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The Effect of Workplace Discrimination on the Mental Health of Women Going Back to Work after Breast Cancer

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LIST OF ACRONYMS

- **BCS** – Breast Cancer Survivors
- **CANTO** – CANcer TOxicities cohort
- **DAG** – Directed Acyclic Graph
- **EEOC** – Equal Employment Opportunity Commission
- **EORTC QLQ-C30** – European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire – Core 30
- **HADS** – Hospital Anxiety and Depression Scale
- **IPW** – Inverse Probability Weighting
- **MICE** – Multivariate Imputation by Chained Equations
- **MSM** – Marginal Structural Model
- **OR** – Odds Ratio
- **CI** - confidence intervals
- **QoL** – Quality of Life
- **SEP** – Socioeconomic Position
- **SMD** – Standardized Mean Difference
- **T0, T1, T2, T3, T4, T6** – Timepoints of follow-up in the CANTO study

The effect of workplace discrimination on the mental health of women going back to work after breast cancer

ABSTRACT

Background: Breast cancer is the most commonly diagnosed cancer worldwide. With increasing survival rates and many women working at the time of diagnosis, employment following treatment is a major public health concern. Although returning to work is crucial for recovery and social reintegration, some breast cancer survivors (BCS) may face workplace discrimination, which can have a deleterious effect on their mental health. **Objective:** This study aimed to assess the impact of workplace discrimination due to cancer on the mental health of BCS, particularly its effect on anxiety. In addition, this study aimed to identify the subgroups in which the effects may be amplified.

Methods: We used data from a French prospective cohort (CANTO) including women diagnosed with stage I-III breast cancer. Using the statistical program R, we analysed 1316 BCS who returned to work after treatment. We used Inverse probability weighting (IPW) to adjust for covariates and time-varying confounders and a Marginal Structural Model (MSM) to estimate the causal effect of perceived workplace discrimination at 2 and 3 years post-diagnosis on anxiety symptoms at 4 years. **Results:** Overall, 38.6% of survivors reported perceived workplace discrimination. Among those who reported this discrimination, 57.9% had elevated anxiety symptoms, while 42.1% had normal anxiety at four years post-diagnosis. We found that workplace discrimination was associated with increased odds of elevated anxiety (OR: 1.46; CI: 1.14 - 1.86).**Conclusions:** We recommend that anti-discrimination laws should be reinforced to improve the working conditions for BCS so to reduce the burden on their mental health.

Keywords: *Breast cancer survivors, perceived workplace discrimination, Anxiety*

RÉSUMÉ

Contexte : Le cancer du sein est le cancer le plus fréquemment diagnostiqué dans le monde. Avec l'augmentation des taux de survie et de nombreuses femmes en activité professionnelle au moment du diagnostic, le retour à l'emploi après les traitements représente un enjeu majeur de santé publique. Bien que ce retour soit essentiel à la récupération et à la réinsertion sociale, certaines survivantes du cancer du sein (SCS) peuvent faire face à des discriminations sur leur lieu de travail, ce qui peut nuire à leur santé mentale. **Objectif:** Cette étude avait pour objectif d'évaluer comment la discrimination au travail liée au cancer influence la santé mentale des femmes ayant eu un cancer du sein, en particulier en ce qui concerne l'anxiété. Elle cherchait aussi à repérer les sous-groupes pour lesquels ces effets pourraient être plus prononcés. **Méthodes :** Nous avons utilisé les données de la cohorte prospective française CANTO, incluant des femmes diagnostiquées avec un cancer du sein de stade I à III. À l'aide du logiciel statistique R, nous avons analysé 1 316 SCS ayant repris le travail après les traitements. Nous avons utilisé la pondération par l'inverse de la probabilité (IPW) pour ajuster les covariables et les facteurs de confusion temporels, et un Modèle Structurel Marginal (MSM) pour estimer l'effet causal de la discrimination perçue au travail à 2 et 3 ans après le diagnostic sur les symptômes d'anxiété à 4 ans. **Résultats :** Au total, 38,6 % des survivantes ont déclaré avoir été victimes de discrimination au travail. Parmi elles, 57,9 % présentaient des symptômes d'anxiété élevés, tandis que 42,1 % avaient une anxiété normale à quatre ans post-diagnostic. Nous avons constaté que la discrimination au travail était associée à une augmentation des chances de présenter une anxiété élevée (OR: 1,46; IC: 1,14 - 1,86). **Conclusions :** Nous recommandons un renforcement des lois anti-discrimination afin d'améliorer les conditions de travail des SCS afin de réduire les répercussions sur leur santé mentale.

Mots-clés : *Survivantes du cancer du sein, discrimination perçue au travail, anxiété*

1. INTRODUCTION

1.1. Breast Cancer Survivorship and Return to Work

Breast cancer is the most diagnosed cancer amongst women worldwide, affecting approximately 2.3 million women each year (1). However, advancements in early detection and treatment have resulted in higher survival rates, allowing many breast cancer survivors (BCS) to return to their regular life activities, including work. The word survivor in this report is used to refer to women with a diagnosis of cancer regardless of the stage they are on in their recovery journey (2). Employment or the prospect of returning to work is a key component of cancer survivorship, as it promotes financial stability, social reintegration, and psychological well-being. It is also often considered as a sign of recovery, providing a sense of normalcy and improved self-esteem to the survivors (3-5).

However, despite the benefits of returning to work, many breast cancer survivors face major barriers that may affect employment. Among the most significant issues are the long-term effects of cancer treatment, which frequently entail ongoing physical and mental difficulties such as fatigue, pain, and cognitive deficits. The absence of adequate workplace accommodations and the lingering stigma tied to a cancer diagnosis further complicate the reintegration process. Moreover, factors like older age and physically demanding job roles can exacerbate these challenges, emphasizing the complexities of post-treatment work reintegration (6,7).

1.2. Workplace Discrimination

Among these barriers, workplace discrimination continues to be a major issue, with survivors reporting experiences of career stagnation, reduced responsibilities, lower salaries, and even job loss (8). Discrimination refers to the unfair treatment of individuals based on specific characteristics, including but not limited to gender, age, disability, or health conditions such as cancer (9). Workplace discrimination can manifest in unjustified dismissal, career stagnation, exclusion from promotions, denial of reasonable accommodations, and workplace stigma, which all make it difficult for survivors to reintegrate into their professional lives (8). Research shows that cancer survivors experience higher rates of workplace discrimination compared to the overall disabled population, suggesting that a cancer diagnosis has a unique employment-related stigma (6). According to an analysis of Equal Employment Opportunity Commission (EEOC) data in the United States, 27.1% of workplace discrimination claims made by individuals with cancer were deemed valid, meaning that the EEOC found enough evidence to

support these claims as compared to 21.8% of claims made by individuals with other disabilities (9).

Despite the existence of anti-discrimination laws, workplace discrimination remains a significant challenge for cancer survivors. They often encounter significant challenges whereby employers may regard them as less productive, unreliable, or expensive to accommodate (8). Policies such as the Americans with Disabilities Act (ADA) in the U.S and France's labour protections (Code du Travail, Articles L1132-1 to L1132-4; Code Pénal, Articles 225-1 to 225-4) are intended to prevent these kind of opinions from affecting survivors and protecting them from overall workplace discrimination. However, many survivors continue to face unfair treatment, indicating a disconnect between legal frameworks and real-world employment practices (4,10,11).

Studies indicate that in the year after primary cancer treatment, survivors have substantial healthcare needs, and require psychological support services and many rely on physical and occupational therapy to manage treatment related side effects (12). However, access to post-treatment support varies and those survivors who lack strong social networks or suitable workplace support may have a more difficult time maintaining their jobs and mental health. Studies indicate that a lack social support is associated with poorer mental health outcomes, while a lack of workplace support is associated with increased sickness absence (13,14).

