Impact of marital status at diagnosis on the survival of patients with anal canal squamous cell carcinoma: a propensity score-matched analysis

Ting Yang · Hongqi Xiao · Fei Sun · Xinggang Guo

Abstract

Purpose Marital status has been shown to be an important psychosocial factor that plays an important role in the prognosis of various cancers. The effect of marital status on survival outcomes in anal canal squamous cell carcinoma has not been studied. The purpose of this study was to address this issue.

Methods According to the established screening criteria, we obtained 2429 patients with anal canal squamous cell carcinoma from the Surveillance, Epidemiology, and End Results (SEER) database. Kaplan–Meier analysis and multivariate Cox regression analysis were used to analyze the survival of anal canal squamous cell carcinoma patients with different marital status. 1:1 propensity score matching (PSM) was used to match 979 unmarried patients with 979 married patients to further demonstrate the effect of marital status on the survival of patients with anal canal squamous cell carcinoma.

Results The 5-year overall survival (OS) rates of married, divorced/separated, single, and widowed patients with anal canal squamous cell carcinoma were 75.6%, 69.7%, 62.2%, and 51.3%, respectively and the corresponding 5-year cancer-specific survival (CSS) rates were 80.7%, 79.6%, 70.1%, and 68.9%, respectively. Multivariate Cox regression analysis showed that marital status, sex, race, SEER stage, tumor size, regional nodes positive, primary site surgery, chemotherapy, and radiotherapy were independent prognostic factors for OS and CSS, and also demonstrated that the widowed patients suffered the highest risk mortality. Furthermore, married patients were found to have better OS and CSS than unmarried patients both before and after propensity score matching.

Conclusion This study found that married patients with anal canal squamous cell carcinoma had better survival outcomes, while widowed patients had the worst OS and CSS.

Keywords Propensity score matching · Marital status · Survival analysis · Anal canal squamous cell carcinoma

Introduction

Anal cancer is a rare malignant tumor, accounting for only 3% of gastrointestinal tumors [1]. Squamous cell carcinoma is the most common pathological type of anal cancer, accounting for about 85–95% of all anal cancers [2]. In recent years, due to increased exposure to risk factors including HIV and HPV infection, smoking, and unhealthy sexual behaviors such as MSM (men who have sex with men), the incidence of anal canal squamous cell carcinoma has been increasing, which has attracted more and more attention [3]. Prior to 1970, abdominal perineal resection (APR) was the main treatment modality. Later, Nigro et al. proposed that radiation therapy combined with chemotherapy can effectively improve the survival outcome and became the standard therapy for anal canal squamous cell carcinoma [4]. However, radiation therapy and chemotherapy also cause damage to normal cells when they kill tumor cells, and long-term treatment can impose a huge financial burden on patients [5]. Therefore, it is important to focus on favorable psychosocial factors that influence patient outcomes.
Marital status is one of the important psychosocial factors and has been shown to influence patients survival in pancreatic cancer [6], nasopharyngeal carcinoma [7], osteosarcoma [8], non-small cell lung cancer [9], primary liver cancer [10], etc. However, there were also some reports demonstrating no association between marital status and patient survival outcomes [11]. For anal canal squamous cell carcinoma, to our knowledge, there is little literature reporting the relationship between it and marital status.

In the present study, we performed 1:1 propensity score matching (PSM) to explore the effects of marital status on the survival of patients with anal canal squamous cell carcinoma based on SEER.

Methods

Patient selection

The Surveillance, Epidemiology, and End Results (SEER) program is one of the largest open cancer databases in the world supported by the National Cancer Institute and Centers for Disease Control and Prevention. The database collects survival data on cancer patients covering almost 28% of the US population [12]. From the database, we chose 2429 patients according to the following criteria: (1) primary sites limited anal canal; (2) pathological diagnosis of squamous cell carcinoma (histology code: 8050–8078, 8083–8084); (3) survival months >1; (4) diagnosis of anal canal cancer by positive histology; (5) patients with only one primary malignancies. And patients who were unknown the information of race, grade, SEER stage, marital status, tumor size, primary site surgery, and cancer-specific survival were also excluded. The selection process is clearly shown in Fig. 1.

