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# Melanoma in children and adolescents — a literature review of the last 5 years

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## ABSTRACT

Melanoma in the pediatric population is a rare entity, accounting for about 3% of all childhood cancers, and is particularly infrequent in children under the age of 5. Its rarity, coupled with clinical features that mimic other dermatological conditions, often leads to delayed diagnosis and poorer outcomes. This review aims to synthesize recent literature (2020–2024) on pediatric melanoma to highlight advancements in diagnosis, prognosis, treatment, and prevention strategies. A PubMed search yielded 28 articles, with topics spanning epidemiology, risk factors, ultraviolet (UV) radiation exposure, genetic mutations, clinical guidelines, and prevention. Recent studies confirm that the mitotic rate in primary melanoma is a stronger prognostic indicator than tumor thickness, independently correlating with recurrence-free survival in children and adolescents. Emerging research underscores distinct biological patterns in subtypes such as nodular and spitzoid melanoma, necessitating updated surgical and treatment protocols tailored to pediatric cases. Sun protection education for parents, particularly for children with familial melanoma risk, remains a critical prevention strategy. Moreover, studies emphasize the importance of close monitoring for malignancy in children with congenital melanocytic nevi and the utility of regular skin examinations to enhance early detection. Pediatric treatment guidelines largely extrapolate from adult trials, yet mounting evidence indicates significant clinical and biological differences between these populations. In conclusion, pediatric melanoma, while rare, necessitates early detection and vigilant clinical assessment for improved prognosis. Promoting sun protection behaviors and addressing familial risk factors are essential components of prevention. Enhanced understanding of pediatric melanoma's unique clinical and biological characteristics can improve treatment protocols and optimize outcomes.

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**Keywords:** children, pediatric melanoma, oncology, pediatric dermatology, dermatopathology

## INTRODUCTION

Although melanoma is infrequent in the pediatric population, accounting for less than 3% of all pediatric cancers, it is particularly rare in children under the age of 5 [1]. Due to a low level of suspicion and its clinical similarity to other conditions, the diagnosis of melanoma in children is often delayed. This delayed diagnosis can lead to poorer outcomes, highlighting the need for greater awareness and early detection strategies in this age group.

### *Aim*

This review aimed to examine the literature from the past five years regarding melanoma in the pediatric population.

## MATERIAL AND METHODS

The search was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The PubMed database was searched for articles published between 2020 and 2024 using the keywords "melanoma" and "children" in the titles. The flow diagram of this study is presented in Figure 1.

## RESULTS

A total of 28 articles were found. Two articles were inaccessible, and two were duplicates. One focused on prognostic factors [2]. Three articles addressed treatment [3–5], while two discussed epidemiology [6, 7]. Another study focused on ultraviolet (UV) radiation [8]. One article examined the prognosis of different melanoma types [9], and another explored prevention strategies [10]. Two articles addressed frequency [11, 12] and one article was a case report [13]. Three studies discussed mutations [14–16]. One article involved surveys on prevention [17], and one examined risk factors for cutaneous melanoma and Spitz

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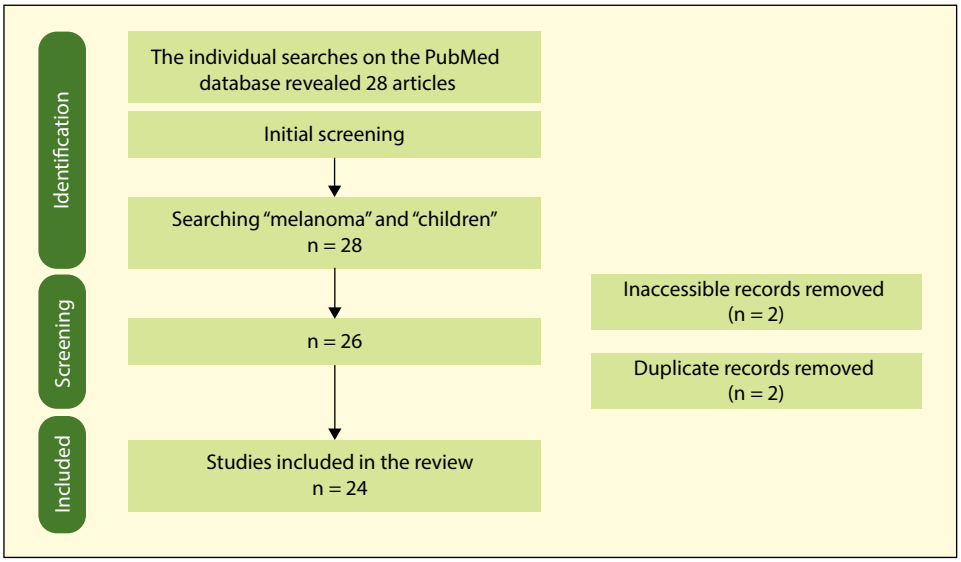


