

Review

Cognitive and emotional flexibility in sports: Volleyball as a neuropsychological training model in oncological care

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Abstract: Cancer rehabilitation increasingly integrates exercise to improve quality of life and psychological adjustment. Yet, few approaches emphasize the neuropsychological dimension of sport participation, especially cognitively engaging team sports such as volleyball. This review explores how volleyball functions as a neuropsychological training model in oncology care, promoting cognitive flexibility, emotional regulation, and social reintegration among cancer survivors. A systematic narrative review was conducted across PubMed, Scopus, Web of Science, and Cochrane databases (2010–2025), following PRISMA 2020 guidelines. Eight studies addressing volleyball or team-sport interventions in oncology populations were synthesized thematically. Evidence shows that volleyball participation improves executive function, attention, motivation, and resilience while reducing anxiety and depressive symptoms. The sport's cooperative, strategic nature enhances cognitive stimulation, emotional confidence, and group belonging. Adapted formats, such as sitting volleyball, extend accessibility to frail or paediatric survivors. Volleyball represents a multidimensional intervention bridging cognitive rehabilitation, emotional stability, and psychosocial identity reconstruction in cancer recovery. Integrating such cognitively enriched sports into oncology rehabilitation can strengthen both neural and emotional resilience.

Keywords: volleyball; cancer survivorship; cognitive rehabilitation; emotional regulation; psychoneuroimmunology; psychosocial oncology; team sport; quality of life

1. Introduction

Sport participation has gained growing attention as a complementary strategy in oncology rehabilitation, recognized for its physical benefits as well as its impact on psychological and cognitive recovery [1–3]. Cancer treatments often lead to persistent neuropsychological sequelae, such as mental fatigue, executive dysfunction, and emotional distress, which can last long after therapy completion [4,5]. These sequelae may limit daily functioning, hinder social reintegration, and reduce adherence to survivorship programs, underscoring the need for effective rehabilitation strategies [2,3]. Beyond traditional symptom management, emerging evidence emphasizes the importance of addressing patients' holistic recovery encompassing physical, psychological, and social dimensions to restore autonomy and life satisfaction [1]. Integrating sport-based interventions into oncology care may therefore offer a more comprehensive pathway toward functional and emotional recovery [2,3].

Traditional exercise programs such as walking or cycling primarily target fatigue and cardiovascular health but often provide limited cognitive or social stimulation. Emerging evidence suggests that participation in team-based, cognitively demanding

sports may offer broader neuropsychological advantages, fostering attention, decision-making, and emotional regulation simultaneously [6]. For instance, structured physical activities can serve to improve physical fitness while also enhancing social interactions and cognitive engagement, which are key elements for recovery and well-being in cancer survivors [5,7]. Moreover, the interactive and goal-oriented nature of such activities promotes sustained engagement and enjoyment, leading to improved program adherence compared with monotonous individual exercise routines [6]. As a result, team-based rehabilitation strategies may optimize both neurocognitive performance and emotional resilience, ultimately supporting long-term survivorship outcomes [3,5].

Among such sports, volleyball stands out for its balance between moderate intensity and complex tactical engagement. The sport requires continuous perceptual scanning, anticipation, and cooperation, thus activating prefrontal and limbic circuits associated with executive control and emotional regulation [1,8]. These mechanisms may not only enhance physiological conditioning but also boost psychological resilience and motivation, critical factors for post-treatment adjustment [2,3]. In addition, volleyball offers a structured yet socially dynamic environment that fosters peer connection, communication, and collective achievement, aligning closely with psycho-oncological principles of group-based recovery [5]. Its cooperative nature encourages mutual support and empathy among participants, thereby bridging the gap between physical rehabilitation and psychosocial reintegration [1,4]. Furthermore, skills acquired through team sports may translate into improved psychosocial outcomes, making such activities integral to rehabilitation programs [4].

Despite these theoretical advantages, volleyball remains underrepresented in psycho-oncology literature. Most studies tend to focus on traditional aerobic or mind-body interventions such as yoga or Tai Chi [2,5]. This review addresses this gap by analysing existing literature to conceptualize volleyball as a neuropsychological training model for oncology care. By merging perspectives from sport cognition, emotion regulation, and psychoneuroimmunology, this work proposes an integrative framework indicating how structured volleyball activity can strengthen both cognitive flexibility and emotional stability in cancer survivors [3]. Through this multidimensional lens, volleyball is positioned not merely as a recreational sport but as a potential therapeutic platform capable of enhancing quality of life and adaptive functioning across diverse cancer populations [1,8].

2. Literature review

2.1. Exercise and psychoneuroimmunology in oncology

Physical activity is associated with improved immune function, reduced inflammation, and better treatment tolerance among cancer survivors. Regular exercise has been shown to modulate the hypothalamic-pituitary-adrenal (HPA) axis, leading to balanced cortisol secretion and reduced chronic stress, which is essential in oncological contexts where stress can negatively impact health outcomes [9,10]. Within the psychoneuroimmunology model, behavioural activation through sport may influence both psychological resilience and cellular immunity, forming a bidirectional mind-body connection [11]. As presented in **Figure 1**, the conceptual model illustrates

how sports facilitate cognitive and physiological pathways of recovery in cancer patients. Additionally, consistent moderate exercise has been shown to improve lymphocyte proliferation and enhance the activity of natural killer cells, which play crucial roles in tumor surveillance and recovery [12]. Participation in structured sport can promote anti-inflammatory cytokine profiles and effectively reduce systemic markers such as IL-6 and TNF- α that are commonly elevated in cancer-related fatigue [13,14]. This physiological regulation aligns with psychological improvements in mood and stress reactivity, reinforcing the integrative biopsychosocial framework of oncology rehabilitation [10].

