Post-surgery anxiety and depression in prostate cancer patients: prevalence, longitudinal progression, and their correlations with survival profiles during a 3-year follow-up

Su Hu 1 · Li Li 1 · Xiaoling Wu 1 · Zhengqing Liu 1 · Adan Fu 1

Received: 21 August 2020 / Accepted: 17 October 2020 / Published online: 7 January 2021 © The Author(s) 2021

Abstract

Background Anxiety and depression are more frequent in cancer patients than general population and may be correlated with cancer prognosis; however, their value in prostate cancer patients is largely unknown. We aimed to evaluate prevalence of anxiety and depression in prostate cancer survivors post the surgeries, and their correlations with patients’ disease-free survival (DFS) and overall survival (OS).

Methods A hundred and ninety-four patients with prostate cancer who underwent radical prostatectomy were enrolled. After discharged from hospital, patients were assessed for post-surgery anxiety and depression every 3 months using Zung Self-rating Anxiety/Depression Scale (SAS/SDS) for a total of 36 months. In addition, disease conditions, DFS, and OS were also documented.

Results SAS score ($P < 0.001$), anxiety rate ($P = 0.004$), SDS score ($P < 0.001$), and depression rate ($P < 0.001$) gradually elevated from baseline to month 36 in prostate cancer patients. Anxiety at baseline ($P = 0.009$) and anxiety at 3 years ($P = 0.017$) were correlated with worse DFS, and anxiety at baseline ($P = 0.009$) was also correlated with shorter OS in prostate cancer patients. Furthermore, depression at baseline ($P = 0.005$) and depression at 2 years ($P = 0.008$) were associated with unfavorable DFS, and depression at baseline ($P = 0.001$), 1 year ($P = 0.025$), and 2 years ($P = 0.008$) were associated with worse OS in prostate cancer patients. Moreover, multivariate Cox’s proportional hazards regression analysis elucidated that depression at baseline ($P = 0.027$) was an independent predictive factor for shorter DFS in prostate cancer patients.

Conclusion Anxiety and depression both gradually deteriorate, and they correlate with unfavorable survival profile in prostate cancer patients after radical prostatectomy.

Keywords Anxiety · Depression · Disease-free survival · Overall survival · Prostate cancer

Introduction

Anxiety and depression have long been the most common mental disorders that impact on approximately 6–7% of the worldwide population, and they often coexist in the same individual [1, 2]. These mental disorders not only sabotage psychiatric health but also result in physical dysfunction, such as increasing cardiovascular disease risk and cause fatigue in affected individuals [3, 4]. In the past decades, anxiety and depression are more and more noted in cancer patients as they tend to have obviously increased prevalence in cancer patients than in the general populations [5, 6]. The mechanism underlying the occurrence of anxiety and depression in cancer patients is complex. Nowadays, several possible mechanisms including the change of biopsychosocial status, some anti-tumor drugs, and neuron affected tumors have been implied [7–9]. However, although anxiety and depression present with a relatively high prevalence in cancer patients, very limited patients can obtain proper intervention, what’s worse is that these two mental disorders are increasingly reported to be correlated with worse prognosis [10, 11].

Among males, prostate cancer is currently the most frequent cancer in over a half of countries worldwide [12]. Prostate cancer treatments are categorized by the disease...
condition; for localized patients, the first line methods are prostatectomy and radio-therapy, and for metastatic patients, hormone therapy and chemotherapy are the most frequently applied methods in practice [13, 14]. Most of the patients with prostate cancer present with a favorable survival profile; therefore, the number of prostate cancer survivors after the surgeries is very considerable; although survived from the disease, patients have to confront various issues that often impair their health status and quality of life, such as the fear of relapse and decrease of physical function [15, 16]. Recently, there have been reports of the development of anxiety and depression in prostate cancer survivors, which is not surprising in view of the incidence of these two mental disorders in other cancers [17], while the impact of anxiety and/or depression on prostate cancer patients’ clinical outcome remains ambiguous, and corresponding studies are very few.

Therefore, we investigated the prevalence of anxiety and depression in prostate cancer survivors post the surgeries, and their correlations with patients’ disease-free survival (DFS) as well as overall survival (OS) in this current study.

