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Cervical pre-cancer and cancer incidence among insured women with and without mental disorders in South Africa

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ABSTRACT

Introduction: The burden of cervical cancer is disproportionately high in sub-Saharan Africa.
Methods: We examined whether mental disorders contribute to cervical cancer-related disparities in South Africa, analysing medical claims data from an insurance scheme between 2011 and 2020. Using Cox proportional hazards models, we computed adjusted hazard ratios (aHRs) for the association between various types of mental disorders and the incidence of cervical pre-cancer and cancer compared to women without any mental disorder.
Results: We included 568,408 women in the analysis of cervical pre-cancer and 567,984 in the analysis of cervical cancer. A total of 15,062 women had an incident cervical pre-cancer diagnosis (722.0/100 000 person-years, 95% confidence interval [CI] 710.6–733.7) and 653 a cervical cancer diagnosis (30.7/100,000 person-years, 95% CI 28.4–33.2). Women with any mental disorder diagnosis were more likely to be diagnosed with cervical pre-cancer (aHR 1.06, 95% CI 1.02–1.10) but less likely to be diagnosed with cervical cancer (aHR 0.62, 95% CI 0.51–0.75). Similarly, women with depression (aHR 1.10, 95% CI 1.05–1.16) or bipolar disorder (aHR 1.15, 95% CI 1.01–1.39) were more likely to be diagnosed with cervical pre-cancer than women without any mental disorder, but less likely to have a cervical cancer diagnosis. Anxiety was also associated with lower cervical cancer diagnosis rates (adjusted HR 0.61, 95%CI 0.46–0.81).
Conclusions: Our findings highlight the complex interplay between mental health, health care access, and cervical cancer risk and underscore the necessity of research to inform equitable cervical cancer prevention for women with and without mental disorders in South Africa.

1. Introduction

Cervical cancer remains a significant public health challenge worldwide, particularly in low- and middle-income countries, despite being largely preventable through human papillomavirus (HPV) vaccination and effective screening programs. It is the fourth most common cancer among women globally, with approximately 660,000 new cases and 350,000 deaths reported in 2022 alone [1,2]. In South Africa, cervical cancer is the second most common cancer among women and a leading cause of cancer-related mortality, with over 10,700 new cases and nearly 6000 deaths annually [3,4]. The burden of cervical cancer is disproportionately high in sub-Saharan Africa, where factors such as limited access to cervical cancer screening, high prevalence of HPV infection, and co-infection with HIV exacerbate the risk of developing cervical cancer. Women with HIV, for instance, are more susceptible to persistent HPV infections, and they develop cervical cancer at younger

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ages [5].

In 2020, the World Health Organization (WHO) set global targets to eliminate cervical cancer as a public health problem, focusing on achieving 90% HPV vaccination coverage, 70% screening coverage, and 90% treatment of detected pre-cancerous lesions or invasive cancer by 2030 [2]. Achieving these goals requires identifying and addressing disparities in cervical cancer risk and healthcare access among vulnerable populations [2]. Women with mental disorders may represent one of these vulnerable populations. In South Africa, women with mental disorders die on average 2.2 years earlier than those without, primarily from physical illnesses including cardiovascular disease, chronic respiratory disease and cancer, with barriers to healthcare access contributing to this disparity [6–9]. These barriers may include reduced participation in screening programs and inadequate treatment for physical health conditions [6,7,10,11]. Systematic reviews and meta-analyses, mostly including studies from high-income countries, have shown that severe mental disorders, such as psychoses, bipolar disorder, and major depression, are associated with increased incidence and mortality from cervical cancer [12–14]. However, evidence regarding the association of cervical cancer with common mental disorders such as anxiety disorders is inconsistent [15–17]. Some studies suggested higher cervical cancer risk [16], while others indicated that anxiety may promote greater screening uptake, potentially lowering cervical cancer risk [17].

In South Africa, evidence on the association of mental disorders and cervical cancer risk remains scarce, despite the high cervical cancer burden and significant mental health challenges [14,18]. Understanding whether women with different types of mental disorders face elevated risks of cervical pre-cancer and cancer is critical for developing targeted prevention strategies. In this study, we used data from a South African medical insurance scheme to investigate the association between various types of mental disorders and the risk of incident cervical pre-cancer and cervical cancer.