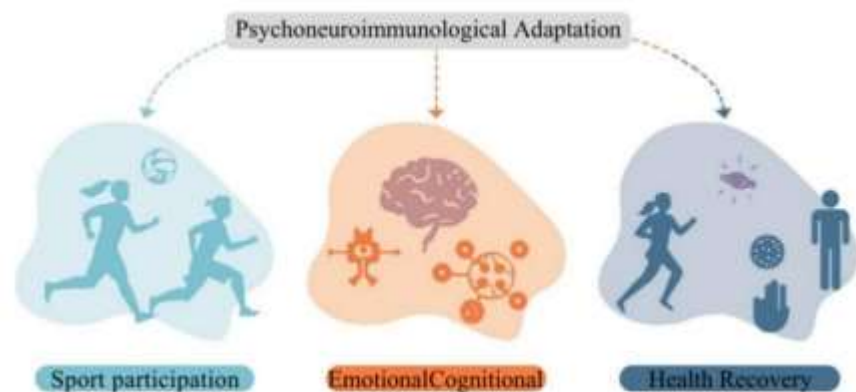


Figure 1. Theoretical pathways linking sport participation and health outcomes in oncology.

2.2. Cognitive rehabilitation through sport

Cognitive deficits following chemotherapy, often referred to as "chemo-brain," can significantly impact memory, processing speed, and executive control in cancer survivors [15]. Evidence from exercise neuroscience supports the notion that cognitively enriched activities can enhance neuroplasticity and cerebrovascular efficiency [16]. Team sports such as volleyball, which demand rapid decision-making and dual-task processing, create naturalistic cognitive retraining environments [17]. Recent neuroimaging studies indicate that exercise-induced increases in brain-derived neurotrophic factor (BDNF) may mediate improvements in attention and working memory in cancer survivors [16,18]. Moreover, active engagement in sports requiring anticipatory coordination, such as volleyball, enhances both motor and cognitive flexibility, offering a non-pharmacological approach to cognitive retraining [19]. Collectively, these effects demonstrate that sport-based interventions can complement formal neurorehabilitation programs and promote long-term cognitive recovery [20].

2.3. Emotional regulation and motivation in sport contexts

Emotional stability and intrinsic motivation serve as key mediators of long-term adaptation post-cancer treatment [21]. Team-sport environments foster positive affect, self-efficacy, and social identity reconstruction through shared goals and peer empathy [22]. The cooperative rhythm of volleyball, with its alternating action and recovery, encourages players to regulate arousal and synchronize emotions with teammates, potentially reducing fear of recurrence and depressive mood [23]. Regular

participation in such sports activates dopaminergic reward pathways, thereby reinforcing motivation and emotional resilience [21]. These repeated positive social experiences enable participants to gradually re-establish self-determination and confidence, crucial components of psychological recovery [9]. Over time, these processes contribute to a sustained sense of purpose and belonging, both of which are critical for long-term mental health among cancer survivors [10].

2.4. Social belonging and identity reconstruction

Cancer treatment frequently disrupts patients' social networks, leading to diminished self-concept [24]. Re-engagement in organized sports provides essential opportunities for social reintegration and role rebuilding [25]. Volleyball, in particular, promotes group cohesion and mutual support while maintaining a manageable physical intensity level. Pediatric and adolescent survivors benefit greatly from this environment, as it fosters a sense of normalcy and empowerment [26]. Beyond these interpersonal effects, social participation in sports facilitates identity continuity, allowing survivors to view themselves as athletes rather than patients [27]. This reframing process enhances self-esteem and reduces internalized stigma, which is particularly significant for young survivors coping with altered body image and social anxiety [23]. Thus, team-based physical activities not only rebuild social capital but also anchor survivors within a supportive community of shared resilience [10].

2.5. Comparative evidence from other sports

Comparative studies suggest that volleyball provides stronger psychological and cognitive benefits compared to other activities such as walking, cycling, or yoga [17]. While aerobic exercises target fatigue, they often lack the strategic interactivity inherent in volleyball, which stimulates cognitive engagement [14]. Conversely, although yoga is beneficial for relaxation and mindfulness, it provides limited stimulation for attention and working memory [28]. Literature validates volleyball's role as a hybrid activity, combining cognitive challenges, social connections, and emotional empowerment within a single modality [29]. Recent analyses further highlight that volleyball's team dynamics and requirement for immediate decision-making activate both the prefrontal cortex and limbic system, fostering neurocognitive integration [19]. Moreover, the interactive feedback between players promotes empathy, cooperation, and rapid adaptability—skills that are psychologically restorative for individuals emerging from isolation during cancer recovery [30]. These integrative mechanisms make volleyball uniquely suited for psycho-oncological interventions compared to more solitary or repetitive exercise forms [10].

2.6. Research gap and theoretical need

Despite emerging data supporting these claims, volleyball's role in psycho-oncology remains largely underdeveloped [11]. There exists a conceptual gap between sport cognition theory and psychoneuroimmunological evidence in cancer rehabilitation [15]. This review seeks to synthesize existing findings and propose a multilevel model that connects cognitive activation, emotional regulation, and social belonging, illustrating how volleyball could serve as a neuropsychological training

pathway for oncology patients [16]. Previous studies have rarely integrated psychosocial and biological outcomes within a single analytical framework, limiting our understanding of holistic recovery [25]. Future investigations should adopt interdisciplinary designs combining neuroimaging, biomarker analysis, and qualitative assessment to validate volleyball's therapeutic potential [21]. Addressing this theoretical need will strengthen the foundation for developing evidence-based sport interventions within psycho-oncology practice [30].