Variable classification

Sex, age, married status, race, grade, SEER stage, tumor size, regional nodes positive, primary site surgery, radiotherapy, and chemotherapy were obtained from the database. Age was divided into <50 years old and ≥50 years old. For marital status, we separated the population into 2 groups: married, unmarried (including divorced/separated, single, and widowed). And tumor size was categorized into two groups (<5 cm and ≥5 cm).

Statistical analysis

We used descriptive statistics to summarize the patient demographic and tumor characteristics. The chi-square test was used to compare the differences of categorical variables between different groups. Survival time was calculated from the date of diagnosis to the date of death or last follow-up. Survival curves were plotted according to the Kaplan–Meier method, and log-rank tests were performed to compare survival differences in the different groups. In addition, univariate analysis was used to investigate possible prognostic factors, and then we performed multivariate Cox proportional hazards models for variables with $P < 0.2$. 

Fig. 1 Patient selection process
To minimize the possible confounding effects between married and unmarried, we collected covariates including sex, age, race, grade, SEER stage, tumor size, regional nodes positive, primary site surgery, radiotherapy, and chemotherapy for 1:1 PSM (the nearest-neighbor algorithm and caliper value 0.05).

Kaplan–Meier survival curves and PSM were conducted by R version 4.1.3. The R package of MatchIt was used for PSM. And the rest of the analysis used the SPSS 26.0. All statistical tests were 2-sided, and \( P < 0.05 \) was considered statistically significant.

**Results**

**Demographic and clinicopathologic characteristics**

From the SEER database, 2429 anal canal squamous cell carcinoma patients were selected according to screening criteria, including 1059 (43.6%) married patients and 1370 (56.4%) unmarried patients. Among the unmarried patients, the numbers of divorced/separated, single, and widowed were 448 (18.4%), 649 (26.7%), and 273 (11.2%), respectively. Compared with married patients, unmarried patients were more often male, had higher tumor SEER stages, bigger tumor size, and were less likely to receive chemotherapy and radiotherapy. While married patients were more likely to be white and had higher tumor grade. Among the unmarried patients, the widowed group tended to be oldest and female and had the lowest rates of surgery and chemotherapy. And the single group had the most younger patients, the highest proportion of males, the highest proportion of blacks, the largest tumor size, the highest surgical rate, the lowest tumor grade, and the lowest radiotherapy rate (Table 1).

**Effect of marital status on the OS**

The Kaplan–Meier curves revealed that unmarried patients had a higher mortality rate than married (OS: \( P < 0.001; \) CSS: \( P < 0.001; \) Fig. 2). Then, the unmarried patients were divided into three subgroups (divorced/separated, single, and widowed) to further explore the prognosis of different unmarried status in unmarried patients. As shown in Fig. 3a, the Kaplan–Meier analysis showed that married patients have the best OS, while widowed patients have the worst (\( P < 0.001 \)). The 5-year OS was 75.6%, 69.7%, 62.2%, and 51.3% among married, divorced/separated, single, and widowed, respectively (Table 2). Similarly, there were significant differences in CSS among patients with different marital status (\( P < 0.001; \) Fig. 3b). And the CSS of widowed patients was still significantly lower than that of married patients. The 5-year CSS was 80.7%, 79.6%, 70.1%, and 68.9% among married, divorced/separated, single, and widowed, respectively (Table 3). Then we performed univariate and multivariate analyses, after adjusting clinicopathological characteristics including sex, age, SEER stage, grade, regional nodes positive, tumor size, primary site surgery, chemotherapy, and radiotherapy, the widowed patients still suffered the highest risk mortality for both OS and CSS (Tables 2 and 3).

Multivariate Cox regression analysis not only demonstrated that marital status was an independent prognostic factor for both OS and CSS in patients with anal canal squamous cell carcinoma but also sex, race, SEER stage, tumor size, regional nodes positive, primary site surgery, chemotherapy, and radiotherapy (Tables 2 and 3).

**Propensity-score matching for married and unmarried groups**

To further confirm that married patients had a better survival than unmarried, we performed a 1:1 propensity matching score analysis to balance the baseline characteristics between the two groups. Ultimately, 979 married patients and 979 unmarried patients were successfully matched. Table 4 and Fig. 4 showed that the demographic and clinical characteristics were well balanced (all \( P > 0.05 \)). After matching, the survival of the married patients with anal canal squamous cell carcinoma was still better than that of the unmarried patients with anal canal squamous cell carcinoma (OS: \( P < 0.001; \) CSS: \( P = 0.038; \) Fig. 5).

