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The Relationship between Executive Dysfunction and Depression in Adult Women with Breast Cancer: A Systematic Review

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Abstract

Introduction: Adult women treated for breast cancer frequently exhibit executive function (EF) deficits—particularly in working memory and processing speed—with potential interplay with depressive symptomatology; however, the relationship between depression and EF impairments in this population remains poorly defined.

Methods: We conducted a PRISMA-guided systematic review of literature in the Web of Science and Scopus databases (1998–2023) using the keywords "breast cancer," "executive function," and "depression." After duplicate removal, 143 unique records were screened by title and abstract. Inclusion criteria were: (1) empirical quantitative studies (cross-sectional, cohort, case-control, randomized controlled trials); (2) adult women diagnosed with breast cancer; (3) standardized assessments of both EF (e.g., Trail Making Test, Stroop, Wisconsin Card Sorting Test) and depression (e.g., Beck Depression Inventory-II, HADS); and (4) publications in English or Spanish. Exclusion criteria included: clinical populations with additional psychiatric diagnoses, qualitative-only designs, non-empirical articles, and studies lacking separate EF/depression data. Full-text review yielded 22 eligible studies.

Results: Three primary research domains emerged: (1) Physical activity interventions (n = 6; total N = 2 731) demonstrated moderate-to-vigorous exercise regimens (e.g., HIIT, structured walking) improved EF performance and reduced depressive symptoms. (2) Cognitive-training programs (n = 9; total N = 2 991) showed computerized or therapist-led protocols enhanced cognitive flexibility and processing speed, with mixed effects on mood. (3) Cognitive impairment and quality of life (n = 7; total N = 725) linked EF deficits to declines in daily functioning and health-related quality of life.

Discussion: Findings indicate that both physical activity and cognitive training hold promise for mitigating EF deficits and depressive symptomatology in breast cancer survivors. We recommend future longitudinal, multicenter trials employing standardized EF and depression measures, mechanistic biomarkers, and longer follow-up to determine optimal intervention modalities and inform clinical survivorship care.

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1. Introduction

Breast cancer (BC) is the most commonly diagnosed malignancy and the leading cause of cancer-related death among women worldwide. According to recent estimates, there were approximately 2.26 million new BC cases (age-standardized incidence rate [ASR] 47.8 per 100 000 women) and 685 000 deaths globally (Lei et al., 2021). In Latin America, the ASR is 38.6 per 100 000, with Colombia reporting an ASR of 48.2 per 100 000 and a mortality ASR of 15.7 per 100 000 in 2022, reflecting a rising epidemiological burden compared to prior decades (Pan American Health Organization, 2022; Bonilla Santos et al., 2016).

Executive functions (EF) are a set of top-down cognitive processes essential for goal-directed behavior, including working memory (holding and manipulating information), inhibitory control (suppressing prepotent responses), cognitive flexibility (shifting between tasks or mental sets), planning, and problem-solving. These higher-order functions are principally mediated by prefrontal cortical networks and underlie adaptive functioning across occupational, social, and personal domains (Diamond, 2013; Miyake et al., 2000).

Breast cancer survivors frequently report cognitive deficits—colloquially termed "chemo brain"—following diagnosis and treatment. Meta-analyses estimate that approximately one-third of survivors exhibit objective cognitive impairment on neuropsychological tests, whereas up to 80% report subjective cognitive complaints (Janelsins et al., 2014; Pullens et al., 2010). Deficits are particularly pronounced in attention, processing speed, and EF, and can persist for years post-treatment (Chan et al., 2015; Janelsins et al., 2014). Neuroimaging studies corroborate these findings, demonstrating reduced frontal gray matter density and altered functional activation patterns after chemotherapy (Deprez et al., 2012; McDonald et al., 2013).