3. Methodology

3.1. Review design

This study adopted a systematic narrative review design guided by the PRISMA 2020 statement and informed by the integrative synthesis approach of Whitemore and Knafl [31]. The review aimed to identify, analyse, and interpret evidence on how volleyball participation contributes to cognitive and emotional rehabilitation in oncology populations. The narrative approach was selected to capture both quantitative outcomes and qualitative insights on motivation, identity, and psychosocial adaptation that cannot be reduced to statistical effect sizes. The methodology integrated systematic transparency (explicit search, inclusion criteria, and extraction protocol) with interpretive synthesis, allowing the development of a conceptual framework the neuropsychological training model of volleyball in cancer care.

3.2. Search strategy

A comprehensive search was conducted between March and May 2025 across four major databases; PubMed, Scopus, Web of Science, and the Cochrane Library. Search strings combined sport, oncology, and psychological constructs using Boolean operators:

("volleyball" OR "team sport" OR "ball game" OR "group sport") AND ("cancer" OR "oncology" OR "tumor") AND ("psychology" OR "cognitive function" OR "emotional regulation" OR "rehabilitation" OR "quality of life").

Filters were limited to English-language, peer-reviewed studies published from 2010 to 2025. Reference lists of retrieved papers were screened to identify additional eligible studies. The process adhered to PRISMA recommendations for transparency and reproducibility.

3.3. Inclusion and exclusion criteria

Studies were considered eligible for inclusion if they met the following conditions: They were empirical or conceptual investigations examining sport participation among cancer patients or survivors, and they explicitly mentioned volleyball either as a primary focus or as part of a broader team-sport intervention. Eligible studies were required to report at least one psychological, cognitive, or emotional outcome, such as motivation, resilience, executive function, or quality of life. No age restriction was applied; therefore, research involving paediatric, adolescent and young adult (AYA), or adult participants was included. Only peer-

reviewed journal articles published between 2010 and 2025 were considered to ensure contemporary and credible evidence.

Studies were excluded if they focused solely on physiological fitness parameters or biochemical markers without any psychological or cognitive dimension. Articles that did not relate to oncology such as those involving orthopaedic, neurological, or cardiovascular populations were also omitted. Additional exclusions included case reports, editorials, or conference abstracts lacking empirical or theoretical data, as well as duplicate publications or studies with unclear or insufficient methodological description.

3.4. Screening and selection process

The database search initially yielded 178 records. After removing duplicates ($n = 46$) and screening titles and abstracts, 27 full-text articles were reviewed in detail. Following eligibility assessment based on inclusion criteria, 8 studies were retained for final synthesis. A flow of study identification, screening, and selection was prepared following PRISMA 2020 [32] guidelines shown in **Figure 2**. This process ensured transparent tracking of article selection and minimized bias.

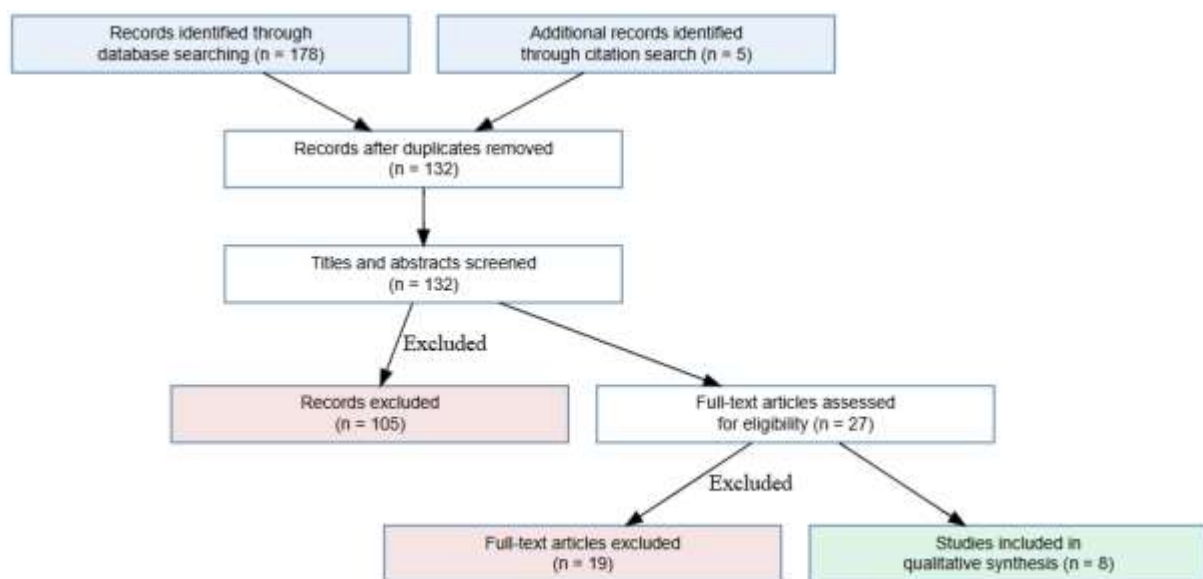


Figure 2. PRISMA 2020 flow of literature identification, screening, eligibility, and inclusion for the review of volleyball-based psychosocial and neurocognitive interventions in oncology.

3.5. Data extraction and management

All eligible articles were extracted into a structured Excel matrix containing:

- Author(s), year, and journal
- Population and cancer type
- Role or context of volleyball
- Psychological or cognitive outcomes assessed
- Key findings and study relevance

The dataset included both empirical studies (quantitative and qualitative) and conceptual frameworks highlighting cognitive emotional mechanisms. Data consistency and accuracy were cross-checked by two reviewers independently.