1.3. Mental Health of Breast Cancer Survivors

According to the Global Burden of Disease Study (15), mental health conditions, especially anxiety and depression, are one of the main causes of disability globally and represent a global health crisis. The World Health Organization (WHO) estimates that 280 million people suffer from depression, and that anxiety disorders are the most common mental disorders in the world, affecting 301 million people in 2019 (16). However, the burden of mental illness is disproportionately high for those who face socioeconomic instability, chronic illnesses such as cancer, and employment related stress (17).

In France, mental health conditions are particularly pressing with studies showing that over 21% of the general population experiences an anxiety disorder each year, with about one in every ten people battling depression (18). However, these figures are even more pronounced for women, people in precarious work and those with chronic illnesses as per the 2017 French National Health Survey (19). For BCS, just the emotional burden of being diagnosed with cancer, undergoing aggressive treatments, and having to deal with the fears of recurrence adds to their psychological distress (20).

BCS are particularly susceptible to mental health challenges; according to a systematic review and meta-analysis, depression affects an estimated 32.2% of adult women diagnosed with breast cancer across various countries worldwide. The reported prevalence varied widely from 9.3% to 56% across the synthesized studies, based on factors such as age, cancer stage, and socioeconomic status (21). For anxiety, it is estimated to affect 41% of BCS, especially during active treatment and survivorship, which can persist for years after treatment (5,22,23). Additionally, disturbances in cancer care, such as those observed during the COVID-19 pandemic have worsened psychological distress, resulting in increased anxiety and depression among survivors (24).

1.4. Biological Mechanism of the Effect of Discrimination on Mental Health

Discrimination in the workplace does more than hinder employment; it can also lead to serious health consequences in the general population, including increased risks of anxiety, depression, and psychological distress (25). Although research has largely centred on racial discrimination, evidence shows that any form of discrimination can trigger similar stress-related biological responses that negatively affect mental well-being. Chronic exposure to discrimination serves as a significant social stressor, which leads to prolonged activation of the hypothalamic-pituitary-adrenal axis and disturbances in cortisol regulation (26). This prolonged rise in cortisol, which is sometimes called "toxic stress," leads to an increase in allostatic load, a state in which the body's capacity to adjust and maintain stability is overwhelmed. Over time, this physiological dysregulation erodes both mental and physical health, which supports the argument that discrimination is associated to negative psychological effects (27).

It has also been demonstrated that discriminatory experiences affect the parts of the brain that control emotions and cognition. Neuroimaging studies show that such experiences activate the anterior cingulate cortex, which processes social pain, and may impair the prefrontal cortex, which is responsible for executive function, and stress regulation. This physiological stress response, when chronic, increases vulnerability to anxiety and mood disorders (28,29).

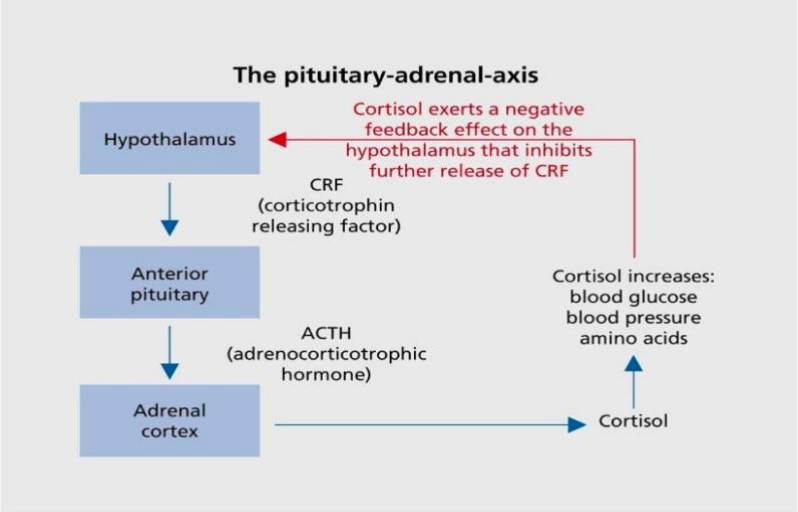

Figure 1: Biological cascade triggered by stress *- When chronic discrimination is perceived, the* hypothalamic-pituitary-adrenal *axis becomes overactive, resulting in prolonged/dysregulated cortisol release. Over time, this contributes to allostatic load, increasing the risk of mental health problems (30).*

1.5. Groups More Vulnerable to Stress-related Health Effects

Building on these biological mechanisms, the idea of biological embedding provides additional insight into how social and economic disadvantages gradually become physically ingrained in the body, increasing vulnerability to stress-related health outcomes and contributing to the explanation of why certain groups are more vulnerable than others. Socioeconomic position (SEP), particularly low income, precarious employment, and limited access to healthcare, has been linked to chronic physiological dysregulation as they are also social stressors, similar to discrimination. The biological mechanism of the effect is similar to that of discrimination as explained above, chronic physiological dysregulation includes dysfunctional hypothalamic-pituitary-adrenal axis activity, increased inflammatory responses, and extended cortisol secretion (28, 31). These biological changes help explain why some groups are more vulnerable to physical and mental health conditions than others.

Research shows that people with lower SEP show greater levels of inflammatory markers such as C-reactive protein and interleukin-6, both of which are associated with an increased risk of anxiety and depression (32,33). Cumulative exposure to socioeconomic adversity can change the way the brain regulates stress, especially in regions like the amygdala and prefrontal cortex, which makes people more sensitive to social stressors such as discrimination (34,35). Now for BCS, the simultaneous impact of structural inequalities (such as SEP) and the physiological burden of cancer-related stress may make them even more vulnerable to the effects of workplace discrimination on their mental health.

1.6. Bi-directionality of the Relationship Between Discrimination and Poor Mental Health Outcomes

Perceived discrimination is an individual's subjective experience or belief that they have been treated unfairly because of their characteristics such as race, gender, health status or other factors. This can create a cycle of distress where people who already have mental health issues may be more susceptible to seeing interactions at work as discriminatory, which can exacerbate their psychological state (36). This suggests a bidirectional relationship between mental health and workplace discrimination, where poor mental health increases the likelihood of perceiving discrimination, and experiencing discrimination further deteriorates mental health (37,38).

1.7. Breast Cancer Discrimination versus Other Forms of Discrimination

According to Mehnert (6) , as well as to Stergiou-Kita and colleagues (39), survivors commonly face negative stereotypes about their performance in the workplace, which are worsened by gendered standards of appearance and health. Treatment-related visible physical changes, such as hair loss, mastectomy, or weight gain may affect femininity and can lead to perceptions of vulnerability and alienation (40).Unlike other cancers, breast cancer stigma is closely tied to femininity and societal expectations of women's bodies, which can lead to discrimination, negatively impact psychological health, and hinder work reintegration. Survivors may be concerned about being regarded as less competent, less productive, or not fully recovered by employers and colleagues and this can lead to delayed returns to work or reduced hours (41,42).

1.8. Gaps and Complexities in the Literature

Breast cancer survivors have one of the highest return-to-work rates, typically returning to work despite ongoing medical and psychological obstacles, but many continue to encounter workplace discrimination, job insecurities, and/or occupational stagnation (7,43). Most existing studies focus on return to work as the main indicator of cancer survivorship, focussing on the factors that facilitate initial work reintegration (3). However, far less emphasis has been given to what actually happens to survivors after they resume employment, particularly their ability to remain in the workforce and maintain professional progress as well as their mental health profiles with regards to work-related challenges such as discrimination. There is some evidence that show that workplace discrimination is associated with higher levels of anxiety, despair, and psychological distress (6,44) however this evidence is still limited and there are still some gaps.

