

Prevalence and Correlates of Depression and Anxiety Among Women with HPV-Related Cervical Disease: A Hospital-Based Cross-Sectional Study in Shenzhen, China

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Background: Human papillomavirus (HPV) infection is a prevalent sexually transmitted infection, significantly contributing to cervical lesions and cancer. It not only damages physical health but also causes substantial mental problems, including depression and anxiety. However, research remains fragmented in China.

Methods: A hospital-based cross-sectional study was conducted in Shenzhen, China, from December 2024 to February 2025. Five hundred and one female participants with HPV infection, cervical lesions, or cancers were recruited via convenience sampling. Data on demographic characteristics, HPV-related information, and psychosocial indicators were collected using a self-reported questionnaire. Key measures included the 9-item Patient Health Questionnaire (PHQ-9, cutoff ≥ 10 for PHQ-defined depression), 7-item Generalized Anxiety Disorder Scale (GAD-7, cutoff ≥ 10 for GAD-defined anxiety), 14-item Fatigue Scale (FS-14, higher scores = more severe fatigue), 10-item Connor-Davidson Resilience Scale (CD-RISC-10, higher scores = stronger resilience), and 5-item Mindful Attention Awareness Scale (MAAS-5, higher scores = lower mindfulness levels). Univariate analysis and multivariable binary logistic regression were performed to identify factors associated with depression and anxiety.

Results: The prevalence of PHQ-defined depression and GAD-defined anxiety was 22.36% ($n=112/501$, 95% CI: 0.187–0.260) and 21.36% ($n=107/501$, 95% CI: 0.178–0.250), respectively. Multivariable binary logistic regression indicated that high-grade cervical lesions or cervical cancer (vs HPV infection or low-grade cervical lesions; Depression: OR = 8.879, $P < 0.00$; Anxiety: OR = 14.154, $P < 0.001$) and poor sleep condition (Depression: OR = 1.155, $P = 0.004$; Anxiety: OR = 1.175, $P < 0.001$) emerged as significant predictors of depression and anxiety, whereas higher levels of resilience (Depression: OR = 0.896, $P = 0.001$; Anxiety: OR = 0.934, $P = 0.018$) demonstrated a protective effect among females infected with HPV. Meanwhile, the results also found that fatigue (OR = 1.284, $P = 0.008$) and lower mindfulness level (OR = 1.163, $P = 0.011$) were also associated with depression among females infected with HPV.

Conclusion: This study reveals a high prevalence of depression and anxiety among HPV-infected women, along with the associations between PHQ-defined depression, GAD-defined anxiety, and advanced disease staging, fatigue, lower mindfulness, and higher resilience in women infected with HPV. Routine mental health assessment is warranted for this population, especially for those with high-grade cervical lesions or cervical cancer.

Keywords: HPV-infected women, depression, anxiety, influencing factors

Introduction

Human papillomavirus (HPV) infection is a highly prevalent sexually transmitted infection that plays a central role in the development of nearly all cases of cervical lesions and cervical cancer worldwide.^{1–3} It is estimated that around 80–90%



of sexually active individuals will acquire HPV at some point in their lifetime.^{4,5} The consequences of HPV infection are far-reaching, extending beyond physical health to include significant psychological and emotional burdens. While many HPV infections resolve spontaneously, persistent infections can lead to more severe conditions such as cervical intraepithelial neoplasia (CIN) or even invasive cervical cancer.^{6,7} Despite the advancements made in screening and prevention efforts, the psychological burden experienced by those infected with HPV and those contracted cervical cancer remains a critical yet often overlooked public health issue.⁸

Recent studies have begun to reveal the considerable psychological distress that individuals confirmed HPV infection and cervical cancer may face. This distress includes symptoms of anxiety, depression,^{9,10} fear of cancer progression,^{11,12} and sexual dysfunction.¹³ Women who receive abnormal Pap smear results or are diagnosed as HPV-positive report feelings of shame, isolation, and self-stigmatization, which can be exacerbated by common misconceptions linking HPV infection to promiscuity.¹⁴ The anxiety surrounding the potential recurrence of the disease, the possibility of transmitting the infection to partners, and the fear of social rejection all serve to deepen the emotional strain experienced by those affected.^{15–17} In fact, studies comparing individuals infected with HPV to cancer patients have found that they experience similar levels of anxiety and concerns related to their relationships with partners.¹⁸ These studies all highlight the serious mental problems experienced by HPV-infected females and cervical cancer patients.

The psychological effects of HPV infection are further compounded by the prevalence of conflicting health information, which leads to increased uncertainty, confusion, and distorted perceptions of cancer risk.^{19,20} The uncertainty associated with the illness, coupled with a low tolerance for ambiguity, tends to worsen the fear of disease progression and can disrupt effective coping mechanisms.^{21,22} Moreover, chronic psychological stress can impair the immune system, particularly cell-mediated immunity, potentially facilitating the persistence of HPV and the development of cervical cancer.^{23,24} As for females diagnosed with cervical cancer, the psychological burden is often more severe than that experienced by women with HPV infections alone.²⁵ Females affected by cervical cancer often experience significant psychological distress, including high levels of anxiety, depression, and cancer-related fears.²⁶ The psychological burden can be further exacerbated by long-term challenges. The side effects of treatment, such as surgery, radiation, or chemotherapy, can exacerbate physical discomforts such as pain, fatigue, and sexual dysfunction, while emotional tolls often include feelings of helplessness, fear of the future, and distress over changes in personal identity and relationships.²⁷

As for the theoretical analysis, emerging evidence highlights a dynamic interplay among sleep disturbances, fatigue, diminished resilience, and reduced mindfulness in shaping clinical trajectories of HPV-related conditions and cervical cancer. Among these populations, disrupted circadian rhythms have been epidemiologically associated with elevated HPV susceptibility and mental problems,²⁸ while chronic fatigue manifests as a multidimensional burden exacerbated by inflammatory cascades and biopsychosocial stressors.²⁹ Crucially, this sleep-fatigue dyad appears to create a vicious cycle – sleep deprivation amplifies inflammatory mediators that perpetuate fatigue, which in turn disrupts sleep architecture through hyperarousal states. Within this pathogenic loop, psychological resilience emerges as a critical moderator, enabling individuals to maintain functional homeostasis through adaptive stress reappraisal and resource mobilization strategies.³⁰ Complementing this, mindfulness practices cultivate awareness without any judgement to alleviate mental problems and negative emotional responses, as evidenced by intervention studies demonstrating improved mental health among females.^{31–33} Though mechanistic research remains limited in oncology contexts, preliminary models posit that resilience-building and mindfulness training may buffer neuroendocrine dysregulation while improving overall psychological well-being.³⁴

Despite these important findings, research into the psychological dimensions of HPV infection and cervical cancer patients remains fragmented, and analysis of their relationship with other factors such as sleep, fatigue, and resilience is scarce.^{23,26} To address this gap, this hospital-based cross-sectional study aimed to investigate the prevalence and correlates of depression and anxiety among women with HPV-related cervical disease (encompassing HPV infection, low-grade squamous intraepithelial lesions [LSIL], high-grade squamous intraepithelial lesions [HSIL], and cervical cancer) in Shenzhen, China. Although hospital-based samples have limited generalizability, hospitals facilitate the recruitment of HPV-infected women across different disease stages, enabling researchers to explore the characteristics of mental problems among this population at various phases. We hypothesized that more advanced disease stages, poorer sleep quality, greater fatigue, lower resilience, and lower mindfulness would be significantly positively associated with depression and anxiety among HPV-infected females. The results of this research will provide valuable insights that can

help develop targeted interventions aimed at alleviating mental problems among HPV-infected females and cervical cancer patients and improving the overall mental health status within this vulnerable population.

