PHYSICAL ACTIVITY, EXERCISE AND CANCER

REVIEW ARTICLE

Prehabilitation: A forgotten strategy in pediatric oncology?

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ABSTRACT

Introduction: Advances in childhood cancer treatment have increased survival rates, underscoring the need to address treatment-related late effects and long-term functional outcomes. Prehabilitation aims to optimize physical, psychological, and nutritional status before treatment to improve subsequent outcomes; however, it remains a poorly defined and understudied concept in paediatric oncology. Materials and Methods: Following PRISMA guidelines, a systematic search of PubMed and EMBASE databases was conducted for English-language publications from 2015 to 2025 investigating the effects of pre-treatment exercise-based interventions in paediatric cancer patients. Results: Limited evidence exists regarding the role of prehabilitation in paediatric oncology. However, benefits of implementing ERAS protocols in paediatric orthopaedics have been observed. Additionally, implementation of physical exercise during and after oncologic treatment also offers positive results. Although no standardized paediatric recommendations exist, studies in adult populations demonstrate benefits secondary to prehabilitation. Discussion: Considerable heterogeneity exists in terms of exercise regimens, timing of interventions, and outcome measures. Despite this, evidence from paediatric surgery and adult oncology suggests a potential beneficial role for prehabilitation in paediatric oncology. Conclusion: Available evidence supports the potential value of prehabilitation and highlights the need for structured, multidimensional intervention studies incorporating exercise, nutritional support, and psychological care in paediatric oncology.

Keywords: Paediatric cancer, Pretreatment intervention, Long-term outcome, Physical performance, Functional recovery.

Cite this article as:
Ramia Guillén, B., Segura Segovia, P., Fernández Navarro, J. M., Aparicio Aparicio, I., Carrión González, C., Escriba Alepuz, F. J., & Balaguer Guill, J. (2026). Prehabilitation: A forgotten strategy in pediatric oncology?. *Physical Activity, Exercise and Cancer*, 3(2), 81-86. https://doi.org/10.55860/AEHS1247

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Submitted for publication February 12, 2026.
Accepted for publication March 12, 2026.
Published March 26, 2026.
Physical Activity, Exercise and Cancer.

Identifier: https://doi.org/10.55860/AEHS1247

INTRODUCTION

Childhood cancers remain rare and complex diseases; however, advances in diagnosis and treatment have substantially improved survival rates. As a result, increasing attention must be paid to treatment-related late effects and their impact on long-term physical function and quality of life. Hematopoietic stem cell transplantation (HSCT), in particular, represents a treatment modality associated with marked functional decline due to high-dose ablative therapies and treatment-related complications.

Comprehensive pediatric oncologic care requires an integrated approach, including individualized rehabilitation strategies. Within this framework, four stages can be defined: preventive, restorative, supportive, and palliative.

The preventive stage, commonly referred as prehabilitation, is already included into standard care for various chronic conditions in adults, particularly through Enhanced Recovery After Surgery (ERAS) protocols. Prehabilitation aims to optimize physical endurance, muscle strength, psychological well-being, and nutritional status, while also establishing baseline physical, cognitive, and psychological parameters to support subsequent clinical decision making.

The objective of this study is to review the current state of prehabilitation in the pediatric oncology population, focusing on its physical conditioning component.

MATERIALS AND METHODS

Following PRISMA guidelines, we conducted a systematic search of the electronic databases PubMed and EMBASE (ScienceDirect). Search terms included: (1) preoperative exercise OR prehabilitation OR pretreatment conditioning OR preoperative conditioning, (2) cancer patients OR oncology patients OR cancer OR neoplasm OR solid tumors OR leukemia, and (3) child OR children OR childhood OR pediatric.

Inclusion criteria encompassed narrative reviews, systematic reviews, and cohort studies, published in full text in English, during the period from 2015 to 2025. Eligible studies investigated physical activity- or therapeutic exercise-based interventions implemented before the initiation of oncologic treatment in pediatric patients.