2. Materials and methods

2.1. Study design and data source

We analysed reimbursement claims from a cohort of beneficiaries of a South African medical insurance scheme. Claims data were coded based on the International Classification of Diseases (ICD)-10, the Anatomical Therapeutic Chemical (ATC) Classification System, the Current Procedural Terminology (CPT), and the National Reference Price List (NRPL). We included women aged 18 years or older and covered by the medical insurance scheme at some point between 1 January 2011 (start of study period) and 1 July 2020 (end of study period). The Human Research Ethics Committee of the University of Cape Town and the Cantonal Ethics Committee of the Canton of Bern granted permission to analyse data.

2.2. Exposures and outcomes

Our primary exposures of interest were diagnoses of mental disorders (ICD-10 codes F00-F99, excluding smoking use disorder [F17]). We specifically analysed organic disorders (comprising mental disorders with demonstrable cerebral or organic cause, such as dementia, or other disorders due to brain damage or physical disease, ICD-10 codes F00-F09), substance use disorders excluding smoking (ICD-10 codes F10–16, F18, F19), psychotic disorders (F20-F29), bipolar disorders (F30, F31), depressive disorders (F32, F33), and anxiety disorders (F40-F48). Other types of disorders were regrouped into a single category. We coded mental disorders as time-updated variables, with women considered unexposed until the first diagnosis of the condition in question and exposed thereafter.

Other potential risk factors included HIV status, genital warts, other sexually transmitted infections (STIs), other HPV-related anogenital cancers, and oral contraceptive use. We assigned HIV status based on the following indicators: HIV-related ICD-10 diagnoses (B20–24, F02.4, O98.7, R75, Z21), HIV-related laboratory tests (positive HIV test, HIV RNA viral load, CD4 cell count), ATC codes for antiretroviral therapy (ART), or registration in the Aid for AIDS (AfA) disease management program. Women were considered HIV-negative until the first occurrence of an HIV indicator, and HIV-positive thereafter. Women whose only indicator of HIV-positivity was membership in the AfA program were considered HIV-positive from the date of entry into the medical insurance scheme, as dates of entry into AfA were not available. We identified other STIs using ICD-10 codes, including syphilis (A51, A52), gonorrhoea (A54), chlamydia (A55, A56), trichomoniasis (A59), and unspecified sexually transmitted diseases (A64). We identified genital warts based on the ICD-10 code A63.0, and other HPV-related anogenital cancers on codes C21 (anal cancer), C51 (vulvar cancer), and C52 (vaginal cancer). Oral contraceptive use was identified from medical claims with the ATC code G03A.

The two endpoints of our analyses were first ICD-10 diagnoses of cervical pre-cancer (D06, N87) and cervical cancer (C53). We defined women as having cervical cancer if they had at least two corresponding ICD-10 codes recorded in their inpatient or outpatient reimbursement claims. We excluded women with a single C53 code from the cervical cancer analysis, because the specificity of claims-based algorithms using single ICD-10 codes to define cervical cancer diagnoses has been shown to be low [19]. Generally, women with confirmed invasive cervical cancer are expected to obtain repeated C53 codes during staging, treatment and follow-up. For cervical pre-cancer, a single ICD-10 code was deemed sufficient to avoid biasing our analysis towards recurrent precancerous disease.

For both endpoints, we excluded women who had an ICD-10 diagnosis for the endpoint of interest recorded before or at the start of time-at-risk (prevalent diagnoses). Time-at-risk for each woman started at the date of entry into the insurance scheme, their 18th birthday, or 1 January 2011, whichever came last, and ended at the first diagnosis of the endpoint of interest, removal of the cervix (identified using CPT and NRPL codes), transfer from the medical insurance scheme, death, or database closure (1 July 2020), whichever came first. Removals of the cervix that were recorded within 60 days before the diagnosis of cervical pre-cancer or cancer were assumed to be linked to the diagnosis of the endpoint of interest and were ignored. In a first sensitivity analysis we include single-diagnosis cervical cancers and in a second one we left-truncated follow-up three months after the start of a person's insurance plan.

2.3. Statistical analysis

We produced descriptive statistics to assess sociodemographic characteristics of included women, stratified by whether they were diagnosed with a mental disorder or not. We calculated crude cervical pre-cancer and cancer diagnosis rates per 100,000 person-years in women with and without a mental disorder by dividing the number of women with an incident cervical pre-cancer or cancer diagnosis by the number of person-years.

