (108)
Unknown	49.8 ± 10 (76)	48.1 ± 10 (298)	**46.5 ± 10**[c] (342)
	Prostate, Mean T Score ± SD (No.)		
	Before Treatment (n = 294)	0-12 mo (n = 793)	>12 mo (n = 1425)
First line of treatment			
Surgery	55.3 ± 8 (78)	50.3 ± 9 (271)	52.6 ± 8 (351)
Active surveillance	—	**55.6 ± 7**[b] (25)	52.4 ± 9 (220)
Radiation	53.2 ± 9 (55)	51.5 ± 9 (55)	50.5 ± 10 (129)
Hormone	51.8 ± 9 (37)	50.4 ± 9 (151)	**47.6 ± 9**[c] (251)
Chemotherapy	49.5 ± 10 (25)	49.9 ± 9 (32)	**44.9 ± 11**[c] (33)
Other/unknown	48.2 ± 9 (75)	49.8 ± 9 (213)	50.8 ± 9 (478)
Age			
<55 y	54.3 ± 7 (26)	51.2 ± 9 (72)	51.6 ± 9 (143)
55-75 y	52.7 ± 9 (191)	50.9 ± 9 (550)	51.4 ± 9 (112)
>75 y	**48.3 ± 9**[a] (56)	48.8 ± 7 (135)	**46.5 ± 9**[c] (207)
Race			
White	52.4 ± 9 (200)	51.1 ± 9 (540)	51.0 ± 9 (1095)
Black	48.7 ± 11 (11)	47.6 ± 10 (35)	50.8 ± 10 (42)
Hispanic	—	47.6 ± 11 (27)	48.2 ± 9 (73)
Asian	54.5 ± 6 (33)	50.2 ± 8 (106)	50.1 ± 9 (187)
Other/unknown	**45.8 ± 9**[a] (24)	48.5 ± 9 (49)	51.0 ± 11 (65)
Insurance status			
Private	54.1 ± 9 (100)	51.6 ± 9 (286)	53.3 ± 9
Public	**51.1 ± 9**[a] (151)	**49.8 ± 9**[a] (417)	**50.0 ± 9**[c] (1028)
None/unknown	**48.3 ± 7**[a] (22)	50.5 ± 9 (54)	**47.8 ± 9**[c] (66)
Stage at diagnosis			
I	52.3 ± 9 (30)	51.5 ± 9 (85)	52.5 ± 9 (249)
II	54.4 ± 8 (111)	51.5 ± 9 (300)	51.3 ± 9 (581)
III	57.7 ± 6 (23)	50.6 ± 8 (99)	51.1 ± 9 (174)
IV	50.2 ± 11 (10)	48.4 ± 9 (69)	**47.2 ± 9**[c] (118)
Unknown	47.9 ± 9 (99)	49.4 ± 9 (204)	**49.5 ± 10**[c] (340)

Abbreviation: SD, standard deviation.

Bolded values are significant with respect to the reference category within that time bin (the first listed group). The general US population mean T score is 50 (SD, 10). Cells with counts lower than 10 have been omitted.

[a] $P \leq .05$.

[b] $P \leq .01$.

[c] $P \leq .001$.

time bin. In both breast and prostate cancer, GPH was lower in the >12-month time bin in certain vulnerable populations: patients with breast cancer who underwent radiotherapy and systemic therapy, patients with prostate cancer with hormone or chemotherapy as the first line of treatment, patients older than 75 years, patients on public insurance schemes (observed in earlier time windows also), and those with advanced disease at the time of diagnosis. In breast cancer only, there were strong ethnic differences, with black, Hispanic, and Asian patients all showing lower GPH scores than white subjects.

Table 4 shows the GMH scores across the same demographic and clinical groupings. Across both tumor types in the >12-month time bin, lower GMH scores were observed for Hispanic and Asian subjects, patients on public insurance schemes, and those with advanced disease. In prostate cancer only, GMH deficits were seen >12 months after treatment initiation in subjects who underwent first-line hormone therapy or chemotherapy as well as elderly patients.

DISCUSSION

Using one of the largest cohorts of PROMIS data from an oncology population, this study provides insights into how survey completion rates and survey content vary by demographic and clinical parameters across patients' treatment courses. Survey completion rates were modest yet nonetheless yielded more than 16,000 surveys across the 2 tumor types. GPH and GMH scores demonstrated the most significant differences at >12 months after treatment initiation, and they showed important variations on the basis of ethnicity, insurance status, treatment type, and disease stage. To our knowledge, this is the first comprehensive study to generate baseline PRO data for breast and prostate cancers with the EHR. These data highlight vulnerable populations that must be targeted in future implementation efforts.

