

Review

Family and school support and physical activity behaviour in childhood cancer survivors: A meta-analytic review from a social ecological perspective

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Abstract: Physical activity is increasingly recognised as an important component of survivorship care for childhood cancer survivors, yet participation levels often remain low following treatment. Social ecological frameworks suggest that family, peer, and school environments may influence physical activity behaviour; however, quantitative synthesis of this evidence remains limited. This study aimed to systematically review and meta-analytically synthesise available quantitative evidence on the association between family, parental, peer, and school-related support and physical activity behaviour among childhood cancer survivors. A systematic review was conducted in accordance with PRISMA 2020 guidelines. Observational and interventional studies examining social support contexts in relation to physical activity outcomes among survivors aged ≤ 21 years were eligible for inclusion. Quantitative synthesis was restricted to methodologically comparable association-based studies. Pearson correlation coefficients and odds ratios were extracted or derived and synthesised using random-effects models. Methodological quality was assessed using the Newcastle–Ottawa Scale. Three observational studies met the criteria for quantitative synthesis. Two studies examining family or parental support reported positive associations with moderate-to-vigorous physical activity (MVPA), yielding a pooled correlation coefficient of $r = 0.42$ (95% CI 0.11–0.65). One large cross-sectional study further demonstrated that higher parental support was associated with a greater likelihood of MVPA participation (OR = 0.92, 95% CI 0.88–0.96). Overall methodological quality was rated as moderate, with limitations primarily related to cross-sectional study designs and residual confounding. These findings indicate that family and parental support are positively associated with physical activity behaviour among childhood cancer survivors; however, the limited number of studies and observational nature of the evidence preclude causal inference. Future longitudinal and intervention studies that explicitly integrate family- and peer-based support mechanisms are needed to inform socially grounded physical activity promotion strategies in survivorship care.

Keywords: childhood cancer survivors; physical activity; parental support; peer support; social ecological model

1. Introduction

1.1. Background

Survival rates among children and adolescents diagnosed with cancer have increased significantly in recent decades. In many high-income countries, more than 80% of children diagnosed with malignancies now survive at least five years post-diagnosis, transforming cancer from a condition that was once nearly universally fatal to one associated with long-term survivorship [1,2]. This improvement reflects

advances in diagnostics, treatment protocols, supportive care, and follow-up surveillance [3,4]. However, survival does not equate to a complete return to pre-illness life; a growing body of literature has highlighted those survivors face persistent late effects that extend beyond physical complications to psychosocial challenges enduring across developmental stages [1,5]. Among these challenges, social functioning has emerged as a central concern. Social functioning refers to an individual's ability to form and maintain interpersonal relationships, engage meaningfully in school and community activities, and achieve developmental milestones related to social competence and identity [2,6].

For childhood cancer survivors, treatment regimens involving extended hospitalizations, physical side effects such as hair loss or reduced mobility, and neurocognitive sequelae from therapies like cranial irradiation often disrupt normal patterns of peer interaction and academic engagement [1,7]. As a result, survivors may experience difficulties in re-establishing friendships, sustaining peer acceptance, participating in group activities, and reintegrating into classrooms [1,5]. Studies consistently document higher levels of social withdrawal, loneliness, and peer victimization among survivors compared with their healthy peers [8,9]. These difficulties can extend into adulthood, affecting self-esteem, employability, intimate relationships, and overall quality of life [5,9]. Social function recovery is therefore not an optional aspect of survivorship care but an essential outcome alongside medical monitoring and psychological well-being [6]. Successful reintegration into peer groups, positive experiences in school participation, and sustained quality of life are key indicators of how well survivors can reclaim developmental trajectories interrupted by illness [3,6].

Encouragingly, emerging evidence indicates that physical activity (PA) can serve as a promising vehicle for promoting such recovery. Physical activity encompassing structured exercise programs, recreational play, and sports participation has been shown to reduce fatigue, improve mood, enhance cognitive functioning, and stimulate social engagement in both paediatric and adult oncology populations [6,9]. For survivors of childhood cancer specifically, PA provides opportunities for not only physical rehabilitation but also meaningful peer interaction, shared experiences, and identity reconstruction through participation in "normal" childhood activities [10,11]. Nonetheless, participation in PA is not solely determined by survivors; engagement is profoundly influenced by the support systems surrounding the child, particularly family and school environments [6,12].

It is within these relational and institutional contexts that opportunities for PA are created, encouraged, or hindered. Understanding how family and school support function to facilitate PA, and how these supports shape survivors' engagement in physical activity, is therefore important, as such engagement may have broader implications for social well-being [5,12].

1.2. Role of family and school support

Families occupy the most immediate and enduring context for survivors' recovery [12,13]. Parents and caregivers play a central role in establishing routines, modelling health behaviours, and providing emotional encouragement. Research has

shown that parental support for PA whether through logistical assistance such as transportation, co-participation in activities, or verbal encouragement significantly increases children's likelihood of engaging in regular exercise [11,14]. In the context of childhood cancer survivorship, family involvement may be even more crucial, as medical fragility, fatigue, and social stigma can deter participation [4,14]. Families that integrate PA into daily life, normalize exercise as part of recovery, and foster open communication around survivors' limitations and capacities create enabling conditions for social re-engagement [12,14]. Moreover, family-supported PA can strengthen parent—child bonds, improve collective coping, and reduce parental anxiety about the child's vulnerabilities [4,14].