**Figure 1.** Literature selection process according to PRISMA guidelines

tumors [18]. Additionally, one article provided guidelines [19], one focused on differentiating melanoma from Reed's syndrome [20], and one analyzed survival rates [21]. One article discussed management following genetic testing [22], and one explored screening [23]. Another study [24] analyzed the course of melanoma in children. Finally, another retrospective study [25] analyzed clinical features, histopathology, disease progression, treatment methods, and follow-up outcomes.

The objective of the study by Ipenburg et al. [2] was to evaluate the prognostic significance of the mitotic rate in primary melanoma among children and adolescents. Out of 156 patients, 13 (8%) were children. The mitotic rate was found to be a more significant prognostic factor than tumor thickness and was the only independent factor associated with recurrence-free survival. The study concludes that the mitotic rate is an independent predictor of recurrence-free survival in pediatric melanoma.

The aim of the Sargen et al. [3] study was to develop recommendations for the diagnosis and surgical management of, among others, cutaneous melanoma (CM) in patients up to 18 years of age. Thirty-three experts from various specialties (cutaneous/medical/surgical oncology, dermatology, and dermatopathology) developed recommendations supported by data from 87 peer-reviewed publications.

The next article by Polish authors — Sosnowska-Sienkiewicz et al. [4] — examines the diagnosis and treatment of melanocytic nevi, as well as the risk factors that contribute to melanoma development. It covers the most common types of melanocytic nevi in children, discussing their epidemiology, morphology, diagnostic methods, and treatment strategies.

The study conducted by Scoville et al. [5] focused on patients aged 18 years or younger diagnosed with cutaneous melanoma and aimed to evaluate the effectiveness of nodal basin ultrasound (US) surveillance compared to completion lymph node dissection (CLND) in children and adolescents with sentinel lymph node (SLN) positive melanoma.

A retrospective study conducted by Hawryluk et al. [6] involving 317 patients, 73% of whom were adolescents (aged 11 years and older), found that the most prevalent melanoma subtypes were spitzoid (31%) and superficial spreading (26%), with 11% originating from congenital nevi. Sentinel lymph node biopsy was performed in 68% of cases, yielding positive results in 46%, and the observed fatality rate was 7%. Adolescent patients were more likely to have a family history of melanoma compared to the control group.

The objective of the study by Wu et al. [7] was to explore the relationship between parents' fatalistic views on melanoma and their children's sun protection practices, with a focus on the potential moderating effect of parent–child communication. In this observational study, which included 69 parents who survived melanoma and had children aged 8 to 17, parents reported their own levels of fatalism, their children's sun safety behaviors, and discussions regarding sun safety. The study suggests that parents' fatalistic attitudes can indirectly influence their children's sun protection habits, potentially increasing the risk of inadequate sun protection.

In another study made by Wu et al. [8] with a single-group design, including 21 parent–child pairs with children aged 8–17. The participants engaged in three in-person assessments along with three intervention sessions conducted

*via* live video teleconferences. The purpose of the study was to assess the feasibility and acceptability of a telehealth intervention centered on families, targeting children with a familial risk of melanoma and involving their parents. The research also evaluated changes in the children's sun protection habits, risky behaviors related to sun exposure, and sunburn incidents, and measured ultraviolet radiation (UVR) exposure objectively. The results suggested that this family-oriented telehealth intervention for melanoma prevention was both feasible to implement and well-received by the parent-child pairs. Future melanoma prevention efforts for this high-risk group could benefit from incorporating eHealth technologies to support improved sun protection measures and tracking of UVR exposure.

The goal of the research conducted by Pampena et al. [9] was to systematically evaluate the existing evidence on pediatric melanoma. A literature search was conducted spanning from 1948 to 2021. Data concerning individual patients were obtained from 213 studies, involving a total of 1,002 patients. Among the various histological subtypes, nodular melanoma (NM) exhibited a lower melanoma-specific survival (MSS) compared to both superficial spreading melanoma (SSM) and spitzoid melanoma, as well as a reduced progression-free survival (PFS) when contrasted with SSM. Additionally, spitzoid melanoma displayed a significantly higher progression risk than SSM, along with a trend toward lower mortality. In terms of nevus-associated status, *de novo* melanoma (DNM) showed superior MSS after progression in comparison to congenital nevus-associated melanomas (NAM), with no notable differences in PFS. The present results highlight the presence of distinct biological patterns in pediatric melanoma. Notably, spitzoid melanomas exhibited an intermediate behavior between SSM and NM, showing a high risk of nodal progression while maintaining low mortality rates. This raises the question of whether spitzoid lesions are being inaccurately diagnosed as melanoma during childhood.