In addition to cognitive sequelae, survivors commonly experience psychological distress—including depression and anxiety—which interacts bidirectionally with cognitive outcomes. Depressive symptoms have been linked to both subjective cognitive complaints and poorer performance on EF tasks (Crouch et al., 2022; Dong et al., 2024). Moreover, psychosocial factors such as coping styles and social support critically influence adjustment. For example, Di Giuseppe et al. (2020) and Tomai et al. (2019) found that defensive responses and social support differentially predict emotional adjustment in early versus advanced cancer stages, while Faraci et al. (2021) identified perceived social support as a moderator of fatigue and depressive symptoms. Recent studies by De Vincenzo et al. (2022) linked depressive symptomatology to altered heart rate variability in ovarian cancer survivors, and Guerra et al. (2024) and Ranieri et al. (2023) underscored the roles of emotion regulation and genetic risk disclosure, respectively, in psychological adaptation among BC populations.

Despite extensive research on cognitive and affective outcomes in breast cancer survivors, no systematic review has specifically synthesized objective EF impairments alongside depressive symptomatology in adult women with BC. By concentrating on EF rather than global cognition and examining depression as a co-occurring outcome, this review aims to: (1) Determine the prevalence and magnitude of EF impairments following BC treatment; (2) Elucidate the relationship between EF dysfunction and depressive symptoms; and (3) Identify methodological gaps to inform the development of targeted neuropsychological assessment and rehabilitation protocols.

Accordingly, we conducted a PRISMA-guided systematic review of observational and interventional studies assessing EF and depression in adult women with breast cancer. Our goal is to advance understanding of the cognitive and emotional sequelae of BC and to provide an evidence base for clinical assessment and intervention strategies.

2. Method

This systematic review was conducted in accordance with the PRISMA 2020 guidelines (Page et al., 2021). This article was also built based on tools that allowed us to find research on the relationship between EF and depression, in adult women diagnosed with breast cancer, two indexed databases were used, the first was Web of Science (WoS), where the following search execution was used "breast cancer" AND , "executive functions", AND "anxiety" AND "depression", the search yielded a total of ninety (90) studies, with a date range from 1998 to 2023. Second, the Scopus database was also used with the previous search equation. A total of thirteen (13) studies were found between 2013 and 2022. This search was conducted on November 2024

2.1 Eligibility Criteria

We included only empirical quantitative studies in adult women diagnosed with breast cancer that reported (1) a clinical diagnosis or standardized assessment of depression and (2) objective measures of executive function (e.g., neuropsychological tests of working memory, inhibition, cognitive flexibility).

2.2 Exclusion Criteria

We excluded studies in which (1) participants with breast cancer and depression had additional psychiatric diagnoses (e.g., bipolar disorder, psychosis), (2) Qualitative-only designs (e.g., interviews, focus groups) without quantitative EF or depression data, (3) Mixed-methods studies in which quantitative results for EF and depression could not be disaggregated.

2.3 Study Selection and Data Management

Titles and abstracts of 103 unique records were screened against these criteria. Data from all eligible articles were then extracted into an Excel database capturing: author(s), year, article title, journal, volume/issue, page range, DOI, abstract, and main findings—facilitating transparent application of our eligibility criteria and efficient access during full-text review.

Finally, it should be mentioned that after the search was carried out, the documents were downloaded in PDF files, which were uploaded to the Tree of Science -ToS platform and this allowed an exhaustive analysis of the scientific literature that is based on graph theory metrics, this tool also allows visualizing the works in a field of knowledge as a tree "metaphorically" where the roots are the classic articles, the trunk represents those articles that allow the area to advance in these research topics and on the other hand, the leaves are the recently published articles (Zuluaga et al., 2022).

3. Results

A total of 103 unique records were identified (90 from WoS; 13 from Scopus). After title/abstract screening and full-text assessment against our a priori criteria, 22 studies were included. Reasons for full-text exclusions are detailed in Figure 1. Figure 2 shows the keyword co-occurrence network of the 103 studies, generated in VOSviewer using a minimum occurrence threshold of 5. The map partitions into four major clusters (color-coded): The Red cluster (upper left) centers on foundational measurement instruments (e.g., "Zigmond & Snaith, 1983) and scale development, reflecting the field's reliance on core anxiety–depression tools; the Blue cluster (lower left) groups psychosocial adaptation themes (e.g., Simard et al., 2013), capturing work on coping and social support; the Green cluster (right) comprises neurobiological and behavioral-therapy studies (e.g., Lovibond & Lovibond, 1995; Meyer et al., 1990), indicating a stream focused on interventions for mood and EF. Finally, the Yellow cluster (bottom left) includes recent applied-technology keywords (e.g., Alcaraz-Ibáñez et al., 2020), highlighting emerging interest in digital/tech-enhanced cognitive training.