Schools serve as the primary sites of peer interaction and structured socialization. Returning to school after cancer treatment is often described by survivors as one of the most challenging yet defining aspects of recovery [9,15]. Teachers and classmates become critical agents in shaping whether this transition is experienced as supportive or alienating [4,15]. School-based PA interventions ranging from inclusive physical education (PE) classes to extracurricular sports teams offer survivors avenues for both physical health improvement and social reintegration [4,12]. Teacher facilitation, peer inclusion, and school policies on reintegration directly determine survivors' access to these opportunities [4,11]. For example, a teacher who adapts PE curricula to survivors' capabilities signals inclusivity and fosters peer empathy, while a school implementing structured reintegration programs reduces stigma and enhances acceptance [7].

Taken together, family and school support systems operate as intertwined determinants of PA engagement. Families may advocate for accommodations within schools, while teachers may rely on parental communication to understand survivors' medical limitations [13,14]. Peer dynamics in schools can be influenced by family-led awareness initiatives, and parental encouragement can be amplified when schools provide structured opportunities for survivors to participate. Investigating these supports in tandem, rather than in isolation, is critical for understanding the full ecology of survivorship.

1.3. Theoretical framework: Social ecological perspective

To conceptualize these dynamics, this review is anchored in Bronfenbrenner's social ecological model. This theory posits that human development unfolds within nested systems of influence, ranging from the microsystem (immediate environments such as family and school) to the mesosystem (interactions between microsystems), ecosystem (indirect influences such as parental workplaces or healthcare systems), and macrosystem (cultural and societal norms) [2,12]. The chronosystem further highlights temporal dimensions, such as life transitions and historical context. Within this model, PA functions as a behavioural health practice situated at the intersection of individual agency and systemic supports.

At the microsystem level, survivors' direct interactions with parents, siblings, teachers, and peers shape their opportunities for and experiences of PA. Family encouragement, co-participation, and routines represent key proximal mechanisms facilitating engagement [2,6]. At the mesosystem level, coordination between family

and school systems becomes particularly salient. Collaborative family–school communication regarding medical accommodations, participation limits, and reintegration strategies can amplify or undermine survivors’ ability to participate in school-based PA [2,12]. At the ecosystem level, policies such as hospital–school liaison programs, insurance coverage for rehabilitation, or parental employment flexibility indirectly affect survivors’ PA opportunities [2,12]. At the macrosystem level, societal attitudes toward disability, cancer stigma, and cultural norms around children’s activity influence whether PA is perceived as feasible, safe, or desirable for survivors [2,14].

Positioning PA within this ecological perspective underscores that survivors’ recovery is not reducible to individual motivation or physical capacity. Recovery is dynamically co-constructed across systems [6,12]. The social ecological framework therefore provides both a theoretical rationale and a practical interpretive lens for meta-analysis, justifying the analysis of family and school supports as embedded, interacting contexts. It offers a structure for subgroup analyses, where variations in outcomes can be interpreted in light of different ecological levels, such as cultural region (macrosystem) or intervention format (mesosystem).

1.4. Rationale and objectives

Despite the acknowledged importance of PA, family involvement, and school support in survivorship, the existing literature remains fragmented [5,16]. Individual studies have demonstrated benefits of PA for fatigue, mood, and social functioning; others have highlighted the role of parents or teachers in facilitating reintegration. However, these studies are dispersed across disciplines paediatric oncology, rehabilitation, psychology, and education and vary widely in methodology, outcome measures, and intervention formats [6,17]. Narrative reviews have provided valuable overviews but lack the capacity to quantify effect sizes or systematically examine moderators. Moreover, few syntheses have explicitly examined the combined influence of PA, family, and school support, leaving unanswered questions about how these elements interact [5,17].

A meta-analysis is therefore timely and necessary. By pooling data from diverse studies, this review can provide robust estimates of the association between family- and school-related support and physical activity behaviour, which may have broader implications for social well-being in childhood cancer survivors [2,5]. Furthermore, by situating the analysis within the social ecological framework, the review can illuminate not only the strength and consistency of observed associations, but also how and under what contextual conditions these associations may emerge.

The guiding research questions of this review were as follows:

- 1) What is the quantitative association between family-, parental-, peer-, and school-related support and physical activity behaviour among childhood cancer survivors?
- 2) How consistent are these associations across different study designs and support contexts?
- 3) What methodological strengths and limitations characterise the existing quantitative evidence base?

- 4) How can the observed associations be interpreted within a social ecological framework of childhood cancer survivorship?

Accordingly, the objectives of this review were to:

- Systematically synthesise quantitative evidence on the association between family-, parental-, peer-, and school-related support and physical activity behaviour among childhood cancer survivors.
- Quantitatively summarise association-based effect sizes, where methodologically appropriate, using meta-analytic techniques.
- Critically appraise the methodological quality and risk of bias of included studies using the Newcastle–Ottawa Scale.
- Contextualise findings within a social ecological perspective, highlighting the role of family and school environments in shaping physical activity behaviour during survivorship.