The Family Lifestyles, Actions, and Risk Education (FLARE) intervention aims to determine whether it can help reduce familial melanoma risk in children by teaching practices that, when implemented, decrease the occurrence of sunburns and improve the use of well-established sun protection strategies [10].

This study by Nakata et al. [11] aimed to compare the distribution of carcinoma and melanoma subtypes in children and adolescents between Japan and other countries. It analyzed the incidence and proportion of carcinoma and melanoma subtypes in children (0–14 years old) and adolescents (15–19 years old) across different continents. The incidence of carcinoma and melanoma in children ranged from 2.5 to 7.8 cases per 1,000,000 person-years, while in adolescents, the rates were higher, ranging from 15.1 to 84.1 cases per 1,000,000 person-years, with the highest rate observed in Oceanian countries.

The objective of Rousi et al. [12] study was to assess the incidence of pediatric and adolescent melanomas in Finland from 1990 to 2014, alongside related clinical and histopathological characteristics. A total of 122 patients were included. The study revealed a 5.6% annual increase in melanoma incidence among children and adolescents, particularly in the adolescent group, indicating a clear rise in cases of cutaneous melanoma among young people in Finland.

A report showed by Larrosa et al. [13] describes the case of a 12-month-old girl with a lesion on her right ankle, initially measured at 0.5 cm. Over time, the lesion became an irregular, erythematous, dome-shaped nodule. After 13 months and multiple misdiagnoses — including a traumatic injury, wart, and telangiectatic granuloma — the lesion was excised for biopsy. Histopathological analysis showed a proliferation of atypical fusiform melanocytes with a high mitotic index (> 20%).

In Helgadottir et al. [14] study, germline variants in known melanoma susceptibility genes were examined among 123 pediatric melanoma patients. The study compared the frequency of variants in CDKN2A, CDK4, POT1, MITF, and MC1R across sporadic and familial melanoma cases, as well as between adolescents and younger children. This research confirms that there is no routine genetic test for sporadic pediatric melanoma. However, it stresses the importance of thorough family and personal cancer histories, suggesting that familial or multiple primary pediatric melanoma cases should undergo germline genetic testing and evaluation. Consideration should also be given to testing for CDKN2A or panel testing.

The aim of the study written by Pellegrini et al. [15] was to analyze the major high- and intermediate-risk melanoma genes, such as CDKN2A, CDK4, POT1, MITF, and MC1R, in a large multicenter cohort of Italian children and adolescents to explore the genetic context of pediatric melanoma and to reveal potential differences in heritability between children and adolescents. A total of 123 patients (< 21 years old) were analyzed. The study confirmed the limited involvement of major high-risk susceptibility genes in pediatric melanoma and suggested the implication of MC1R gene variants, particularly in the pediatric population.

The study conducted by Larrosa et al. [16] examined melanoma in 122 pediatric and adolescent patients from the Finnish population, focusing on incidence rates, clinical progression, treatment approaches, prognosis, and the expression of BRAFV600E, anaplastic lymphoma kinase (ALK), and programmed death-ligand 1 (PD-L1) in primary

tumors. Results showed a rise in pediatric melanoma incidence from 0.02 to 0.1 per 100,000 between 1990 and 2014. Spitzoid melanoma was the most prevalent subtype, accounting for 66% of cases. The 10-year cancer-specific survival (CSS) rate was 88.7%, with no significant difference observed between sentinel lymph node biopsy (SLNB)--positive and SLNB-negative groups. BRAFV600E mutations were detected in 48% of tumors, ALK in 9%, and PD-L1 in 2%, with BRAFV600E mutations linked to 83% of melanoma-related fatalities.

The study conducted by Haddad et al. [17] aimed to evaluate the understanding and practices of Lebanese parents concerning melanoma and its prevention in children. A survey was conducted with 1,012 participants. Only 23.5% of parents reported consistently covering their children's skin during sun exposure, and 74.1% did not apply sunscreen regularly. The results suggest that sun protection for children is inadequate, leading to frequent sunburns, underscoring the need for awareness campaigns about melanoma prevention.

The study of Fortes et al. [18] aimed to identify differences in individual and environmental factors between cutaneous melanoma and atypical Spitz tumors. The research included 105 participants under the age of 20 with either condition. Findings revealed that children and adolescents with cutaneous melanoma had a higher number of nevi compared to those with atypical Spitz tumors. The results suggest that the number of nevi is the sole distinguishing factor in individual and environmental risk profiles between these two conditions in young patients.