Methods

Sampling and Participants

This hospital-based cross-sectional study was conducted among females diagnosed with HPV infection, cervical lesions, or cancers in Shenzhen, Guangdong Province, China, from December 2024 to February 2025. Participants were recruited from the Cervical Department of a maternity and child healthcare hospital in Shenzhen. This hospital was selected due to its specialization in cervical disease diagnosis and management, ensuring access to a clinically diverse population of HPV-positive patients across disease progression stages, thereby optimizing sample representativeness for this investigation. Inclusion criteria comprised females: 1) diagnosed with HPV positivity based on the standard laboratory testing; 2) fully aware of their HPV infection status and relevant disease stages (cervical lesions, or cancers); 3) aged 18 years or above; 4) capable of completing multiple-scale assessments independently; 5) voluntarily participating in this study. Exclusion criteria included individuals with significant cognitive impairment.

Convenience sampling was utilized to enroll participants, with potential participants being HPV-infected females who visited the Cervical Department during the recruitment period, which is about 540. Due to the dynamic nature of outpatient visits and the lack of a dedicated real-time tracking system for HPV-infected patients during recruitment, fully accurate data on the total number of outpatients remains difficult to obtain. Participants were invited through multiple approaches, including posters displayed in the department waiting area, brochures distributed by researchers, and verbal introductions by researchers following the outpatient consultation. To alleviate selection bias, all approached females with HPV infection were screened against the inclusion and exclusion criteria by trained researchers, and 501 who met the criteria and agreed to participate were provided with the link to the online questionnaire to complete.

A self-reported online structured questionnaire was designed by an expert team including epidemiologists, psychologists, doctors, and nurses through several rounds of literature reviews and focus group discussions. The online survey platform “Wenjuanxing” was employed to distribute the questionnaire. All questions were set as mandatory to ensure that every submitted questionnaire was complete and free of any missing data. Diagnosis of disease types (HPV infection, cervical lesions, or cervical cancer) and staging of participants were extracted from the hospital’s electronic medical record system, which is based on clinical standardized diagnostic criteria. All participants were explicitly aware of their HPV infection status and associated disease stages before completing the questionnaire, which ensured that the research findings could accurately reflect the mental well-being of individuals with HPV infection. Additionally, as for the common method bias, first, a pilot study was conducted to refine the questionnaire, and researchers optimized the wording of the items to ensure they were clear, unambiguous, and easy to understand, thereby minimizing measurement error. Second, the questionnaire was designed with clear thematic sections and instructions, creating psychological separation between the measures of independent and dependent variables to reduce artificial covariance. Third, as mentioned above, emphasizing anonymity helped reduce evaluation apprehension, making participants more likely to provide honest answers rather than socially desirable ones. Fourth, reverse-scored items and scales such as the MAAS-5 were intentionally included within our questionnaires. Finally, during data cleaning, researchers rigorously screened for straight-line responding, including identical answers across a large number of items.

Ultimately, all 501 participants completed the questionnaire, none of which were excluded for further analysis after a thorough check of the response time and logical inconsistencies, resulting in a response rate of 92.78% (501/540) and effective rate of 100.0% (501/501). This study was approved by the Ethics Committee of the Chinese Academy of Medical Science (ID: CAMS&PUMC-IEC-2024-001) on January 12th, 2024. Electronic informed consent was obtained from all participants before the study commenced. All data collection procedures adhered to ethical guidelines and the principles of patient privacy protection. Data were de-identified by replacing direct identifiers with unique codes and stored securely on encrypted systems, and all data were encrypted during transmission and storage.

Measures

Demographic Characteristics

Demographic characteristics included age, ethnicity, permanent residence in the past 6 months, religion degree, marriage status, annual household income, alcohol consumption, number of children, and sexual partners. Additionally, variables related to HPV infection were also collected, including whether the participants had received the HPV vaccine or undergone regular cervical cancer screening before the diagnosis, disease staging, and discomforts during the treatment, among these the disease staging of each participant was collected from the hospital's electronic medical record system.

Depression

The depression among females infected with HPV in this study was measured by the nine-item Patient Health Questionnaire (PHQ-9), a self-reported scale rated on a 4-point Likert scale ranging from 0 to 3.²⁵ Higher scores of PHQ-9 indicate more severe depressive symptoms. The cut-off value of the PHQ-9 scale was 10, and participants with a score ≥ 10 were considered to suffer from depression.²⁷ The instrument's Cronbach's alpha in this study was 0.934.

Anxiety

The 7-item Generalized Anxiety Disorder Questionnaire (GAD-7) was used to assess anxiety among females infected with HPV. This self-reported scale is rated on a 4-point Likert scale ranging from 0 to 3.³⁵ The GAD-7 yields a total score of 0 to 21 points, with a cut-off value of 10 for anxiety and higher scores indicating more severe symptoms. The instrument has been validated in various Chinese populations,²⁸ and Cronbach's alpha in this study was 0.956.

Sleep Condition

The Self-Rating Scale of Sleep (SRSS) assessed participants' sleep conditions. It contains 10 items ranging from 1 to 5, and higher scores indicate more severe sleep problems.²⁹ The SRSS has demonstrated good reliability and validity in previous studies, and the Cronbach's alpha of the SRSS in this study was 0.917.

Fatigue

The 14-item Fatigue scale (FS-14) was used to assess the fatigue severity among participants, comprising 14 questions reflecting physical and mental fatigue. Each item has two options and a score of 0 to 1 (0 = no, 1 = yes), resulting in a total score ranging from 0 to 14.³⁶ Higher scores indicate a higher level of chronic fatigue. The Cronbach's alpha of the instrument in this study was 0.838.

Resilience

The 10-item Connor-Davidson Resilience Scale (CD-RISC-10) was used to measure participants' resilience, which was developed by Connor et al in 2003 with 25 items and was reduced to 10 items by Campbell-Sillset al in 2007.^{30,37} This instrument contains 10 items on 5-point Likert scales ranging from 0 to 4. Higher scores of this scale indicate greater resilience. In this study, Cronbach's alpha of the instrument was 0.978.