### Table 1 Clinical characteristics of patients

| Items                               | Prostate cancer patients (N = 194) |
|-------------------------------------|-------------------------------------|
| **Demographics**                    |                                     |
| Age (years), M ± D                  | 62.5 ± 9.0                          |
| Education duration (years), median (IQR) | 9.0 (6.0–12.0)             |
| Marry status, no. (%)               |                                     |
| Married                             | 129 (66.5)                          |
| Single/divorced/widowed             | 65 (33.5)                           |
| Employment status before surgery, no. (%) |                                     |
| Employed                            | 66 (34.0)                           |
| Unemployed                          | 128 (66.0)                          |
| Smoker, no. (%)                     | 84 (43.3)                           |
| **Comorbidities**                   |                                     |
| Hypertension, no. (%)               | 83 (42.8)                           |
| Hyperlipidemia, no. (%)             | 45 (23.2)                           |
| Diabetes, no. (%)                   | 35 (18.0)                           |
| CKD, no. (%)                        | 32 (16.5)                           |
| **Disease features**                |                                     |
| PSA level, no. (%)                  |                                     |
| ≤ 10 ng/ml                          | 46 (23.7)                           |
| 10–20 ng/ml                         | 100 (51.5)                          |
| ≥ 10–20 ng/ml                       | 48 (24.8)                           |
| Gleason score, no. (%)              |                                     |
| ≤ 6                                 | 44 (22.7)                           |
| 7                                   | 107 (55.2)                          |
| ≥ 8                                 | 43 (22.1)                           |
| Pathological T stage, no. (%)       |                                     |
| pT2                                 | 112 (57.7)                          |
| pT3                                 | 76 (39.2)                           |
| pT4                                 | 6 (3.1)                             |
| Pathological N stage, no. (%)       |                                     |
| pN0                                 | 140 (72.2)                          |
| pN1                                 | 54 (27.8)                           |
| Surgical margin status, no. (%)     |                                     |
| Negative                            | 160 (82.5)                          |
| Positive                            | 34 (17.5)                           |

*M ± SD, mean ± standard deviation; IQR, interquartile range; CKD, chronic kidney disease; PSA, prostate-specific antigen*
Methods

Patients

From January 2015 to December 2016, 194 patients with prostate cancer who underwent radical prostatectomy in our hospital were consecutively enrolled in this study. The eligible criteria for enrollment were as follows: (1) confirmed diagnosis of primary prostate cancer based on histopathological verification of adenocarcinoma in prostate biopsy cores; (2) age ≥ 18 years; (3) underwent radical prostatectomy; (4) able to understand the study consents and complete the anxiety and depression assessments; (5) willing to comply with follow-up schedule. Patients with the following conditions were not included in the study: (1) known other serious mental disorders (excepting anxiety and depression); (2) severe cognitive impairment; (3) history of severe neurological diseases or neurodegenerative disease; (4) complicated with other cancers. All patients signed the informed consents before enrollment. The Institutional Review Board of our hospital approved the current study before initiation.

Baseline data collection and assessment

Patients’ clinical characteristics, including demographics (age, gender, education duration, marry status, employment status before surgery, and smoke status), comorbidities (hypertension, hyperlipidemia, diabetes, and chronic kidney disease (CKD)), and disease features (prostate-specific antigen (PSA) level, Gleason score, pathological T stage, pathological N stage, surgical margin status), were documented in case report forms on the day of hospital discharge that was defined as baseline (M0). Meanwhile, assessment of anxiety and depression using Zung Self-rating Anxiety/Depression Scale (SAS/SDS) was performed at that time. The assessment was performed by filling the questionnaire by the patients themselves guided by the doctors or nurses, who were blinded to the clinical features of each patient. In detail, before assessment, investigator provided
a

Disease-free survival (DFS)

$P = 0.009$

HR: 1.942, 95%CI: 1.163-3.244 (anxiety vs. non-anxiety)

- Anxiety at baseline ($n=87$)
- Non-anxiety at baseline ($n=107$)

Time (months)

b

Disease-free survival (DFS)

$P = 0.253$

HR: 1.341, 95%CI: 0.807-2.229 (anxiety vs. non-anxiety)

- Anxiety at 1 year ($n=93$)
- Non-anxiety at 1 year ($n=101$)

Time (months)

c

Disease-free survival (DFS)

$P = 0.059$

HR: 1.640, 95%CI: 0.988-2.720 (anxiety vs. non-anxiety)

- Anxiety at 2 years ($n=101$)
- Non-anxiety at 2 years ($n=93$)