We first fit Royston−Parmar flexible parametric survival models to assess the absolute risk of cervical pre-cancer and cancer diagnosis [20]. For both endpoints we estimated diagnosis rates per 100,000 person-years with 95% confidence intervals (CIs) as a continuous function of age, including mental disorder (no/yes) as an independent variable in the model. We considered 1–10 ° of freedom for the natural spline basis for the diagnosis rate and 1–5 ° of freedom for the natural splines modelling an interaction between mental disorders and age. We then selected the degrees of freedom leading to the lowest Akaike Information Criteria (AIC), see Supplemental Tables 1 and 2. Second, we estimated hazard ratios (HR) with 95% CIs for the association of mental disorders with incident cervical cancer and pre-cancer diagnosis using proportional hazard Cox regression on the age scale. We classified

mental disorders into groups using a single categorical time-updated variable based on a hierarchy and compared each group to women without any mental disorder [21]. The hierarchy was as follows: 1) organic mental disorders, 2) psychotic, 3) bipolar, 4) depressive, 5) anxiety, 6) substance use, and 7) other disorders. For each participant, the highest last occurring informative psychiatric diagnosis was assigned as the principal diagnosis according to this hierarchy of diagnoses. As an example, assuming they received no other mental disorder diagnosis, someone diagnosed with anxiety followed by bipolar disorder would first be assigned to the anxiety group until the bipolar disorder diagnosis, after which they would be assigned to the bipolar group instead. To assess the robustness of the associations to progressively broader adjustment, we estimated HRs each type of mental disorder from: (A) unadjusted models, (B) models adjusting for calendar year (2011–2013, 2014–2016, 2017–2020, time-updated) and self-identified population group (Black African, White, Other, Missing), (C) models adjusting for calendar year, population group, and HIV status (negative/positive, time-updated) and (D) models adjusting for calendar year, population group, HIV status, history of genital warts (no/yes, time-updated), history of other STIs (no/yes, time-updated), history of oral contraceptive use (no/yes, time-updated), and diagnosis of another HPV-related anogenital cancer (no/yes, time-updated). As a secondary analysis, we repeated steps (A) to (D) while coding each type of mental disorder as a separate time-updated binary variable. Thus, for each type of mental disorder, we compared people diagnosed with that disorder with people without such a diagnosis, controlling for comorbidity with other types of disorders in a fifth model (E). We fit models (A) through (D) separately for each type of mental disorder, while step (E) included all disorder types in one model. All models were fit on the age scale. Analyses were performed using R 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1. Study population and mental disorders

A total of 791,366 female individuals were covered by the medical insurance scheme at some point between 1 January 2011 and 1 July 2020. We excluded 5407 women who had missing information on age and 217,491 who had not reached their 18th birthday before leaving the scheme or the end of the study period. Further exclusions varied by endpoint of interest (Supplemental Figure 1): we included 568,408 women and 2086,013 person-years in the analysis of cervical pre-cancer and 567,984 women and 2126,051 person-years in the analysis of cervical cancer. A total of 172,404 (30.4%) women were diagnosed with a mental disorder, including 112,681 (19.8%) with anxiety disorders, 97,394 (17.1%) with depressive disorders, 12,550 (2.2%) with bipolar disorder, 5439 (1.0%) with organic mental disorders, 2308 (0.4%) with psychotic disorders, 2083 (0.4%) with a substance use disorder, and 29,135 (5.1%) with another type of disorder. Among women with a diagnosis for mental disorder, 67,010 (38.9%) were also diagnosed with another type of mental disorder during their follow-up. Supplemental Figure 2 shows the frequency of co-occurrence of different mental disorders by type. Women diagnosed with a mental disorder were older at the start of their time-at-risk and were more likely to be diagnosed with HIV or other STIs than those without a mental health diagnosis (Table 1).

3.2. Incident pre-cancer and cancer

We identified 15,062 women with cervical pre-cancer (rate per 100,000 person-years: 722.0, 95% CI 710.6–733.7) and 653 women with cervical cancer (30.7, 95% CI 28.4–33.2). Crude diagnosis rates for cervical pre-cancer were higher in women with a mental disorder than those without, whereas diagnosis rates for cervical cancer were lower in women with mental disorders (Table 2). Cervical pre-cancer rates were highest in women with anxiety disorder while cervical cancer rates were highest in women with a psychotic disorder. The diagnosis rates of both cervical pre-cancer and cancer were lowest in women with organic mental disorders. Cervical pre-cancer rates peaked at age 30 in both women with and without a mental disorder (Fig. 1). Cervical cancer rates peaked at age 49 (37.4 per 100,000 person-years, 95% CI 31.4–44.6) in women with a mental disorder diagnosis and at age 52 (57.4 per 100,000 person-years, 95% CI 51.7–63.9) in women without such diagnoses.