Mindfulness

The five-item Mindful Attention Awareness Scale (MAAS-5) was adapted to measure the level of mindfulness on a Likert scale of 1 to 5 with five items.^{34,38} Higher total scores indicate a lower level of mindfulness. In this study, the Cronbach's alpha of the instrument was 0.979.

Statistical Analysis

Descriptive analyses were conducted to describe the participants' demographic characteristics, the prevalence of depression and anxiety, and the level of sleep condition, fatigue, resilience, and mindfulness. Univariate analyses with the Chi-square test, Fisher's exact test, and two-sample independent *t*-test were applied to evaluate the associations between depression, anxiety, and other variables. Variables showing statistical significance at the level of $p \leq 0.10$ in the univariate analysis were further entered into a binary logistic regression analysis to avoid omitting potential influencing factors. Meanwhile, a Gaussian Copula regression was utilized to examine potential endogeneity in the variables of sleep conditions, fatigue, resilience, and mindfulness prior to the binary logistic regression analysis. Adjusted odds ratio (AOR)

and corresponding 95% confidence intervals (95% CI) were calculated to identify the influencing factors of depression and anxiety among females infected with HPV. All continuous predictors are reported as “per 1-standard deviation change”, which standardizes effect sizes and improves comparability. SAS 9.4 was used for data analysis, with the statistical significance level set at $p < 0.05$.

Results

Demographic Characteristics

A total of 501 females with HPV infection were included in this study, with an average age of 39.74 ± 8.61 . Demographic characteristics showed that 94.21% were of Han ethnicity, with 95.61% residing in urban areas. Regarding socioeconomic status, 29.74% held associate degrees, 54.09% reported an annual household income of CNY 100,000–300,000, 59.48% reported no alcohol consumption, 83.43% were married, 40.52% had one child, 91.82% maintained monogamous sexual relationships. Healthcare-related data revealed that 70.66% had received HPV vaccination, and 86.43% underwent regular cervical cancer screenings prior to diagnosis, 59.68% were diagnosed with HPV infection or low-grade cervical lesions, and 83.43% reported no treatment-related discomfort.

Among all participants, 22.36% ($n=112/501$) reported PHQ-defined depression (PHQ-9 score ≥ 10), and 21.36% ($n=107/501$) reported GAD-defined anxiety (GAD-7 score ≥ 10) over the past two weeks, with the mean scores being 22.01 ± 7.12 for sleep condition, 5.58 ± 3.30 for fatigue, 25.41 ± 12.75 for resilience, and 13.89 ± 7.64 for mindfulness.

The demographic characteristics were illustrated in Table 1.

Table 1 Demographic Characteristics

| Variables | Mean (SD) or n (%) |
|--|--------------------|
| Age | 39.74±8.61 |
| Ethnic | |
| Han | 472 (94.21) |
| Other | 29 (5.79) |
| Usual residence in the past 6 months | |
| Urban area | 479 (95.61) |
| Rural area | 22 (4.39) |
| Religion | |
| No | 474 (94.61) |
| Yes | 27 (5.39) |
| Degree | |
| Junior high school degree or below | 52 (10.38) |
| Senior high school or secondary vocational school degree | 118 (23.55) |
| Associate degree | 149 (29.74) |
| Bachelor's degree | 139 (27.75) |
| Master's or doctor's degree | 43 (8.58) |
| Marriage Status | |
| Single/unmarried | 55 (10.98) |
| Married | 418 (83.43) |
| Divorced | 28 (5.59) |
| Annual household income (ten thousand yuan) | |
| ≤5 | 10 (2.00) |
| 5-10 | 71 (14.17) |
| 10-30 | 271 (54.09) |
| >30 | 149 (29.74) |
| Alcohol | |
| No | 298 (59.48) |
| Yes | 203 (40.52) |

(Continued)

Table 1 (Continued).

| Variables | Mean (SD) or n (%) |
|--|--------------------|
| Number of children | |
| 0 | 74 (14.77) |
| 1 | 203 (40.52) |
| 2 | 191 (38.12) |
| ≥3 | 33 (6.59) |
| Number of sexual partners at the same time | |
| 0 | 6 (1.20) |
| 1 | 460 (91.82) |
| ≥2 | 35 (6.98) |
| HPV vaccination | |
| No | 147 (29.34) |
| Yes | 354 (70.66) |
| Regular cervical cancer screening before diagnosis | |
| No | 68 (13.57) |
| Yes | 433 (86.43) |
| Disease staging | |
| HPV infection or low-grade cervical lesions | 299 (59.68) |
| High-grade cervical lesions or cervical cancer | 202 (40.32) |
| Discomfort during the treatment | |
| No | 418 (83.43) |
| Yes | 83 (16.57) |
| Mental disorders diagnosed by medical institutions before the investigation | |
| No | 466 (93.01) |
| Yes | 34 (6.79%) |
| PHQ-defined depression | |
| No | 389 (77.64) |
| Yes | 112 (22.36) |
| GAD-defined anxiety | |
| No | 394 (78.64) |
| Yes | 107 (21.36) |
| Sleep condition | 22.01±7.12 |
| Fatigue | 5.58±3.30 |
| Resilience | 25.41±12.75 |
| Mindfulness | 13.89±7.64 |

Influencing Factors of PHQ-Defined Depression Among Females Infected with HPV in This Study

The results of the univariate analysis showed a significant difference in age ($F = 5.297$, $P < 0.001$), usual residence in the past 6 months ($\chi^2 = 7.073$, $P = 0.008$), religion ($\chi^2 = 5.558$, $P = 0.018$), degree ($\chi^2 = 44.216$, $P < 0.001$), marriage status ($\chi^2 = 31.157$, $P < 0.001$), annual household income ($\chi^2 = 19.763$, $P < 0.001$), alcohol ($\chi^2 = 17.922$, $P < 0.001$), number of children ($\chi^2 = 14.144$, $P = 0.003$), HPV vaccination ($\chi^2 = 72.435$, $P < 0.001$), regular cervical cancer screening before diagnosis ($\chi^2 = 21.467$, $P < 0.001$), disease staging ($\chi^2 = 42.559$, $P < 0.001$), discomfort during the treatment ($\chi^2 = 28.304$, $P < 0.001$), sleep condition ($F = 19.916$, $P < 0.001$), fatigue ($F = 19.434$, $P < 0.001$), resilience ($F = 18.158$, $P < 0.001$), and mindfulness ($F = 20.147$, $P < 0.001$), shown in [Table 2](#). These variables were further included in the binary logistic regression analysis as independent variables.