Survey completion rates varied widely between the subgroups within the range of 13.4% to 50.7%. The highest completion rates were found in patients with breast cancer receiving systemic therapy and patients with prostate cancer on active surveillance. In some cases, high rates were associated with a high median number of appointments (this suggested that patients were given more opportunities to complete at least 1 survey); however, this was not uniformly the case and was not always commensurate with the difference in completion rates. It is worth noting the significant variation in completion rates between ethnic groups, particularly the consistently lower rates among black subjects. This may be an effect of patient and/or staff behaviors and emphasizes the importance of making efforts to target minority groups in PRO initiatives. Patients with advanced-stage disease also had lower completion rates, which may reflect challenges in completing the surveys either at home or in the clinic. Taken together, these data suggest that multiple demographic and clinical factors influence survey completion and that in future implementations specific efforts may be required to boost completion rates in patients from certain ethnic minorities and with certain treatment profiles.

Mean GPH and GMH scores across both tumor types were lower than the scores reported in the National Health Interview Survey (NHIS) on PROs among cancer survivors.[21] This may be related to the setting in which surveys were collected (mailed surveys in the NHIS vs surveys delivered via the EHR patient portal or in the clinic in our study) and to the proximity to diagnosis and treatment because the majority of the NHIS cohort members were more than 10 years from their diagnosis, whereas the current study focused on patients during both treatment and survivorship. Our study provides valuable baseline data for in-hospital PROMIS surveys recorded during the course of routine care, whereas previous reference data came from household interviews or mailed surveys.[13,21]

Supportive efforts to improve PROs in vulnerable populations, including racial minorities, uninsured patients, and those with advanced disease, are also warranted. Supportive therapies might include physical activity, regular symptom tracking, or cognitive behavior therapy, which have previously been linked to improved quality of life measures.[22,23] We found that both GPH and GMH were lower among certain ethnic groups, including black, Hispanic, and Asian patients with breast cancer. Across both tumor types, patients with advanced disease at the time of diagnosis also reported lower GPH and GMH scores, and this is broadly consistent with reference data showing more severe symptoms and functional deficits with increasing stage.[13] In addition, patients with prostate cancer undergoing chemotherapy or hormone therapy showed significant deficits in both physical and mental health, notably in the >12-month time bin. This is to be expected because these therapies are administered for advanced disease and also have a wide side-effect profile. Many of these trends were not observed in the pretreatment time window or in the 0- to 12-month posttreatment time window, likely because

TABLE 4. Global Mental Health Scores for Demographic and Clinical Subgroups

	Breast, Mean T Score ± SD		
	Before Treatment (n = 218)	0-12 mo (n = 1026)	>12 mo (n = 3869)
First line of treatment			
Surgery	54.1 ± 8	53.4 ± 8	53.1 ± 8
Surgery + radiotherapy	56.5 ± 6	53.6 ± 8	53.0 ± 8
Systemic	55.8 ± 8	50.4 ± 8	51.2 ± 8
Surgery + radiotherapy + systemic	53.0 ± 8	52.0 ± 8	53.0 ± 8
Radiotherapy + systemic	—	—	51.2 ± 9
Surgery + systemic	53.0 ± 8	52.1 ± 8	52.7 ± 8
Other/unknown	—	53.4 ± 10	51.2 ± 8
Age			
<45 y	52.8 ± 7	52.2 ± 8	52.6 ± 8
45-60 y	54.3 ± 8	52.0 ± 8	52.9 ± 8
60-75 y	54.2 ± 9	53.2 ± 8	53.0 ± 8
>75 y	50.0 ± 11	51.9 ± 8	52.5 ± 8
Race			
White	54.8 ± 8	53.0 ± 8	53.8 ± 8
Black	—	51.0 ± 7	**50.6 ± 8**[a]
Hispanic	50.3 ± 7	51.3 ± 9	**50.9 ± 8**[b]
Asian	53.8 ± 8	51.6 ± 8	**51.4 ± 8**[b]
Other/unknown	—	51.7 ± 9	52.1 ± 8
Insurance status			
Private	54.7 ± 7	52.7 ± 8	53.3 ± 8
Public	52.7 ± 9	51.6 ± 9	**51.5 ± 8**[b]
None/unknown	—	52.4 ± 8	52.3 ± 8
Stage at diagnosis			
0	54.3 ± 9	53.9 ± 9	53.9 ± 8
I	54.3 ± 8	53.1 ± 8	53.6 ± 8
II	52.9 ± 9	51.9 ± 9	**52.5 ± 8**[a]
III	—	51.4 ± 9	**51.3 ± 8**[b]
IV	50.4 ± 5	**48.8 ± 9**[c]	**50.9 ± 8**[a]
Unknown	54.0 ± 8	52.4 ± 8	**51.4 ± 8**[b]
	Prostate, Mean T Score ± SD		
	Before Treatment (n = 273)	0-12 mo (n = 757)	>12 mo (n = 1462)
First line of treatment			
Surgery	53.2 ± 10	52.1 ± 9	53.2 ± 8
Active surveillance	52.6 ± 6	55.7 ± 8	53.1 ± 10
Radiation	52.5 ± 8	52.9 ± 9	52.8 ± 9
Hormone	53.2 ± 8	53.1 ± 9	**49.9 ± 8**[b]
Chemotherapy	52.2 ± 11	51.7 ± 10	**47.7 ± 11**[c]
Other/unknown	51.0 ± 9	51.2 ± 9	52.2 ± 9
Age			
<55 y	52.4 ± 9	53.3 ± 9	51.9 ± 10
55-75 y	52.4 ± 9	52.2 ± 9	52.6 ± 9
>75 y	52.3 ± 9	51.9 ± 9	**49.8 ± 9**[c]
Race			
White	53.0 ± 9	52.8 ± 9	52.6 ± 9
Black	48.2 ± 9	50.5 ± 7	52.8 ± 8
Hispanic	50.8 ± 8	51.2 ± 8	**49.4 ± 9**[c]
Asian	53.2 ± 7	51.4 ± 8	**50.3 ± 9**[a]
Other/unknown	48.1 ± 10	49.8 ± 10	52.0 ± 9
Insurance status			
Private	52.7 ± 9	52.5 ± 9	53.3 ± 9
Public	52.7 ± 9	52.2 ± 9	**51.9 ± 9**[c]
None/unknown	48.5 ± 10	51.0 ± 9	**49.5 ± 8**[a]
Stage at diagnosis			
I	50.9 ± 11	52.3 ± 8	53.4 ± 10
II	53.5 ± 9	53.2 ± 9	52.4 ± 9
III	55.6 ± 6	52.4 ± 9	52.0 ± 9
IV	51.9 ± 9	50.3 ± 9	**50.2 ± 9**[a]
Unknown	50.8 ± 9	51.4 ± 9	**51.6 ± 9**[c]