Evidence from larger cancer survivor populations indicates that discrimination is a substantial stressor. According to a qualitative study, several co-workers and employers had doubts about cancer survivors' skills, believed they would be less productive, or anticipated that they would eventually leave the workforce. Survivors stated feeling pressured to prove their competency, conceal their diagnosis, or return to work early in order to avoid discriminatory treatment. This stigma in the workplace often led to discriminatory actions, such as strained relationships with co-workers and managers, hindered career progression, and denied accommodations. By perpetuating inequality and exclusion in professional settings, the study emphasizes how stigma associated with cancer reflects other types of discrimination and exacerbates the psychological burden survivors already endure (45).

Furthermore, although we know that some subgroups of individuals such as those with low SEP are more vulnerable to stress-related health effects (31,46) there is little coverage about this in cancer survivorship research. Less is known about which subgroups of BCS are most vulnerable to workplace discrimination, specifically in terms of SEP, access to workplace accommodations, and social support networks. In addition, there is substantial evidence that cancer survivors face discrimination in various contexts, such as healthcare access (47) and employment (8) but there is a notable gap in research directly comparing the experiences of discrimination across different types of cancer.

Finally, recent research on workplace discrimination and mental health has been largely conducted in the US, with a particular emphasis on racial discrimination as a major factor contributing to employment disparities (38,48,49). While racial discrimination is not the central focus of the current study, it still serves as an important point of reference for the relationship between discrimination and mental health outcomes. Furthermore, there remains a lack of longitudinal studies assessing the effects of workplace discrimination on the mental health of cancer survivors over time, particularly in France. Even while the consequences of workplace discrimination on health are becoming more widely acknowledged, the majority of the literature uses qualitative methodologies, with very few studies using quantitative approaches to evaluate these effects over time (5,8,11,39,45).

2. AIMS AND OBJECTIVES

This study aims to assess the effect of workplace discrimination among women returning to work after breast cancer with their mental health outcomes, particularly anxiety symptoms; and to identify the subgroups in which the effects are amplified. By using longitudinal data and quantitative, causal inference methods, the study will provide a more comprehensive understanding of how perceived workplace discrimination affects the mental health of BCS over time.

3. METHODS

3.1. Study Design and Data Source

This study uses data from the CANcer TOxicity (CANTO) cohort, a large, multicentre, prospective longitudinal study designed to evaluate the long-term toxicities of breast cancer treatment in women. It includes over 12,000 women with stage I–III invasive breast cancer, recruited between 2012 and 2018 from 26 cancer centres across metropolitan France. Participants were followed at multiple time points: diagnosis (T0), and approximately one (T1)[1], two (T2), three (T3), four (T4) and six (T6) years after diagnosis. Data collection included blood sample, patient-reported outcomes, and physician clinical evaluations (see Figure 2). Detailed clinical, demographic, psychosocial, employment, and quality-of-life data are recorded, allowing for robust longitudinal analyses of survivorship outcomes (50).

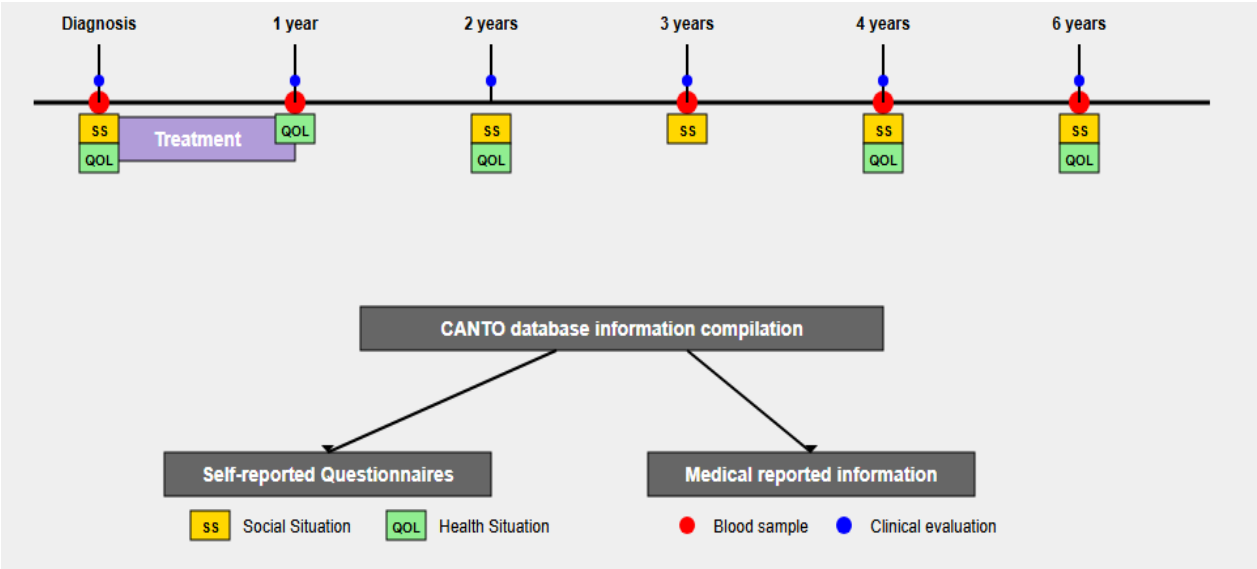

Figure 2: Details on data collection in CANTO prospective longitudinal study.

[1] T1 corresponds to 3–6 months post primary treatment completion namely, surgery, chemotherapy or radiotherapy.

3.2. Study Population

To study the impact of workplace discriminations in BCS we selected the following sample from the CANTO population.

***Inclusion Criteria**:* Employed at diagnosis and returned to work two years post diagnosis (T2)

Exclusion Criteria:

- Women aged 57 years or older at the time of return to work - The age threshold was decided to enable at least five years between diagnosis and France's legal retirement age of 62. This restriction assures that participants would still be conceivably employed during the follow-up period, and have the possibility of experiencing discrimination.
- Self-employed individuals, as the measure of workplace discrimination in CANTO specifically refers to discrimination from employers, which by definition does not apply to the self-employed.
- Everyone without information on the exposure or outcome responses