All retrieved studies were imported into the reference management software Mendeley Reference Manager, where duplicate entries records were removed. Subsequently, two independent reviewers conducted an initial evaluation of study titles and abstracts, followed by a detailed review of the full text to determine eligibility. Discrepancies between reviewers were resolved through discussion and, when necessary, through additional full-text review to reach consensus.

The entire study selection process is represented by the flow diagram of the PRISMA 2020 guidelines (Figure 1).

RESULTS

Prehabilitation is designed to optimize patients' physical capacity and general health status before undergoing intensive cancer treatments, with the goal of reducing treatment-related complications and enhancing recovery outcomes (Sandblom et al., 2024).

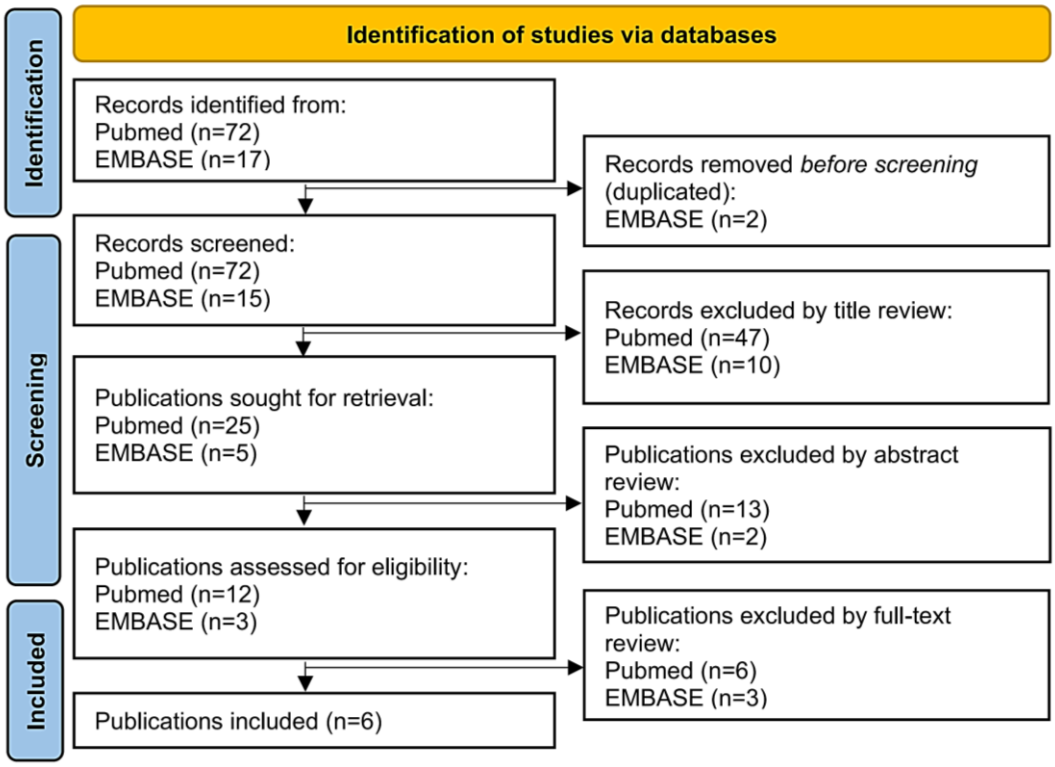

Figure 1. Flow diagram of the article selection process following de PRISMA 2020 guidelines.

While studies addressing prehabilitation in the pediatric surgical population exist, evidence specific to pediatric oncology remains scarce. Implementation of ERAS protocol in pediatric orthopedics has been associated with significant reductions in hospital length of stay, improved postoperative functional recovery, and decreased opioid consumption (Zacha et al., 2023). These advantages are also described in the specific context of pediatric oncologic surgery (Petrichenko et al., 2015).

Despite the shortage of studies focused on pediatric prehabilitation there is robust evidence indicating that exercise performed during treatment as well as subsequent rehabilitation offers positive results with minimal adverse effects (Braam et al., 2016; Sandblom et al., 2024).