Abbreviation: SD, standard deviation.

Bolded values are significant with respect to the reference category within that time bin (the first listed group). The general US population mean T score is 50 (SD, 10). Cells with counts lower than 10 have been omitted.

[a] $P \leq .01$.

[b] $P \leq .001$.

[c] $P \leq .05$.

of smaller sample sizes. These data highlight the utility of implementing PRO assessment tools in the real-world setting and indicate vulnerable patient groups that may benefit from targeted support, namely the elderly, uninsured patients, ethnic minorities, and advanced-stage patients.

This study was limited to using retrospective data from a PROMIS deployment that was not standardized across time or tumor types. As a result, many patients had only 1 survey, and surveys were collected at varying time points in the patient's care journey; this made it difficult to assess trends on an individual patient level. Our calculation of completion rates was an approximation using all patients with an outpatient encounter as the pool of eligible patients; however, it is unclear whether all of these patients were offered a PROMIS survey. The different methods of survey distribution (paper forms vs EHR patient portal) may have influenced completion rates, and further study is warranted to investigate whether the survey format contributed to demographic differences in completion rates. In prostate cancer, many patients were lacking information about their primary treatment modality if they were treated outside our academic cancer center. Nevertheless, given the size of the cohort with respect to previous PROMIS analyses, we believe that our data still have utility as high-level approximations for global health measures. We recognize that there are correlations between the demographic and clinical variables that we have compared, such as older ages among stage IV patients. Our data should not be used to draw causal conclusions; however, they do provide a high-level overview of completion rates and global health measures across clinical and demographic subgroups in one of the largest observational cohorts of PROMIS surveys analyzed to date. In future work, we will analyze how PROMIS scores correlate with clinical outcomes such as recurrence and mortality and investigate the influence of treatment choices (eg, active surveillance vs surgery) on PROMIS scores with matched populations.

In conclusion, this study demonstrates the utility of integrating PROMIS surveys into routine clinical workflows to collect valuable global health measures, which show significant variability across demographic and clinical parameters. In particular, vulnerable populations, including the elderly, uninsured patients, ethnic minorities, and advanced-stage patients, often report lower global physical and mental health and have lower survey completion rates. This evidence may help to inform the design of supportive interventions to improve both PRO collection and patient well-being in these vulnerable groups.

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CONFLICT OF INTEREST DISCLOSURES

Martin G. Seneviratne has served as an advisor and received personal fees from CancerAid, outside the submitted work. Douglas W. Blayney reports grants and nonfinancial support from BeyondSpring Pharmaceuticals, Inc; grants from Amgen, Inc; personal fees and other from Rossy Cancer Network, Artelo Biosciences, Inc, and Madorra, Inc; and personal fees from Apobiologix, Boston Consulting Group, Creare, Inc, Mannatt Phelps, Inc, Heron Therapeutics, Inc, Mylan, Inc, Tersera, Inc, and Oncothyreon, Inc, outside the submitted work. Allison W. Kurian reports funding from Myriad Genetics outside the submitted work.

AUTHOR CONTRIBUTIONS

Martin G. Seneviratne: Study conception and design, analysis, drafting of manuscript, guarantor of content, interpretation of data, and critical revision. **Selen Bozkurt:** Study conception and design, analysis, interpretation of data, and critical revision. **Manali I. Patel:** Interpretation of data and critical revision. **Tina Seto:** Acquisition of data, interpretation of data, and critical revision. **James D. Brooks:** Interpretation of data and critical revision. **Douglas W. Blayney:** Study conception and design, interpretation of data, and critical revision. **Allison W. Kurian:** Interpretation of data and critical revision. **Tina Hernandez-Boussard:** Study conception and design, acquisition of data, study supervision, financial support, guarantor of content, interpretation of data, and critical revision.

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