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Physical activity and testicular cancer survivorship health-related quality of life: a scoping review

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Abstract

Background: While the benefits of physical activity (PA) for cancer survivors are well-documented, there is limited research specifically exploring its effects on health-related quality of life (HRQoL) among testicular cancer (TC) survivors. This review aims to examine the available literature on the relationship between PA and HRQoL in TC survivors post-treatment.

Objective: To identify and synthesize existing studies on the effects of PA on HRQoL outcomes in TC survivors.

Eligibility criteria: Studies that examined the relationship between PA, TC survivorship, and HRQoL across various phases of survivorship were included. Only peer-reviewed articles and gray literature addressing these topics were considered.

Sources of evidence: A systematic search was conducted across seven databases and gray literature. Articles were evaluated based on titles, abstracts, and full-text reviews for inclusion.

Charting methods: Following Arksey and O'Malley's scoping review framework and PRISMA-ScR guidelines, studies were charted for key findings regarding the effects of PA on cancer-related fatigue, psychosocial outcomes, and HRQoL in TC survivors. The search also focused on identifying barriers to PA adherence and gaps in the current literature.

Results: Three studies were examined: one experimental study, one feasibility study, and one cross-sectional study. Findings suggested that PA interventions could reduce cancer-related fatigue, improve psychosocial well-being, and enhance HRQoL indicators such as vitality, self-esteem, and social functioning. High-intensity interval training showed short-term benefits, while low-intensity activities demonstrated feasibility for broader adoption. Adherence barriers included treatment side effects and psychosocial factors. Limitations included small sample sizes, self-reported data, and lack of long-term follow-up.

Conclusion: The findings suggest that PA can improve HRQoL in TC survivors, but significant gaps remain, particularly in terms of longitudinal studies, diverse populations, and tailored interventions. Future research should focus on developing scalable, sustainable PA interventions that address adherence and long-term health outcomes for TC survivors.

Plain language summary

A review of evidence between physical activity and testicular cancer

A scoping review was conducted to understand the breadth and depth of available literature on the relationship between testicular cancer survivorship and if physical activity can have a net-positive benefit to patient-reported post-treatment outcomes. Overall, the

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studies indicated a positive net effect of physical activity and testicular cancer survivorship patient-reported outcomes, particularly around the increased perceived need for exercise, reduced cancer-related fatigue, and a lessening of anxiety and depressive symptoms.

Keywords: health-related quality of life, physical activity, review, testicular cancer

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Introduction

An overview of testicular cancer survivor health concerns

Approximately 80% of all testicular cancer (TC) cases are found in males under the age of 45.[1,2] TC has a 95%–99% five-year survival rate when discovered in earlier stages[3]; however, these rates decrease by nearly 25% in more advanced cases.[4,5] Treatment of TC is remarkably effective, which is evidenced by an approximate 95% 5-year survival rate if caught in the early stages of development.[6] Nevertheless, this rate drastically decreases to 70%–75% in more advanced stages. Recent research suggests that impact of the disease is rising universally throughout all demographic subsets of at-risk men, not just White males, which has historically been the demographic group most affected by the disease.[7,8]

TC survivors are subject to both physical (e.g., hormonal imbalances, impotence, fatigue, overweight/obesity, peripheral neuropathy, cardiovascular toxicity, and fatigue/lethargy)[9–14] and mental (e.g., post-traumatic stress disorder, depression, anxiety, and body image disorders)[15,16] health concerns due in large part to the disease's unique treatment (e.g., platinum-based chemotherapy toxicity).[9]

Benefits of physical activity and TC survivorship

Engaging in regular physical activity (PA) has several physical, social, emotional, and cognitive benefits and has demonstrated efficacy in other fields and with other cancers.[17] We know that, for example, improved health-related quality of life (HRQoL) has been reported in men who met PA guidelines.[18] A meta-analysis by Toohey et al. reviewed 22 trials to assess exercise interventions as a part of palliative care plans for patients suffering from lung, breast, prostate, multiple myeloma, and mixed cancer types. These exercise interventions were administered from 2 weeks to 6 months. The analysis found that participants who engaged in exercise reported an increase in quality of life, aerobic fitness, and lower body strength with a decrease in fatigue (all $p < 0.05$).[19] Moreover, a multicenter study that measured the cumulative burden of morbidity found that vigorous exercise was protective and associated with a lower cumulative burden of morbidity score.[20] Additionally, PA for cancer survivors can improve psychological function, cognitive health, and can help to increase independence.[21]