The size of each node reflects keyword frequency, with Zigmond and Snaith (1983) and Cohen (1988) as the largest nodes, underscoring their role as conceptual "roots" of the literature. Thicker edges between nodes (e.g., Simard & Savard, 2009; Spielberger et al., 1983) denote strong co-occurrence links, suggesting that measurement-focused work remains tightly integrated with interventions research. Overall, the network reveals both the historical underpinnings of anxiety/depression assessment in cancer and the more recent diversification into physiologic markers and digital interventions.

Figure 1.

PRISMA 2020 flow diagram of study selection (adapted from Page et al., 2021)

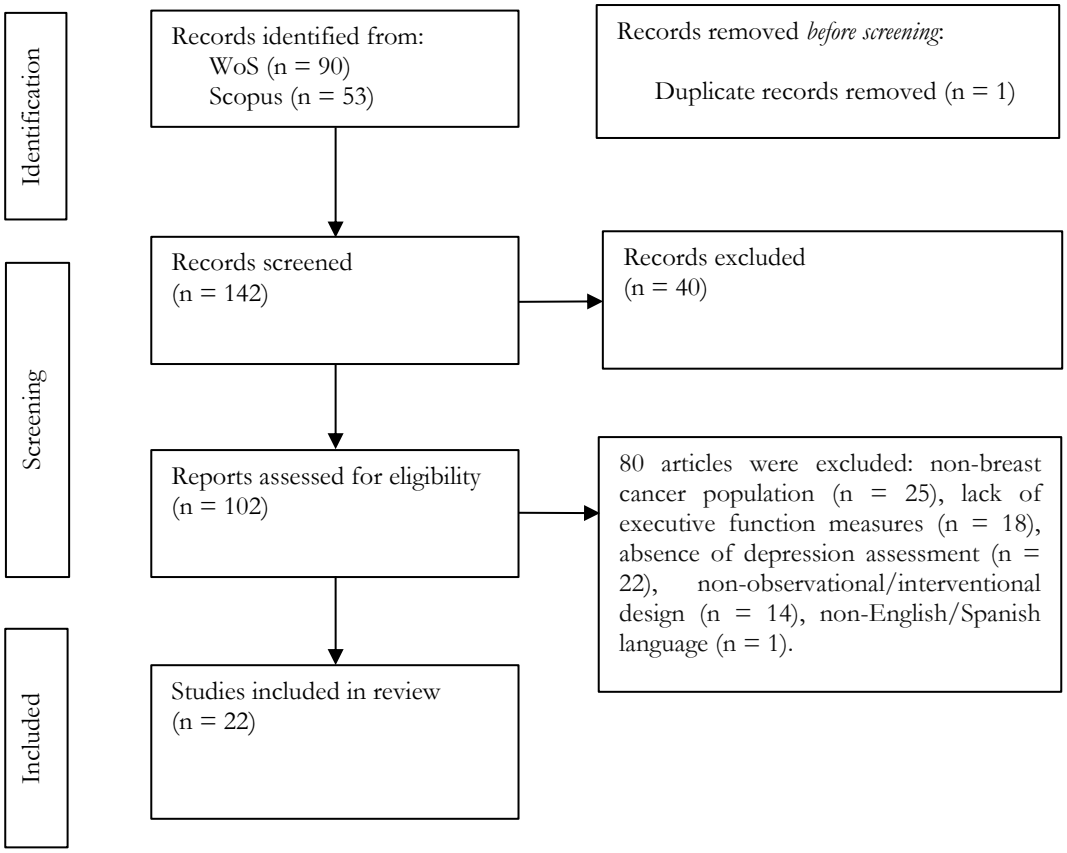
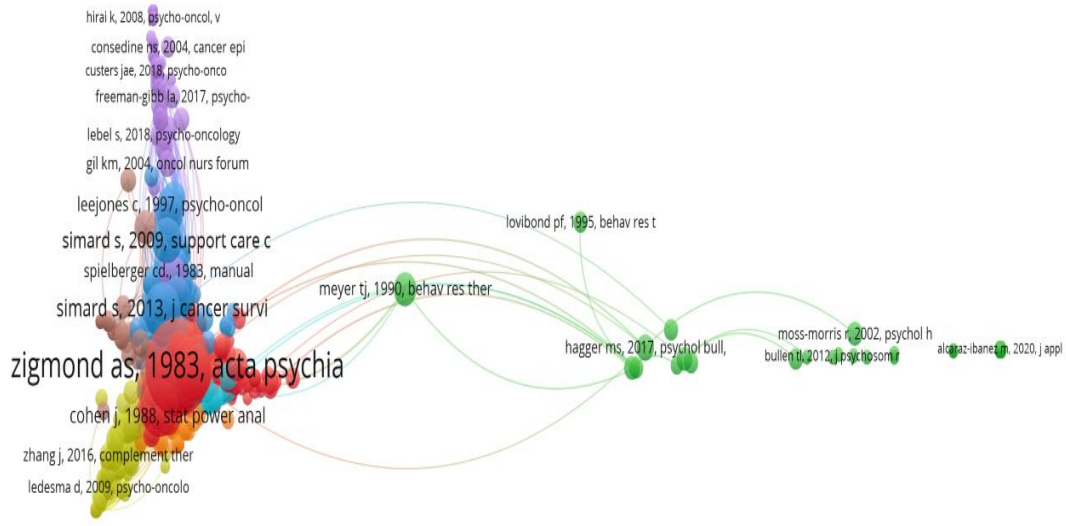