Time (months)

d

Disease-free survival (DFS)

$P = 0.017$

HR: 1.897, 95%CI: 1.143-3.146 (anxiety vs. non-anxiety)

- Anxiety at 3 years ($n=105$)
- Non-anxiety at 3 years ($n=89$)

Time (months)

e

Overall survival (OS)

$P = 0.009$

HR: 2.657, 95%CI: 1.289-5.474 (anxiety vs. non-anxiety)

- Anxiety at baseline ($n=87$)
- Non-anxiety at baseline ($n=107$)

Time (months)

f

Overall survival (OS)

$P = 0.068$

HR: 1.971, 95%CI: 0.962-4.038 (anxiety vs. non-anxiety)

- Anxiety at 1 year ($n=93$)
- Non-anxiety at 1 year ($n=101$)

Time (months)

g

Overall survival (OS)

$P = 0.565$

HR: 1.235, 95%CI: 0.604-2.528 (anxiety vs. non-anxiety)

- Anxiety at 2 years ($n=101$)
- Non-anxiety at 2 years ($n=93$)

Time (months)

h

Overall survival (OS)

$P = 0.140$

HR: 1.757, 95%CI: 0.857-3.599 (anxiety vs. non-anxiety)

- Anxiety at 3 years ($n=105$)
- Non-anxiety at 3 years ($n=89$)

Time (months)
Anxiety at baseline ($P = 0.009$) (Fig. 3a) and anxiety at 3 years ($P = 0.017$) (Fig. 3d) were correlated with worse DFS in prostate cancer survivors post the surgeries, while anxiety at 1 year ($P = 0.253$) (Fig. 3b) or anxiety at 2 years ($P = 0.059$) (Fig. 3c) was not correlated with DFS. As for OS, anxiety at baseline ($P = 0.009$) (Fig. 3e) associated with shorter OS in prostate cancer patients.
Figure 1: Kaplan-Meier survival curves for disease-free survival (DFS) and overall survival (OS).

(a) Disease-free survival (DFS) for patients with depression vs. non-depression at baseline.
P = 0.005
HR: 2.030, 95% CI: 1.178-3.499 (depression vs. non-depression)
- Depression at baseline (n=86)
- Non-depression at baseline (n=128)

(b) Disease-free survival (DFS) for patients with depression vs. non-depression at 1 year.
P = 0.091
HR: 1.540, 95% CI: 0.909-2.606 (depression vs. non-depression)
- Depression at 1 year (n=73)
- Non-depression at 1 year (n=121)

(c) Disease-free survival (DFS) for patients with depression vs. non-depression at 2 years.
P = 0.008
HR: 1.980, 95% CI: 1.173-3.275 (depression vs. non-depression)
- Depression at 2 years (n=87)
- Non-depression at 2 years (n=107)

(d) Disease-free survival (DFS) for patients with depression vs. non-depression at 3 years.
P = 0.122
HR: 1.487, 95% CI: 0.902-2.482 (depression vs. non-depression)
- Depression at 3 years (n=100)
- Non-depression at 3 years (n=94)

(e) Overall survival (OS) for patients with depression vs. non-depression at baseline.
P = 0.001
HR: 3.119, 95% CI: 1.453-6.697 (depression vs. non-depression)
- Depression at baseline (n=86)
- Non-depression at baseline (n=128)

(f) Overall survival (OS) for patients with depression vs. non-depression at 1 year.
P = 0.025
HR: 2.236, 95% CI: 1.065-4.694 (depression vs. non-depression)
- Depression at 1 year (n=73)
- Non-depression at 1 year (n=121)

(g) Overall survival (OS) for patients with depression vs. non-depression at 2 years.
P = 0.008
HR: 2.689, 95% CI: 1.304-5.544 (depression vs. non-depression)
- Depression at 2 years (n=87)
- Non-depression at 2 years (n=107)

(h) Overall survival (OS) for patients with depression vs. non-depression at 3 years.
P = 0.553
HR: 1.243, 95% CI: 0.608-2.544 (depression vs. non-depression)
- Depression at 3 years (n=100)
- Non-depression at 3 years (n=94)
cancer survivors post the surgeries, but anxiety at 1 year \( (P = 0.068) \) (Fig. 3f), anxiety at 2 years \( (P = 0.565) \) (Fig. 3g), or anxiety at 3 years \( (P = 0.140) \) (Fig. 3h) was not associated with OS. These results suggested that the survival profile was worse in prostate cancer patients with anxiety.