In Fig. 2 we show the results from the analysis comparing cervical pre-cancer and cancer diagnosis rates in women with and without a mental disorder, using a hierarchical classification for mental disorders. We found that bipolar (adjusted HR 1.15, 95% CI 1.01–1.30) and depressive disorders (adjusted HR 1.10, 95%CI 1.05–1.16) were associated with increased cervical pre-cancer rates, whereas bipolar (adjusted HR 0.41, 95% CI 0.17–0.98), depressive (adjusted HR: 0.67,

Table 1
Characteristics of women included in the analysis of cervical cancer, stratified by whether they were diagnosed with a mental disorder or not during their time-at-risk.

	No mental disorder	With mental disorder	Overall
N	395580	172404	567984
Age group* **(%)**			
18–24	94055 (23.8)	26750 (15.5)	120805 (21.3)
25–34	104211 (26.3)	42726 (24.8)	146937 (25.9)
35–44	74282 (18.8)	38658 (22.4)	112940 (19.9)
45–54	58937 (14.9)	32529 (18.9)	91466 (16.1)
55–64	37684 (9.5)	17367 (10.1)	55051 (9.7)
≥ 65	26411 (6.7)	14374 (8.3)	40785 (7.2)
Median age* [IQR]	34.9 [25.5, 48.8]	39.1 [29.0, 51.0]	36.0 [26.5, 49.6]
Calendar year* (%)			
2011–2013	209176 (52.9)	115392 (66.9)	324568 (57.1)
2014–2016	63770 (16.1)	25651 (14.9)	89421 (15.7)
2017–2020	122634 (31.0)	31361 (18.2)	153995 (27.1)
HIV-positive (%)**	27599 (7.0)	20271 (11.8)	47870 (8.4)
Genital warts (%)**	1721 (0.4)	1593 (0.9)	3314 (0.6)
Other STIs (%)**	6457 (1.6)	5745 (3.3)	12202 (2.1)
Other anogenital HPV-related cancer (%)**	217 (0.1)	225 (0.1)	442 (0.1)
Oral contraceptive use(%)**	29772 (7.5)	22420 (13.0)	52192 (9.2)
Median time-at-risk (years) [IQR]	2.08 [0.83, 4.16]	5.00 [2.83, 8.79]	3.00 [1.08, 5.92]

* At start of time-at-risk
** During or before start of time-at-risk

Table 2
Cervical pre-cancer and cervical cancer incidence rates per 100,000 person-years, by mental disorder status.

	Cervical pre-cancer	Cervical cancer
Any mental disorder*	734.9 (712.8–757.5)	24.5 (20.7–28.9)
Organic disorder	423.5 (318.1–552.6)	7.7 (0.2–43.1)
Substance use disorder*	748.3 (529.5–1027.1)	19.1 (0.5–106.4)
Psychotic disorder	493.4 (345.5–683.0)	40.4 (8.3–117.9)
Bipolar disorder	692.3 (611.3–781.0)	15.3 (5.6–33.4)
Depressive disorder	732.6 (702.9–763.2)	25.7 (20.5–31.8)
Anxiety disorder	770.5 (742.2–799.5)	23.9 (19.2–29.4)
Other mental disorder*	709.1 (654.1–767.4)	25.7 (16.3–38.6)
No mental disorder	717.2 (703.8–730.8)	33.1 (30.3–36.1)
Overall	722.0 (710.6–733.7)	30.7 (28.4–33.2)