Figure 2.

Co-ocurrence network



3.1 Study Characteristics Overview

A total of 22 quantitative studies, published between 2010 and 2023, were grouped into three research domains: (1) physical activity interventions (n = 6; total N = 2 731), (2) cognitive training programs (n = 9; total N = 2 991), and (3) the association between cognitive impairment

and quality of life (n = 7; total N = 725). These investigations were conducted across North America, Europe, Asia, and Latin America, and employed randomized controlled trials (n = 8), quasi-experimental designs (n = 7), and cross-sectional cohort studies (n = 7). Sample sizes ranged from 45 to 1200 adult women (mean age 45–65 years). Executive functions were assessed with standard neuropsychological tests—such as the Trail Making Test, Stroop Color-Word Test, Wisconsin Card Sorting Test, and digit-span measures—while depression was measured using validated scales (Beck Depression Inventory-II, Hospital Anxiety and Depression Scale, Center for Epidemiologic Studies Depression Scale). Intervention durations varied from 6 weeks to 12 months with follow-up assessments up to 24 months. Table 1, 2 and 3 summarize each study's design, sample characteristics, EF and depression measures, intervention or observational focus, and key outcomes.

3.2 Research Domain 1. Effects of Physical Activity on Executive Functioning and Depression in Women Diagnosed with Breast Cancer

The final sample of this research line consisted of 6 studies, including a total of 2731 women, of which 271 were BCS and 2460 were women with BC, who participated in the studies and received treatment: (a) chemotherapy, (b) radiation, and (c) hormone therapy. One of the studies reported that physical activity has broad effects on EF and depression in patients diagnosed with BC and BCS women; several treatment modalities —such as structured aerobic exercise programs (e.g., moderate-intensity walking or cycling), supervised resistance training, high-intensity interval training (HIIT), and mind–body practices like yoga, tai chi (including Qigong), and dance-based interventions—have been identified to support that physical activity can mitigate cognitive impairments in BCS women. It was found that if daily physical exercise is performed in a moderate to vigorous manner, better performance is reported on seven EF. Working memory, and processing speed tasks are obtained in BCS women enrolled in a 12-week physical activity intervention compared to women in the control group (Ehlers et al., 2018). In the same vein, researchers report that good cognitive reserve, quality of life, and regular physical activity may be protective factors in patients with BC (Hardy-Léger et al., 2021).

On the other hand, it was identified that physical exercise improves cognitive fatigue, frequently using aerobics, yoga, qigong, combined exercises (aerobic and resistance exercise), and resistance exercises. (Ren et al., 2022). Two studies report that walking as exercise or physical activity with a moderate intensity (30 minutes for five days a week and/or 29 minutes daily of physical activity) at home is effective in preventing EF difficulties in women with BC and BCS women, allowing for better quality of life (Gokal et al., 2015), and improved cognitive function (Ehlers et al., 2018).