### Difference in survivors between patients with depression and patients without depression

Depression at baseline \( (P = 0.005) \) (Fig. 4a) and depression at 2 years \( (P = 0.008) \) (Fig. 4c) were correlated with unfavorable DFS in prostate cancer survivors post the surgeries, while depression at 1 year \( (P = 0.091) \) (Fig. 4b) or depression at 3 years \( (P = 0.122) \) (Fig. 4d) was not associated with DFS. Moreover, depression at baseline \( (P = 0.001) \) (Fig. 4e), depression at 1 year \( (P = 0.025) \) (Fig. 4f), and depression at 2 years \( (P = 0.008) \) (Fig. 4g) were associated with worse OS, but depression at 3 years \( (P = 0.553) \) (Fig. 4h) was not correlated with OS. These implied that the survival profile was unfavorable in prostate cancer patients with depression.

### Analyses of independent factors related to survival

Furthermore, multivariate Cox’s proportional hazards regression analysis disclosed that depression at baseline \( (P = 0.027) \) (HR = 1.796) was a factor that could independently predict shorter DFS in prostate cancer patients after radical prostatectomy, besides, the other independent predictive factors for worse DFS were higher Gleason score \( (P = 0.013) \) (HR = 1.638) and positive surgical margin \( (P = 0.040) \) (HR = 1.828) (Table 2). In addition, regarding OS, higher Gleason score \( (P = 0.014) \) (HR = 2.007), higher pathological T stage \( (P = 0.001) \) (HR = 2.630), and positive surgical margin \( (P = 0.003) \) (HR = 3.134) were independent predictive factors for worse OS (Table 3). These findings suggested that depression at baseline was independently correlated with an elevated risk of relapse in prostate cancer patients.

### Discussion

It is relatively established that anxiety and depression are more likely to occur in cancer patients than in healthy population, with reported prevalence of clinically documented anxiety and depression at approximately 20% and 10% according to a previous meta-analysis [5]. While for prostate cancer, neither the epidemiology of anxiety and depression nor the correlation of anxiety and depression with patients’ outcome is well investigated. Therefore, we conducted this study, and found in prostate cancer survivors post the surgeries the following: (1) prevalence of anxiety and depression post the surgeries was 44.8% and 34.0%, respectively; then anxiety and depression both gradually worsened throughout the 3-year follow-up duration. (2) Anxiety and depression both correlated with worse DFS and OS, and baseline depression was an independent predictive factor for unfavorable DFS.

Throughout the long follow-up time of 3 years in the prostate cancer survivors post the surgeries, we found that the prevalence of anxiety and depression was 44.8% and 34.0%, respectively, and the score and prevalence of anxiety and depression constantly increased from M0 to M36, which obviously caught our attention of the need in psychiatric management. In the previous studies of other cancers, anxiety and depression are also abundantly reported. Such as, a study reports that the prevalence of depressed symptoms assessed by Patient Health Questionnaire-2 (PHQ-2) scale and anxious symptoms assessed by Generalized Anxiety Disorder-2 (GAD-2) scale in breast cancer patients are 38.2% and 32.2%, respectively [20]. And a register-based study that enrolls 3370 working age cancer survivors (who are diagnosed with cancer 25–55 years before) illuminates that 40% of the participants present with moderate to high anxiety score (assessed by German version of HADS scale) [21]. Additionally, a study with a large sample size of 29,366 women diagnosed with breast or other genital organ cancer demonstrates that there are 7994 patients with confirmed depression or anxiety, the incidence of anxiety or depression in

| Factors                      | Multivariate Cox’s proportional hazards regression analysis |
|------------------------------|----------------------------------------------------------|
|                              | B   | SE   | Wald | P value | HR   | 95% CI (lower-upper) |
| Depression at baseline       | 0.586 | 0.265 | 4.890 | 0.027  | 1.796 | 1.069–3.018 |
| Higher Gleason score         | 0.493 | 0.198 | 6.181 | 0.013  | 1.638 | 1.110–2.417 |
| Positive surgical margin     | 0.603 | 0.294 | 4.221 | 0.040  | 1.828 | 1.028–3.251 |