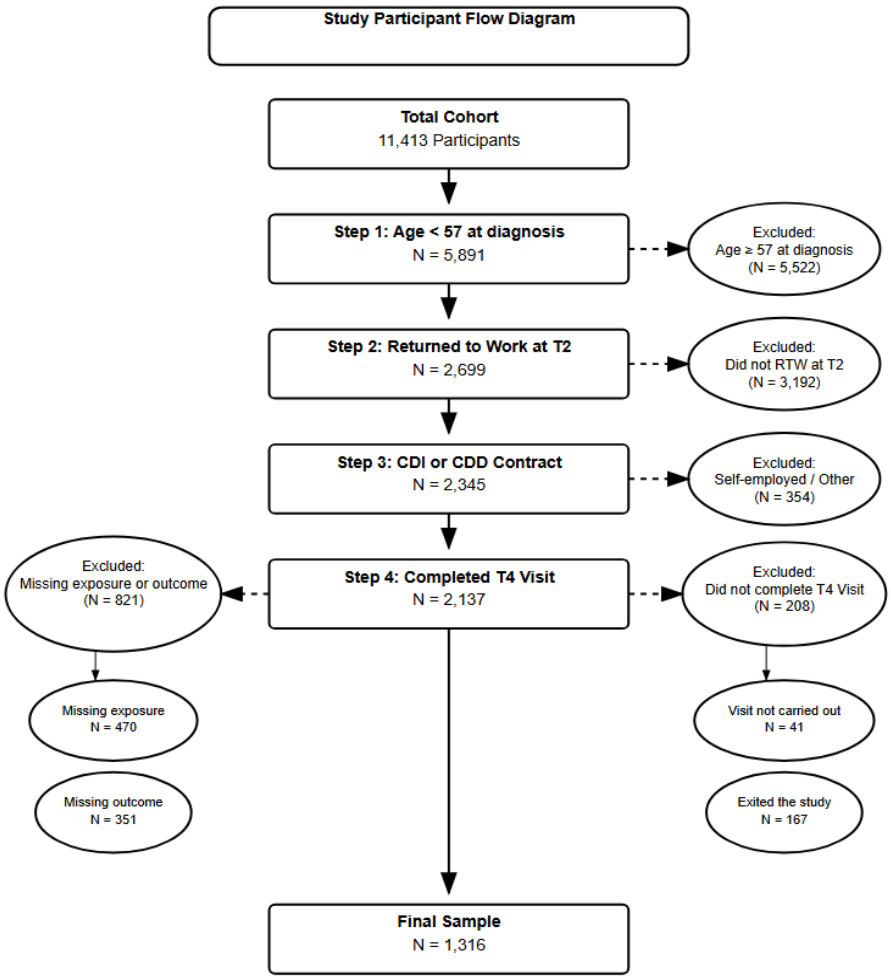

Figure 3: Flowchart - Final Analytical sample

3.3. Variables

3.3.1. Exposure: Perceived Workplace Discrimination

Workplace discrimination is defined as perceived unfair treatment from employers, based on reported experiences at T2 and T3. It is operationalized as a composite binary variable with any of the following experiences: loss of responsibilities, denied promotions, unwanted transfers, or employment changes directly attributed to cancer (e.g., job loss, reduced hours). Responses at T2 and T3 were then combined to create a single binary exposure variable. The binary coding was 1 (“Yes”) if discrimination was reported at either T2 or T3, and 0 (“No”) if it was not reported at both time points. If only one time point was missing, the non-missing value was used to determine the coding. For example, if a participant's response at T2 was “1” (“Yes”) and their response at T3 was missing, the overall discrimination variable was coded as 1. Similarly, if the T2 response was “0” (“No”) and T3 was missing, the variable was coded as 0, based on the available non-missing value. Participants with missing data at both time points were coded as “Unknown” and treated as missing in the analysis.

3.3.2. Outcome: Mental Health

Mental health outcomes were evaluated using the Hospital Anxiety and Depression Scale (HADS) at T4. This scale consists of two subscales: HADS-A for anxiety symptoms and HADS-D for depressive symptoms (51); but we only consider the anxiety component for this analysis. Each subscale gives a score that falls into one of three categories: Normal (0–7), Borderline (8–10), and Case (11 or higher). For the purposes of this study, the Borderline and Case categories were combined into a single binary variable labelled 'Elevated Anxiety' (Borderline/Case = 1 vs. Normal = 0). This decision to combine the categories was because we had little participants who scored in the case category, this binary categorization is also supported in literature indicating that both borderline and clinical scores are linked to meaningful psychological distress and reduced functional outcomes so can therefore be used (51-53).

3.3.3. Covariates and Potential Confounders

These variables are used to describe the data, while those included in the final analyses are a subset selected based on existing literature (6,44,54) and Directed Acyclic Graph (DAG) (see Appendix 1).

- **Demographic and Socioeconomic Factors:** Age at diagnosis categorised as <50 and 50+; Education categorised as <High school, High school and Tertiary; Social

support: Relationship status and satisfaction with quality of support from family members, friends and romantic partners with a Likert scale - Not at all, Low, Moderate, High.

- **Clinical and Health-Related Factors:** Comorbid health conditions, which is coded as yes/no, indicating the presence of at least three comorbid conditions at diagnosis. Also included is cancer stage (I-III) and type of treatment (axillary surgery, chemotherapy, radiotherapy) coded as yes/no.
- **Workplace and Employment Factors:** Workplace support categorised as support from colleagues only, supervisor only, both or no support. Workplace accommodations at year 2 post diagnosis categorised as none, duties adjusted or time adjusted. Contract type: permanent vs. temporary, also at 2 years post diagnosis.
- **Quality of Life (QoL) and Psychosocial Factors:**
    - Pain and fatigue (T0,T1,T2,T4) - assessed using the symptom scales of the EORTC QLQ-C30 (European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire - Core 30). The fatigue scale is based on three questions about whether participants felt tired, weak and needed rest. While the pain scale includes two items on whether the participants felt pain and if this pain interferes with their daily activities. Responses were recorded on a four-point Likert scale ranging from "not at all" to "very much," and scores were transformed to a 0–100 scale, with higher scores indicating greater symptom severity. Validated thresholds were used to determine clinically relevant symptom burden. A fatigue score of ≥39 indicated severe fatigue, while a pain score of ≥25 indicated severe pain. These cut-offs have been found to reflect symptom levels that may interfere with daily functioning and overall well-being (55,56).
    - Perceived impact of cancer on life – pessimistic and optimistic perceptions (T1,T2,T4) which are assessed using the Impact of Cancer version 2 questionnaire - coded as continuous variables: Negative perceptions included worries such as fear of recurrence, loss of confidence, and identity disruption, whereas positive perceptions included features such as personal growth, enhanced connections, and new perspectives on life. These items were rated independently for each domain, and composite scores were produced to characterize whether participants viewed their cancer experience via an optimistic or pessimistic lens. Higher pessimism subscale scores reflect more negative views of cancer's influence on life, whereas higher optimism subscale scores show more optimistic views.

Missing data: The analysis uses a complete case approach for the exposure and outcome to avoid introducing bias through imputation, since imputation relies on observed variables that are then used to generate the weights and fit the marginal structural model. Out of the 2137 final sample, 470 (22%) of data were missing for the exposure variable (perceived workplace discrimination) at T2 and T3, and 351 (16.4%) were missing for anxiety at T4. The final analytical sample includes 1,316 participants who provided complete data on both exposure and outcome, which made up to 61.6% from the 2137 of those who completed the T4 visit. The initial checks conducted showed no significant differences in outcome distribution between those with missing and non-missing exposure data (Chi-squared test, $p = 0.25$), supporting the use of complete case analysis for both exposure and outcome. For our covariates of interest, missingness is generally low, 3.2% missingness in total, with the highest missingness coming from workplace support at 29.0% as the question pertaining to this variable was introduced into the questionnaire only two years after initial participant inclusions, resulting in missing data for all women enrolled during the first two years. Cancer Perception - Pessimism (T1) and Optimism (T1), both at 16.6%, followed this. We therefore used multiple imputation by chained equations (MICE) to impute missing values for the covariates, generating five complete datasets.

3.4. Statistical Analysis

Descriptive statistics were used to characterize the cohort and examine differences in anxiety outcomes by exposure status (workplace discrimination). Categorical variables were summarized using frequencies and percentages, while continuous variables were summarized using means and standard deviations. To explore associations between covariates and anxiety we used Chi-square tests for the categorical variables and Wilcoxon rank-sum test for continuous variables.

To investigate the relationship between workplace discrimination and anxiety symptoms, we first estimated an unadjusted logistic regression model to determine the basic relationship between exposure and outcome. This crude model does not account for any potential confounding factors. We then fit a multivariable logistic regression model that accounts for a wide range of factors identified as direct confounders based on the DAG (appendix 1). These include age at diagnosis, comorbid health conditions, education level, partnered status, workplace support, depression and anxiety at diagnosis and at T1, pain and fatigue at the same time points, cancer-related perceptions at T1, workplace accommodations and type of contract assessed at T2.