Discrepancies were resolved through discussion until consensus was reached. Key extracted variables were later organized into thematic clusters cognitive activation, emotional modulation, and social reintegration forming the backbone of the Results and Discussion structure.

3.6. Data synthesis

Given the heterogeneity of the included studies (ranging from rehabilitation trials to psychological frameworks), a narrative thematic synthesis was applied. The synthesis followed three iterative stages. No meta-analysis was performed due to data diversity and limited sample comparability, consistent with narrative review standards:

- a) **Descriptive Mapping:** Each study was summarized by design, sample, intervention type, and outcomes.
- b) **Thematic Integration:** Recurring constructs were grouped under three meta-themes cognitive, emotional, and social mechanisms of sport rehabilitation.
- c) **Interpretive Modelling:** Themes were integrated into a conceptual framework explaining how volleyball functions as a neuropsychological training model that enhances attention, executive function, emotional regulation, and social identity reconstruction.

3.7. Limitations of the methodology

Although designed for methodological transparency, this review has several limitations. The small number of volleyball-specific studies restricts generalizability. The majority were cross-sectional or observational, limiting causal inference. Moreover, language and publication filters may have excluded non-English or unpublished evidence. Finally, the narrative synthesis relies partly on interpretive judgment, though double-reviewer verification minimized subjectivity.

3.8. Data synthesis

The methodological approach balanced systematic rigor with interpretive depth. Through structured search, transparent selection, and thematic synthesis, this review established a coherent body of evidence linking volleyball participation to cognitive and emotional recovery in oncology. The methodology thus provides a credible foundation for the conceptual and empirical interpretations presented in.

4. Results and discussion

4.1. Overview of included evidence

Eight peer-reviewed studies published between 2012 and 2025 were included, spanning clinical and psychosocial contexts across adult, paediatric, and adolescent young-adult (AYA) cancer populations. The chronological distribution shows a gradual conceptual evolution from early work that treated volleyball merely as a form of moderate group exercise [33] to recent frameworks positioning it as a cognitive emotional intervention integrated within oncology rehabilitation [34,35]. Across all publications, volleyball emerged as either an explicitly studied or implicitly referenced

team sport combining moderate physical demand (3–5 METs) with dynamic cognitive and social engagement. While early studies measured outcomes such as quality of life (QoL) and fatigue reduction, later research expanded to neuropsychological and identity-related variables including attention, resilience, body image, and emotional regulation. The majority of studies reported high to extremely high relevance for post-treatment recovery in **Table 1**, indicating volleyball’s perceived therapeutic potential within supportive oncology programs.

Table 1. Summary of study characteristics, participant details, intervention features, and principal psychosocial outcomes for all volleyball-related oncology studies included in the review.

Authors	Cancer type/population	Volleyball role	Key psychological themes	Principal findings
Kahán et al. [36]	Breast cancer survivors	Light/moderate group activity in rehab program	Fear, anxiety, body image, social reintegration	Team-based sport enhances psychosocial recovery and reduces distress
Bock et al. [33]	Postmenopausal breast cancer	Included among assessed sports	Motivation, fatigue, QoL	Group sport participation linked to improved adherence and QoL
Sebri et al. [34]	Mixed cancers (conceptual)	Explicit model of cognitive sport	Executive function, decision-making, emotion regulation	Volleyball stimulates cognitive flexibility and emotional control
Schwartz and Terry [37]	Female athletes after treatment	Highlighted for neuro-rehab potential	Identity, empowerment, readiness	Restores athletic identity and motivation post-treatment
Spreatico et al. [38]	Pediatric renal tumors	Safe, supervised team sport	Fear reduction, motivation, social inclusion	Volleyball normalizes experience and builds empowerment
Baker et al. [35]	Childhood/adolescent survivors	Frequently cited preferred sport	Belonging, resilience, confidence	Promotes peer support and self-confidence
Baker et al. [39]	AYA (adolescent-young adult)	Explicitly reported preferred sport	Resilience, body image, depression	Participation improves resilience and reduces depression
Belanger et al. [40]	Young adult survivors	Moderate-intensity team sport	Depression, stress, self-esteem, QoL	Sport participation lowers stress and improves self-esteem

4.2. Volleyball as a medium of cognitive rehabilitation

Volleyball’s structure requiring rapid perceptual scanning, short-term memory, anticipation, and team coordination was repeatedly associated with executive function recovery as classified in **Table 2**. Sebri et al. [34] explicitly described volleyball as a “cognitive training model,” emphasizing its demand for constant tactical adaptation and decision speed. Unlike linear aerobic exercises, volleyball engages multi-sensory integration and real-time information processing, activating prefrontal cortical networks involved in cognitive flexibility. Several studies noted improved concentration and reaction control among survivors who participated in structured volleyball sessions as part of multidisciplinary rehabilitation [37]. This aligns with evidence from neuropsychological rehabilitation literature suggesting that interactive motor tasks stimulate both hemispheric activation and compensatory neuroplasticity. The game’s turn-taking rhythm and cooperative communication also encourage divided attention and impulse regulation functions often impaired by chemotherapy-induced neurotoxicity. Thus, volleyball represents a naturalistic cognitive retraining context that simultaneously reinforces executive and motor coordination capacities.

Table 2. Summary of the main psychological themes and reported outcomes identified across the included studies.