The Ferrari et al. [19] article outlines globally accepted guidelines for diagnosing and treating cutaneous melanoma in children and adolescents, developed by the European Cooperative Study Group for Pediatric Rare Tumors (EXPeRT).

A Volgareva [20] article on differentiating between Reed nevus, which is common in children and adolescents, and cutaneous melanoma. It has been noted that the immunohistochemical test for cyclin D1, p16INK4a, and human leukocyte antigen (HLA) class I antigens represents a promising approach for the differential diagnosis between Reed nevus and cutaneous melanoma in children and adolescents.

A retrospective study conducted by Purim et al. [21] on survival in juvenile melanoma found delays in diagnosis, high morbidity and mortality rates, and an average survival of less than five years.

Bressac-de Paillerets et al. [22] in there study explored family dynamics related to skin cancer prevention and management over the course of a year following genetic testing for melanoma predisposition and subsequent counseling. The research included 18 children who underwent genetic testing, alongside their parents. Findings indicated that genetic testing influenced both planning and discussions surrounding sun protection measures. Additionally, the study highlighted strong collaboration between parents and children in implementing strategies to safeguard children from sun exposure.

The objective of the study made by Wu et al. [23] was to investigate the screening practices and recommendations provided by healthcare professionals for children of melanoma survivors. Parents with a family history of melanoma completed a survey addressing the frequency, thoroughness, and individuals conducting their children's skin screenings. Results showed that 74% of parents indicated their children [average age = 9 years, standard deviation (SD) = 4.8] had participated in parent-assisted skin self--examination (SSEs) within the previous six months. However, only 12% of parents reported that their children conducted SSEs monthly, which is the recommended frequency for adult melanoma survivors.

A retrospective Bay study [24] analyzed cases of malignant melanoma in patients under the age of 15 who were treated between 2003 and 2018. The cohort comprised 17 children (10 girls and 7 boys) with a median age of 7 years, ranging from 7 months to 13 years. Among these patients, five had congenital melanocytic nevi. All but one case, which involved mucosal (conjunctival) melanoma, were diagnosed as cutaneous melanoma. The lower limbs were the most common site for primary tumors, accounting for 35% of cases.

At diagnosis, staging involved sentinel lymphoscintigraphy, sentinel node biopsy, and positron emission tomography/computed tomography (PET/CT) imaging. Eight patients presented with localized melanoma, while nine exhibited regional lymph node metastases. Localized cases were managed solely through surgical intervention, whereas those with lymph node involvement underwent surgery combined with adjuvant interferon therapy.

Three patients developed distant metastases, affecting the bone, lungs, and brain, with a median time to metastasis of 9 months post-diagnosis. The median follow-up duration for the study population was 25 months, and the 5-year overall survival rate was reported as 76.6%.

A retrospective, descriptive, multi-center study [25] examined cases of cutaneous malignant melanoma in patients under 18 years of age over a 20-year span (1994–2014). The research analyzed clinical features, histopathology, disease progression, treatment methods, and follow-up outcomes. Across Australasian Childhood Cancer Centers, 37 cases were identified, with a median patient age of 10 years. Pigmented lesions were the most common, seen in 16 patients (57%), while amelanotic lesions were noted

in 7 patients (25%). In 11 cases (27.9%), the Breslow thickness exceeded 4 mm. Relapses occurred in 11 patients (29.7%), and 90% of these individuals succumbed to the disease. The five-year event-free survival (EFS) rate was 63.2%, and overall survival was 67.7%. These findings reinforce the importance of early, multidisciplinary management in pediatric cancer centers, supported by collaboration with adult melanoma specialists, to address the complexities of this rare condition.

Pediatric melanoma is a rare yet clinically diverse condition, presenting unique challenges in diagnosis, management, and prevention. Its rarity complicates early detection, and current treatment protocols often rely on evidence derived from adult cases. Research indicates significant biological and clinical differences between pediatric and adult melanoma, necessitating age-specific guidelines. Prevention efforts, including public awareness campaigns and genetic counseling, are particularly vital for high-risk groups.

## CONCLUSIONS

Effective management of pediatric melanoma requires a multifaceted approach that prioritizes early detection, tailored treatment protocols, and robust prevention strategies. Regular skin examinations and proactive sun protection measures are critical for reducing melanoma risk across all age groups. Genetic insights and advancements in diagnostic tools hold promise for improving outcomes in this rare but significant cancer type.

## Article information and declarations


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### *Author contributions*

This article has just one author.

### *Conflict of interest*

No conflicts of interest to declare.

### *Ethics statement*

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