Through these objectives, this review seeks to clarify the current quantitative evidence linking social support contexts to physical activity behaviour in childhood cancer survivors. Rather than evaluating intervention effectiveness or causal mechanisms, the analysis provides an integrative overview of observed associations within real-world family and school environments. By situating these findings within a social ecological framework, the review highlights important gaps in the literature and identifies directions for future longitudinal and intervention research aimed at developing socially grounded physical activity promotion strategies in survivorship care.

2. Literature review

2.1. Physical activity and survivorship outcomes

The growing population of childhood cancer survivors has spurred increased attention to survivorship outcomes that extend beyond clinical remission. Among these outcomes, physical activity (PA) has emerged as a key factor in promoting both physiological and psychosocial recovery [18,19]. Evidence consistently suggests that engagement in physical activity is associated with reduced fatigue, enhanced psychological resilience, and improved indicators of social reintegration among survivors of paediatric cancers [3,20]. Cancer-related fatigue, which often persists long after the completion of treatment, is a major barrier to quality of life and social participation. Regular engagement in aerobic and resistance-based activities has been shown to mitigate fatigue and improve vitality, thereby enabling survivors to more fully engage in peer and school activities [12].

Beyond fatigue management, PA is strongly associated with improvements in psychological functioning. Participation in structured exercise programs has been linked to reduced symptoms of anxiety and depression, greater emotional stability, and higher self-esteem [19,21]. These benefits are particularly salient for children and adolescents navigating the transition from intensive medical treatment back into normative developmental contexts such as school and peer groups. Importantly, PA provides a vehicle for mastery experiences, goal attainment, and social bonding, all of which enhance resilience and coping capacities in the face of cancer's long-term sequelae [11].

Social engagement represents another domain positively influenced by PA. Organized activities such as team sports or group exercise sessions foster peer interaction and inclusion, which are crucial to reducing the social isolation commonly reported among childhood cancer survivors [4,22]. This social dimension of PA complements its physiological benefits, reinforcing its role as a holistic survivorship intervention. Collectively, these findings underscore the dual contribution of PA to both health-related quality of life (QoL) and social function recovery, positioning it as an important component of survivorship care [3,18].

2.2. Family-supported PA interventions

Family plays a pivotal role in shaping children's health behaviours, including engagement in PA. Within the survivorship context, parental encouragement, modelling, and structured routines create an enabling environment for consistent activity participation [20,22]. Research indicates that children are more likely to adhere to PA regimens when caregivers actively participate in exercise sessions or demonstrate positive attitudes toward physical fitness [3,19]. Parents who prioritize active lifestyles model health-promoting behaviours, reinforcing the normalization of PA despite the child's medical history [12].

Structured routines established by families such as scheduling daily walks, weekend sports, or home-based exercise programs further embed PA into the child's daily life. These routines not only promote physical health but also restore a sense of normalcy and predictability, counteracting the disruptions caused by cancer treatment [3,23]. Involving siblings in these routines fosters inclusion and shared experiences, reducing feelings of "otherness" in the survivor and promoting stronger family cohesion [18,19].

Empirical evidence suggests potential psychosocial benefits associated with family-supported physical activity. Studies demonstrate that parental involvement in PA interventions correlates with enhanced social connectedness, better emotional regulation, and reduced behavioural difficulties [3,20]. These outcomes reflect the buffering effect of familial support against the psychological vulnerabilities associated with cancer survivorship. Moreover, family engagement mitigates logistical barriers such as transportation or motivational lapses, ensuring higher levels of adherence and program completion [12,19].

Thus, family-supported PA interventions represent not only a mechanism of physical rehabilitation but also a relational strategy that strengthens emotional bonds and facilitates the child's social reintegration. In this way, families serve as both role models and facilitators of health-promoting behaviours, amplifying the potential role of PA within survivorship contexts [3,20].

2.3. School-supported PA interventions

Schools constitute a central arena for children's socialization and development, making them critical partners in the rehabilitation of childhood cancer survivors. School-supported PA interventions include structured physical education (PE) classes, inclusive sport programs, and extracurricular activities designed to accommodate varying levels of physical ability [4,23]. Teacher facilitation and peer inclusion within

these settings are essential to ensuring that survivors feel welcomed and competent [3,18].

Participation in PE and sport programs addresses the dual objectives of reintegration and developmental continuity. Survivors often face challenges such as reduced stamina, compromised motor skills, or lingering medical restrictions, which can hinder full participation [11,22]. Schools that implement adaptive PE strategies such as modified exercises or flexible participation criteria promote inclusivity and help survivors engage without fear of stigmatization [12,23]. Teacher training in understanding cancer survivorship needs is crucial in creating supportive environments that balance safety with encouragement [3,4].

Peer dynamics within school-based PA are equally influential. Inclusion in group sports fosters camaraderie, teamwork, and mutual support, mitigating the risk of social withdrawal or bullying that some survivors encounter [19,22]. Positive peer interactions within PA contexts extend beyond the sports field, enhancing classroom engagement and overall academic–social balance. Evidence suggests that survivors who participate in school sports report higher levels of social competence and self-efficacy, reinforcing the value of these interventions as vehicles for psychosocial recovery [18,20].