* Excluding smoking disorders

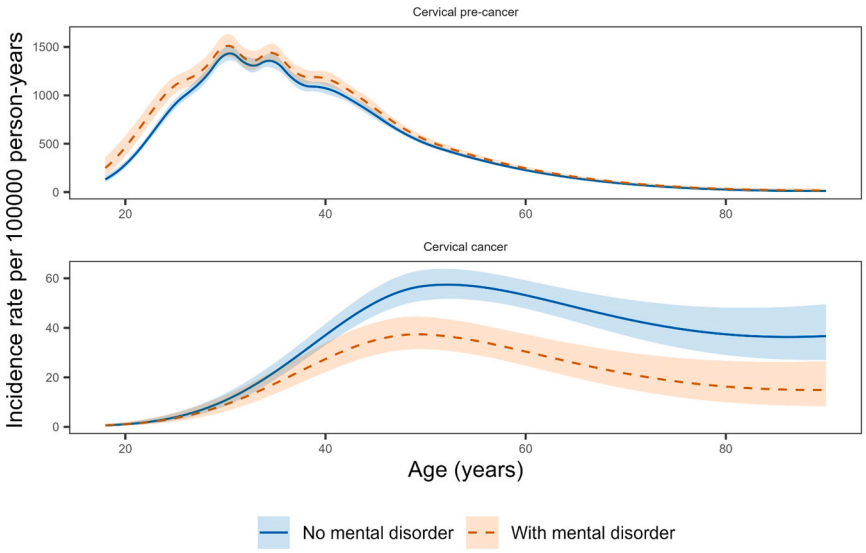

Fig. 1. Incidence rates of cervical pre-cancer and cancer per 100,000 person-years, as a function of age and mental disorder status.