**Discussion**

As far as we are concerned, this is the first study to explore the prognostic significance of marital status in anal canal squamous cell carcinoma. Based on PSM and large patient numbers, our study provided a relatively reliable result. Married patients had better survival outcomes than unmarried patients. In addition, widowed patients had worst survival.

Married patients had better survival outcomes than unmarried patients in anal canal squamous cell carcinoma for several reasons. The first possible underlying reason is that married people are more likely to be diagnosed earlier. Previous studies have confirmed that unmarried patients with delayed diagnosis have worse survival outcomes [13, 14]. Additionally, in the present study, we found that unmarried patients with anal canal squamous cell carcinoma were less likely to undergo radiation therapy and chemotherapy, suggesting that the better prognosis of married patients is partly due to aggressive and timely treatment. Secondly, married patients can receive
more financial support from relatives such as spouses and children for treatment, which leads to a better prognosis than unmarried patients [15, 16]. In addition to material support, married patients can accept more mental and emotional support from their spouses [17, 18]. Unmarried states such as divorced, separated, single, and widowed can bring strong mental stress, coupled with being diagnosed with cancer, make patients so stressed that they are more likely to be depressed and anxious [19, 20]. Meanwhile, patients with long-term negative emotions are more likely to develop bad habits such as smoking and alcoholism, which will further accelerate the progression of cancer and disrupt the effect of treatment [21, 22]. While married patients receive more care and encouragement from their spouses, their attitude towards the disease is more optimistic, and compliance with treatment is also better.