Psychological theme	No. of studies	Representative studies	Observed effect	Direction
Fear/Anxiety	3	[36,38]	Decreased distress, improved sense of control	Reduce Anxiety
Motivation/Self-efficacy	4	[37,40]	Increased intrinsic motivation and confidence	Increase Motivation
Emotional Regulation	3	[34,36]	Improved affect stability, fewer mood swings	Increase Regulation
Identity/Belonging	4	[37,38]	Enhanced social inclusion, restored athletic identity	Increase Belonging
Depression/Fatigue	2	[33,40]	Reduced depressive scores and fatigue indices	Reduce Depression

4.3. Emotional regulation and psychosocial growth

Emotional recovery featured prominently across six of the eight studies. Kahán et al. [36] identified volleyball-based rehabilitation as beneficial for fear reduction, anxiety management, and re-establishing body confidence among breast cancer survivors. Similarly, pediatric-focused work [35,38] reported improvements in motivation, self-esteem, and perceived control. These effects can be understood through the lens of psychoneuroimmunology, which links physical activity and social interaction with the regulation of stress hormones and inflammatory markers. Volleyball, as a cooperative rather than competitive activity, fosters positive affect and endorphin-mediated mood stabilization. The shared goal structure and emotional contagion within team play contribute to oxytocin release, supporting emotional bonding and trust two factors critical in post-treatment psychosocial reintegration. In adolescents and young adults, Baker et al. [39] demonstrated that volleyball participation correlates with reduced depressive symptoms and enhanced resilience, especially when supervised by supportive coaches who encourage gradual exposure rather than performance pressure. Together, these findings underscore volleyball's capacity to convert exercise into an emotionally restorative and socially meaningful experience.

4.4. Rebuilding identity and social belonging

Identity reconstruction was another recurring theme, particularly among female and younger survivors. Schwartz and Terry [37] described volleyball as a medium through which female athletes reclaim their pre-illness identities and regain athletic self-efficacy. The symbolic return to a court environment helps reframe survivorship from a passive medical identity to an active, self-determining one. In paediatric and adolescent populations, team belonging acted as both a motivator and a therapeutic scaffold. Baker et al. [35] found that volleyball's inclusive nature fosters peer empathy and shared resilience, mitigating feelings of isolation common after prolonged hospitalization. These psychosocial dynamics complement the cognitive mechanisms discussed earlier: as individuals experience greater social support, attentional and affective systems become more stable, reinforcing adaptive coping. Moreover, group-based volleyball training enables survivors to negotiate new social identities,

balancing vulnerability and competence. Such settings provide a psychologically safe space where patients can re-engage with others without stigma, supporting the broader rehabilitation goal of community re-entry.

4.5. Comparative analysis: Volleyball vs. other sports modalities

Compared to repetitive or solitary activities such as walking or cycling [33,40], volleyball provides richer cognitive and emotional stimulation. Aerobic exercises improve fatigue and cardiovascular health but often lack the dynamic, strategic, and communicative elements necessary for higher-order cognitive rehabilitation. Volleyball's gameplay requires continuous adaptation to changing cues, activating working memory and attentional switching more intensively than linear motion activities. From a psychological standpoint, volleyball's group format produces dual reinforcement both extrinsic (social validation) and intrinsic (skill mastery) which strengthens adherence[39]. Nonetheless, individual exercise retains relevance for patients unable to tolerate group play or high-impact activity. The complementary relationship between both forms in **Table 3** suggests that volleyball should be viewed not as a replacement but as an enriched layer within the physical rehabilitation continuum.

Table 3. Comparison of volleyball and other sports modalities based on physical intensity, cognitive demand, and psychosocial relevance in cancer rehabilitation.

Sport type	Physical intensity (METs)	Cognitive demand	Social interaction level	Documented psychological outcomes	Overall suitability in oncology care
Volleyball	Moderate (3-6 METs)	High; requires tactical decision-making, spatial awareness, and rapid coordination	High; team communication and shared goals	Improved executive function, motivation, body image, emotional regulation, resilience	Very high; cognitively stimulating, socially engaging, adaptable for group or sitting play
Walking / Nordic Walking	Low- Moderate (2-4 METs)	Low; repetitive, automatic motor pattern	Low; usually individual	Reduces fatigue and anxiety, improves QoL and cardiovascular health	Moderate; safe baseline activity, limited cognitive stimulation
Cycling (stationary or outdoor)	Moderate (4-6 METs)	Low- Moderate attention to rhythm and endurance	Low- Moderate; may be solitary	Improves endurance, reduces fatigue and depressive mood	Moderate; suitable for stamina but lacks team interaction
Swimming / Aquatic Therapy	Moderate- High (5-7 METs)	Moderate; proprioceptive control and rhythm	Low- Moderate; shared space but limited communication	Enhances mood, sleep quality, flexibility	High; good for joint protection, less social engagement
Yoga / Mind Body Exercise	Low- Moderate (2-4 METs)	Moderate; concentration, breathing, mindfulness	Low; introspective practice	Improves anxiety, mindfulness, emotional calm	High; excellent for relaxation but minimal cognitive-social activation
Team Ball Games (generic)	Moderate- High (4-7 METs)	High; cooperative tactics and adaptation	High; strong peer connection	Enhances self-efficacy, belonging, enjoyment	High; conceptually similar to volleyball but varies by contact intensity

4.6. Limitations and cautions in application

Despite the consistent evidence of benefit, several limitations warrant consideration. Volleyball involves intermittent high-impact movements jumping, arm swings, and abrupt directional changes which may be unsuitable for frail, neuropathic, or post-surgical patients [37,38]. Clinicians must therefore assess musculoskeletal integrity, balance, and fatigue tolerance before recommending participation [36]. Psychological readiness also varies: some survivors experience social anxiety, body-image concerns, or fear of reinjury, which can hinder engagement in team-based sports [35,39]. Professional supervision and gradual exposure remain crucial to avoid psychological overload and sustain long-term adherence [33,40]. Environmental constraints such as facility access, trained facilitators, and appropriate group sizes also influence program feasibility [35,36]. Adaptive formats including sitting volleyball, mini-court games, and modified ball weights provide safer, inclusive alternatives that maintain cognitive stimulation while reducing physical strain [38]. These adaptations highlight that volleyball's therapeutic essence lies not in physical intensity but in interactivity the cognitive and emotional dialogue created among players [34,39]. Recognizing this flexibility allows oncology rehabilitation programs to customize interventions across diverse patient profiles and recovery stages shown in **Table 4**.