Initial results from the Gaussian Copula analysis revealed significant endogeneity in the “sleep condition” variable ($P = 0.017$). However, endogeneity was not detected for fatigue, resilience, or mindfulness ($P = 0.299$, $P = 0.472$, and $P = 0.267$, respectively). Given the possibility of an omitted variable, the analysis was repeated with disease staging

Table 2 Univariate Analysis of PHQ-Defined Depression and GAD-Defined Anxiety in the Participants

| Variables | PHQ-defined depression | | Statistics | P | GAD-defined anxiety | | Statistics | P |
|--|------------------------|--------------|------------|--------|---------------------|--------------|------------|--------|
| | No | Yes | | | No | Yes | | |
| Age | 389 (77.64%) | 112 (22.36%) | 5.297 | <0.001 | 394 (78.64%) | 107 (21.36%) | 6.063 | <0.001 |
| | 38.55±7.86 | 43.88±9.77 | | | 38.43±7.84 | 44.54±9.59 | | |
| Ethnic | | | 0.464 | 0.496 | | | 0.310 | 0.577 |
| Han | 365 (93.83%) | 107 (95.54%) | | | 370 (93.91%) | 102 (95.33%) | | |
| Other | 24 (6.17%) | 5 (4.46%) | | | 24 (6.09%) | 5 (4.67%) | | |
| Usual residence in the past 6 months | | | 7.073 | 0.008 | | | 6.525 | 0.011 |
| Urban area | 377 (96.92%) | 102 (91.07%) | | | 382 (96.95%) | 97 (90.65%) | | |
| Rural area | 12 (3.08%) | 10 (8.93%) | | | 12 (3.05%) | 10 (9.35%) | | |
| Religion | | | 5.558 | 0.018 | | | 6.384 | 0.012 |
| No | 373 (95.89%) | 101 (90.18%) | | | 378 (95.94%) | 96 (89.72%) | | |
| Yes | 16 (4.11%) | 11 (9.82%) | | | 16 (4.06%) | 11 (10.28%) | | |
| Degree | | | 44.216 | <0.001 | | | 49.069 | <0.001 |
| Junior high school degree or below | 26 (6.68%) | 26 (23.21%) | | | 26 (6.60%) | 26 (24.30%) | | |
| Senior high school or secondary vocational school degree | 80 (20.57%) | 38 (33.93%) | | | 80 (20.30%) | 38 (35.51%) | | |
| Associate degree | 121 (31.11%) | 28 (25.00%) | | | 125 (31.73%) | 24 (22.43%) | | |
| Bachelor's degree | 123 (31.62%) | 16 (14.29%) | | | 124 (31.47%) | 15 (14.02%) | | |
| Master's or doctor's degree | 39 (10.02%) | 4 (3.57%) | | | 39 (9.90%) | 4 (3.74%) | | |
| Marriage Status | | | 31.157 | <0.001 | | | 27.386 | <0.001 |
| Single/unmarried | 41 (10.54%) | 14 (12.50%) | | | 44 (11.17%) | 11 (10.28%) | | |
| Married | 338 (86.89%) | 80 (71.43%) | | | 339 (86.04%) | 79 (73.83%) | | |
| Divorced | 10 (2.57%) | 18 (16.07%) | | | 11 (2.79%) | 17 (15.89%) | | |
| Annual household income (ten thousand yuan) | | | 19.763 | <0.001 | | | 22.815 | <0.001 |
| ≤5 | 7 (1.80%) | 3 (2.68%) | | | 7 (1.78%) | 3 (2.81%) | | |
| 5-10 | 43 (11.05%) | 28 (25.00%) | | | 42 (10.66%) | 29 (27.10%) | | |
| 10-30 | 209 (53.73%) | 62 (55.36%) | | | 214 (54.31%) | 57 (53.27%) | | |
| >30 | 130 (33.42%) | 19 (16.96%) | | | 131 (33.25%) | 18 (16.82%) | | |
| Alcohol | | | 17.922 | <0.001 | | | 14.852 | <0.001 |
| No | 212 (54.50%) | 86 (76.79%) | | | 217 (55.08%) | 81 (75.70%) | | |
| Yes | 177 (45.50%) | 26 (23.21%) | | | 177 (44.92%) | 26 (24.30%) | | |
| Number of children | | | 14.144 | 0.003 | | | 28.730 | <0.001 |
| 0 | 58 (14.91%) | 16 (14.29%) | | | 63 (15.99%) | 11 (10.28%) | | |
| 1 | 160 (41.13%) | 43 (38.39%) | | | 161 (40.86%) | 42 (39.25%) | | |
| 2 | 154 (39.59%) | 37 (33.03%) | | | 156 (39.60%) | 35 (32.71%) | | |
| ≥3 | 17 (4.37%) | 16 (14.29%) | | | 14 (3.55%) | 19 (17.76%) | | |

(Continued)

Table 2 (Continued).

| Variables | PHQ-defined depression | | Statistics | P | GAD-defined anxiety | | Statistics | P |
|--|------------------------|--------------|------------|--------|---------------------|-------------|------------|--------|
| | No | Yes | | | No | Yes | | |
| Number of sexual partners at the same time | | | 0.897 | 0.639 | | | 3.262 | 0.196 |
| 0 | 5 (1.28%) | 1 (0.89%) | | | 6 (1.52%) | 0 (0.00%) | | |
| 1 | 359 (92.29%) | 101 (90.18%) | | | 362 (91.88%) | 98 (91.59%) | | |
| ≥2 | 25 (6.43%) | 10 (8.93%) | | | 26 (6.60%) | 9 (8.41%) | | |
| HPV vaccination | | | 72.435 | <0.001 | | | 68.641 | <0.001 |
| No | 78 (20.05%) | 69 (61.61%) | | | 81 (20.56%) | 66 (61.68%) | | |
| Yes | 311 (79.95%) | 43 (38.39%) | | | 313 (79.44%) | 41 (38.32%) | | |
| Regular cervical cancer screening before diagnosis | | | 21.467 | <0.001 | | | 15.771 | <0.001 |
| No | 38 (9.77%) | 20 (26.79%) | | | 41 (10.41%) | 27 (25.23%) | | |
| Yes | 351 (90.23%) | 82 (73.21%) | | | 353 (89.59%) | 80 (74.77%) | | |
| Disease staging | | | 42.559 | <0.001 | | | 56.616 | <0.001 |
| HPV infection or Low-grade cervical lesions | 262 (67.35%) | 37 (33.04%) | | | 269 (68.27%) | 30 (28.04%) | | |
| High-grade cervical lesions or Cervical cancer | 127 (32.65%) | 75 (66.96%) | | | 125 (31.73%) | 77 (71.96%) | | |
| Discomfort during the treatment | | | 28.304 | <0.001 | | | 31.937 | <0.001 |
| No | 343 (88.17%) | 75 (66.96%) | | | 348 (88.32%) | 70 (65.42%) | | |
| Yes | 46 (11.83%) | 37 (33.04%) | | | 46 (11.68%) | 37 (34.58%) | | |
| Mental disorders diagnosed by medical institutions before the investigation | | | 0.037 | >0.999 | | | 0.008 | >0.999 |
| No | 363 (93.32%) | 103 (92.79%) | | | 367 (93.15%) | 27 (6.85%) | | |
| Yes | 26 (6.68%) | 8 (7.21%) | | | 99 (93.40%) | 7 (6.60%) | | |
| Sleep condition | 19.47±5.20 | 30.84±5.74 | 19.916 | <0.001 | 19.62±5.37 | 30.83±5.71 | 18.893 | <0.001 |
| Fatigue | 4.49±2.68 | 9.38±2.25 | 19.434 | <0.001 | 4.59±2.76 | 9.21±2.47 | 15.710 | <0.001 |
| Resilience | 29.71±10.23 | 10.44±8.66 | 18.158 | <0.001 | 29.16±10.74 | 11.58±9.67 | 15.331 | <0.001 |
| Mindfulness | 11.32±6.19 | 22.83±5.05 | 20.147 | <0.001 | 11.61±6.41 | 22.31±5.67 | 16.825 | <0.001 |