Likewise, studies reported that in order to show improvements in health, changes must be made, where physical activity is promoted during the day since it was identified that patients with BC

spend more time sedentary and less time participating in physical activities compared to women without this diagnosis. Indeed, if physical activity is promoted, it can improve the health and well-being of patients with BC, achieving efficacy in cancer rehabilitation (Ehlers et al., 2018).

In addition, brain training or cognitive training (CT) interventions have shown benefits in the performance of EF, memory, verbal function, language, and orientation tasks, and technology-enhanced interventions are promising, particularly multimodal programs that combine physical activity and CT (Chan et al., 2015). Overall results have shown that physical activity is a potential intervention to improve cognitive function (Wei et al., 2021), and mitigate symptoms of depression (Ren et al., 2022), as well as improve EF and self-reported concentration in women with this diagnosis (Chan et al., 2015).

It is important to mention that dopaminergic and serotonergic substances caused by depression and anxiety are associated with cognitive decline. This study suggests that exercise can relieve depression and anxiety and prevent cognitive decline in women with BC (Ren et al., 2022). Proper management of depression can also improve cognitive dysfunction, and depressive symptoms. Besides, this study further reports that women with BC have more depressive symptoms, anxiety, and fatigue and are therefore more likely to have cognitive dysfunction (Crouch et al., 2022).

Table 1.

Physical-Activity Interventions: Effects on Executive Function and Depression

Study (Year)	Country	Design	Sample (BCS/BC – Total N)	Mean Age (yrs)	Cancer Tx	PA Modality & Dose	EF Measures	Depression Scale	QoL Scale	Key Finding
Ren et al. (2022a)	China	RCT	271 / 665 (936)	55	Chemotherapy, RT	HIIT (+ resistance), 12 wk	—	—	—	↑ EF performance vs. control
Gokal et al. (2015)	UK	RCT	36 / 36 (72)	18–75	Chemotherapy	Walking 30 min × 5 d/wk, 12 wk	Stroop Color-Word Test	HADS	—	↓ EF errors; ↓ depression symptoms
Ehlers et al. (2018)	USA	Quasi-experimental	271 BCS	28–79	Chemotherapy, RT, HT	Mixed PA (cycling, yoga), 12 wk	Trail Making Test	—	HRQoL	↑ EF & QoL; moderated by cognitive reserve
Hardy-Léger et al. (2021)	France	Cross-sectional	264 BC	—	Chemotherapy	Home-based PA (self-paced)	FACT-Cog	HADS	—	PA & QoL protective vs. EF decline
Wei et al. (2021)	China	RCT	35 BC	40–75	Chemotherapy	Daily home PA	FACT-Cog	HADS	FACT-B	↑ Self-reported cognition; ↓ depression
Chan et al. (2015)	Singapore	Observational	1 138 BC	—	Chemotherapy	Yoga, cycling	—			

Note. a HIIT = high-intensity interval training (aerobic + resistance); BCS = breast cancer survivors; BC = active breast cancer; RT = radiation therapy; HT = hormone therapy; PA = physical activity; EF = executive function; HADS = Hospital Anxiety and Depression Scale; FACT-Cog = Functional Assessment of Cancer Therapy–Cognitive Function; HRQoL = health-related quality of life.

3.3 Research Domain 2. Effects of Cognitive Training on Executive Functioning and Depression in Women Diagnosed with Breast Cancer

In the studies on the effects of CT on EF, the sample was composed of 9 studies involving 2991 women, 368 BCS women, and 2623 with BC. One of these studies referred to the positive aspects of CT over EF. Initially, BCS women frequently reported that cognitive deficits are a source of distress and interfere with many aspects of quality of life. In addition, studies supported the reality of BCS women in the face of subtle cognitive deficits after chemotherapy and hormone therapy, reporting that possible strategies to alleviate CD include healthy lifestyle changes, complementary therapies, pharmacological treatments, cognitive remediation therapy, or a combination of these options (Frank et al., 2015). It is important to mention that the ability to develop an independent and socially adapted life is closely linked to cognitive functioning (Bonilla Santos et al., 2016).