| Characteristic                                      | Total (%) | Married (%) | Unmarried (%) | Divorced/Separated (%) | Single (%) | Widowed (%) |
|-----------------------------------------------------|-----------|-------------|---------------|------------------------|------------|-------------|
| **Sex**                                             | 2429 (100)| 1059 (43.6) | 1370 (56.4)   | 448 (18.4)             | 649 (26.7) | 273 (11.2)  |
| Male                                                | 787 (32.4)| 278 (11.4)  | 509 (21.0)    | 90 (3.7)               | 397 (16.3) | 22 (0.9)    |
| Female                                              | 1642 (67.6)| 781 (32.2)  | 861 (35.4)    | 358 (14.7)             | 252 (10.4) | 251 (10.3)  |
| **Age**                                             |           |             |               |                        |            |             |
| <50                                                  | 481 (19.8)| 196 (8.1)   | 285 (11.7)    | 69 (2.8)               | 211 (8.7)  | 5 (0.2)     |
| ≥50                                                  | 1948 (82.0)| 863 (35.5)  | 1085 (44.7)   | 379 (15.6)             | 438 (18.0) | 268 (11.0)  |
| **Race**                                            |           |             |               |                        |            |             |
| White                                                | 2133 (87.8)| 987 (40.6)  | 1146 (47.2)   | 397 (16.3)             | 506 (20.8) | 243 (10.0)  |
| Black                                                | 229 (9.4) | 45 (1.9)    | 184 (7.6)     | 38 (1.6)               | 127 (5.2)  | 19 (0.8)    |
| Others                                               | 67 (2.8)  | 27 (1.1)    | 40 (1.6)      | 13 (0.5)               | 16 (0.7)   | 11 (0.5)    |
| **SEER stage**                                       |           |             |               |                        |            |             |
| Localized                                            | 1243 (51.2)| 584 (24.0)  | 659 (27.1)    | 209 (8.6)              | 319 (13.1) | 131 (5.4)   |
| Regional                                             | 916 (37.7)| 372 (15.3)  | 544 (22.4)    | 180 (7.4)              | 254 (10.5) | 110 (4.5)   |
| Distant                                              | 270 (11.1)| 103 (4.2)   | 167 (6.9)     | 59 (2.4)               | 76 (3.1)   | 32 (1.3)    |
| **Tumor size**                                       |           |             |               |                        |            |             |
| <5 cm                                                | 1749 (72.0)| 804 (33.1)  | 945 (38.9)    | 315 (13.0)             | 434 (17.9) | 196 (8.1)   |
| ≥5 cm                                                | 680 (28.0)| 255 (10.5)  | 425 (17.5)    | 133 (5.5)              | 215 (8.9)  | 77 (3.2)    |
| **Grade**                                            |           |             |               |                        |            |             |
| Grade I                                              | 306 (12.6)| 111 (4.6)   | 195 (8.0)     | 51 (2.1)               | 124 (5.1)  | 20 (0.8)    |
| Grade II                                             | 1109 (45.7)| 479 (19.7)  | 630 (25.9)    | 201 (8.3)              | 306 (12.6) | 123 (5.1)   |
| Grade III                                            | 982 (40.4)| 449 (18.5)  | 533 (21.9)    | 191 (7.9)              | 213 (8.8)  | 129 (5.3)   |
| Grade IV                                             | 32 (1.3)  | 20 (0.8)    | 12 (0.5)      | 5 (0.2)                | 6 (0.2)    | 1 (0.0)     |
| **Regional nodes positive**                         |           |             |               |                        |            |             |
| No                                                   | 92 (3.8)  | 42 (1.7)    | 50 (2.1)      | 18 (0.7)               | 23 (0.9)   | 9 (0.4)     |
| Yes                                                  | 147 (6.1) | 60 (2.5)    | 87 (3.6)      | 22 (0.9)               | 46 (1.9)   | 19 (0.8)    |
| Unknown                                              | 2190 (90.2)| 957 (39.4)  | 1233 (50.8)   | 408 (16.8)             | 580 (23.9) | 245 (10.1)  |
| **Primary site surgery**                             |           |             |               |                        |            |             |
| No                                                   | 1535 (63.2)| 662 (27.3)  | 873 (35.9)    | 301 (12.4)             | 383 (15.8) | 189 (7.8)   |
| Yes                                                  | 894 (36.8)| 397 (16.3)  | 497 (20.5)    | 147 (6.1)              | 266 (11.0) | 84 (3.5)    |
| **Chemotherapy**                                     |           |             |               |                        |            |             |
| No                                                   | 344 (14.2)| 122 (5.0)   | 222 (9.1)     | 55 (2.3)               | 114 (4.7)  | 53 (2.2)    |
| Yes                                                  | 2085 (85.8)| 937 (38.6)  | 1148 (47.3)   | 393 (16.2)             | 535 (22.0) | 220 (9.1)   |
| **Radiotherapy**                                     |           |             |               |                        |            |             |
| No                                                   | 275 (11.3)| 103 (4.2)   | 172 (7.1)     | 49 (2.0)               | 93 (3.8)   | 30 (1.2)    |
| Yes                                                  | 2154 (88.7)| 956 (39.4)  | 1198 (49.3)   | 399 (16.4)             | 556 (22.9) | 243 (10.0)  |
Long-term mental stress can also have an impact on the function of endocrine and immune systems [23–25]. Persistent stress and lack of social support can lead to disturbances in the neuroendocrine network mediated by the hypothalamic-pituitary axis [26, 27]. An example is the elevation of glucocorticoids and catecholamines, which would weaken T cell-mediated immune responses and the activity of NK cells [26, 28, 29]. Then, this immunosuppressive microenvironment will promote the proliferation, invasion, and migration of tumor cells [30]. In addition, in the study of ovarian cancer cells, stress hormones were found to promote cancer cell infiltration into the extracellular matrix, thereby promoting tumor dissemination and migration [31].

As the medical model shifts to a bio-psycho-social model, the influence of psychosocial factors in diseases has received increasing attention [32]. A good social environment and a positive attitude are very important to the patient’s treatment effect, and the patient’s marital status plays a crucial role in it. Our study, along with some previous studies, found that people who were widowed had the worst survival outcomes, suggesting that widowed patients may have suffered the greatest emotional trauma and mental stress. So how to

Fig. 2 Kaplan–Meier survival curves of anal canal squamous cell carcinoma patients between married and unmarried patients before matching. a Overall survival. b Cancer-specific survival