Exercise can also benefit those suffering from chemotherapy-induced peripheral neuropathy (CIPN). CIPN is a phenomenon that is a side effect of some chemotherapy drugs and presents as numbness, tingling, sharp pain, lack of temperature sensation, or muscle weakness in the peripheral nerves, typically in the hands, feet, or both. A multicenter study found that one of the most common adverse health outcomes among TC survivors was sensory neuropathy, which was reported by 56.3% of 1214 survivors.[20] CIPN is not well managed pharmacologically, as the limited evidence available concludes low efficacy. In turn, a systematic review by Tanay et al. evaluated nonpharmacological methods for treating CIPN. The review found that 13 studies evaluated CIPN management with exercise. Of these, 10 concluded that groups receiving exercise interventions experience reduced CIPN symptoms during and/or after chemotherapy treatment.[22] Thus, PA for cancer survivors can improve their quality of life in ways beyond their physical health.

Despite the demonstrated benefits of exercise for cancer patients and survivors alike, adherence to exercise regimens among patients remains to be a problem. Unfortunately, less than 1-in-5 cancer survivors participate in regular PA, placing them at increased risk for developing chronic diseases.[23] Moreover, the meta-analysis by Toohey et al. found that overall median recruitment, retention, and adherence rates among patients with advanced cancer regarding exercise engagement were 56%, 80%, and 69%, respectively.[19] These

numbers should be contrasted to the predefined criterion of >25%, >75%, and >75% for recruitment, retention, and adherence, respectively. Thus, exercise engagement habits could be improved among both advanced cancer patients and survivors alike.

It is widely thought that behavior maintenance is defined as engagement with the intervention practice for at least 6 months. A systematic review by Salisbury et al. found that of 142 articles assessed, 21 articles referred to 18 total trials that considered the 6-month intervention point. The majority of these (10/18) focused on breast cancer, while the remaining involved prostate cancer, colorectal cancer, lymphoma, and/ or other cancer. Only five trials found significantly higher PA among the group receiving exercise intervention at 6 months and beyond when compared to the control group.[24] Thus, adherence to the intervention remains an issue.

Beyond adherence, there are many topical areas within the broader cancer discussion, however, that have a limited amount of information available on the efficacy of employed interventions. Evidence exists demonstrating that low-intensity PA interventions may be sufficient in promoting small changes in behavior that can last beyond intervention completion, such as increases in PA at 3-months post-intervention (~3 months).[25] For example, high-intensity interval training (HIIT) is the PA intervention of choice for numerous studies. However, HIIT may not be necessary to achieve favorable health outcomes for cancer survivors.[21] In fact, lower levels of PA may be more feasible and attainable for patients to engage in during treatment and succeeding treatment as this population can face various acute side effects during and post-treatment that may act as additional barrier to participating in regular PA. Thus, adopting PA strategies that consider both intensity for health-benefit and sustainability are of paramount importance.

Specific to TC, one unexplored area is the role regular PA can play in alleviating some of the morbidity burden associated with survivorship. Considering that TC survivors have an increased risk for a myriad of physical and mental health concerns and given the potential benefits of PA upon some of the most pressing reported concerns of this population, a review of the literature is warranted to determine the extent of the scope of available research.

For this study, we examined studies evaluating the relationship between PA and TC survivorship HRQoL. The research questions guiding this review were: What is the depth and breadth of existing research analyzing the relationship between PA and HRQoL among TC survivors? Further, what gaps exist in the current literature exploring the relationship? Our intention was, therefore, to provide to the field the next steps and implications of future research exploring PA interventions among TC survivors.

Materials and methods

Design

This scoping review mapped the existing literature on PA and TC to identify key themes, research gaps, and opportunities for future inquiry. Using Arksey and O'Malley's[26] framework for scoping reviews, we included studies that explored any association between PA (including exercise interventions, activity levels, and sedentary behavior) and TC across the prevention, diagnosis, treatment, and survivorship phases.

In adhering to the PRISMA-ScR[26] (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews; Supplemental Material) reporting guidelines, we ensured transparency and rigor in the review process by detailing our inclusion and exclusion criteria, search strategy, screening process, and data extraction methods. This systematic approach enabled us to synthesize the findings comprehensively, offering insights into the influence of PA on TC-related health outcomes, quality of life, and psychosocial well-being with results guiding recommendations for both clinical practice and future research on PA interventions for TC patients and survivors.