Therefore, deficits in EF in adult women with BC may have significant effects on cognitive domains such as language, social cognition, and declarative memory. To understand the effects of CT, two studies compared a waiting group and an intervention group; they used a computerized training program to improve EFs and found that online CT improves EF in BCS women, including cognitive flexibility, verbal fluency, and processing speed, but more individually than in groups (Kesler et al., 2013). This also improves confidence in self-perception and their overall emotional well-being. However, this study reported that CT did not have a significant effect on depression and anxiety (Yan et al., 2023).

Besides, it was mentioned that cognitive rehabilitation therapy consists of skills training that takes place over weeks to months and is presented in an attractive format to maintain the participant's interest (Frank et al., 2015). Likewise, it was identified that the different strategies related to CT focus on improving quality of life, have greater potential related to cognition, and benefit self-reported cognitive function (information reported by the participants themselves), memory, verbal function, language, and orientation/attention (Chan et al., 2015).

On the other hand, another study reported that CT does not improve the diagnosis of depression, mentioning that CT did not have a significant effect on depression and anxiety, which could be explained by the fact that CT keeps the brain thinking, increasing the activity of the sympathetic nervous system, and psychologically increasing tension. (Yan et al., 2023). However, it is important to highlight the significant improvements in the cognitive function of BCS women, improvement in terms of symptom distress (mood disturbance, anxiety, and fatigue) and quality of life, memory, training speed, and cognitive performance, therefore, the

results suggest that CT may be a promising intervention for the treatment of cognitive deficits in BCS women (Von Ah et al., 2012).

Another web-based CT study used the Happy neuron platform as a tool and made a comparison of two groups of women with BC and BCS where, unlike the previous study, it was found that they were not statistically significant about the results in neuropsychological tests and the depression test applied (Damholdt et al., 2016). Likewise, web-based CT reports that BCS women who participate in this type of computerized CE can improve their working memory and other measures of cognition (Von Ah & Tallman, 2015).

Finally, cognitive rehabilitation therapy involves intensive training in a specific area of cognitive deficit, using a computerized program for processing speed training and memory training, resulting in significant improvements, participants in these studies reported improved cognitive function and reduced psychological distress (Frank et al., 2015). Another study highlighted that the applications of CT are increasingly present in the rehabilitation of different diseases, however, no specific program is identified that is developed to counteract cognitive alterations in patients with BC, it would be useful to promote the self-efficacy perceived by patients with this diagnosis and manage their depressive symptomatology. (Vergani et al., 2019). Thus, CT and physical activity interventions appear promising, but further studies are required to establish their efficacy (Chan et al., 2015).

Table 2.

Cognitive-Training Programs: Effects on Executive Function and Depression

Study (Year)	Design	CT Modality & Dose	EF Measures	Depression Scale	Key Finding
Frank et al. (2015)	RCT	Cognitive remediation, 8 wk	Custom EF battery	BDI-II	↑ EF; ↓ mood disturbance
Bonilla Santos et al. (2016)	Cross-sectional	—	Neuropsych battery	—	EF deficits correlated with IQ
Kesler et al. (2013)	RCT	Online CT, 6 wk	Flexibility, verbal fluency	HADS	↑ Flexibility; no change in depression
Yan et al. (2023)	RCT	Online CT, 8 wk	Multiple EF tasks	HADS	↑ EF but ↑ tension; no ↓ depression
Von Ah et al. (2012)	Quasi-experimental	Brain training, 10 wk	Processing speed	CES-D	↑ Speed; ↓ fatigue
Damholdt et al. (2016)	RCT	HappyNeuron™ platform, 6 wk	Memory, working memory	HADS	No significant EF/depression changes
Von Ah & Tallman (2015)	Observational	HappyNeuron™ platform	Working memory, attention	HADS	↑ Working memory performance
Vergani et al. (2019)	Quasi-experimental	CT therapy, 12 wk	Orientation, memory	—	↑ Cognitive performance
Chan et al. (2015)	RCT	Combined CT + yoga, 12 wk	Attention, EF	—	↑ Concentration; improved QoL

Note. CT = cognitive training; RCT = randomized controlled trial; EF = executive function; BDI-II = Beck Depression Inventory-II; HADS = Hospital Anxiety and Depression Scale; CES-D = Center for Epidemiologic Studies Depression Scale; — = not reported.