included as a covariate. This adjusted model showed no evidence of endogeneity for fatigue ($P = 0.121$), sleep condition ($P = 0.123$), resilience ($P = 0.226$), and mindfulness ($P = 0.379$), which led to “sleep condition” being retained as an independent variable in the logistic regression analysis.

The results of the binary logistic regression analysis are illustrated in Table 3. The results demonstrated that diagnosed with high-grade cervical lesions or cervical cancer ($OR = 8.879$, $P < 0.001$), sleep condition ($OR = 1.155$, $P = 0.004$), fatigue ($OR = 1.284$, $P = 0.008$), and lower mindfulness level ($OR = 1.163$, $P = 0.011$) were positively associated with PHQ-defined depression among females infected with HPV, while resilience ($OR = 0.896$, $P = 0.001$) was negatively associated with depression.

Table 3 Binary Logistic Regression Analysis of Influencing Factors of PHQ-Defined Depression

| Variables | β | SE | Wald χ^2 | P | OR | OR 95% CI | |
|---|---------|-------|---------------|-------|-------|-----------|--------|
| | | | | | | LL | UL |
| Age | 0.016 | 0.036 | 0.187 | 0.666 | 1.016 | 0.946 | 1.090 |
| Usual residence in the past 6 months | | | | | | | |
| Urban area | 0.000 | | | | 1.000 | | |
| Rural area | -1.323 | 0.999 | 1.752 | 0.186 | 0.266 | 0.038 | 1.888 |
| Religion | | | | | | | |
| No | 0.000 | | | | 1.000 | | |
| Yes | -0.375 | 0.731 | 0.264 | 0.608 | 0.687 | 0.164 | 2.877 |
| Degree | | | | | | | |
| Junior high school degree or below | 0.000 | | | | 1.000 | | |
| Senior high school or secondary vocational school degree | 0.235 | 0.708 | 0.110 | 0.740 | 1.265 | 0.316 | 5.069 |
| Associate degree | 0.918 | 0.882 | 1.082 | 0.298 | 2.503 | 0.444 | 14.105 |
| Bachelor's degree | 0.515 | 1.044 | 0.243 | 0.622 | 1.674 | 0.216 | 12.964 |
| Master's or doctor's degree | 0.488 | 1.314 | 0.138 | 0.710 | 1.629 | 0.124 | 21.397 |
| Marriage status | | | | | | | |
| Single/unmarried | 0.000 | | | | 1.000 | | |
| Married | -0.223 | 1.106 | 0.041 | 0.840 | 0.800 | 0.092 | 6.995 |
| Divorced | 1.097 | 1.229 | 0.798 | 0.372 | 2.996 | 0.270 | 33.298 |
| Annual household income (ten thousand yuan) | | | | | | | |
| ≤5 | 0.000 | | | | 1.000 | | |
| 5-10 | -0.893 | 1.272 | 0.493 | 0.483 | 0.409 | 0.034 | 4.952 |
| 10-30 | 0.325 | 1.244 | 0.068 | 0.794 | 1.384 | 0.121 | 15.859 |
| >30 | 1.700 | 1.410 | 1.454 | 0.228 | 5.475 | 0.345 | 86.802 |
| Alcohol | | | | | | | |
| No | 0.000 | | | | 1.000 | | |
| Yes | -0.456 | 0.472 | 0.934 | 0.334 | 0.634 | 0.252 | 1.597 |
| Number of children | | | | | | | |
| 0 | 0.000 | | | | 1.000 | | |
| 1 | -1.638 | 0.993 | 2.720 | 0.099 | 0.194 | 0.028 | 1.361 |
| 2 | -1.652 | 0.998 | 2.738 | 0.098 | 0.192 | 0.027 | 1.356 |
| ≥3 | -1.434 | 1.258 | 1.300 | 0.254 | 0.238 | 0.020 | 2.804 |
| HPV vaccination | | | | | | | |
| No | 0.000 | | | | 1.000 | | |
| Yes | -0.879 | 0.535 | 2.696 | 0.101 | 0.415 | 0.145 | 1.186 |
| Regular cervical cancer screening before diagnosis | | | | | | | |
| No | 0.000 | | | | 1.000 | | |
| Yes | -0.223 | 0.578 | 0.149 | 0.700 | 0.800 | 0.257 | 2.486 |

(Continued)

Table 3 (Continued).

| Variables | β | SE | Wald χ^2 | P | OR | OR 95% CI | |
|--|---------|-------|---------------|--------|-------|-----------|--------|
| | | | | | | LL | UL |
| Disease staging | | | | | | | |
| HPV infection or Low-grade cervical lesions | 0.000 | | | | 1.000 | | |
| High-grade cervical lesions or Cervical cancer | 2.184 | 0.537 | 16.514 | <0.001 | 8.879 | 3.097 | 25.453 |
| Discomfort during the treatment | | | | | | | |
| No | 0.000 | | | | 1.000 | | |
| Yes | -0.123 | 0.527 | 0.055 | 0.815 | 0.884 | 0.315 | 2.482 |
| Sleep Condition | | | | | | | |
| | 0.144 | 0.050 | 8.387 | 0.004 | 1.155 | 1.048 | 1.273 |
| Fatigue | | | | | | | |
| | 0.250 | 0.094 | 7.138 | 0.008 | 1.284 | 1.069 | 1.543 |
| Resilience | | | | | | | |
| | -0.110 | 0.033 | 11.420 | 0.001 | 0.896 | 0.840 | 0.955 |
| Mindfulness | | | | | | | |
| | 0.151 | 0.059 | 6.490 | 0.011 | 1.163 | 1.035 | 1.307 |