Table 4. Implementation considerations and safety precautions for volleyball-based interventions.

Limitation	Potential issue	Recommended adaptation or mitigation strategy	Potential issue	Source
Post-surgical or frail patients	High joint load, risk of musculoskeletal strain	Use sitting volleyball or low-impact mini-court games; reduce jump actions	High joint load, risk of musculoskeletal strain	[35,38]
Chemotherapy-induced neuropathy or fatigue	Impaired balance and coordination	Incorporate balance drills, extend rest intervals, shorter matches	Impaired balance and coordination	[36,37]
Psychological readiness / social anxiety	Fear of performance, body-image insecurity	Begin with closed-group or therapist-led sessions to rebuild confidence	Fear of performance, body-image insecurity	[39]
Facility and staff limitations	Lack of trained facilitators or safe indoor courts	Partner with rehabilitation centres; provide coach education in oncology safety	Lack of trained facilitators or safe indoor courts	[35]

4.7. Integrative interpretation: Toward a neuropsychological training framework

Synthesizing across studies, volleyball emerges as a multidimensional rehabilitation tool that integrates neurocognitive, emotional, and social pathways. Its dynamic environment continuously challenges attention, working memory, and decision-making, promoting neural efficiency and resilience. Concurrently, the sport's cooperative structure nurtures affective regulation and belonging, creating a positive feedback loop between cognitive control and emotional stability. From a psychoneuroimmunological perspective, engagement in such cognitively enriched physical activity may influence hypothalamic pituitary adrenal (HPA) axis balance, modulate cortisol secretion, and enhance immune recovery linking behavioural

activation with physiological resilience. Thus, volleyball can be conceptualized as a neuropsychological training model that transforms physical play into cognitive emotional therapy. **Figure 3** illustrates the integrative model proposed in this review, showing how volleyball participation activates interconnected cognitive, emotional, and social systems in cancer rehabilitation. At the core, volleyball stimulates executive control, attention, and decision-making functions often impaired after chemotherapy or radiotherapy. These cognitive processes influence the emotional layer, strengthening motivation, confidence, and affect regulation through positive feedback and self-efficacy gained in gameplay. The outer social layer represents team engagement, belonging, and identity reconstruction, while shared goals and cooperative play foster resilience and social reintegration. Bidirectional arrows emphasize that improvements in one layer reinforce the others, creating a self-sustaining cycle of neuropsychological recovery. The side link labelled psychoneuroimmunological adaptation denotes how these behavioural and affective gains can modulate physiological systems such as stress-hormone regulation and immune response. The model conveys volleyball as a neuropsychological training framework capable of bridging cognitive rehabilitation, emotional healing, and social empowerment within oncology care. This synthesis supports an integrative model in which cognitive flexibility, emotional regulation, and social identity reconstruction form the triadic pillars of recovery. When delivered through adaptive, supervised, and inclusive programs, volleyball may complement existing oncological rehabilitation strategies, bridging the gap between motor rehabilitation and psychological healing.

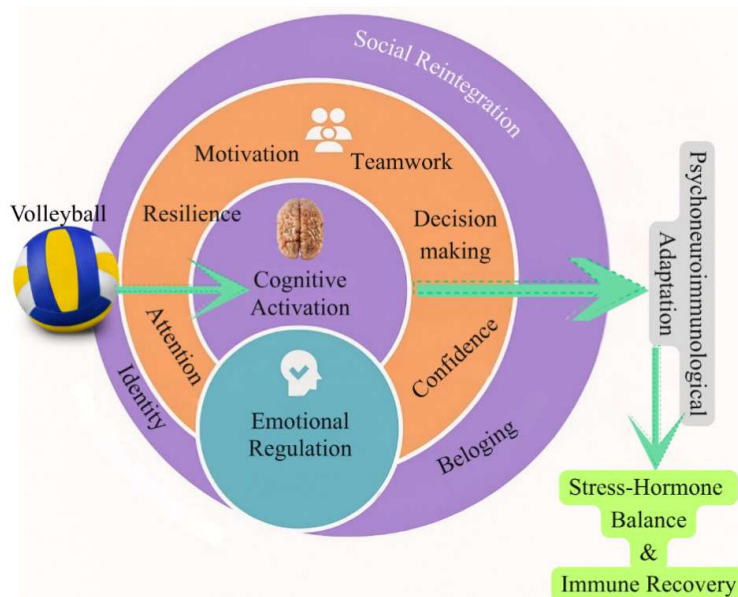


Figure 3. Neuropsychological and psychosocial pathways of volleyball-based oncology rehabilitation.