In sum, School-supported PA interventions have been proposed as addressing not only physical health but also psychosocial aspects of reintegration, belonging, and developmental progression. Schools, by leveraging structured programs and supportive peer environments, thus act as mesosystemic enablers of survivor well-being [3,18].

2.4. Integration into the social ecological perspective

Bronfenbrenner's ecological systems theory provides a comprehensive lens through which the interplay between PA, family, and school can be understood. At the micro-level, the individual survivor's active participation in PA directly influences physical and psychosocial outcomes [19,20]. Individual motivation, treatment history, and personal resilience shape the capacity to engage in such activities.

At the meso-level, the intersection of family and school environments creates a synergistic platform for supporting PA participation. Families provide encouragement, modelling, and logistical support, while schools offer structured opportunities and peer inclusion [18,19]. The bidirectional reinforcement between these contexts magnifies the positive impact of PA on behaviour. For example, a child who receives family encouragement to participate in school sports is more likely to experience seamless reintegration and sustained social competence [12,22].

Exo- and macro-level influences further contextualize these dynamics. Healthcare policies that endorse PA as part of survivorship care plans, cultural attitudes toward childhood cancer, and societal norms surrounding exercise and inclusivity all shape the accessibility and acceptance of PA interventions [4,20]. In cultures where collective activity and family involvement are highly valued, the impact of family-supported PA may be particularly pronounced. Conversely, in educational systems that prioritize academic performance over extracurricular engagement, the implementation of school-based PA programs may face greater

challenges [18,23].

Positioning PA within this ecological framework highlights its role as a behavioural health intervention that is not solely individual but also relational and systemic. This perspective underscores the importance of considering multilevel supports when interpreting physical activity behaviour among childhood cancer survivors [1,19].

2.5. Gaps in current evidence

Despite the recognized benefits of PA, current research reveals several critical gaps. First, most studies examine PA in isolation, without adequately considering the moderating role of family and school support. This fragmented approach overlooks the ecological interplay that shapes PA engagement and its outcomes. Consequently, there is limited understanding of how family and school contexts jointly influence physical activity behaviour, which may have implications for social well-being [18,19].

Second, while numerous studies highlight the physiological and psychological benefits of PA, relatively few explicitly address social outcomes such as peer reintegration, social competence, or academic-social balance. Given the centrality of social functioning in survivorship, this omission represents a significant gap in the literature [11,19].

Third, meta-analyses examining PA in paediatric oncology populations have largely focused on biomedical outcomes (e.g., cardiorespiratory fitness, fatigue reduction) with minimal attention to psychosocial dimensions. Few, if any, meta-analytic reviews explicitly apply ecological theory as an interpretive lens to synthesize findings. As a result, the field lacks a comprehensive evidence base that situates PA within the family-school ecosystem of support [1,19].

Finally, heterogeneity in study designs, intervention formats, and outcome measures complicates the comparability of findings. Some studies employ structured exercise programs, while others examine informal activity participation. Outcome measures range from self-reported QoL scales to observational assessments of social behaviour, creating challenges in aggregating evidence [18,19]. This methodological diversity underscores the need for a systematic and meta-analytic synthesis to distil robust conclusions.

Collectively, these gaps justify the present review. By integrating evidence across studies through a meta-analytic framework and grounding interpretation in the social ecological model, this review aims to clarify the role of family and school support in shaping physical activity behaviour among childhood cancer survivors, interpreted within a social ecological framework [1,18].

3. Methodology

3.1. Design

This study was conducted as a systematic review with a targeted quantitative synthesis, following the PRISMA 2020 guidelines for transparent reporting of study identification, screening, eligibility assessment, and inclusion. Given the

methodological heterogeneity of the available literature, quantitative meta-analysis was restricted to methodologically comparable association-based studies, while intervention evidence was synthesised separately and narratively. This hybrid approach was adopted to ensure methodological rigor and to avoid inappropriate pooling of heterogeneous study designs, in line with current methodological recommendations.

3.2. Eligibility criteria (PICOS)

Eligibility criteria were defined a priori using the PICOS framework (Population, Intervention/Exposure, Comparator, Outcomes, Study design) and are summarised in **Table 1**.

Table 1. Inclusion and exclusion criteria applied in this study.

Domain	Inclusion Criteria	Exclusion Criteria
Population	Children and adolescents (≤ 21 years) diagnosed with any type of cancer, including those undergoing treatment or in post-treatment survivorship phases.	Adults > 21 years; populations without a cancer diagnosis; non-cancer chronic illness populations.
Intervention/Exposure	Family-, parental-, peer-, or school-related support contexts relevant to physical activity (e.g., parental encouragement or modelling, family involvement in PA, peer support, school-based facilitation of PA).	Studies without an explicit family, parental, peer, or school support component linked to physical activity.
Comparator	Survivors exposed to lower levels of support, usual care, or comparison groups defined within observational analyses.	Studies without an identifiable comparator or reference category for support exposure.
Outcome	Physical activity behaviour, including moderate-to-vigorous physical activity (MVPA), physical activity participation, exercise frequency, or validated physical activity scores.	Outcomes limited solely to biomedical indicators (e.g., survival, recurrence) or psychosocial outcomes without a physical activity measure.
Study design	Randomized controlled trials (RCTs), quasi-experimental studies, longitudinal cohort studies, and cross-sectional observational studies.	Case reports, qualitative-only studies, narrative reviews, systematic reviews, editorials, or commentaries.
Setting	Family, peer, and/or school contexts in any country or healthcare system.	Not applicable.
Language	English-language publications.	Non-English publications without available translation.