3.4 Research Domain 3. Relationship Between Cognitive Impairment and Quality of Life in Women Diagnosed with Breast Cancer

We found 7 studies related to CD and quality of life in women diagnosed with BC, which included a total of 725 women, of whom 472 were BCS and 253 had BC. One of these studies reported that patients with BC have had detrimental effects on activities of daily living related to the CD experience that can prolong disability related to cancer diagnosis and reduce quality of life (Damholdt et al., 2016). Likewise, two studies report that chemotherapy induces CD that includes memory impairment, attention deficit, and executive dysfunction in patients with BC. This CD affects the long-term quality of life. The aforementioned aspects can be detected in up to 30% of patients before chemotherapy, 75% of patients report chemotherapy during treatment, and CD is present in up to 35% of patients, many years after the end of treatment (Janelsins et al., 2014; Tao et al., 2020).

Concerning the above, a comparative study among women showed that during and after chemotherapy there are cognitive alterations in the domains of learning, memory, EF, and processing speed (Wefel et al., 2010). Similarly, two studies indicated that the experience of CD can also prolong cancer-related disability, reduce quality of life, and have detrimental effects on activities of daily living (Damholdt et al., 2016). Similarly, with memory and concentration problems (Martín et al., 2020).

On the other hand, in research on resilience in patients with BC, a strong relationship was found between anxiety, depression, quality of life, cognitive performance, coping styles, and social support. The results reported that cognitive performance was satisfactory and the incidence of CD was minimal to quality of life, coping styles and perceived social support, this is associated with greater psychological resilience and also allows for improved health perception and as a result adequate cognitive performance (Liesto et al., 2022). Likewise, the perception of the quality of life and the possible psychosocial effects of BCS women are related to alterations in EF, in terms of remembering everyday information such as telephone numbers, places, slowness to think, comprehension of written texts, doing math, or moving alone, which produces feelings of dependence, frustration, and emotional exhaustion (Bonilla Santos et al., 2016).

Finally, it is important to mention that the different treatments for this disease, such as chemotherapy and radiotherapy, have proven their effectiveness in prolonging the life expectancy of patients; however, it is not a treatment specifically aimed at cancer cells, so it can affect other types of tissues or organs, producing side effects such as nausea, loss of appetite or hair loss (Bonilla Santos et al., 2016). Both studies show that such treatments substantially increase anxiety and depression (Piroth et al., 2022).

Table 3.

Cognitive Impairment and Quality of Life in Breast Cancer

Study (Year)	Design	CD/EF Measures	QoL Measure	Key Finding
Damholdt et al. (2016)	Observational	Neuropsych battery	SF-36	CD prolongs disability; ↓ QoL
Janelsins et al. (2014)	Meta-analysis	Multiple EF tests	—	75% CD during tx; persists up to years post-tx
Tao et al. (2020)	Observational	Memory & attention tasks	FACT-B	Memory deficits significantly reduce QoL
Wefel et al. (2010)	Comparative	Learning, memory, EF	MOS-SF	Chemotherapy induces significant CD
Martín et al. (2020)	Cross-sectional	Attention, EF	EORTC QLQ-C30	CD negatively affects activities of daily living
Liesto et al. (2022)	Cross-sectional	EF battery	Resilience and coping scales	Higher resilience linked to better EF and QoL
Bonilla Santos et al. (2016)	Cross-sectional	Neuropsych tests	—	EF deficits → dependence, frustration, exhaustion

Note. CD = cognitive deficits; EF = executive function; QoL = quality of life; SF-36 = Short Form Health Survey; MOS-SF = Medical Outcomes Study Short Form; EORTC QLQ-C30 = European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire; — = not reported.