Using the same covariates, we applied inverse probability weighting (IPW) within a marginal structural logistic model (MSM) for the main analysis. To create the propensity scores, each individual is assigned a weight equal to the inverse of the probability of receiving their observed exposure level, conditional on their covariate history (57). The weights are derived from logistic regression models that estimate the probability of experiencing workplace discrimination, conditional on a set of baseline and time-varying covariates, sociodemographic, clinical, work-related and psychosocial factors. The weights are then stabilized to reduce variability, calculated as the ratio of the probability of exposure given baseline covariates to the probability of exposure given both baseline and time-varying covariates. To further improve model stability and to reduce the effect of extreme weights we truncated them at the 1st and 99th percentiles. These weights reduce the differences in confounding between the exposed and unexposed groups by creating a pseudo-population where covariates are balanced across the discrimination groups, mimicking the conditions of a randomised trial (57). The balance of the groups after the weights were created, were diagnosed using standardized mean differences (SMDs).

For the estimation of the outcome, these inverse proportionality truncated weights were applied to a final Marginal Structural Model, which uses binomial logistic regression estimation to produce adjusted odds ratios, which represent the estimate causal effect of perceived workplace discrimination on anxiety symptoms. The steps and formulas for creating the weights and application to the final model are specified in (appendix 2)**.** We then pooled the estimates of the odds ratios and their corresponding standard errors across the five datasets using Rubin's rules (58,59) to obtain final effect estimates and 95% confidence intervals (CI).

This methodological approach was selected as our final method because it effectively addresses time-dependent confounding which is a major issue in longitudinal observational studies. Unlike standard regression approaches, MSMs takes into consideration confounders that influence both the outcome and the exposure and correct for their fluctuation over time (57)**.** This is especially relevant in this context of post-treatment breast cancer survivors, whose psychosocial and health profiles change as they progress through recovery and reintegration stages. While workplace discrimination and mental health are potentially bidirectional, this study has a temporal structure where discrimination is measured at two and three years post diagnosis, and anxiety is assessed four years post diagnosis, which allows us to read the results as unidirectional for our exposure-outcome relationship.

Effect Modification Analyses

In addition to estimating the main effect of workplace discrimination on anxiety symptoms, we tested for effect modification by education level, partnered status (as a proxy for social support), age at diagnosis, and workplace accommodations. These variables were selected based on existing literature suggesting that individuals with lower education, limited social support, younger age, or fewer workplace adjustments may be more vulnerable to the psychological impacts of discrimination (38, 60-62). We hypothesized that the association between discrimination and anxiety would be stronger within these more vulnerable subgroups. Stratified analyses were performed using the truncated weights from the final marginal structural model to ensure similar confounder control within each stratum.

3.5. Software

All data manipulation, visualization, and analysis were carried out with R version 4.3.3. Data manipulation was carried out with libraries - dplyr, tidyverse, and janitor. Missing data were investigated with naniar, Amelia, and visdat. Descriptive statistics and styled tables were generated with skimr, tableone, gtsummary, and gt. Propensity scores were computed using ipw, and covariate balance was evaluated using cobalt. Mice were used for multiple imputation, and survey and mitools provided assistance for weighted analyses across imputed datasets.

4. RESULTS

4.1. Descriptive Analysis

4.1.1. Sociodemographic and Work-related Characteristics

Table 1 shows the descriptive statistics of our study sample. The study included 1,316 breast cancer survivors who returned to work within two years of diagnosis, with 728 (55.3%) classified as having normal anxiety levels and 588 (44.7%) experiencing elevated anxiety at four years post diagnosis. Most of the women are younger than 50 years at diagnosis, majority had a tertiary education, were in romantic partnerships and many scored their satisfaction with the quality of support they receive as low, followed by moderate, high, and then not at all satisfied. About 60.7% of the women were employed full time at T2, with the elevated anxiety group having a higher number reporting time-adjusted duties, while the normal group had more reporting no accommodations. In terms of support at work, both the anxious and normal groups had more women reporting that they had support from both their colleagues and employers.

Overall, 514 (70.6%) participants with normal anxiety and 294 (50.0%) with elevated anxiety reported no experiences of discrimination, while 214 (29.4%) with normal anxiety and 294 (50.0%) with elevated anxiety reported such experiences. We have an identical number of participants (294) in both the discrimination and non-discrimination categories. This univariate analysis showed that there are differences in anxiety between those who reported discrimination and those who did not, $p<0.001$.

4.1.2. Clinical and QoL Characteristics

For treatment, 62.7% of the women had chemotherapy, 83.4% had hormonal therapy and most of them had none or sentinel axillary lymph surgery as compared to dissection. However for each of the treatments there seems to be no significant difference between those who underwent the treatments and those who did not in terms of their anxiety as indicated by the none significant p-values. For QoL variables, from diagnosis to T4 there are significant differences between those who are fatigued and those who are not as well as for pain in relation to their anxiety levels as shown by the $p<0.001$. These differences were consistent across all follow-up time points.

4.1.3. Psychological and Coping Profiles

Those with elevated anxiety at T4 had higher levels of depression at all other time periods. At T0, 10.4% of this group were depression cases, compared to 3.2% in the normal T4 anxiety group. Although overall depression rates decreased significantly over time, group variations remained. The score for cancer-related pessimistic perceptions were higher than optimistic ones across all time points. Mean pessimism scores were consistently higher in the elevated anxiety group compared to the normal anxiety group. Over time, pessimism and optimism followed contrasting trends between the two groups. Among those with normal anxiety, pessimism remained relatively stable around a mean of 3.14, while in the elevated anxiety group it fluctuates at higher levels. In contrast, optimism declined over time in the normal anxiety group (from mean 2.41 to 2.26), whereas in the elevated anxiety group it fluctuates overtime (from mean 3.04 to 2.98 then back to 3.04).

***Table 1**: Characteristics of BCS who returned to work at T2 with anxiety status at T4*

Variable	Normal N = 728	Elevated_Anxiety N = 588	p-value
Discrimination			<0.001
No	514 (70.6%)	294 (50.0%)	
Yes	214 (29.4%)	294 (50.0%)	
Age at diagnosis			0.014
<50	429 (58.9%)	386 (65.6%)	
50+	299 (41.1%)	202 (34.4%)	
Education			0.4
<High school	166 (22.8%)	152 (25.9%)	
High school	143 (19.6%)	111 (18.9%)	
Tertiary	419 (57.6%)	325 (55.3%)	
Partnered			0.8
No	112 (15.4%)	87 (14.8%)	
Yes	616 (84.6%)	501 (85.2%)	
Satisfaction with quality of support			0.8
Not at all	56 (7.7%)	53 (9.0%)	
Low	295 (40.5%)	242 (41.2%)	
Moderate	246 (33.8%)	193 (32.8%)	
High	131 (18.0%)	100 (17.0%)	
Type of contract			0.008
Full-time	466 (64.0%)	333 (56.6%)	
Part-time	262 (36.0%)	255 (43.4%)	
Workplace accommodations			<0.001
None	295 (40.5%)	178 (30.3%)	
Duties Adjusted	244 (33.5%)	207 (35.2%)	
Time Adjusted	189 (26.0%)	203 (34.5%)	
Workplace support			0.004
Both Support	394 (54.1%)	368 (62.6%)	
Colleagues Only	85 (11.7%)	73 (12.4%)	
Supervisor Only	74 (10.2%)	39 (6.6%)	
No Support	175 (24.0%)	108 (18.4%)	
Chemotherapy			0.8
No	274 (37.6%)	217 (36.9%)	
Yes	454 (62.4%)	371 (63.1%)	