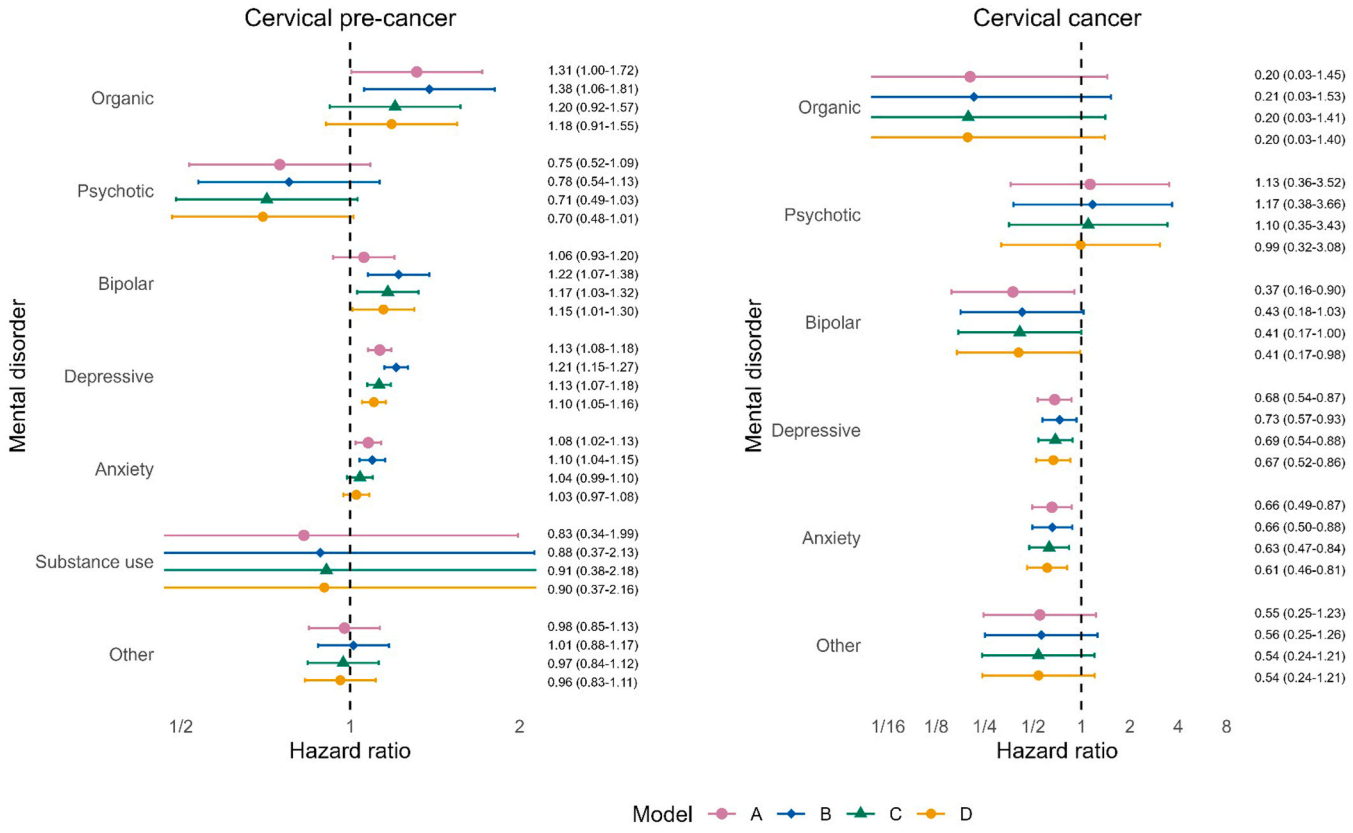

Fig. 2. Hazard ratios for the association between a mental disorder diagnosis and the incidence of cervical pre-cancer and cancer, using a hierarchical classification of mental disorders (top to bottom in the Figure). A) Unadjusted model, B) adjusting for calendar year and population group, C) further adjusting for HIV status, D) further adjusting for STIs, oral contraceptive use, genital warts, and other HPV-related anogenital cancers. Models were fit on the age scale; time-at-risk without any mental disorder served as the reference group. Hazard ratios for the association between substance use disorder and cervical cancer are not shown due to no one in the exposure group experiencing the outcome.

95% CI 0.52–0.86), and anxiety disorders (adjusted HR 0.61, 95%CI 0.46–0.81) were associated with lower cervical cancer rates. Psychotic disorders tended to be linked with lower cervical pre-cancer rates (adjusted HR 0.70, 95%CI 0.48–1.01). Generally, associations were similar between the unadjusted and the various adjusted models, both for cervical pre-cancer and cancer (Fig. 2).

Results were broadly similar in the secondary analysis without the hierarchical classification of mental disorders (Fig. 3). In this analysis the diagnosis of any mental disorder was associated with higher cervical pre-cancer diagnosis rates (adjusted HR: 1.06, 95% CI 1.02–1.10), but the strength and direction of the association differed by the type of mental disorder. For example, depressive disorders were associated with