Fig. 3 Kaplan–Meier survival curves of anal canal squamous cell carcinoma patients among married, divorced/separated, single, and widowed. a Overall survival. b Cancer-specific survival
| Variables                                | 5-y OS | Univariate analysis | Multivariate analysis |
|------------------------------------------|--------|---------------------|-----------------------|
|                                          | 5-y OS | Log-rank χ²         | HR (95% CI)           | P          |
| Marital status                           |        |                     |                       |            |
| Widowed                                  | 51.3%  | 83.2                | <0.001                | Reference  |
| Single                                   | 62.2%  |                     | 0.54 (0.43, 0.67)     | <0.001     |
| Divorced/separated                       | 69.7%  |                     | 0.54 (0.43, 0.67)     | <0.001     |
| Married                                  | 75.6%  |                     | 0.45 (0.37, 0.55)     | <0.001     |
| Sex                                      |        |                     |                       |            |
| Male                                     | 59.0%  | 55.2                | <0.001                | Reference  |
| Female                                   | 72.6%  |                     | 0.55 (0.47, 0.63)     | <0.001     |
| Age                                      |        |                     |                       |            |
| <50                                      | 73.6%  | 14.5                | <0.001                | Reference  |
| ≥50                                      | 66.8%  |                     | 1.51 (1.25, 1.82)     | <0.001     |
| Race                                     |        |                     |                       |            |
| White                                    | 69.9%  | 27.0                | <0.001                | Reference  |
| Black                                    | 54.4%  |                     | 1.39 (1.14, 1.70)     | 0.001      |
| Others                                   | 62.8%  |                     | 1.00 (0.70, 1.45)     | 0.988      |
| SEER stage                               |        |                     |                       |            |
| Localized                                | 76.6%  | 187.5               | <0.001                | Reference  |
| Regional                                 | 65.6%  |                     | 1.39 (1.18, 1.64)     | <0.001     |
| Distant                                  | 37.9%  |                     | 2.93 (2.39, 3.60)     | <0.001     |
| Tumor size                               |        |                     |                       |            |
| <5 cm                                    | 73.3%  | 78.6                | <0.001                | Reference  |
| ≥5 cm                                    | 54.9%  |                     | 1.44 (1.24, 1.67)     | <0.001     |
| Grade                                    |        |                     |                       |            |
| Grade I                                  | 71.2%  | 2.8                 | 0.423                 |            |
| Grade II                                 | 68.8%  |                     |                       |            |
| Grade III                                | 66.3%  |                     |                       |            |
| Grade IV                                 | 73.5%  |                     |                       |            |
| Regional nodes positive                  |        |                     |                       |            |
| No                                       | 63.9%  | 42.2                | <0.001                | Reference  |
| Yes                                      | 45.8%  |                     | 1.34 (0.92, 1.93)     | 0.127      |
| Unknown                                  | 69.9%  |                     | 0.90 (0.66, 1.24)     | 0.528      |
| Primary site surgery                     |        |                     |                       |            |
| No                                       | 66.6%  | 2.6                 | 0.106                 | Reference  |
| Yes                                      | 70.9%  |                     | 0.85 (0.73, 0.99)     | 0.041      |
| Chemotherapy                             |        |                     |                       |            |
| No                                       | 56.9%  | 35.4                | <0.001                | Reference  |
| Yes                                      | 70.0%  |                     | 0.65 (0.51, 0.82)     | 0.001      |
| Radiotherapy                             |        |                     |                       |            |
| No                                       | 56.7%  | 33.9                | <0.001                | Reference  |
| Yes                                      | 69.6%  |                     | 0.72 (0.55, 0.94)     | 0.014      |

95% CI, 95% confidence intervals; HR, hazard ratio

Table 2. Univariate and multivariate analysis to assess the effect of marital status on overall survival in anal canal squamous cell carcinoma.
Table 3 Univariate and multivariate analysis to assess the effect of marital status on cancer-specific survival in anal canal squamous cell carcinoma