DFS, disease-free survival; SE, standard error; HR, hazards ratio; CI, confidence interval.
breast cancer patients is 8.8 every 100 person-years, and in patients with other genital organ cancer is 5.9 per 100 person-years [22]. As for the findings in our study, they could be explained by the following aspects. First, stress is the predominant cause of anxiety and depression, and coping with prostate cancer, its clinical symptoms, and treatment certainly result in increased stress in prostate cancer patients, which increases the risk of developing mood disorders including anxiety and depression. Second, studies report that the change of testosterone level and androgen deprivation therapy may also play a role in the development of anxiety and depression in prostate cancer patients [23]. Third, radical prostatectomy normally results in a reduced quality of prostate cancer patients’ domestic life, and may also damage patients’ self-esteem; these all constantly contribute to the developments of anxiety and depression. Additionally, we would like to note that other scales may be needed to assess the anxiety and depression in our patients; however, it was difficult to apply another scale since the data in our study was retrospectively analyzed.

In this study, we also discovered that post-surgery anxiety and depression are associated with worse survival profile, and post-surgery depression could independently predict worse DFS in prostate cancer patients. Previous studies all indicate that anxiety and depression are not uncommon in cancer patients; for this reason, many clinicians are trying to reveal some veiled mechanisms. A study elucidates that depression plays a role in enhancing the progression of hepatocellular carcinoma in mice via increasing programmed death 1 (PD-1) level regulated by glucocorticoids in tumor infiltrating natural killer (NK) cells [24]. Another study reveals that depression correlates with worse clinical outcome in gastric cancer patients, and the in vivo and in vitro experiments disclose that gastric cancer–related depression involves the participation of reactive oxygen species via the ABL1-modulated inflammatory pathway [25]. In addition, a previous study illustrates that anxiety and depression play a role in mediating the correlation of chemotherapy-induced peripheral neuropathy with fatigue in colorectal cancer patients; however, this study also states that this needs more experimental evidence to validate [26]. Furthermore, there are already findings regarding cellular mechanisms of the harmful impact of anxiety and depression on prostate cancer patients. For instance, in mouse model of prostate cancer, depression is illuminated to increase the infiltration of myeloid cells and interleukin-6 (IL-6) expressions via mediating sympathetic neuropeptide Y (NPY) signaling pathway and subsequently enhances the tumor growth [27].

And in the clinical setting, there are also studies about the pejorative role of anxiety and depression in cancer patients’ prognosis. For example, a previous study reveals that in oropharynx cancer patients, the self-report depression independently correlates with unfavorable OS and DFS, which is partially similar to our results [28]. In accordance with this, another study reports that in postoperative non-small cell lung cancer patients, post-surgery anxiety predicts shorter OS, and post-surgery anxiety and depression both predict less prolonged DFS [29]. In terms of our results, we tried to explain them by the following possible reasons. First, prostate cancer patients are more likely to have a low adherence to therapies, and this could contribute to a worse treatment efficacy and thus a worse prognosis [30]. Second, anxiety and depression also induce many physical symptoms, such as fatigue, insomnia, and change of weight as well as appetite; these all contribute to a worse physical function and may interfere with the physical health of prostate cancer patients [31, 32]. Third, anxiety and depression may aggregate the disease in prostate cancer patients via affecting several biological processes or pathways, such as regulating the tumor infiltrating NK cells and reactive oxygen species [24–27]. In the future, the status of anxiety and depression may be useful in optimizing the prognosis prediction in surgical prostate cancer patients; however, this should be validated by more high-quality trials or large-scale cohort studies.

Furthermore, there were a few limitations we liked to discuss. First, we only included surgical prostate cancer patients, which indicated that our findings were not applicable in patients who were not suitable for surgery. Second, we would like to enroll more patients in the future study due to that the sample size in this study was comparatively small, and this may result in an insufficient statistical power.

Altogether, anxiety and depression both gradually deteriorate, and they correlate with unfavorable survival profile in prostate cancer patients after radical prostatectomy.

**Funding** This study was supported by Nature Science Foundation of Hubei Province (No. 2017CFC851).
Compliance with ethical standards  All patients signed the informed consents before enrollment. The Institutional Review Board of our hospital approved the current study before initiation.

Competing interests  The authors declare that they have no conflict of interest.