Data sources and search strategy

The search strategy used Ovid Medline (1950 to present), CINAHL (1982 to present), PsycInfo (1806 to present), All EBM Reviews (2023), Ovid Healthstar (1966 to present), ERIC, and Google Scholar (2023) databases to locate relevant literature. Further, the review used ancestry and gray literature searches to ensure full capture of relevant behavioral intervention research. The gray literature searches were confined to conferences and dissertation research concerning TC

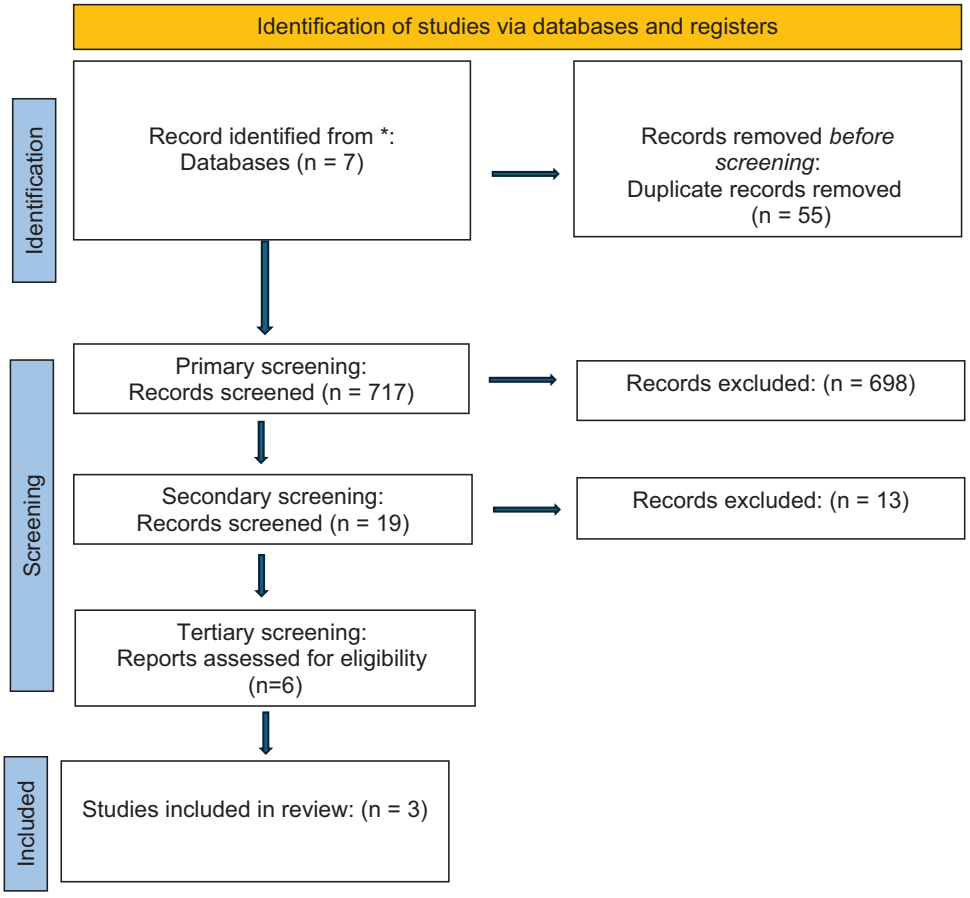

Figure 1. PRISMA flowchart.

and PA. All databases except for Google Scholar and ERIC used OVID Gateway. Google Scholar used its own search catalog while ERIC employed EBSCOhost.

Inclusion/Exclusion criteria

The inclusionary criteria for this scoping review of literature included peer-reviewed English-language literature examining the role between TC survivorship HRQoL and PA, as we were interested in determining the depth and breadth of existing literature.

This review did not include studies using participants who have sought care at a genitourinary medical clinic as these individuals may be more apt to follow recommended pelvic (i.e., testicular) health regimens than others.[27] Studies were excluded if it solely discussed the etiology of, and surgical or physical treatments for, TC.

Screening procedure

Primary screening. Our first assessment was to screen titles and abstracts for relevance. Articles were excluded that solely discussed the etiology and surgical or physical treatments for TC.

Secondary screening. Our second assessment screened full articles for relevance. Studies that did not specifically address/discuss PA, TC, and HRQoL were excluded.

Tertiary screening. Our third assessment of the articles further excluded studies that did not assess the relationship of PA vis-à-vis intervention methodologies. Only those studies that used experimental designs were included.