Population

Eligible participants were children and adolescents aged ≤ 21 years diagnosed with any type of cancer, including those undergoing active treatment or in post-treatment survivorship phases. Studies focusing exclusively on adults (> 21 years) or on non-cancer chronic illness populations were excluded.

Intervention/Exposure

The primary exposures of interest were family- and/or peer-related support contexts relevant to physical activity (PA). Family support was defined as parental encouragement, logistical support, or parental modelling of PA, while peer or school support encompassed peer encouragement or facilitation of PA participation. Studies without an explicit family, peer, or school-related support component linked to PA were excluded.

Comparator

Eligible comparators included survivors receiving usual care, those exposed to lower levels of family or peer support, or comparison groups defined within observational analyses. Studies without an identifiable comparator or reference category were excluded from quantitative synthesis.

Outcomes

The sole outcome of interest in this review was physical activity behaviour, operationalised as moderate-to-vigorous physical activity (MVPA), physical activity participation, exercise frequency, or validated physical activity scores. Only studies that quantitatively assessed physical activity outcomes in relation to family, parental, peer, or school support were eligible for inclusion. Studies reporting outcomes restricted solely to biomedical indicators (e.g., survival, recurrence) or psychosocial outcomes without a physical activity measure were excluded.

Study design

Randomized controlled trials (RCTs), quasi-experimental studies, longitudinal cohort studies, and cross-sectional observational studies were eligible for inclusion. However, quantitative meta-analysis was restricted to observational studies reporting extractable association-based effect sizes (e.g., Pearson's r , odds ratios). Intervention studies were synthesised narratively due to limited comparability. Case reports, qualitative-only studies, narrative reviews, and commentaries were excluded.

Language

Only studies published in English were included. Non-English studies without translation were excluded.

3.3. Search strategy

The study selection process followed the PRISMA 2020 guidelines and is summarised in **Figure 1**. A total of 1,041 records were identified through database searching, including ScienceDirect, Web of Science, and Nature. An additional four records were identified through other sources, including Google Scholar and reference list screening. After removal of 376 duplicate records, 669 unique records remained for title and abstract screening. During this stage, 611 records were excluded, primarily due to ineligible age groups or absence of a physical activity component.

The full texts of 58 articles were assessed for eligibility. Following full-text screening, 55 articles were excluded, most commonly due to insufficient or non-extractable quantitative data ($n = 43$) or failure to meet one or more inclusion criteria ($n = 12$). Ultimately, three studies met all eligibility criteria and were included in the quantitative synthesis. These studies formed the final evidence base for the association-based meta-analysis.

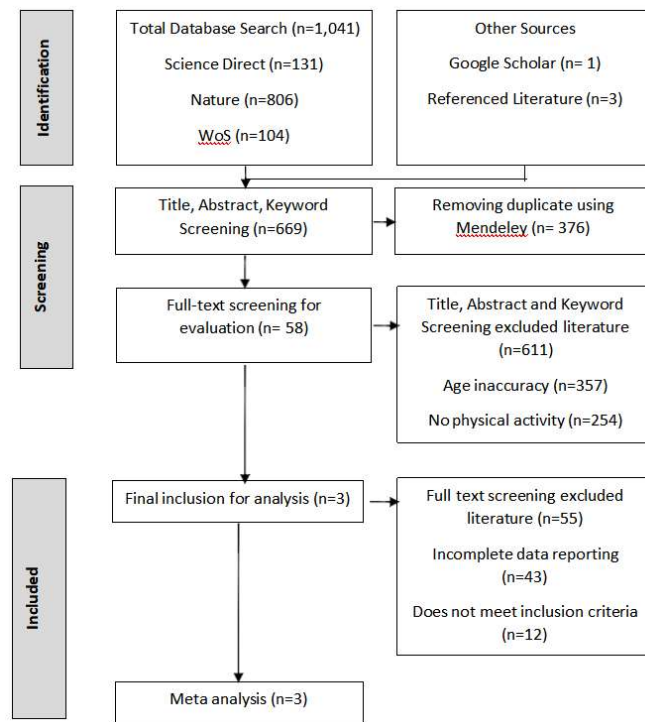


Figure 1. PRISMA flow chart.

3.4. Quality and risk bias assessment

Because the studies included in the quantitative synthesis were non-randomized and observational, methodological quality was assessed using the Newcastle–Ottawa Scale (NOS). The NOS evaluates three domains: (1) selection of participants, (2) comparability of study groups, and (3) outcome assessment. Each study was awarded up to nine stars, with higher scores indicating greater methodological quality.