Influencing Factors of Anxiety Among Females Infected with HPV in This Study

As shown in Table 2, significant differences in age ($F = 6.063, P < 0.001$), usual residence in the past 6 months ($\chi^2 = 6.525, P = 0.011$), religion ($\chi^2 = 6.384, P = 0.012$), degree ($\chi^2 = 49.069, P < 0.001$), marriage status ($\chi^2=27.386, P < 0.001$), alcohol ($\chi^2=14.852, P < 0.001$), number of children ($\chi^2= 28.730, P < 0.001$), HPV vaccination ($\chi^2=68.641, P < 0.001$), regular cervical cancer screening before diagnosis ($\chi^2=15.771, P < 0.001$), disease staging ($\chi^2= 56.616, P < 0.001$), discomfort during the treatment ($\chi^2= 31.937, P < 0.001$), sleep condition ($F = 18.893, P < 0.001$), fatigue ($F = 15.710, P < 0.001$), resilience ($F = 15.331, P < 0.001$), and mindfulness ($F = 16.825, P < 0.001$) were observed in the univariate analysis, which was further included in the binary logistic regression analysis as independent variables.

The Gaussian Copula analysis was also conducted before the binary logistic regression. It was also found that the “sleep condition” had significant endogeneity ($P = 0.018$), whereas endogeneity was absent in the variables of fatigue ($P = 0.179$), resilience ($P = 0.116$), and mindfulness ($P = 0.280$). Similarly, the analysis was rerun with disease staging incorporated as a covariate. In this adjusted model, endogeneity was absent across all variables: fatigue ($P = 0.167$), sleep condition ($P = 0.174$), resilience ($P = 0.291$), and mindfulness ($P = 0.433$).

Table 4 presents the results of the binary logistic regression analysis on factors associated with GAD-defined anxiety. Advanced disease staging (high-grade cervical lesions or cervical cancer) ($OR = 14.154, p < 0.001$), and sleep condition

Table 4 Binary Logistic Regression Analysis of GAD-Defined Anxiety

| Variables | β | SE | Wald χ^2 | P | OR | OR 95% CI | |
|--|---------|-------|---------------|-------|-------|-----------|--------|
| | | | | | | LL | UL |
| Age | 0.007 | 0.034 | 0.045 | 0.833 | 1.007 | 0.942 | 1.077 |
| Usual residence in the past 6 months | | | | | | | |
| Urban area | 0.000 | | | | 1.000 | | |
| Rural area | -1.247 | 0.906 | 1.896 | 0.169 | 0.287 | 0.049 | 1.696 |
| Religion | | | | | | | |
| No | 0.000 | | | | 1.000 | | |
| Yes | 0.038 | 0.692 | 0.003 | 0.957 | 1.038 | 0.268 | 4.027 |
| Degree | | | | | | | |
| Junior high school degree or below | 0.000 | | | | 1.000 | | |
| Senior high school or secondary vocational school degree | 0.784 | 0.665 | 1.393 | 0.238 | 2.191 | 0.596 | 8.060 |
| Associate degree | 0.208 | 0.838 | 0.061 | 0.804 | 1.231 | 0.238 | 6.359 |
| Bachelor’s degree | -0.033 | 0.956 | 0.001 | 0.972 | 0.967 | 0.149 | 6.292 |
| Master’s or doctor’s degree | 0.205 | 1.242 | 0.027 | 0.869 | 1.228 | 0.108 | 14.007 |

(Continued)

Table 4 (Continued).

| Variables | β | SE | Wald X^2 | P | OR | OR 95% CI | |
|---|---------|-------|------------|--------|--------|-----------|---------|
| | | | | | | LL | UL |
| Marriage status | | | | | | | |
| Single/unmarried | 0.000 | | | | 1.000 | | |
| Married | -1.072 | 1.157 | 0.857 | 0.355 | 0.342 | 0.035 | 3.310 |
| Divorced | -0.388 | 1.254 | 0.096 | 0.757 | 0.679 | 0.058 | 7.928 |
| Annual household income (ten thousand yuan) | | | | | | | |
| ≤5 | 0.000 | | | | 1.000 | | |
| 5-10 | 0.026 | 1.131 | 0.001 | 0.981 | 1.027 | 0.112 | 9.421 |
| 10-30 | -0.055 | 1.131 | 0.002 | 0.961 | 0.947 | 0.103 | 8.683 |
| >30 | 1.254 | 1.263 | 0.986 | 0.321 | 3.505 | 0.295 | 41.632 |
| Alcohol | | | | | | | |
| No | 0.000 | | | | 1.000 | | |
| Yes | -0.037 | 0.416 | 0.008 | 0.929 | 0.964 | 0.427 | 2.178 |
| Number of children | | | | | | | |
| 0 | 0.000 | | | | 1.000 | | |
| 1 | 1.090 | 1.083 | 1.013 | 0.314 | 2.973 | 0.356 | 24.820 |
| 2 | 0.741 | 1.088 | 0.464 | 0.496 | 2.097 | 0.249 | 17.682 |
| ≥3 | 2.266 | 1.247 | 3.299 | 0.069 | 9.639 | 0.836 | 111.146 |
| HPV vaccination | | | | | | | |
| No | 0.000 | | | | 1.000 | | |
| Yes | -0.271 | 0.474 | 0.328 | 0.567 | 0.762 | 0.301 | 1.931 |
| Regular cervical cancer screening before diagnosis | | | | | | | |
| No | 0.000 | | | | 1.000 | | |
| Yes | 0.606 | 0.547 | 1.226 | 0.268 | 1.833 | 0.627 | 5.354 |
| Disease staging | | | | | | | |
| HPV infection or Low-grade cervical lesions | 0.000 | | | | 1.000 | | |
| High-grade cervical lesions or Cervical cancer | 2.650 | 0.513 | 26.650 | <0.001 | 14.154 | 5.175 | 38.712 |
| Discomfort during the treatment | | | | | | | |
| No | 0.000 | | | | 1.000 | | |
| Yes | -0.283 | 0.454 | 0.388 | 0.533 | 0.754 | 0.310 | 1.834 |
| Sleep Condition | | | | | | | |
| | 0.161 | 0.045 | 12.811 | <0.001 | 1.175 | 1.076 | 1.283 |
| Fatigue | | | | | | | |
| | 0.159 | 0.083 | 3.686 | 0.055 | 1.172 | 0.997 | 1.378 |
| Resilience | | | | | | | |
| | -0.068 | 0.029 | 5.604 | 0.018 | 0.934 | 0.882 | 0.988 |
| Mindfulness | | | | | | | |
| | 0.098 | 0.053 | 3.354 | 0.067 | 1.103 | 0.993 | 1.224 |

(OR = 1.175, $p < 0.001$) emerged as significant predictors of anxiety, whereas higher levels of resilience (OR = 0.934, $p = 0.018$) demonstrated a protective effect against anxiety among females infected with HPV.