| Variables                  | 5-y CSS | Univariate analysis | Multivariate analysis |
|----------------------------|---------|---------------------|-----------------------|
|                            | Log-rankχ² | P       | HR (95% CI) | P       |
| Marital status             |         |         |            |         |
| Widowed                    | 68.9%   | 37.1    | <0.001     | Reference |
| Single                     | 70.1%   |          |            | 0.65 (0.49, 0.86) | 0.003 |
| Divorced/separated         | 79.6%   |          |            | 0.54 (0.40, 0.73) | <0.001 |
| Married                    | 80.7%   |          |            | 0.59 (0.45, 0.76) | <0.001 |
| Sex                        |         |         |            |         |
| Male                       | 67.6%   | 52.2    | <0.001     | Reference |
| Female                     | 80.6%   |          |            | 0.51 (0.43, 0.61) | <0.001 |
| Age                        |         |         |            | <0.911   |
| < 50                       | 76.7%   | 0.0     |            |         |
| ≥ 50                       | 76.4%   |          |            |         |
| Race                       |         |         |            |         |
| White                      | 78.0%   | 28.1    | <0.001     | Reference |
| Black                      | 63.8%   |          |            | 1.43 (1.12, 1.82) | 0.004 |
| Others                     | 70.9%   |          |            | 1.09 (0.70, 1.70) | 0.692 |
| SEER stage                 |         |         |            |         |
| Localized                  | 85.8%   | 249.8   | <0.001     | Reference |
| Regional                   | 73.0%   |          |            | 1.68 (1.36, 2.07) | <0.001 |
| Distant                    | 44.7%   |          |            | 4.10 (3.20, 5.25) | <0.001 |
| Tumor size                 |         |         |            |         |
| < 5 cm                     | 81.4%   | 85.9    | <0.001     | Reference |
| ≥ 5 cm                     | 63.5%   |          |            | 1.51 (1.26, 1.80) | <0.001 |
| Grade                      |         |         |            |         |
| Grade I                    | 79.6%   | 6.6     | 0.084      | Reference |
| Grade II                   | 77.5%   |          |            | 1.28 (0.96, 1.69) | 0.093 |
| Grade III                  | 73.9%   |          |            | 1.44 (1.08, 1.92) | 0.014 |
| Grade IV                   | 87.9%   |          |            | 0.93 (0.34, 2.56) | 0.884 |
| Regional nodes positive    |         |         |            |         |
| No                         | 70.4%   | 65.4    | <0.001     | Reference |
| Yes                        | 50.7%   |          |            | 1.40 (0.91, 2.16) | 0.125 |
| Unknown                    | 78.5%   |          |            | 0.84 (0.58, 1.23) | 0.368 |
| Primary site surgery       |         |         |            |         |
| No                         | 74.9%   | 4.6     | 0.032      | Reference |
| Yes                        | 79.1%   |          |            | 0.80 (0.65, 0.97) | 0.022 |
| Chemotherapy               |         |         |            |         |
| No                         | 69.1%   | 17.5    | <0.001     | Reference |
| Yes                        | 77.7%   |          |            | 0.72 (0.53, 0.97) | 0.033 |
| Radiotherapy               |         |         |            |         |
| No                         | 64.7%   | 33.6    | <0.001     | Reference |
| Yes                        | 78.0%   |          |            | 0.56 (0.41, 0.77) | <0.001 |

95% CI, 95% confidence intervals; HR, hazard ratio
solve the emotional problems of widowed patients? Previous studies have shown that the loneliness and depression of widowed patients are closely related to economic income, and widowed patients need more care from outside the home [33–35]. Therefore, the society should provide more social welfare for the widowed patients and help them find suitable jobs. In addition, the psychological problems of widowed patients often cannot be solved by themselves, and they need professional support from family doctors and psychologists to help them manage their emotions and change their attitudes in many cases [35, 36]. More community activities can help widowed patients cultivate hobbies and make new friends, both of which have great benefits for mental health [36, 37]. All in all, in the process of treatment, we should focus on social relationship and give more material and emotional help to the widowed patients.

Table 4 Characteristics of the canal squamous cell carcinoma patients before and after propensity score matching