Review procedures and data abstraction

Three articles were ultimately included in this scoping review (see Figure 1). Relevant data,

Table 1. Selected study overview.

Reference	Design	Sample	Primary findings	Limitations
Effects of HIIT on fatigue and quality of life in testicular cancer survivors[21]	Prospective, two-armed randomized control trial (phase II)	*n* = 63	HIIT training is still a statistically significant intervention for cancer related fatigue in TC survivors' post-intervention. HIIT training has grander effects on those who did not partake in physical activity previously, had high testosterone, clinical fatigue, and lower fitness ability.	HIIT training showed no improvement for anxiety, stress, depression, or sleep quality (psychosocial outcomes). No significant effects on physical functioning, bodily pain, role-emotional or in their physical component score post intervention.
Psychological needs satisfaction, self-rated health and the mediating role of exercise among testicular cancer survivors[25]	Cross-Sectional with convenience sampling	*n* = 135	Physical activity satisfied the physiological need for autonomy, competence, and exercise.	Only 66% (*n* = 76) of participants stuck with their weekly exercise guidelines. Bivariate correlations indicated that covariates (age, cancer stage, and time since cancer diagnosis) were not significantly correlated with study variables. Self-rated mental health was significantly positively related to satisfaction of the needs for competence and relatedness but unrelated to autonomy and exercise. Utilized a convenience study and self-reported questionnaire.
Feasibility of a physical activity intervention during and shortly after chemotherapy for testicular cancer[27]	A single, institutional one-armed intervention study	*n* = 12	The intent to engage in physical activity was noted to be during the tail end of chemotherapy treatment and/or once treatment has ended.	With a small sample size, very few participants carried out the physical activity guidelines although it is important to note that these patients were still undergoing chemotherapy during the time of these PA assignments. Therefore, treatment related barriers were present. Gradually, all the participants were unable to keep up with the weekly guidelines. The researchers and labs were asynchronous in their collaborative efforts resulting in the inability to fully commit to this study.

HIIT, high-intensity interval training; TC, testicular cancer.

including type of intervention, research setting, behavioral change outcomes, and health outcomes, were extracted from each study and summarized. Due to the heterogeneity in study design and outcome measures, coupled with the lower numbers of identified qualifying articles, a systematic review or meta-analysis was not appropriate for this research topic.

A total of four reviewers conducted the primary searching and screening for relevant literature. Each reviewer had their criteria for search strategy parameters and appropriate databases to search through. Peer conferencing techniques were employed to discuss search findings and to decide on a final qualified batch of articles.

Results

Figure 1 demonstrates the process for identification of included studies. Of the three studies that focused on the relationship between PA's possible benefits among TC survivors, one was a feasibility study,[25] one was a randomized controlled trial (RCT),[18] and one was a descriptive study[23] (see Table 1).

In the RCT,[18] 63 TC survivors in Canada were randomly assigned to 12 weeks of supervised

HIIT (35 participants) or usual care (28 participants). Men between the ages of 18 and 80 with a confirmed history of TC and confirmation of post-surgery and treatment were eligible. Exclusion criteria included the inability to complete the first two stages of the aerobic exercise test, the presence of any uncontrolled cardiovascular condition, the presence of any psychiatric condition, or the regular performance of vigorous-intensity aerobic exercise.

HIIT participants attended three supervised sessions per week each approximately 35 min in length.[18] Usual care participants were asked to maintain their baseline exercise levels. Baseline characteristics included an average participant age of 43.7 years. 92.1% had a single orchidectomy and 36.5% received chemotherapy. Participants self-reported an average of 105 exercise min/week. Post-intervention results showed significantly improved self-reported cancer-related fatigue in the HIIT group ($p = 0.003$) and self-esteem ($p = 0.029$) but not depression, anxiety, stress, or sleep quality. In the HIIT group, there was also significant improvement in participants' mental component score ($p = 0.034$), vitality ($p = 0.001$), social functioning ($p = 0.011$), general health ($p = 0.016$), and role-physical ($p = 0.048$), and mental health ($p = 0.054$). Of note, there were no significant changes in physical functioning, bodily pain, role-emotional, or physical component score. At 3-month follow-up, HIIT maintained its significant effect on cancer related fatigue ($p = 0.031$) and vitality ($p = 0.015$). Yet, there were no other significant between-group differences for any other psychosocial or quality of life outcomes at 3-month follow-up.