Discussion

HPV infections are significant public health issues that warrant attention and prevention globally. With the increase in cervical cancer screening coverage in China, more women infected with HPV have been identified and received corresponding management or treatment.³⁹ However, HPV infection, particularly with high-risk types, is closely associated with the development of cervical lesions and cervical cancer, which may contribute to anxiety and depression among HPV-infected women.^{40,41} Additionally, despite a large body of clinical and economic research on HPV testing, research on psychosocial outcomes among HPV-positive women is relatively lacking.⁴²

Our study investigated the prevalence and influencing factors of depression and anxiety among females infected with HPV in Shenzhen City, Guangdong Province, China. This study demonstrated a notable prevalence of depression (22.36%) and anxiety (21.36%) among HPV-infected women, indicating that a substantial proportion of this population

experience depression and anxiety following the HPV infection, a phenomenon that warrants increased attention from healthcare workers. Our findings are consistent with prior studies, which demonstrated that testing positive for HPV was associated with higher levels of anxiety and depression among women, emphasizing that HPV infection can interfere with their mental health.^{42,43} Graziottin et al have highlighted that personal psychological vulnerability increases with the frequency of HPV infections, and simultaneously, depression, anxiety, and anger were the most commonly reported emotional responses.⁴³ A systematic review including 60 studies also revealed a negative impact of HPV diagnosis on the occurrence of depressive and anxiety symptoms, poorer quality of life, as well as on the sexual functioning of the affected women.⁴⁴ The prevalence of PHQ-defined depression and GAD-defined anxiety among HPV-positive women in this study was lower than those reported in a Shanghai-based investigation (35.71% for depression and 31.32% for anxiety) conducted between 2018 and 2019 among HPV-infected women.⁴⁵ This discrepancy may be attributed to the time interval between the studies. The cross-sectional study in Shanghai was conducted six years before our study, and since then the public awareness of HPV-related knowledge, including treatment modalities, disease progression, and prognosis, has been increasing among Chinese women. This enhanced comprehension may have contributed to mitigating anxiety and depression in HPV-infected women.

This study revealed a positive association between disease severity and depression/anxiety in HPV-infected women. Compared with those diagnosed with HPV infection alone or low-grade cervical lesions (the reference group), women with high-grade cervical lesions or cervical cancer were more likely to suffer from depression (OR = 8.879, 95% CI: 3.097–25.453) and anxiety (OR = 14.154, 95% CI: 5.175–38.712). Clinical practice guidelines endorsed by global consensus have proved that reversal is possible to occur in both HPV infections and LSIL.⁴⁶ This biological behavior is attributed to the cell-mediated immune clearance mechanisms coordinated by pro-inflammatory cytokines and the vaginal microbiome, typically occurring within 12–24 months post-infection.⁴⁷ Given this spontaneous regression potential, women diagnosed with HPV infections or low-grade cervical lesions are less likely to develop severe mental disorders, and even those with mental problems often demonstrate symptom alleviation concurrent with HPV clearance. In contrast, high-grade cervical lesions or cervical cancer demonstrate negligible potential for spontaneous regression in the absence of therapy or intervention, with the majority of cases exhibiting persistent progression that could ultimately lead to severe negative outcomes,⁴⁸ causing a higher prevalence of anxiety and depression. One research showed that the prevalence of anxiety was 44.9%, and the prevalence of depression was 36.1% with cervical cancer, which was significantly higher than that among women at other stages of HPV infection.⁴⁹ Additionally, according to previous studies conducted in Germany, another cause of anxiety and depression among this population was that women demonstrated limited awareness regarding the low malignant transformation probability of high-grade cervical lesions and the high cure rate for early cervical cancer after receiving standardized treatment.⁵⁰ Although public health education campaigns about HPV have been vigorously carried out in China, exaggerated perceptions regarding the severity of HPV infection, especially the fear regarding high-grade cervical lesions and cervical cancer, may still persist among a portion of Chinese women. Therefore, in clinical practice, mental assessments and health education activities should be conducted among women infected with HPV to monitor their psychological state and improve their understanding of the HPV infection. Patients with high-grade cervical lesions and cervical cancer should be given more focused and prioritized attention to early identify their mental problems and provide effective interventions.

A qualitative study conducted among Iranian women revealed that HPV-positive women often experience negative emotions such as self-blame or shame, exacerbating their mental problems,⁵¹ of which the stigmatization of HPV was a significant driver. As a sexually transmitted infection, HPV is erroneously associated with promiscuity or having multiple sexual partners, despite evidence contradicting such assumptions.⁵² These stereotypes and prejudices have led to discrimination against HPV positive women from partners, friends, the general public, and even healthcare professionals.⁵³ More critically, these stigmatized conditions may cause women to avoid health-seeking behaviors, leading to disease progression.¹⁴ In addition, the qualitative research mentioned above also revealed that women infected with HPV also worried about spreading the virus to their partners, and some people even considered the non-sexual modes of HPV contagion, making them nervous about passing the virus to their children through casual contacts, surfaces, towels, clothes, and utensils.⁵¹ This fear of infect others further damages their mental health. Based on this, healthcare authorities are supposed to conduct public education campaigns about HPV to mitigate the stigmatization of

HPV and alleviate the mental distress experienced by women infected with HPV. Furthermore, clinicians involved in the HPV screening, need to be prepared to provide HPV-positive women with update comprehensive information. Targeted educational activities on preventing the spread of HPV should be implemented for women infected with HPV.

The results of this study demonstrated that sleep disturbances were positively associated with depression and anxiety. Testing positive for HPV can lead to elevated fear and concern related to the possible development of cervical lesions or cancers, and these stressful life events are associated with severe sleep disturbances among women infected with HPV. A substantial body of evidence suggests that sleep disturbances were associated with a higher risk of developing anxiety and depression among women,⁵⁴ and a prospective study conducted in Australia has found that women who reported difficulty in sleeping had a significantly doubled risk of depression and anxiety after 3 years.⁵⁵ For women infected with HPV, sleep disturbance was also a potential factor related to mental problems, which damages the activity of the T cell effector, affects circadian rhythm, and interferes with cortisol secretion, inducing a stress response and hormonal imbalance among HPV-infected women, contributing to depression and anxiety.^{56,57} Consistent with our research findings, previous studies conducted among patients with precancerous cervical lesions and cervical cancers caused by HPV infection have also shown that sleep disturbances are closely related to depression and anxiety.⁵⁸ In addition to sleep disturbances, this study also found that fatigue was positively associated with depression (OR = 1.284, 95% CI: 1.069–1.543) among HPV-infected women. Prior research conducted in women co-infected with HIV and HPV has revealed that severe mental problems were associated with greater fatigue ($p < 0.01$) based on multiple regression analyses.⁵⁹ Meanwhile, studies conducted in other female populations have also demonstrated significant positive correlations between fatigue and mental problems.^{60,61} In this study, we found that depression, rather than anxiety, was correlated with fatigue, which was consistent with the findings among females infected with COVID-19.⁶² This may be because, unlike anxiety, the development of depression and fatigue share common pathophysiological mechanisms of immune-mediated injury and neuroinflammation, with their causal relationship already being verified.^{62,63} Notably, emerging evidence suggests a bidirectional relationship between sleep disturbances, fatigue, and mental problems.^{64,65} However, there is a lack of relevant evidence on women with HPV infection, and future investigations are needed to verify it in this population. Nevertheless, our finding demonstrated that alleviating sleep disturbances and fatigue symptoms in HPV-positive women remains a critical clinical priority, as this condition may create a pathway for immune downregulation and subsequent HPV persistence.⁵⁷