Two reviewers independently conducted the quality assessment. Disagreements were resolved by consensus. NOS scores were reported at the study level and considered in the interpretation of findings. Given the small number of included studies, formal sensitivity analyses excluding lower-quality studies were not conducted; instead, quality considerations were addressed narratively.

3.5. Statistical analysis

Quantitative synthesis was conducted exclusively for physical activity behaviour outcomes. For studies reporting continuous physical activity measures, Pearson correlation coefficients (r) were extracted as the primary effect size. When studies reported Kendall's tau (τ) instead of Pearson's r , coefficients were converted prior to meta-analysis using an established approximation:

$$r \approx \sin\left(\frac{\pi}{2} \times \tau\right)$$

This transformation has been widely applied in meta-analytic research to harmonise nonparametric correlation coefficients with Pearson's r for pooling purposes. Following conversion, correlation coefficients were transformed to Fisher's z values for meta-analysis and back-transformed to Pearson's r for presentation of results.

For studies reporting dichotomous physical activity outcomes, odds ratios (ORs) with 95% confidence intervals (CIs) were extracted. Correlation-based estimates and odds ratios were analysed separately and were not combined within a single pooled model due to their differing statistical scales.

Random-effects models were applied to account for between-study variability in study populations, exposure definitions, and physical activity measurement instruments. Given the small number of eligible studies, formal tests of publication bias (e.g., funnel plots or Egger’s regression test) were not conducted, in accordance with methodological recommendations. Heterogeneity was interpreted descriptively, with emphasis placed on consistency and magnitude of effects rather than statistical significance alone.

All statistical analyses were performed using *R* (version 4.5.1) with the metafor package. Results are reported with 95% confidence intervals, and statistical inference was interpreted cautiously in light of the limited number of studies.

4. Results and discussion

4.1. Characteristic of included studies

Table 2 summarises the characteristics of observational studies included in the association-based quantitative synthesis. These studies employed cross-sectional or cohort designs to examine the relationships between family or peer contextual factors (such as parental support, peer support, or parental physical activity) and physical activity outcomes among childhood cancer survivors. All studies in **Table 2** reported extractable quantitative effect sizes, including Pearson correlation coefficients or odds ratios, which permitted inclusion in the meta-analysis. Given the observational nature of these designs, findings from **Table 2** were synthesised to quantify associations rather than causal effects, and interpretation was accordingly restricted to correlational inferences.

Table 2. Characteristic of included studies-observational studies (association-based quantitative synthesis).

Study (Year)	Country	Study design	Sample size	Age (years)	Cancer type	Family/Peer context (Exposure)	Physical activity outcome	Effect size used	Meta-analytic Role
Gilliam et al., 2012 [24]	USA	Cross-sectional survey	105 childhood cancer survivors	8–16	Leukemia, CNS, sarcoma, lymphoma, mixed	Family support for PA (pooled); peer support (descriptive only)	MVPA (hours/week, GLTEQ-derived)	Pearson’s <i>r</i>	Association-based meta-analysis
Ha et al., 2022 [13]	Australia	Cross-sectional parent–child dyads	125 survivor–parent dyads	Survivors mean 12.9 ± 3.3	ALL (46%), others	Parent–child PA modelling; parental support	MVPA (Godin Leisure-Time Exercise Questionnaire)	Kendall’s τ (converted to Pearson’s <i>r</i>)	Association-based meta-analysis
Xu et al., 2025 [25]	China	Cross-sectional (quantitative component of mixed-methods study)	503 childhood cancer survivors	8–18	Leukemia, lymphoma, sarcoma, others	Paternal support; maternal support; parental MVPA	MVPA participation	Odds ratio (OR)	Association-based meta-analysis (OR-based)

Kendall’s tau coefficients were converted to Pearson’s *r* using the approximation $r \approx \sin(\pi/2 \times \tau)$ prior to Fisher’s *z* transformation.

4.2. Quality assessment and risk of bias

The methodological quality of the included observational studies was assessed using the Newcastle–Ottawa Scale (NOS), with results summarised in **Table 3**. Overall, the studies demonstrated moderate methodological quality, with total NOS scores ranging from 6 to 9 out of a possible 9 stars.

Table 3. Quality assessment of included studies using the Newcastle–Ottawa Scale.

Study	Selection (4)	Comparability (2)	Outcome (3)	Total
Gilliam et al., 2012 [19]	4	1	2	7
Ha et al., 2022 [13]	3	1	2	6
Xu et al., 2025 [25]	4	2	3	9

Across studies, performance was generally strongest in the selection domain, reflecting clear definition of childhood cancer survivor populations, appropriate ascertainment of family or parental support exposures, and use of recognised recruitment sources such as clinics or survivor registries. Gilliam et al. [19] and Xu et al. [13] achieved the maximum number of stars for selection [24,25], while Ha et al. [13] received slightly fewer stars due to more limited sample size justification.