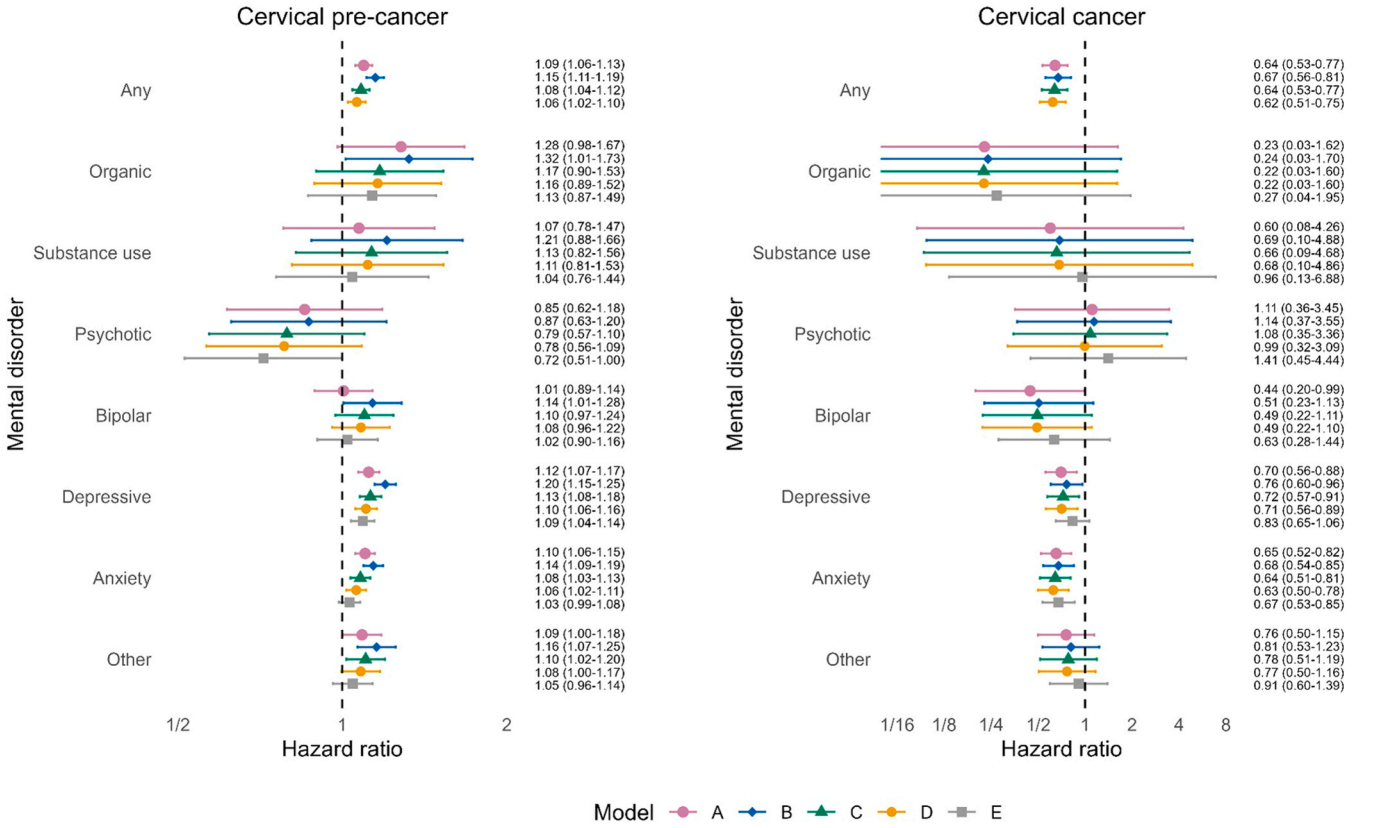

Fig. 3. Hazard ratios for the association between a mental disorder diagnosis and the incidence of cervical pre-cancer and cancer. A) Unadjusted model, B) adjusting for calendar year and population group, C) further adjusting for HIV status, D) further adjusting for STIs, oral contraceptive use, genital warts, and other HPV-related cancers, E) further adjusting for psychiatric comorbidity. Models were fit on the age scale; time-at-risk without the mental disorder of interest served as the reference group.

higher diagnosis rates of cervical pre-cancer (adjusted HR: 1.09, 95% CI 1.04–1.14) and psychotic disorders with lower rates of cervical pre-cancer (adjusted HR: 0.72, 95% CI 0.51–1.00). In contrast to cervical pre-cancer, we found a negative association between any mental disorder (adjusted HR: 0.62, 95% CI 0.51–0.75) or anxiety disorders (adjusted HR: 0.67, 95% CI 0.53–0.85) and incident cervical cancer diagnoses. Depressive disorders were also associated with lower cervical cancer diagnosis rates in the partially adjusted models, but this negative association was no longer clearly evident when further adjusting for psychiatric comorbidity (adjusted HR: 0.83, 95% CI 0.65–1.06).

3.3. Sensitivity analyses

When including women with a single cervical cancer diagnosis, the association between bipolar disorder and a lower risk of cervical cancer was no longer evident (adjusted HR 0.87, 95% CI 0.54–1.41, Supplemental Figure 3), whereas the results for other mental disorders remained similar to the main analysis. When we left-truncated follow-up three months after the start of a person's insurance plan, results were similar to the main analysis (Supplemental Figure 4).

4. Discussion

This large cohort study of insured women in South Africa found that, contrary to our hypothesis, women with a diagnosed mental disorder were slightly more likely to obtain a cervical pre-cancer diagnosis but less likely to obtain a cervical cancer diagnosis than women without any mental disorder. This pattern was observed for most disorders, in particular depressive and anxiety disorders – the most common mental health diagnoses in our cohort – but not for psychotic disorders.

To our knowledge, this is one of the first studies to assess the association of mental disorders with cervical cancer risk among women in sub-Saharan Africa, leveraging data from a real-world cohort of more than half a million women. However, several limitations must be acknowledged. First, our findings are unlikely to be generalizable to women outside South Africa's private sector, who may have different risk profiles, different patterns of mental disorders, and more limited healthcare access. Information on several potentially relevant confounding and mediating factors such as socioeconomic status, education, sexual and health behaviors, smoking, and cervical cancer screening history was not available and could, thus, not be considered in the analysis. Additionally, the dataset did not allow for stratification by severity or treatment status of mental disorders, which may influence cervical cancer risk and screening behaviors. An evaluation of global functioning and severity of mental disorders, such as the Global Assessment of Functioning (GAF), may be more informative than using diagnostic categories only [22]. Furthermore, while our overall sample size was large, some associations were still imprecisely estimated, due to small number of women with cervical cancer and specific mental disorders. Lastly, relying on routinely collected claims data and the date of diagnosis instead of disease onset may have led to misclassification of both mental disorders and cervical cancer outcomes. This misclassification may have resulted in an underestimation of the true disease burden as women with undiagnosed illnesses were not accounted for. Moreover, exposure misclassification due to delays between the onset and diagnosis of mental disorders is likely to vary by disorder type. In general, the timing of disease onset cannot be reliably established from claims data and disorder-specific assumptions would be required. Additionally, mental disorders diagnosed shortly before cervical cancer diagnosis may reflect the underlying, yet undiagnosed, cancer,

potentially introducing reverse causality and inflating the observed associations.