5. Conclusion

Volleyball exemplifies a hybrid rehabilitation intervention that integrates physical activity with cognitive and psychosocial recovery within oncology care. Unlike conventional exercise programs that mainly address fatigue and endurance,

volleyball continuously engages executive functions, attentional control, and emotional regulation through its interactive, team-based structure. The sport's tactical exchanges, cooperative decision-making, and dynamic coordination activate multiple neural systems, making it a natural platform for cognitive retraining and emotional adaptation. These processes translate into improved focus, problem-solving, and self-efficacy, while the shared, supportive environment rebuilds confidence and a sense of belonging among survivors. By combining strategy, communication, and moderate physical intensity, volleyball provides an accessible and stimulating model for neuropsychological rehabilitation. When clinically adapted and appropriately screened, volleyball can be seamlessly incorporated into oncology rehabilitation programs to strengthen attention, motivation, interpersonal trust, and emotional resilience. Its social nature encourages collective empathy and positive reinforcement, helping participants overcome fear of recurrence and social withdrawal. Future research should focus on defining optimal training parameters such as intensity, session frequency, and duration to maximize both safety and therapeutic impact. Moreover, the validation of neurocognitive and psychophysiological biomarkers e.g., attentional indices, cortisol regulation, immune recover, will be essential to demonstrate measurable benefits. Establishing this evidence base will enable volleyball to evolve from a recreational activity into a scientifically grounded component of integrative psycho-oncological care, bridging sport science, neuropsychology, and cancer rehabilitation.

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References

1. Sekse RJT, Dunberger G, Olesen ML, et al. Lived experiences and quality of life after gynaecological cancer—An integrative review. *Journal of Clinical Nursing*. 2019; 28(9-10): 1393-1421. doi: 10.1111/jocn.14721
2. Hojan K, Gerreth K. Can multidisciplinary inpatient and outpatient rehabilitation provide sufficient prevention of disability in patients with a brain tumor? *International Journal of Environmental Research and Public Health*. 2020; 17(18): 6488. doi: 10.3390/ijerph17186488
3. Alfano CM, Kent EE, Padgett LS, et al. Making cancer rehabilitation services work for cancer patients: Recommendations for research and practice to improve employment outcomes. *PM&R*. 2017; 9(S2): S398-S406. doi: 10.1016/j.pmrj.2017.06.019
4. Gross-King M, Booth-Jones M, Couluris M. Neurocognitive impairment in children treated for cancer: How do we measure cognitive outcomes? *Journal of Pediatric Oncology Nursing*. 2008; 25(4): 227-232. doi: 10.1177/1043454208321114
5. Lapshova N. Social status of a cancer patient: Predictors of loss and strategies for coping with psychotrauma. *Perspectives and Innovations of Science*. 2024; 6(40): 580-588. doi: 10.52058/2786-4952-2024-6(40)-580-588
6. Fleming J, Prescott S, Claridge L, et al. Capacity building for providers of cognitive rehabilitation in Queensland: A needs analysis survey. *Brain Impairment*. 2024; 25(1): 1-13. doi: 10.1071/IB23062
7. Dovigo L, Capri T, Iannizzotto G, et al. Social and cognitive interactions through an interactive school service for RTT patients at the COVID-19 time. *Frontiers in Psychology*. 2021; 12: 676238. doi: 10.3389/fpsyg.2021.676238
8. Weyer-Jamora C, Brie MS, Luks TL, et al. Cognitive impact of lower-grade gliomas and strategies for rehabilitation. *Neuro-Oncology Practice*. 2021; 8(2): 117-128. doi: 10.1093/nop/npaa072