Hormonal therapy			0.3
No	128 (17.6%)	91 (15.5%)	
Yes	600 (82.4%)	497 (84.5%)	
Axillary dissection			0.3
Dissection	281 (38.6%)	244 (41.5%)	
None or sentinel	447 (61.4%)	344 (58.5%)	
Stage of cancer			0.8
Stage I	329 (45.2%)	277 (47.1%)	
Stage II	331 (45.5%)	256 (43.5%)	
Stage III	68 (9.3%)	55 (9.4%)	
Comorbid health conditions			0.017
No	584 (80.2%)	439 (74.7%)	
Yes	144 (19.8%)	149 (25.3%)	
Severe Fatigue TO			<0.001
No	573 (78.7%)	407 (69.2%)	
Yes	155 (21.3%)	181 (30.8%)	
Severe Fatigue T1			<0.001
No	520 (71.4%)	314 (53.4%)	
Yes	208 (28.6%)	274 (46.6%)	
Severe Fatigue T2			<0.001
No	518 (71.2%)	293 (49.8%)	
Yes	210 (28.8%)	295 (50.2%)	
Severe Fatigue T4			<0.001
No	559 (76.8%)	279 (47.4%)	
Yes	169 (23.2%)	309 (52.6%)	
Severe Pain TO			0.001
No	589 (80.9%)	431 (73.3%)	
Yes	139 (19.1%)	157 (26.7%)	
Severe Pain T1			<0.001
No	424 (58.2%)	242 (41.2%)	
Yes	304 (41.8%)	346 (58.8%)	
Severe Pain T2			<0.001
No	447 (61.4%)	250 (42.5%)	
Yes	281 (38.6%)	338 (57.5%)	
Severe Pain T4			<0.001
No	463 (63.6%)	247 (42.0%)	

Yes	265 (36.4%)	341 (58.0%)	
Depression_T0			<0.001
a: Normal	656 (90.1%)	440 (74.8%)	
b: Borderline	49 (6.7%)	87 (14.8%)	
c: Case	23 (3.2%)	61 (10.4%)	
Depression_T1			<0.001
a: Normal	661 (90.8%)	462 (78.6%)	
b: Borderline	39 (5.4%)	86 (14.6%)	
c: Case	28 (3.8%)	40 (6.8%)	
Depression_T2			<0.001
a: Normal	667 (91.6%)	464 (78.9%)	
b: Borderline	49 (6.7%)	81 (13.8%)	
c: Case	12 (1.6%)	43 (7.3%)	
Cancer Perception - Pessimism (T1)			<0.001
Mean (SD)	3.15 (0.63)	3.29 (0.59)	
Cancer Perception - Pessimism (T2)			<0.001
Mean (SD)	3.14 (0.67)	3.30 (0.60)	
Cancer Perception - Pessimism (T4)			0.005
Mean (SD)	3.14 (0.66)	3.23 (0.61)	
Cancer Perception - Optimism (T1)			<0.001
Mean (SD)	2.41 (0.72)	3.04 (0.71)	
Cancer Perception - Optimism (T2)			<0.001
Mean (SD)	2.35 (0.70)	2.98 (0.73)	
Cancer Perception - Optimism (T4)			<0.001
Mean (SD)	2.26 (0.67)	3.04(0.71)	

Note: *Values are presented as* n (%) *for categorical variables and* mean (SD) *for continuous variables. P-values are based on Chi-square tests for categorical and Wilcoxon rank-sum tests for continuous variables.*

4.2 Regression Analyses

Unadjusted and Adjusted Logistic Regression Models and IPW-MSM Examining the Association Between Workplace Discrimination and Anxiety (see Table 2)

In the unadjusted logistic regression model, exposure to workplace discrimination was significantly associated with higher odds of experiencing elevated anxiety symptoms (OR: 2.40; 95% CI: 1.91–3.01; $p < 0.001$). After adjusting for the set of confounders, the association remained statistically significant, though attenuated (OR: 1.52; 95% CI: 1.11–2.08; $p = 0.009$). In the final step, we applied the IPW-weights to a marginal structural logistic model to further account for confounding and improve covariate balance between exposure groups. In this fully adjusted model, workplace discrimination remained significantly associated with increased odds of anxiety (OR: 1.46; 95% CI: 1.14–1.86).

Table 2. Association between Workplace Discrimination and Anxiety across Model Specifications

Model	OR [95% CI]	*p*-value
Unadjusted logistic model	2.40 [1.91, 3.01]	<0.001
Multivariable-adjusted logistic model	1.52 [1.11, 2.08]	0.009
IPW-MSM model	1.46 [1.14, 1.86]	0.00234

***Note**: The adjusted model includes age at diagnosis, comorbid health conditions, education, partnered status, workplace support, depression and anxiety (at diagnosis and at 1 year), pain and fatigue (at diagnosis and at 1 year), cancer-related perceptions (1 year post-diagnosis), and workplace accommodations and contract type (2 years post-diagnosis). The IPW model uses these same covariates for weighting.*

Covariate Balance Diagnostics Before and After Weighting:

The SMDs of the weights applied to the IPW-MSM model confirmed that the covariates were well balanced across the categories of discrimination (see table 3). Before weighting, the mean absolute SMD was 0.09, with a maximum absolute SMD of 0.25. Approximately 39% of covariates showed an imbalance greater than the conventional threshold of 0.1, indicating meaningful differences in baseline characteristics between groups. After applying inverse probability weighting, covariate balance substantially improved. The mean absolute SMD decreased to 0.00, and the maximum absolute SMD was reduced to 0.013. Importantly, none of the covariates exceeded the 0.1 imbalance threshold post-weighting. These results indicate excellent balance, supporting the assumption that confounding was effectively controlled in the weighted sample.

Table 3: Covariate balance diagnostics

Metric	Before Weighting	After Weighting
Mean absolute SMD	0.09	0.00
Maximum absolute SMD	0.25	0.013
Proportion of covariates with SMD > 0.1	0.39 (39%)	0.00 (0%)

Effect Modification

Table 4 shows the stratified IPW-Weighted associations. When the IPW-MSM model was stratified by age, the association was stronger among participants aged <50 years (OR: 1.66; 95% CI: 1.22–2.26), whereas the association was weaker among those aged ≥50 years (OR: 1.14; 95% CI: 0.76–1.72). Stratification by partnership status showed that discrimination was significantly associated with anxiety among partnered individuals (OR: 1.56; 95% CI: 1.23–1.99), while no significant association was observed among those who were not partnered (OR: 1.02; 95% CI: 0.57–1.83). Educational level also appeared to modify the association. The highest odds of anxiety were observed among participants with a high school education (OR: 2.10; 95% CI: 1.25–3.55), followed by less than high school (OR: 1.49; 95% CI: 0.95–2.34), and then tertiary education (OR: 1.30; 95% CI: 0.96–1.75). Only the association for high school level was statistically significant. Regarding workplace accommodations, the association between discrimination and anxiety was not statistically significant across strata, though the direction of the effect remained positive. Participants with no accommodations had an OR of 1.44 (95% CI: 0.90–2.28), those with adjusted duties had an OR of 1.22 (95% CI: 0.82–1.80), and those with adjusted time OR of 1.57 (95% CI: 0.97–2.53).

Table 4. Stratified IPW-Weighted Associations between Discrimination and Anxiety

Stratification Variable	Category	OR [95% CI]
Age at diagnosis	<50 years	1.66 [1.22, 2.26]
	≥50 years	1.14 [0.76, 1.72]
Partnered	Yes	1.56 [1.23, 1.99]
	No	1.02 [0.57, 1.83]
Education	<High school	1.49 [0.95, 2.34]
	High school	2.10 [1.25, 3.55]
	Tertiary	1.30 [0.96, 1.75]
Workplace Accommodations	None	1.44 [0.90, 2.28]
	Duties Adjusted	1.22 [0.82, 1.80]
	Time Adjusted	1.57 [0.97, 2.53]

***Note**: ORs and CIs presented here were estimated using the IPW-MSM, as specified in Table 2. All the stratified analyses were conducted using this same model, with the same propensity score specification.*

5. DISCUSSION

The purpose of this study was to investigate the relationship between perceived workplace discrimination at two and three years post diagnosis and anxiety at four years post diagnosis among women returning to work after breast cancer, as well as to explore if this relationship differed among important sociodemographic and work-related subgroups. Our results show a positive association between perceived workplace discrimination and anxiety. Women who perceived workplace discrimination have 46% higher odds of experiencing elevated anxiety symptoms than those who did not. These findings are consistent with the biological mechanisms previously discussed whereby discrimination acts as a persistent stressor, contributing to dysregulated stress responses and psychological repercussions (25-27).