Although the mental health status of women infected with HPV faces severe challenges, fortunately, according to the results of our study, resilience, and mindfulness might be important protective factors for alleviating mental problems of this population. A systemic review and meta-analysis involving 55 studies have proved a strong association between resilience and mental health in the somatically ill.⁶⁶ A cross-sectional study conducted among Chinese women with abnormal cervical cancer screening results also demonstrated that resilience was negatively correlated with mental problems.⁶⁷ It has been well-acknowledged that higher levels of resilience empowered individuals to adopt proactive coping and fully leverage familial and societal coping resources, which help women infected with HPV to recover from adversity, rebuild confidence in life, and face challenges with a positive attitude.^{68,69} Mindfulness could enhance confidence in disease prognosis and improves mental health by allowing individuals to feel their current emotions and face themselves with an open, accepting, and non-critical attitude.⁷⁰ Resting-state fMRI studies have reported that mindfulness could activate the brain's frontal cortex, which was related to emotion regulation and was beneficial in alleviating many kinds of mental problems.⁷¹ However, this study found that mindfulness was negatively associated with depression, rather than anxiety. The distinct mechanisms of anxiety and depression may explain this. Depression involves rumination on negative self- and past-related thoughts,⁷² and mindfulness, by enhancing awareness at present moment and reducing rumination, directly alleviates depressive symptoms. In contrast, anxiety is mainly driven by future-oriented worry and physiological hyperarousal.⁷³ Mindfulness interventions may not effectively target the cognitive and physiological mechanisms underlying anxiety, thus showing no significant correlation with anxiety improvement. Mindfulness is regarded as one of the preferred non-pharmacological intervention measures for improving women's mental problems, and the close relation between mindfulness and women's mental health has been well documented elsewhere. Currently, mindfulness interventions have been widely applied among pregnant and parturient women or those with breast cancer and ovarian cancer, which has been proven to effectively relieve the mental problems of the participants.^{74,75}

A randomized controlled trial conducted among patients with cervical cancer caused by HPV infection has found that the 8-week mindfulness interventions alleviated the severity of anxiety and depression and promoted patients to adopt positive coping measures, enhancing their ability to accept and deal with the disease.⁷⁰

Based on our findings, multifaceted approaches may exist to alleviate the mental health burden of women with HPV infection. In clinical practice, it is crucial to implement routine psychological assessment, and women diagnosed with high-grade cervical lesions or cervical cancer should be identified as a high-priority group for mental health screening. As for the promotion of mental health, programs aimed at enhancing resilience and mindfulness levels should be developed and implemented after their effectiveness has been rigorously verified. Additionally, symptoms management cannot be overlooked. Clinicians should actively inquire about and address insomnia and fatigue to improve both mental well-being and potentially the immune response. Finally, comprehensive and destigmatizing health education is essential at the public health level. Public campaigns and clinician-patient communication should jointly work to reduce stigma, and provide accurate information on disease progression and prognosis, thereby empowering women and mitigating unwarranted fear.

Our study has several limitations. First, the cross-sectional design precludes causal inference. Second, the hospital-based sampling approach could have introduced selection bias due to inherent limitations in population representativeness and conclusions should be interpreted cautiously. Meanwhile, the number of statistically significant associations explored, relative to the sample size, raises the possibility of overfitting and that some findings could be due to chance; thus, our results require validation in future, larger studies. Third, non-response bias may exist because individuals who chose to answer the questionnaire may differ from non-responders, reducing the representability of this study's sample. Fourth, the entire questionnaire was only administered to women living in Shenzhen City, Guangdong Province, China, a younger, richer, and better-educated group likely more aware of HPV-related information than other HPV-infected women living elsewhere. Fifth, residual confounding by unmeasured variables (eg, HPV genotypes, duration of HPV infection) requires cautious interpretation. Although we included a range of demographic and psychological factors, other potential confounding variables such as family harmony, medical utilization level, health literacy, and social security were not fully captured and controlled for in our analysis. Future research would benefit from a more comprehensive inclusion of these social determinants to better elucidate their roles in mental health outcomes among HPV-infected females. Sixth, this study was conducted from December 2024 to February 2025 (winter in Shenzhen), and seasonal factors such as the climate change may have influenced mental health outcomes. However, considering that the climate in Shenzhen changes little in winter and the average temperature is around 18°C, which is relatively mild, the impact of climate on this study may be insignificant. Finally, we collected data on participants' self-reported clinical diagnoses of depression, anxiety, or other mental disorders confirmed by medical institutions prior to the survey. Statistical analyses showed no significant associations between these prior diagnoses and current mental issues. However, we could not determine whether these mental disorders occurred before or after HPV infection due to incomplete data on the timing of diagnoses. Future longitudinal studies tracking mental health status pre- and post-HPV infection are needed to clarify the extent to which mental health issues are attributable to HPV infection.

Conclusion

This study revealed the mental health problem among HPV-infected women in China. While the hospital-based cross-sectional design limits the generalizability to the broader HPV-infected population, this study still provides valuable insights for future clinical practice. The high prevalence of depression and anxiety in women infected with HPV should receive sufficient attention. Mental assessment should be carried out among women who seek medical treatment due to HPV infection, especially among patients with high-grade cervical lesions or cervical cancer, in order to early identify high-risk populations with mental problems. Additionally, interventions, such as mindfulness-based approaches, might be a potential strategy to alleviate depression and anxiety in this population. However, their effectiveness requires rigorous validation through well-designed randomized controlled trials, which are expected in the future.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author Xiaoyou Su, upon reasonable request.

Ethics Statement

This study followed the Declaration of Helsinki, and ethical approval was obtained from the Ethics Committee of Chinese Academy of Medical Science (ID: CAMS&PUMC-IEC-2024-001).

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work. Shu Jing, You Xin, and Zhenwei Dai are Joint first authors.

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Disclosure

The authors declare no conflict of interest.

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