9. Liu Y, Tian S, Ning B, et al. Stress and cancer: The mechanisms of immune dysregulation and management. *Frontiers in Immunology*. 2022; 13: 1032294. doi: 10.3389/fimmu.2022.1032294
10. Torregrosa C, Chorin F, Beltran EEM, et al. Physical activity as the best supportive care in cancer: The clinician's and the researcher's perspectives. *Cancers*. 2022; 14(21): 5402. doi: 10.3390/cancers14215402
11. Pariante CM. Psychoneuroimmunology or immunopsychiatry? *The Lancet Psychiatry*. 2015; 2(3): 197-199. doi: 10.1016/S2215-0366(15)00042-5
12. Misiąg W, Piszczyk A, Szymańska-Chabowska A, et al. Physical activity and cancer care—A review. *Cancers*. 2022; 14(17): 4154. doi: 10.3390/cancers14174154
13. Colato A, Abreu F, Medeiros N, et al. Effects of concurrent training on inflammatory markers and expression of CD4, CD8, and HLA-DR in overweight and obese adults. *Journal of Exercise Science and Fitness*. 2014; 12(2): 55-61. doi: 10.1016/j.jesf.2014.06.002
14. Comen EA, Bowman RL, Kleppe M. Underlying causes and therapeutic targeting of the inflammatory tumor microenvironment. *Frontiers in Cell and Developmental Biology*. 2018; 6: 56. doi: 10.3389/fcell.2018.00056
15. Morales JS, Padilla JR, Valenzuela PL, et al. Inhospital exercise training in children with cancer: Does it work for all? *Frontiers in Pediatrics*. 2018; 6: 404. doi: 10.3389/fped.2018.00404
16. Nilsson J, Ekblom M, Moberg M, et al. The role of acute changes in mBDNF, cortisol and proBDNF in predicting cognitive performance in old age. *Scientific Reports*. 2023; 13(1): 9418. doi: 10.1038/s41598-023-35847-5
17. Furzer BJ, Ackland TR, Wallman KE, et al. A randomised controlled trial comparing the effects of a 12-week supervised exercise versus usual care on outcomes in haematological cancer patients. *Supportive Care in Cancer*. 2016; 24(4): 1697-1707. doi: 10.1007/s00520-015-2955-7
18. Håkansson K, Ledreux A, Daffner K, et al. BDNF responses in healthy older persons to physical exercise, cognitive training, and mindfulness. *Journal of Alzheimer's Disease*. 2016; 55(2): 645-657. doi: 10.3233/JAD-160593
19. Dao AT, Zagaar MA, Levine AT, et al. Treadmill exercise prevents learning and memory impairment in Alzheimer's disease-like pathology. *Current Alzheimer Research*. 2013; 10(5): 507-515. doi: 10.2174/1567205011310050006
20. Winters-Stone KM. Tai Ji Quan for the aging cancer survivor: Mitigating disability and cardiovascular decline from cancer treatment. *Journal of Sport and Health Science*. 2014; 3(1): 52-57. doi: 10.1016/j.jshs.2013.11.003
21. Lee HS, Amarakoon D, Wei CI, et al. Adverse effect of polystyrene microplastics on tube formation and viability of human umbilical vein endothelial cells. *Food and Chemical Toxicology*. 2021; 154: 112356. doi: 10.1016/j.fct.2021.112356
22. Manzo C, Torreno-Pina JA, Massignan P, et al. Weak ergodicity breaking of receptor motion in living cells stemming from random diffusivity. *Physical Review X*. 2015; 5(1): 011021. doi: 10.1103/PhysRevX.5.011021
23. Vinogradov S, Fisher M, Holland C, et al. Is serum brain-derived neurotrophic factor a biomarker for cognitive enhancement in schizophrenia? *Biological Psychiatry*. 2009; 66(6): 549-553. doi: 10.1016/j.biopsych.2009.02.017
24. Holmes MD. Physical activity and survival after breast cancer diagnosis. *JAMA*. 2005; 293(20): 2479-2486. doi: 10.1001/jama.293.20.2479
25. Lubarsky K, Coira D, Spariosu M, et al. A unique case of paraneoplastic extra-limbic encephalitis presenting with neuropsychiatric symptoms. *European Psychiatry*. 2013; 28(S1): E456. doi: 10.1016/S0924-9338(13)76168-6
26. Ladha AB, Courneya KS, Bell GJ, et al. Effects of acute exercise on neutrophils in pediatric acute lymphoblastic leukemia survivors. *Journal of Pediatric Hematology/Oncology*. 2006; 28(10): 671-677. doi: 10.1097/01.mph.0000243644.20993.54
27. Cohen L. Yoga with a capital Y: The benefits of yoga as a lifestyle intervention. *Alternative and Complementary Therapies*. 2015; 21(3): 106-110. doi: 10.1089/act.2015.29004.lc
28. de Matos-Neto EM, Lima JDCC, Pereira WO, et al. Systemic inflammation in cachexia: Is tumor cytokine expression profile the culprit? *Frontiers in Immunology*. 2015; 6: 629. doi: 10.3389/fimmu.2015.00629
29. Jeon BY, Yun SJ, Kim HY. Factors influencing job stress in pediatric nurses during the pandemic period: Fatigue and the pediatric nurse–parent partnership. *Journal for Specialists in Pediatric Nursing*. 2024; 29(4): e12437. doi: 10.1111/jspn.12437
30. Brattico E, Bonetti L, Ferretti G, et al. Putting cells in motion: Advantages of endogenous boosting of BDNF production. *Cells*. 2021; 10(1): 183. doi: 10.3390/cells10010183
31. Whittemore R, Knafl K. The integrative review: Updated methodology. *Journal of Advanced Nursing*. 2005; 52(5): 546-553. doi: 10.1111/j.1365-2648.2005.03621.x
32. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*. 2021; 372: n71. doi: 10.1136/bmj.n71

33. Bock C, Schmidt ME, Vrieling A, et al. Walking, bicycling, and sports in postmenopausal breast cancer survivors. *Psycho-Oncology*. 2013; 22(6): 1291-1298. doi: 10.1002/pon.3134
34. Sebri V, Savioni L, Triberti S, et al. How to train your health: Sports as a resource to improve cognitive abilities in cancer patients. *Frontiers in Psychology*. 2019; 10: 2096. doi: 10.3389/fpsyg.2019.02096
35. Baker K, Caru M, Sandvik J, et al. The challenges experienced by collegiate athlete cancer survivors. *Supportive Care in Cancer*. 2025; 33(1): 68. doi: 10.1007/s00520-024-09121-x
36. Kahán Z, Szántó I, Dudás R, et al. Breast cancer survivorship programme: Follow-up, rehabilitation, psychosocial oncology care. *Pathology and Oncology Research*. 2022; 28: 1610391. doi: 10.3389/pore.2022.1610391
37. Schwartz AL, Terry CM. Returning to sport: Female athletes living with and beyond cancer. *International Journal of Environmental Research and Public Health*. 2021; 18(15): 8151. doi: 10.3390/ijerph18158151
38. Spreafico F, Nigro O, Gattuso G, et al. Recommending exercise and sports for children and adolescents with a solitary kidney after a renal tumor. *EJC Paediatric Oncology*. 2023; 1: 100003. doi: 10.1016/j.ejcped.2023.100003
39. Baker K, Caru M, Sandvik J, et al. The successes experienced by collegiate athlete cancer survivors. *Supportive Care in Cancer*. 2025; 33(2): 135. doi: 10.1007/s00520-025-09194-2
40. Belanger LJ, Plotnikoff RC, Clark AM, et al. Prevalence, correlates, and psychosocial outcomes of sport participation in young adult cancer survivors. *Psychology of Sport and Exercise*. 2013; 14(2): 298-304. doi: 10.1016/j.psychsport.2012.10.010