In contrast, the comparability domain represented the most consistent source of methodological limitation. While all studies accounted for basic demographic variables such as age and sex, only Xu et al. [25] implemented more comprehensive multivariable adjustment for additional clinical or contextual confounders [25]. As a result, most studies received one or fewer stars in this domain, indicating a potential risk of residual confounding that should be considered when interpreting observed associations between family support and physical activity behaviour.

With respect to the outcome domain, all included studies employed validated physical activity assessment tools, such as established self-report questionnaires or structured activity measures, and applied appropriate statistical analyses to estimate associations. Outcome assessment was therefore judged to be acceptable across studies, although reliance on self-reported physical activity measures introduces the possibility of recall or social desirability bias. Given the predominance of cross-sectional designs, follow-up adequacy could not be evaluated.

Taken together, the overall risk of bias was considered moderate. These quality considerations do not invalidate the observed associations but underscore the need for cautious interpretation, particularly regarding causal inference. The NOS findings align with the broader methodological profile of the evidence base, highlighting the need for future studies employing longitudinal or experimental designs with stronger control for confounding to clarify the role of family and parental support in shaping physical activity behaviour among childhood cancer survivors.

4.3. Association between family/parental support and MVPA

Figure 2 summarises the association between family or parental support and physical activity outcomes among childhood cancer survivors. As shown in **Figure 2**, two observational studies examined the relationship between family or parental support and moderate-to-vigorous physical activity (MVPA). Gilliam et al. reported a

moderate-to-strong positive association between family support for physical activity and survivor MVPA ($r = 0.55$, 95% CI 0.40–0.67, $n = 105$), indicating that higher perceived familial encouragement and support were associated with greater engagement in physical activity [24]. In contrast, Ha et al. [13] identified a smaller but statistically significant association between parent–child physical activity modelling and survivor MVPA ($r = 0.27$, 95% CI 0.10–0.43, $n = 125$), suggesting that parental behavioural modelling may contribute to activity engagement, albeit with a more modest effect size [13].

When synthesised using a random-effects model, the pooled correlation coefficient was $r = 0.42$ (95% CI 0.11–0.65), reflecting an overall positive association between family or parental support and MVPA. The width of the confidence interval highlights the presence of between-study heterogeneity and the limited number of eligible studies available for quantitative synthesis. Nevertheless, the direction of effect was consistent across studies, supporting the relevance of familial social contexts in shaping physical activity behaviour among childhood cancer survivors.

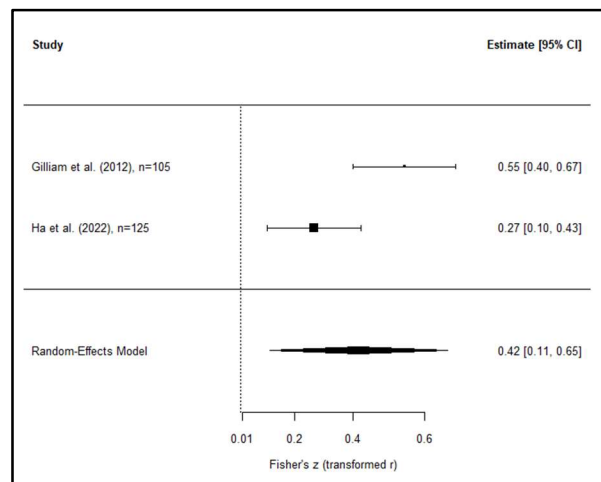


Figure 2. Forest plot of pooled correlation coefficients between family or parental support and MVPA.

Additional evidence based on odds ratios is presented in **Figure 3**. In a large cross-sectional study, Xu et al. [25] demonstrated that higher levels of parental support were associated with significantly reduced odds of physical inactivity, corresponding to a greater likelihood of MVPA participation (OR = 0.92, 95% CI 0.88–0.96). Although derived from a single study, this finding complements the correlation-based evidence by suggesting that family support may influence not only the amount of physical activity performed but also the probability of engaging in physical activity at all.

Taken together, these findings indicate that family and parental support are consistently associated with physical activity engagement in childhood cancer survivors. However, the magnitude of association varied across studies, likely reflecting differences in how support was operationalised, participant age ranges, and contextual factors related to survivorship and treatment history. Importantly, all association-based studies employed cross-sectional designs, precluding causal inference. It remains unclear whether family support actively promotes physical

activity or whether more active survivors elicit greater encouragement and involvement from their families.

Despite these limitations, the convergence of correlation-based and odds-ratio-based findings underscore the potential importance of family and parental contexts in post-treatment physical activity behaviour. The small number of eligible studies and wide confidence intervals observed in the pooled estimates reflect genuine gaps in the literature rather than methodological shortcomings of the present review. Future research should prioritise longitudinal and intervention designs that explicitly incorporate family-based support mechanisms to clarify causal pathways and inform the development of socially grounded physical activity interventions for childhood cancer survivors.