The stratified results indicate that this association is modified by sociodemographic and work-related characteristics. Specifically, discrimination had a greater impact on anxiety among women diagnosed before the age of 50, those who were partnered, and those with only a high school education. For workplace accommodations, none of the results of the levels were significant as the CIs include the null. The results confirm our hypothesis that discrimination has a stronger effect among younger women than among older women. This is consistent with earlier research suggesting that younger survivors might experience particular difficulties at work, like interrupted careers and perceived stigma from their cancer diagnosis which then leads to discrimination [44,67]. Furthermore, younger individuals can be more susceptible to social judgment and complex workplace dynamics, which could exacerbate the psychological effects of discrimination [38].

On the other hand, having a partner did not modify the relationship in the way that was anticipated. In women who were coupled, discrimination was substantially linked to elevated anxiety, but not in women who were alone. This unexpected result could be attributed to the unique demands that coupled women encounter, since they often face the dual demands of both caregiving and employment. They may also face new role expectations at home and work, which could add to their mental health burden [11]. It is also likely that the lesser number of unmarried women in the sample led to lower statistical significance.

Stratification by education only revealed a significant association among women with high school education, which was the most amplified group. Although our hypothesis predicted the biggest effect among the least educated, the observed pattern could be attributed to coping strategies accessible to mid-educated individuals, who may be more inclined to perceive and internalize unfair treatment [39,68,69]. Although this may help explain the experiences of survivors with a moderate level of education, it is still unclear why the effect appears to be less

pronounced for individuals with the lowest level of education, which calls for further research to explore this unexpected pattern. Concerning workplace accommodations, contrary to our hypotheses, the lack of accommodations did not result in the most significant association. One explanation could be that accommodations, if poorly implemented or viewed as superficial will not be impactful, therefore not attenuate the impacts of discrimination [70].

Since breast cancer has one of the highest survival rates, it is both a socioeconomic and public health priority to ensure that patients have stable work after treatment (16). Resuming employment following a diagnosis is essential to recovery because it gives survivors a sense of identity and financial stability (7,12,13). Discrimination often complicates this shift, though, and can seriously impede reintegration and psychological health. Our findings also highlight the high prevalence of workplace discrimination, emphasizing its urgency as a public health concern. This is consistent with that studied by Paraponaris and colleagues (4), who, in a study of 4,270 French individuals aged 18–58 diagnosed with various cancers and working at the time of diagnosis, found that out of the 66% who returned to work two years later, 22% of them reported experiencing workplace discrimination. On another note, Bouknight (65) showed that even perceived discrimination before cancer could lower the probability of going back to work within a year after diagnosis highlighting the significant negative effects of discriminatory encounters on employment.

Although not specifically for cancer survivors, additional research by Karl and colleagues (66) adds credence to the general knowledge that unstable work environments characterized by a lack of support, high demands, and job insecurity can have a significant negative influence on mental health. Discrimination frequently contributes to or worsens these stressors, further supporting the claim that structural workplace injustices act as long-term stressors, especially for vulnerable populations like cancer survivors. This emphasizes even more how crucial it is to address discrimination as a potentially modifiable risk factor, in addition to being a social determinant in the context of survivorship care.

6. STRENGTHS AND LIMITATIONS

The results of our study offer important new information about the relationship between BCs' mental health and discrimination in France, as this association has never been studied before, especially using quantitative, causal inference methods. Prior research has shown that workplace discrimination following cancer is common, but it has not examined the direct psychological effects of this discrimination (4). Building upon this context, our research addresses the need for quantitatively robust methodologies to assess the causal relationships between workplace discrimination and mental health outcomes.

One major advantage of the study is that the cohort contains extensive sociodemographic and clinical information, as well as psychological and detailed work-related information allowing us to adjust for them at different time points, thereby increasing the validity of the effect estimates. The use of prospective data also improves temporal interpretation while reducing reverse causation bias given the bi-directionality of the relationship between workplace discrimination and anxiety. We minimize exposure misclassification by using elements in the questionnaires that explicitly ask participants whether the workplace discrimination they experienced was linked to their cancer diagnosis. This improves the specificity of the measurement, ensuring that only cancer-related discrimination is captured, thereby strengthening the internal validity of the findings. The inclusion of just women who have resumed employment helps to guarantee that discrimination is examined within a working setting, rather than being confounded by general labour market exclusion.

The coding of the binary discrimination variable, which classified individuals as having perceived discrimination whether they reported it at T2 or T3, was an intended approach to capture any discrimination that occurred between these two time points. This method aimed to increase sensitivity to exposure by merging reports from both periods into a single indicator, rather than comparing or choosing one time point over another. While this strategy increases the possibility of identifying individuals who faced discrimination at any of the two time points, it may also result in a larger overall prevalence estimate when compared to assessing discrimination at a single time point. Importantly, this is not a bias, but rather a result of the design decision to use the two time points as complimentary sources of information for exposure classification. However, this approach implies that any report of discrimination, regardless of timing or persistence, is equally meaningful to the outcome, potentially limiting the ability to differentiate between transient and prolonged experiences.

It is important to note that both the exposure and outcome variables are collected through self-reported instruments. While our exposure measure is not derived from a formally validated

questionnaire, it is based on questions utilized in a comprehensive national survey of cancer survivors in France (71). The HADS is a well-established tool with validated thresholds commonly used to assess anxiety and depression, especially among medical and cancer patient groups (51). In addition, we are unable to determine migration background in the CANTO cohort, information such as the country of birth of participants and their parents would have provided valuable insight into the role of migration-related factors in shaping work outcomes and potential experiences of discrimination. Given existing evidence that migrant status might interact with vulnerabilities related to health and employment, for instance it is shown that migrants often face increased risks of discrimination, and poorer occupational and mental health outcomes compared to native workers (72). Our inability to investigate this dimension limits us from conducting meaningful subgroup analyses and from discussing crucial equality implications.

Concerning model choice, the unadjusted logistic regression model showed a high association between anxiety and workplace discrimination; however, this value is overstated because of confounding. This constraint was overcome by the multivariable-adjusted model, which directly controlled for a wide range of confounders. However, this type of model does not ensure covariate balance between exposure groups and may still be constrained by problems such as multicollinearity or model misspecification (63, 64). In contrast, by generating a pseudo-population with a balanced distribution of observed covariates, the IPW-MSM model provides a more reliable estimate (57). We therefore consider this the most suitable method for evaluating the causal effect of discrimination on anxiety in this context.

About model definition, we tested a number of different IPW-MSM models and discovered that the effect all went in the same direction (positive effect) with very little variation. The model we proposed in this research was thought to be the most theoretically and empirically acceptable since it avoids overfitting and takes into consideration a wide range of pertinent variables. The consistency across models reinforces the robustness of our findings (see appendix 3). Even while our study produces solid results, there are still certain interpretation difficulties. For example, it can be challenging to totally understand the roles of certain factors, such as chemotherapy as it may have a direct effect on anxiety. Despite not being incorporated into the final model, the results from the other sensititvy models indicated that it had no apparent impact on the outcomes or model performance. We acknowledge its theoretical significance and propose that further investigation is necessary to completely comprehend its function in this relationship.