Those survivors with a more sedentary lifestyle, lower fitness, higher testosterone, and clinical fatigue at baseline had a greater effect overall compared to other participants regarding cancer-related fatigue. Primary limitations of this study included smaller sample size, attrition at 3-months, self-reporting nature of the study, and between-condition baseline heterogeneity of clinical fatigue. Other reported limitations included the recruitment of TC survivors without specific psychosocial or HRQoL deficits and the lack of an attention control comparison group.

The feasibility study's[25] goal was to determine patient recruitment, compliance, and adherence to a PA intervention with consideration for variables such as self-perceived feelings of inefficacy, external obligations, preference of intensity and refusal to participate, and other comorbidities that the survivors suffer from, such as other ongoing cancer diagnoses and treatment. This study highlighted the expected positive relationship between PA and improvement in HRQoL for TC survivors. They noted that patients during and post-chemotherapy were experiencing a reduction in well-being and a sharp increase in their fatigue.[25]

The small sample size (nine completed the entirety of the study) restricts the generalizability of the results, as a larger cohort would provide a more comprehensive understanding of the intervention's effectiveness across diverse populations. Furthermore, the reliance on self-reported measures for assessing PA and quality of life may introduce bias, as participants could overestimate their engagement in PA or the perceived benefits they experienced. The short duration of the study, which was during and 3 months after chemotherapy, limited the ability to assess the long-term impacts on participants' health and quality of life, underscoring the need for future studies with extended observation periods.

The cross-sectional design[23] sought to uncover, based on the psychological needs theory, whether satisfaction of psychological needs was directly associated with increased self-reported health, and if this relationship was mediated by PA in TC survivors. A self-reported questionnaire served as the study's primary data collection tool. The sample size was 135 TC survivors with a mean age of 32.45. Satisfaction of psychological needs was positively correlated with both self-reported physical and mental health. Exercise was a mediator in self-reported physical health.

This study was primarily limited in its analysis where causal mechanisms could not be derived due to the lack of temporal classification and properly defined comparison groups. Improved reliability and validity analyses are needed to ensure more robust data quality. This design[23] indicated significant relationships between PA and improved psychosocial outcomes among TC survivors, including the need for autonomy and exercise.

All studies indicated the negative effects of chemotherapy during treatment, which include statistically significant increases in fatigue, BMI, and

poor mental health in the expressions of depression, anxiety, and stress.[2,4,9]

Discussion

The aim of this scoping review was to explore the literature on PA interventions among TC survivors and determine the depth and breadth of existing research in this area. While several studies have explored the role of exercise and/or PA in cancer patients, few studies have explored the role of PA in TC survivors. The few studies that exist provided encouraging preliminary evidence on the potential role PA can play in improving TC survivors HRQoL and highlighted a degree of interest in these types of interventions from TC survivors[25] paving the way for future studies in this area.

The selected studies from our scoping review indicated that depression, anxiety, and stress improved,[18] there was a general willingness to want to exercise more among survivors,[18,23,25] and that nearly 70% of a reported sample were meeting recommended PA guidelines.[23] This mirrors what the broader literature suggests are the benefits for PA and cancer survivorship outcomes, specifically, HRQoL. In addition to that, short HIIT exercises that are incorporated in the lifestyle of survivors have also shown remarkable improvements in the physical, mental, and social functioning components in the QoL.[9] The studies enlarge the need for an appropriate longitudinal intervention, with several fitness providers and clinicians to draw a clear connection between the effects of PA and the wide span of their innumerable benefits to TC survivors.

Regarding exercise guidelines for cancer survivors, guidance from exercise oncology experts states the need for "exercise prescription" from healthcare workers and fitness professionals when designing and delivering exercise (i.e., PA) programs to adequately address the needs, preferences, and abilities of people with cancer.[28] By implementing PA interventions after cancer treatment, cancer survivors can experience reductions in fatigue, anxiety, and depression, and improvements in physical function, quality of life, with less impact on lymphedema.[28] It is worth noting that these recommendations from the American College of Sports Medicine and other partner organizations—such as the American Cancer Society and the National Cancer Institute—specifically address exercise/PA for prevention, treatment, and recovery from breast, colon, and prostate cancer, and do not speak to TC survivors, specifically.