Our findings diverge from much of the existing literature, most of which report on studies conducted in high-income countries [13,14,22]. In the majority of the studies, severe mental disorders have been linked to higher incidence and mortality from cervical cancer, often attributed to lower screening uptake and delayed cancer treatment. For example, studies from Sweden and the UK have shown that women with psychotic or severe mood disorders were less likely to participate in cervical cancer screening and more likely to be diagnosed at advanced cancer stages [16,23,24]. To our knowledge, no such data are available for sub-Saharan Africa.

The discrepancy between our findings and other studies may be explained by different factors. One hypothesis is that insured women in South Africa generally have good access to healthcare, including preventive services such as cervical cancer screening, regardless of mental health status. This could mitigate the disparities observed in other health care settings. However, if women with mental disorders included in our study did face barriers in accessing cancer diagnostic and treatment services, this could have resulted in an underestimation of the cervical cancer rate in this population, as our definition of cervical cancer was based on medical claims related ICD-10 codes obtained when women access care. Another hypothesis is that women who seek healthcare more frequently may also be more likely to have their mental disorder diagnosed and to attend cervical cancer screening. Thus, healthcare-seeking behavior might confound the observed positive association between mental disorders and cervical pre-cancer diagnosis. On the other hand, women with certain mental disorders may indeed be more likely to attend cervical cancer screenings than women without such disorders, possibly due to greater engagement with healthcare services for mental health follow-up [25–27]. This could lead to earlier detection and treatment of pre-cancerous lesions, and subsequently lower rates of invasive cancer. In line with this hypothesis, we found higher cervical pre-cancer diagnosis rates among women with depressive and bipolar disorders, but the association was less clear for women with anxiety disorders. In contrast, women with psychotic disorders tended to have lower cervical pre-cancer diagnosis rates, consistent with previous studies suggesting that this group faces the greatest barriers to preventive care [13,28–30]. Factors facilitating screening may include better referral systems and improved communication with primary care, resulting in higher engagement with screening programs [22]. A meta-analysis found conflicting results regarding mental illness being a barrier to screening [22], with some studies reporting no differences by mental health status while others found higher screening rates among women with mental disorders [25–27].

The relationship between mental disorders and cervical pre-cancer and cancer incidence rates is complex and may differ by healthcare setting and mental disorder type. Specifically, in the context of South Africa's private healthcare sector, women with bipolar, depressive, and anxiety disorders did not appear to be at increased risk for cervical cancer compared to women without these disorders and may, in fact, be more likely to have pre-cancerous lesions detected. More evidence from sub-Saharan Africa is needed to better understand the relationship between mental disorders and cervical cancer risk in settings where the cervical cancer burden is high. Future studies should specifically explore the impact of mental disorder severity, mental health treatment adherence, and comorbidities on cervical cancer risk among insured and uninsured women, accounting for potential differences in screening participation and general health care access by mental health status.

In contrast to studies from high-income countries, we found that mental disorders were associated with slightly higher cervical pre-cancer diagnosis rates and lower cervical cancer diagnosis rates among insured women in South Africa. These findings obtained among a relatively affluent, insured study population may not be generalizable to uninsured women or those with more severe mental illness. Nevertheless, our findings highlight the complex interplay between mental health, health care access, and cervical cancer risk and underscore the importance of context-specific research to inform equitable cervical cancer prevention for women with and without mental disorders in sub-Saharan Africa.

Disclaimer

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Where authors are identified as personnel of the International Agency for Research on Cancer/World Health Organization, the authors alone are responsible for the views expressed in this article and they do not necessarily represent the decisions, policy or views of the International Agency for Research on Cancer /World Health Organization

Ethical standards

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.canep.2026.103276.

Data availability

Data were obtained from the International epidemiology Databases to Evaluate AIDS–Southern Africa (IeDEA-SA). Due to legal and ethical restrictions, the data cannot be made publicly available. For inquiries about the data, readers can contact IeDEA-SA through the online form available at https://www.iedea-sa.org/contact-us/.

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