7. CONCLUSIONS

Given the improved breast cancer survival rates, particularly among women of working age, there is a need for better labour policies to facilitate their return to work, full reintegration into the workforce, and the maintenance of secure working conditions. Discrimination is a negative experience for anyone, but for BCS, it adds an extra layer of psychological strain to an already precarious situation. Our findings emphasize the necessity of eliminating discrimination as a critical component in enhancing BCS mental health and well-being. Our research also reveals subgroups that experience amplified effects, providing important insights for the targeted allocation of interventions and resources where they are most needed.

While anti-discrimination laws exist, they should be vigorously enforced and expanded to guarantee that BCS are protected from discriminatory behaviours, fostering a more equitable and supportive workplace environment for them. This would allow survivors to stay in their jobs for longer periods, increase their productivity, and improve their general mental health. While broader organizational and policy-level actions are needed to address workplace discrimination, occupational health specialists can also contribute by identifying at-risk individuals and facilitating access to support measures that mitigate the psychological impact.

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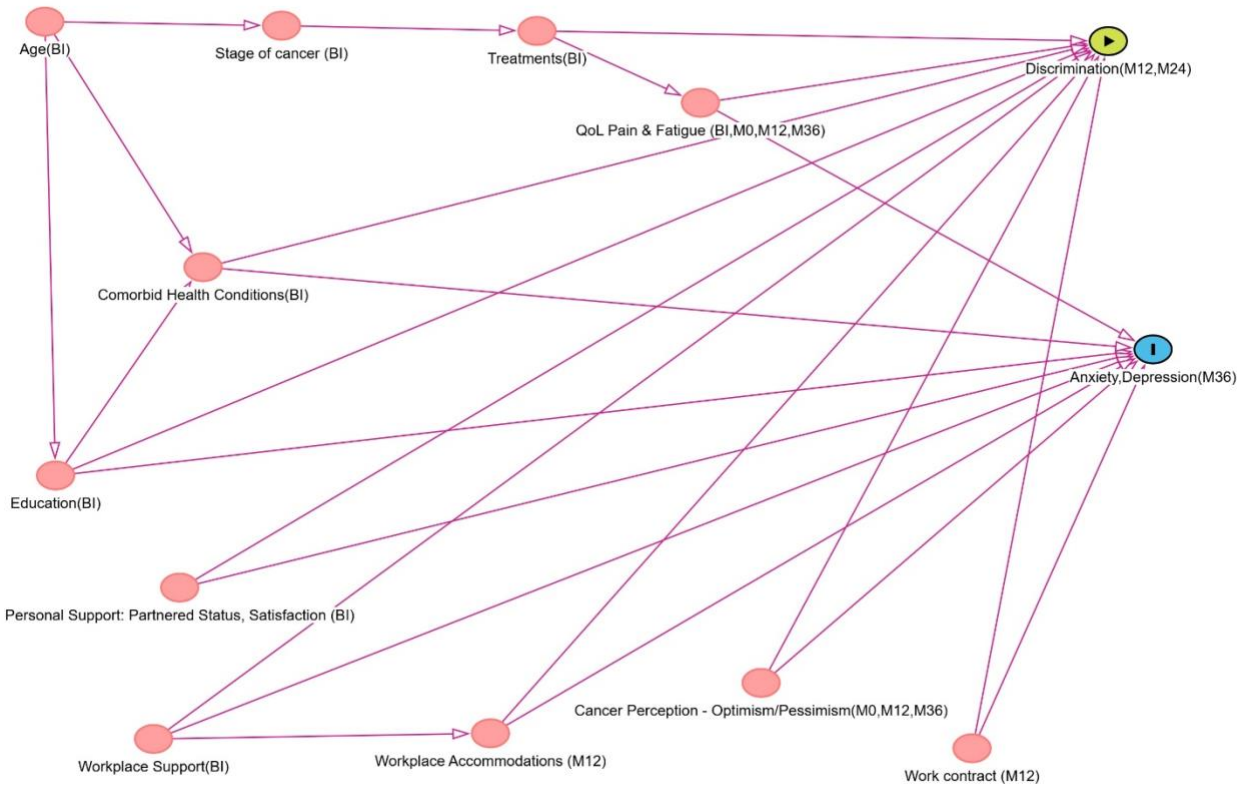
9. APPENDICES

Appendix 1: Directly Acyclic Graph



Appendix 2 - Flowchart showing the equations used to create the propensity scores applied to the weighted model

Mathematical Equations for IPW Analysis

Step 1: Propensity Score Model (Denominator)

$$P(D=1|L) = logit^{-1}(\beta_0 + \beta_1 L_1 + \beta_2 L_2 + \ldots + \beta_p L_p)$$

D = discrimination/exposure (1=exposed, 0=unexposed)

L = vector of measured covariates

β = estimated regression coefficients

logit $^{-1}(x) = 1/(1+e^{-x})$ = inverse logit function

Step 2: Numerator Model (Marginal Probability)

$$P(D=1) = logit^{-1}(\alpha_0)$$

α_0 = intercept from logistic regression with no covariates

P(D=1) = unconditional probability of discrimination

Step 3: Stabilized Weights

$$SW_i = \frac{P(D=d_i)}{P(D=d_i|L=l_i)}$$

For exposed: $$SW_i = \frac{P(D=1)}{P(D=1|L=l_i)}$$

For unexposed: $$SW_i = \frac{P(D=0)}{P(D=0|L=l_i)}$$

d_i = observed discrimination status for individual i (1 or 0)

l_i = covariate values for individual i

Step 4: Weight Truncation

$$SW^i_{truncated} = SW_i \text{ if } q_{0.01} \leq SW_i \leq q_{0.99}$$

$$SW^i_{truncated} = q_{0.01} \text{ if } SW_i < q_{0.01}$$

$$SW^i_{truncated} = q_{0.99} \text{ if } SW_i > q_{0.99}$$

$q_{0.01}$ = 1st percentile of the weight distribution

$q_{0.99}$ = 99th percentile of the weight distribution

Step 5: Weighted Model

$$\hat{\beta} = \arg\max_\beta \sum_i SW_i \cdot [Y_i \cdot \log(p_i) + (1-Y_i) \cdot \log(1-p_i)]$$

Anxiety_M36 = outcome variable (Y)

SW_i = truncated stabilized weights from Step 4

p_i = predicted probability of outcome for individual i

$\hat{\beta}$ = weighted maximum likelihood estimate

Appendix 3 – Sensitivity models: Differences in adjusted covariates across models:

Model	OR (95% CI)	Adjusted Covariates
Model A **Full adjustment (all time points)**	1.35 [1.04, 1.76]	Age at diagnosis, Comorbid health conditions, Chemotherapy, Hormonal therapy, Axillary dissection, Stage of cancer, Anxiety (T0, T1,T2), Partnered, Satisfaction with quality of support, Education, Workplace support, Type of contract, Severe fatigue (T0, T1,T2), Severe pain (T0, T1,T2), Cancer perception – Pessimism (T1,T2), Cancer perception – Optimism (T1,T2), Depression (T0, T1,T2)
Model B **Intermediate adjustment (up to T1)**	1.55 [1.17, 2.05]	Age at diagnosis, Comorbid health conditions, Partnered, Chemotherapy, Hormonal therapy, Axillary dissection, Stage of cancer, Workplace support, Workplace accommodations, Type of contract, Depression (T0, T1), Anxiety (T0, T1), Education, Satisfaction with quality of support, Severe fatigue (T0, T1), Severe pain (T0, T1), Cancer perception – Pessimism (T1)
Model C **Extended temporal confounders**	1.35 [1.04, 1.77]	Age at diagnosis, Comorbid health conditions, Partnered, Stage of cancer, Workplace support, Workplace accommodations, Type of contract, Anxiety (T0, T1,T2), Depression (T0, T1,T2), Education, Cancer perception – Pessimism (T1,T2), Cancer perception – Optimism (T1,T2)