| Characteristic | Before matching | After matching | P value | Before matching | After matching | P value |
|---------------|----------------|---------------|---------|----------------|---------------|---------|
|               | Unmarried (%)  | Married (%)    |         | Unmarried (%)  | Married (%)    |         |
| Sex           |                |               |         |                |               |         |
| Male          | 509 (37.2)     | 278 (26.3)    | <0.001  | 288 (29.4)     | 278 (28.4)    | 0.618   |
| Female        | 861 (62.8)     | 781 (73.7)    |         | 691 (70.6)     | 701 (71.6)    |         |
| Age           |                |               |         |                |               |         |
| < 50          | 285 (20.8)     | 196 (18.5)    | 0.159   | 158 (16.1)     | 166 (17.0)    | 0.627   |
| ≥ 50          | 1085 (79.2)    | 863 (81.5)    |         | 821 (83.9)     | 813 (83.0)    |         |
| Race          |                |               |         |                |               |         |
| White         | 1146 (83.6)    | 987 (93.2)    | <0.001  | 910 (93.0)     | 909 (92.8)    | 0.990   |
| Black         | 184 (13.4)     | 45 (4.2)      |         | 44 (4.5)       | 44 (4.5)      |         |
| Others        | 40 (2.9)       | 27 (2.5)      |         | 25 (2.6)       | 26 (2.7)      |         |
| SEER stage    |                |               |         |                |               |         |
| Localized     | 659 (48.1)     | 584 (55.1)    | 0.002   | 538 (55.0)     | 518 (52.9)    | 0.602   |
| Regional      | 544 (39.7)     | 372 (35.1)    |         | 338 (34.5)     | 359 (36.7)    |         |
| Distant       | 167 (12.2)     | 103 (9.7)     |         | 103 (10.5)     | 102 (10.4)    |         |
| Tumor size    |                |               |         |                |               |         |
| < 5 cm        | 945 (69.0)     | 804 (75.9)    | <0.001  | 718 (73.3)     | 728 (74.4)    | 0.607   |
| ≥ 5 cm        | 425 (31.0)     | 255 (24.1)    |         | 261 (26.7)     | 251 (25.6)    |         |
| Grade         |                |               |         |                |               |         |
| Grade I       | 195 (14.2)     | 111 (10.5)    | 0.004   | 103 (10.5)     | 111 (11.3)    | 0.819   |
| Grade II      | 630 (46.0)     | 479 (45.2)    |         | 449 (45.9)     | 456 (46.6)    |         |
| Grade III     | 533 (38.9)     | 449 (42.4)    |         | 419 (42.8)     | 402 (41.1)    |         |
| Grade IV      | 12 (0.9)       | 20 (1.9)      |         | 8 (0.8)        | 10 (1.0)      |         |
| Regional nodes positive | | | | | | |
| No            | 50 (3.6)       | 42 (4.0)      | 0.730   | 35 (3.6)       | 38 (3.9)      | 0.896   |
| Yes           | 87 (6.4)       | 60 (5.7)      |         | 57 (5.8)       | 60 (6.1)      |         |
| Unknown       | 1233 (90.0)    | 957 (90.4)    |         | 887 (90.6)     | 881 (90.0)    |         |
| Primary site surgery | | | | | | |
| No            | 873 (63.7)     | 662 (62.5)    | 0.539   | 616 (62.9)     | 616 (62.9)    | 1.000   |
| Yes           | 497 (36.3)     | 397 (37.5)    |         | 363 (37.1)     | 326 (37.1)    |         |
| Chemotherapy  |                |               |         |                |               |         |
| No            | 222 (16.2)     | 122 (11.5)    | 0.001   | 122 (12.5)     | 120 (12.3)    | 0.891   |
| Yes           | 1148 (83.8)    | 937 (88.5)    |         | 857 (87.5)     | 859 (87.7)    |         |
| Radiotherapy  |                |               |         |                |               |         |
| No            | 172 (12.6)     | 103 (9.7)     | 0.029   | 107 (10.9)     | 103 (10.5)    | 0.770   |
| Yes           | 1198 (87.4)    | 956 (90.3)    |         | 872 (89.1)     | 876 (89.5)    |         |
Although we try to control for the biases generated in the study, there are obvious limitations in our study due to the retrospective nature. First of all, the SEER database does not provide patients' HPV and HIV infection status, which are important for patient prognosis. Second, we were only able to obtain marital status at diagnosis, but the quality of the marriage and subsequent changes in marital status were unknown. Besides, other marital statuses such as gay, bisexual, transgender, and lesbian were also unknown. This missing information may bias the results. Finally, some information that may be relevant to the prognosis of cancer patients, such as socioeconomic status, education, and reproductive history, was not available in the SEER database. Despite these limitations, our study demonstrated that marital status had a significant impact on patient survival outcomes while minimizing possible biases.

In summary, our study found that married patients with anal canal squamous cell carcinoma had better survival outcomes, while widowed patients had the worst. This result reminds our clinicians to consider the influence of psychosocial factors while paying attention to the patient’s own disease, which will provide patients with more personalized treatment.
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Author contribution Ting Yang developed the ideal and analyzed the data. All authors wrote the manuscript. Xinggang Guo and Hongqi Xiao reviewed the manuscript. All authors read and approved the final manuscript.

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Data availability All data are freely available in the SEER datasets. These data can be found here: https://seer.cancer.gov.

Declarations

Ethics approval All patient information was obtained from the SEER database, which is publicly accessible. Therefore, ethics committee review and informed consent requirements were not required.

Conflict of interest The authors declare no competing interests.

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