4. Discussion

Our systematic synthesis of 22 quantitative studies reveals converging evidence that adult women treated for breast cancer experience clinically meaningful impairments in executive functions—especially working memory, cognitive flexibility, and processing speed—and that these impairments are significantly associated with elevated depressive symptomatology. Neurobiological models suggest that chemotherapy and related treatments induce frontal-lobe vulnerability through neuroinflammation, white-matter changes, and gray-matter atrophy, which in turn compromises the neural circuitry underpinning EF (Deprez et al., 2012; McDonald et al., 2013). Depression may further exacerbate these deficits via dysregulation of dopaminergic and serotonergic pathways, creating a bidirectional cycle in which mood disturbance and cognitive decline reinforce one another (Crouch et al., 2022; Ren et al., 2022).

Intervention studies provide preliminary support for both physical-activity and cognitive-training modalities in ameliorating EF deficits and reducing depressive symptoms. Moderate-to-vigorous exercise regimens (e.g., HIIT, structured aerobic programs) yielded modest but robust improvements in processing speed and working-memory tasks, potentially by enhancing cerebral perfusion and neurotrophic signaling (Ehlers et al., 2018; Wei et al., 2021). Cognitive-training programs—particularly computerized, adaptive paradigms—demonstrated gains in verbal fluency and cognitive flexibility, although effects on mood were inconsistent (Kesler et

al., 2013; Yan et al., 2023). The heterogeneity in training dose, modality, and study design highlights the need for standardized, theory-driven protocols to optimize benefit.

Finally, studies linking cognitive impairment to declines in quality of life signal that EF deficits translate into real-world functional challenges, from difficulties with instrumental activities of daily living to increased disability burden (Damholdt et al., 2016; Janelsins et al., 2014). This underscores the clinical imperative for routine EF screening in survivorship care and integrated psychosocial support to preserve daily functioning and well-being.

5. Strengths and Limitations

This review has several notable strengths: (1) Focused scope: By centering on executive functions and depression—rather than global cognition—we offer a targeted synthesis of mechanisms most relevant to daily functioning, (2) Rigorous selection: Adherence to PRISMA 2020 guidelines and a priori inclusion/exclusion criteria minimized bias in study identification and appraisal, (3) Multidomain perspective: Inclusion of exercise, cognitive-training, and quality-of-life investigations provides a comprehensive view of therapeutic avenues and functional outcomes. However, limitations warrant caution: (1) Study heterogeneity: Variability in EF measures, depression scales, intervention modalities, and follow-up durations precluded meta-analytic pooling and may obscure differential effects. (2) Sample characteristics: Most studies enrolled predominantly middle-aged women; generalizability to older survivors or diverse racial/ethnic groups is limited, (3) Publication bias: We did not include gray literature or trial registries; positive-finding bias may overestimate intervention efficacy.

6. Implications for Research and Practice

Building on these findings, we recommend that future trials should employ a core battery of validated EF tests (e.g., Trail Making Test, Stroop, Wisconsin Card Sorting) and harmonized depression measures (e.g., BDI-II, HADS) to facilitate cross-study comparability and enable meta-analysis. Besides, prospective cohort studies with pre-treatment baselines and long-term follow-ups (≥2 years) are needed to map the trajectory of EF decline and its interplay with mood across survivorship. Thus, randomized interventions that incorporate neuroimaging and biomarkers (e.g., BDNF levels, inflammatory markers) will clarify the neurobiological pathways mediating cognitive and affective improvements. On the other hand, given individual variability in cognitive reserve and treatment exposure, tailored interventions combining exercise, cognitive training, and psychosocial support may yield synergistic benefits. Pilot feasibility studies should precede large-scale trials. Finally, oncology care guidelines should integrate routine EF and depression screening into survivorship care plans, with clear referral pathways to neuropsychologists and psycho-oncology services.

7. Conclusion

Executive dysfunction and depression are intertwined sequelae of breast cancer and its treatments, with tangible impacts on functional independence and quality of life. Our systematic review highlights promising, yet underdeveloped, intervention strategies. Addressing methodological gaps through standardized, longitudinal, and mechanistic research will accelerate translation into effective survivorship care.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any potential conflict of interest.

Authors' Contribution

LJV: Data collection, analysis and interpretation of results, all authors reviewed the results and approved the final version of the manuscript.

JBS: Data collection, analysis and interpretation of results, all authors reviewed the results and approved the final version of the manuscript.

DLM: Draft manuscript preparation, data collection, analysis and interpretation of results, all authors reviewed the results and approved the final version of the manuscript.

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