Although studies have reported an increase in BMI for TC survivors, it is important to distinguish that this is caused by body toxicity after cisplatin chemotherapy leading to a cascade of comorbidities such as: hypertension, compensated reduction in Leydig function, decreased bone mass density, and cardiovascular disease.[29] These aliments leave TC survivors at high risk for mental illness and fatigue, which may be eventually linked to adverse body weight fluctuation.[30] This distinction is important for oncologists and TC patients to be informed about, as it highlights the current absence and need for post chemotherapy treatment research on TC survivors and the role PA intervention can play in optimizing their health. This information is particularly important for this population, as studies have also shown how TC survivors are at an increased risk for increases in annual BMI gains compared to the normal population.[29]

Our goal for conducting this scoping review was to map the landscape of a what research exists in the broader literature concerning TC and PA. However, some potential limitations of this study include a certain lack of depth in our analysis. Although some thoughts were given on the limitations of the selected studies, comments were not comprehensive, nor systematic. Furthermore, our chosen studies were few in number, had varying rigor, and slightly different methodologies, which prevents us from offering strong, evidence-informed recommendations and establishing best practices.

Despite the dearth of literature pertaining to PA interventions for TC survivors, there are still several key takeaways that can help inform future research. First, studies are needed incorporating larger sample sizes, with stronger study designs to examine causal mechanisms (i.e., wait-list control group or delayed treatment), and more robust and longer PA protocols (e.g., accelerometers or wrist-worn devices for weeks/months). Second, future interventions may need to consider feasibility of protocols and programming logistics, PA dose, and potential interactive feedback or counseling to increase adherence to the intervention. Specifically, previous studies have shown that distance to the facility (i.e., location where exercise/PA will take place) can act as a barrier to engaging

in PA programming[30]; thus, adopting a community-based model where the PA "prescription" takes place near the patients' home (e.g., community center, recreational facility) may be one strategy worth adopting in a future trial, especially when trying to assist hard-to-reach populations such as TC survivors living in rural locations.

Finally, tailoring the PA intervention, including the use of counseling and/or peer coaches, has shown a degree of success in previous smaller trials.[25] Although adopting this approach makes it more difficult to generalize appropriate dose and mode of PA for TC survivors and is resource-intensive, there is an opportunity here to leverage technology applications and consumer wearables. Incorporating the use of smart-phone-based applications that can be paired with consumer wearable fitness trackers (e.g., Fitbit) may allow for a more streamlined approach that can unite groups of users (i.e., increase social capacity), allow intervention personnel to monitor PA adherence to guidelines based on real-time data, and provide individualized tailored feedback to multiple users, all from a remote central location.

The findings of this scoping review highlight the emerging but still limited body of research on the relationship between PA and HRQoL among TC survivors. While existing studies suggest that PA—particularly structured interventions like HIIT—can improve cancer-related fatigue, mental well-being, and certain HRQoL components, the breadth of research remains constrained by small sample sizes, methodological limitations, and inconsistent adherence among participants. Notably, PA interventions appear to offer benefits beyond physical health, potentially addressing psychological concerns such as stress, self-esteem, and overall mental health. However, adherence challenges, particularly in long-term engagement beyond structured interventions, underscore the need for sustainable, scalable exercise strategies tailored to the unique needs of TC survivors.

Given the significant morbidity burden associated with TC survivorship—including CIPN, fatigue, and psychological distress—further research is warranted to explore optimized PA interventions. Future studies should incorporate diverse survivor populations, longitudinal designs, and alternative exercise modalities beyond HIIT to determine the most effective and accessible approaches. Additionally, addressing behavioral barriers to exercise engagement through targeted interventions could enhance adherence and long-term benefits. Ultimately, expanding the evidence base in this area will be essential for informing clinical recommendations and developing personalized survivorship care plans that integrate PA as a cornerstone for improving TC survivors' overall quality of life.

Declarations

Ethics approval and consent to participate

No human subjects were solicited for thie study.

Consent for publication

None.

Author contributions

Michael J. Rovito: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Project administration; Writing – original draft; Writing – review & editing.

Keith Brazendale: Conceptualization; Methodology; Writing – original draft; Writing – review & editing.

Samantha Gibson: Conceptualization; Writing – original draft.

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Ciaran Fairman: Conceptualization; Writing – original draft.

Craig Badolato: Conceptualization; Writing – review & editing.

Timothy Lyon: Conceptualization; Writing – review & editing.

Bryce Baird: Conceptualization; Writing – review & editing.

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Competing interests

The authors declare that there is no conflict of interest.

Availability of data and materials

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Supplemental material

Supplemental material for this article is available online.

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