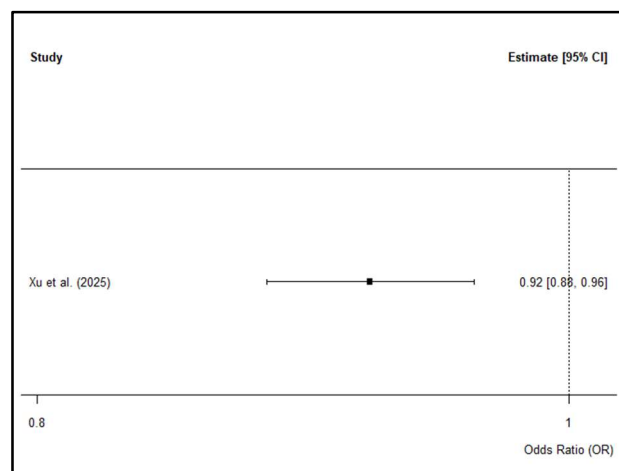


Figure 3. Odds ratio for MVPA participation associated with parental support.

4.4. Peer and school support: limited quantitative evidence

With respect to peer and school support, the available quantitative evidence was limited. Among the included studies, only Gilliam et al. reported a direct bivariate association between peer support for physical activity and survivor MVPA, demonstrating a moderate positive correlation ($r = 0.51, p < 0.01$) [24]. However, peer support was not consistently examined across studies, and no eligible studies quantitatively assessed school-level support in relation to physical activity outcomes using comparable effect size metrics. As a result, peer and school support could not be synthesised quantitatively and were therefore examined descriptively. This scarcity of quantitative evidence highlights a notable gap in the literature, particularly given the central role of peers and school environments in shaping physical activity behaviour during childhood and adolescence. Future research is warranted to systematically evaluate peer- and school-based support mechanisms using standardised measures that allow for quantitative synthesis.

4.5. Integration of observational and intervention findings

When considered together, the observational and intervention evidence highlights a conceptual disconnect within the current literature. Observational studies consistently identify family and parental contexts as important correlates of physical activity behaviour among childhood cancer survivors; however, intervention studies

have rarely incorporated these social factors as explicit targets, mechanisms, or mediators. This misalignment may partly contribute to the mixed or modest effectiveness observed in physical activity promotion efforts within paediatric oncology settings.

The available intervention evidence suggests that structured physical activity programmes can improve activity-related outcomes, yet the absence of family- or parent-focused components limits insight into how social support may influence intervention uptake, adherence, and sustainability. Integrating family-based or parent-supported elements such as joint activity participation, parental modelling, or family-centred goal setting may therefore enhance the ecological relevance and real-world effectiveness of future interventions by better reflecting the social environments in which survivors' activity behaviours are embedded.

4.6. Methodological considerations and limitations

Several methodological limitations warrant consideration. First, the small number of eligible studies reflects the limited availability of quantitative research directly examining social support in relation to physical activity outcomes, rather than shortcomings in the search strategy. Second, the predominance of cross-sectional study designs restricts causal interpretation, as it remains unclear whether family support facilitates greater physical activity or whether more active survivors receive increased encouragement and involvement from their families. Third, heterogeneity in physical activity measurement approaches and effect size metrics constrained the scope of quantitative synthesis and precluded formal assessment of publication bias.

In addition, variation in cultural norms, family structures, and healthcare systems across countries may influence the nature and impact of family support, potentially moderating observed associations. These contextual factors should be explicitly addressed in future multicentre and longitudinal research.

4.7. Implications for research and practice

The findings of this review underscore the need for more rigorous, theory-driven intervention studies that explicitly integrate family and peer support mechanisms into physical activity promotion for childhood cancer survivors. Longitudinal and experimental designs are particularly needed to clarify causal pathways and to determine whether enhancing family support leads to sustained improvements in physical activity behaviour.

From a clinical and survivorship care perspective, the consistent associations observed across studies suggest that parents and caregivers may represent key partners in physical activity counselling and programme delivery. Engaging families in survivorship-focused physical activity initiatives may be especially valuable during the transition from active treatment to survivorship, a period when activity patterns are re-established and long-term health behaviours begin to stabilise.

5. Conclusion

This meta-analytic review synthesised the available quantitative evidence on the relationship between family and parental support and physical activity behaviour

among childhood cancer survivors. Across the limited number of eligible studies, family- and parent-related support demonstrated a consistent positive association with moderate-to-vigorous physical activity, suggesting that social contexts within the family environment are relevant correlates of post-treatment physical activity engagement. However, the magnitude of association varied across studies, and the overall evidence base remains small and methodologically heterogeneous.

Importantly, the findings highlight a clear imbalance in the literature. While observational studies frequently implicate family and parental factors as important correlates of physical activity, intervention studies rarely incorporate these social mechanisms as explicit targets or mediators. This disconnect may limit the effectiveness and sustainability of current physical activity promotion efforts in paediatric oncology.

Given the predominance of cross-sectional designs, causal inferences cannot be drawn, and it remains unclear whether family support actively facilitates physical activity or whether more active survivors elicit greater involvement and encouragement from their families. The small number of eligible studies reflects a genuine gap in research rather than limitations of the present review.

Future research should prioritise longitudinal and intervention studies that explicitly integrate family- and peer-based support mechanisms within a social ecological framework. From a clinical perspective, the consistent associations observed suggest that engaging parents and caregivers as active partners in physical activity counselling and survivorship programmes may represent a promising strategy to support physical activity re-engagement during and after the transition to survivorship.

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