A 2016 Cochrane systematic review that included 171 pediatric patients with acute lymphoblastic leukemia demonstrated that exercise interventions during treatment significantly improved cardiorespiratory fitness, with the 9-minute run-walk test showing significant differences favoring the intervention group along with improvements in bone mineral density, muscle strength, and flexibility (Braam et al., 2016). More recent studies in adolescents and young adults have confirmed these findings, with supervised exercise programs showing large effect sizes on cancer-related fatigue and improvements in strength (Sandblom et al., 2024).

Also, in 2024 a retrospective cohort study, that included 77 patients, demonstrated that greater pre-HSCT muscle strength, particularly hip flexion strength, and better functional performance in the 1 10-meter walk time and time-to-rise-from-floor correlated with improved post-HSCT recovery (den Hartog et al., 2024). They find a positive relationship between physical performance before HSCT and physical performance after HSCT independently of other factors (den Hartog et al., 2024), that suggest that optimizing physical performance before transplantation could improve outcomes.

A literature review published in 2024 noted that while 10 of 11 reviewed studies showed improvement or maintenance of strength, endurance, cardiorespiratory fitness during HSCT, none specifically focused on prehabilitation interventions implemented before transplantation. This literature review has shown that, currently, there are not many studies focused on prehabilitation in pediatrics, but there are many that investigate the effect of exercise during treatment in pediatric patients (Sandblom et al., 2024).

Importantly, pre-HSCT physical functioning assessments in pediatric populations have demonstrated feasibility and safety, with higher baseline muscle strength and physical function correlating with improved post-transplant recovery (Rowley et al., 2025). The consistency of these positive effects across multiple studies, combined with the demonstrated relationship between pre-HSCT physical performance and post-HSCT outcomes, provides a strong rationale for the development of structured prehabilitation programs in pediatric oncology.

As observed in studies conducted in the adult population, prehabilitation could be a safe and effective way to improve physical condition prior to treatment, obtaining greater benefit. However, there are no standard recommendations regarding the prehabilitation program to follow in children, unlike in adults where it appears that maximum benefit is obtained with treatment based on 20-30 minutes sessions of moderate intensity 3 times per week and resistance training 2 times per week for a total of 6 to 8 weeks (Sandblom et al., 2024).

DISCUSSION

Prehabilitation in pediatric oncology remains an ill-defined concept. The existing literature reveals substantial heterogeneity in exercise regimens, timing of interventions, and outcome measures, as well as a lack of validated, pediatric-specific assessment tools (den Hartog et al., 2024; Haas et al., 2025; Sandblom et al., 2024). These limitations, however, also represent an important opportunity for future research.

Although direct evidence in pediatric oncology is limited, data from pediatric surgery and adult oncology consistently suggest that prehabilitation may improve physical outcomes and quality of life. Further research is required to evaluate the feasibility, safety, and efficacy of prehabilitation programs tailored to pediatric oncologic populations.

In addition to physical exercise, nutritional optimization and psychological well-being are integral components of prehabilitation and represent areas with significant potential for future investigation.

CONCLUSIONS

Despite the scarcity of studies specifically addressing prehabilitation in pediatric oncology, evidence from pediatric surgical populations and adult oncology supports its potential to optimize functional recovery in children with cancer. There is a clear need for prospective, structured, and multidimensional prehabilitation interventions incorporating exercise, nutritional support, and psychological care to improve post-treatment physical outcomes in pediatric patients.

AUTHOR CONTRIBUTIONS

Ramia Guillén and Segura Segovia conceived the original idea that initiated the development of this article. Balaguer Guill, Escriba Alepuz and Fernández Navarro conceptualized the review, defined the research objectives, and designed the methodology. Balaguer Guill was responsible for the overall supervision and

scientific direction of the project. Ramia Guillén and Segura Segovia collected and analysed the data, prepared the original draft of the manuscript, and created the figures. Aparicio Aparicio and Carrión González contributed to the scientific review and editing of the manuscript. All authors have read and approved the final version of the manuscript.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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