Open Access  This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

1. Kessler RC, Bromet EJ (2013) The epidemiology of depression across cultures. Annu Rev Public Health 34:119–138. https://doi.org/10.1146/annurev-publhealth-031912-114409

2. Baxter AJ, Scott KM, Vos T, Whiteford HA (2013) Global prevalence of anxiety disorders: a systematic review and meta-regression. Psychol Med 43(5):897–910. https://doi.org/10.1017/S003329171200147X

3. Mal K, Awan ID, Ram J, Shaukat F (2019) Depression and anxiety as a risk factor for myocardial infarction. Cureus 11(11):e6064. https://doi.org/10.7759/cureus.6064

4. Polikandriti M, Tzirogianni K, Zyga S, Koutelekos I, Vasilopoulos G, Theofilou P, Panoutsopoulos G (2018) Effect of anxiety and depression on the fatigue of patients with a permanent pacemaker. Arch Med Sci Atheroscler Dis 3:e6–e17. https://doi.org/10.5114/amsad.2018.73231

5. Mitchell AJ, Chan M, Bhatti H, Halton M, Grassi L, Johansen C, Meader N (2011) Prevalence of depression, anxiety, and adjustment disorder in oncological, haematological, and palliative-care settings: a meta-analysis of 94 interview-based studies. Lancet Oncol 12(2):160–174. https://doi.org/10.1016/S1470-2045(11)70002-X

6. Steel Z, Marmane X, Crouch P, Tey T, Jackson JW, Patel V, Silove D (2014) The global prevalence of common mental disorders: a systematic review and meta-analysis 1980-2013. Int J Epidemiol 43(2):476–493. https://doi.org/10.1093/ije/dyu038

7. Breitbart W, Rosenfeld B, Tobias K, Pessin H, Ku GY, Yuan J, Wolchok J (2014) Depression, cytokines, and pancreatic cancer. Psychooncology 23(3):339–345. https://doi.org/10.1002/pon.3422

8. Jick S, Li L, Gastanaga VM, Liede A (2015) Prevalence of hypercalcaemia of malignancy among cancer patients in the UK: analysis of the Clinical Practice Research Datalink database. Cancer Epidemiol 39(6):901–907. https://doi.org/10.1016/j.canep.2015.10.012

9. Wick W, Hertenstein A, Platten M (2016) Neurological sequelae of cancer immunotherapies and targeted therapies. Lancet Oncol 17(12):e529–e541. https://doi.org/10.1016/S1470-2045(16)30571-X

10. Bortolato B, Hyphantis TN, Valpione S, Perini G, Maes M, Morris G, Kubera M, Köhler CA, Fernandes BS, Stubbs B, Pavlidis N, Carvalho AF (2017) Depression in cancer: the many biobehavioral pathways driving tumor progression. Cancer Treat Rev 52:58–70. https://doi.org/10.1016/j.ctrv.2016.11.004

11. Hasksins CB, McDowell BD, Carnahan RM et al (2019) Impact of preexisting mental illness on breast cancer endocrine therapy adherence. Breast Cancer Res Treat 174(1):197–208. https://doi.org/10.1007/s10549-018-5050-1

12. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A (2018) Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 68(6):394–424. https://doi.org/10.3322/caac.21492

13. Nguyen-Nielsen M, Borre M (2016) Diagnostic and therapeutic strategies for prostate Cancer. Semin Nucl Med 46(6):484–490. https://doi.org/10.1053/j.semmu.2016.07.002

14. Komura K, Sweeney CJ, Inamoto T, Ibuki N, Azuma H, Kantoff PW (2018) Current treatment strategies for advanced prostate cancer. Int J Urol 25(3):220–231. https://doi.org/10.1111/iju.13512

15. Howlader N NA, Krapcho M, Miller D, Kosary CL, Yu M, Ruhl J, Tatalovich Z, Mariotto A, Lewis DR, Chen HS, Feuer EJ, Cronin KA, SEER cancer statistics review, National Cancer Institute, SEER web site, 2017

16. Noonan EM, Farrell TW (2016) Primary care of the prostate cancer survivor. Am Fam Physician 93(9):764–770

17. Nead KT, Sinha S, Yang DD et al (2017) Association of androgen deprivation therapy and depression in the treatment of prostate cancer: a systematic review and meta-analysis. Urol Oncol 35(11):664 e661–664 e669. https://doi.org/10.1016/j.urolonc.2017.07.016

18. Gainotti G, Cianchetti C, Taramelli M, Tiacchi C (1972) The guided self-rating anxiety-depression scale for use in clinical psychopharmacology. Act Nerv Super (Praha) 14(1):49–51

19. Zung WW, Giansurco JA (1971) Personality dimension and the Self-Rating Depression Scale. J Clin Psychol 27(2):247–248. https://doi.org/10.1002/1097-4679(197104)27:2<247::AID-JCPS2207202303.0.CO;2-6

20. Tsaras K, Papathanasiou IV, Mitić D et al (2018) Assessment of depression and anxiety in breast cancer patients: prevalence and associated factors. Asian Pac J Cancer Prev 19(6):1661–1669. https://doi.org/10.22034/APJCP.2018.19.6.1661

21. Inhester L, Beierlein V, Bultmann JC, Müller B, Romer G, Koch U, Bergelt C (2017) Anxiety and depression in working-age cancer survivors: a register-based study. BMC Cancer 17(1):347. https://doi.org/10.1186/s12885-017-3347-9

22. Jacob L, Kalder M, Kostev K (2017) Incidence of depression and anxiety among women newly diagnosed with breast or genital organ cancer in Germany. Psychooncology 26(10):1535–1540. https://doi.org/10.1002/pon.4328

23. Dinh KT, Reznor G, Muralidhar V, Mahal BA, Nezlosky MD, Choueiri TK, Hoffman KE, Hu JC, Sweeney CJ, Tinh QD, Nguyen PL (2016) Association of androgen deprivation therapy with depression in localized prostate cancer. J Clin Oncol 34(16):1905–1912. https://doi.org/10.1200/JCO.2015.64.1969

24. Zhao Y, Jia Y, Shi T, Wang W, Shao D, Zheng X, Sun M, He K, Chen L (2019) Depression promotes hepatocellular carcinoma progression through a glucocorticoids mediated up-regulation of PD-1 expression in tumor infiltrating NK cells. Carcinogenesis. https://doi.org/10.1093/carcin/bgz017

25. Huang T, Zhou F, Yuan X, Yang T, Liang X, Wang Y, Tu H, Chang J, Nan K, Wei Y (2019) Reactive oxygen species are involved in the development of gastric cancer and gastric cancer-related depression through ABL1-mediated inflammation signaling pathway. Oxidative Med Cell Longev 2019:5813985–5813912. https://doi.org/10.1155/2019/5813985

26. Bonhof CS, van de Poll-Franse LV, Vissers PAJ et al (2019) Anxiety and depression mediate the association between chemotherapy-induced peripheral neuropathy and fatigue: results from the population-based PROFILES registry. Psychooncology 28(9):1926–1933. https://doi.org/10.1002/pon.5176
27. Cheng Y, Tang XY, Li YX, Zhao DD, Cao QH, Wu HX, Yang HB, Hao K, Yang Y (2019) Depression-induced neuropeptide Y secretion promotes prostate cancer growth by recruiting myeloid cells. Clin Cancer Res 25(8):2621–2632. https://doi.org/10.1158/1078-0432.CCR-18-2912

28. Shinn EH, Valentine A, Jethanandani A, Basen-Engquist K, Fellman B, Urbauer D, Atkinson E, Yusuf SW, Lenihan D, Woods ML, Kies MS, Sood AK, Carmack C, Morrison WH, Gillenwater A, Sturgis EM, Garden AS (2016) Depression and oropharynx cancer outcome. Psychosom Med 78(1):38–48. https://doi.org/10.1097/PSY.0000000000000256

29. Huang X, Zhang TZ, Li GH, Liu L, Xu GQ (2020) Prevalence and correlation of anxiety and depression on the prognosis of postoperative non-small-cell lung cancer patients in North China. Medicine (Baltimore) 99(11):e19087. https://doi.org/10.1097/MD.0000000000019087

30. DiMatteo MR, Hanskard-Zolnierek KB (2011) Impact of depression on treatment adherence and survival from cancer. In: Kissane DW, Maj M, Sartorius N (eds) Depression and cancer, 1st edn. Wiley-Blackwell, p 101–24

31. Malhi GS, Mann JJ (2018) Depression. Lancet 392(10161):2299–2312. https://doi.org/10.1016/S0140-6736(18)31948-2

32. Craske MG, Stein MB (2016) Anxiety. Lancet 388(10063):3048–3059. https://doi.org/10.1016/S0140-6736(16)30381-6

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.