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REVIEW ARTICLE

Contemporary approach to pediatric ovarian tumors

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ABSTRACT

Introduction. Pediatric ovarian tumors represent a rare but clinically important category of gynecologic conditions, comprising approximately 1-2% of all childhood malignancies and about 5% of pediatric abdominal masses. While most are benign, a meaningful percentage can be hormonally active, raising diagnostic and therapeutic challenges. Due to nonspecific symptoms such as abdominal pain or distension, early diagnosis is often delayed, potentially compromising fertility preservation and long-term outcomes. A multidisciplinary, age-specific approach is essential to optimize management.

Material and methods. This study is a narrative literature review based on an extensive search across *PubMed, ScienceDirect, SpringerLink,* and *Google Scholar*. The search covered the period from 2008 to 2025 and included terms such as "pediatric ovarian tumors", "germ cell tumors", "sex cord-stromal tumors", "diagnostic imaging", and "fertility preservation". Inclusion criteria encompassed peer-reviewed, full-text articles in English focusing on patients aged 0-19 years. A total of 20 sources, including clinical guidelines and articles, were selected for their thematic relevance and quality of evidence.

Results. Pediatric ovarian tumors show wide clinical and histological variability, with germ cell tumors being the most prevalent malignant subtype. Transabdominal ultrasound is the first-line imaging tool, while Magnetic Resonance Imaging is reserved for complex or inconclusive cases. Tumor markers, such as alpha-fetoprotein, beta-human chorionic gonadotropin, lactate dehydrogenase, and Inhibin B, are essential in differentiating tumor types and guiding management. Surgical decisions prioritize minimally invasive, fertility-sparing approaches when malignancy is unlikely. Long-term follow-up includes hormonal, reproductive, and psychosocial monitoring. Psychological support is particularly important for adolescents. Despite advancements, diagnostic delays, lack of pediatric-specific guidelines, and disparities in care, especially in low-resource settings, remain critical challenges.

Conclusions. Pediatric ovarian tumors require an individualized, multidisciplinary management strategy that integrates early detection, age-appropriate surgical care, fertility preservation, and long-term endocrine and psychological support. This review highlights the need for pediatric-specific protocols and improved access to diagnostics to enhance outcomes and preserve the future reproductive potential of affected children and adolescents.

Keywords: pediatric ovarian tumors, diagnostic imaging, tumor markers, minimally invasive surgery, fertility preservation, multidisciplinary management.

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Key messages

What is not yet known on the issue addressed in the submitted manuscript

Despite advances in the management of pediatric ovarian tumors, several knowledge gaps persist. There is limited availability of standardized, age-specific diagnostic and therapeutic guidelines tailored to the pediatric population. The interpretation of tumor markers in children lacks universally accepted pediatric reference ranges. The long-term impact of conservative surgical approaches on hormonal function, fertility, and psychosocial outcomes remains insufficiently studied. These gaps are particularly significant

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in low-resource settings, where access to imaging, tumor markers, and pediatric-trained specialists is limited.

The research hypothesis

Adherence to evidence-based, age-specific diagnostic and surgical management guidelines for pediatric ovarian tumors, incorporating imaging, tumor marker profiling, and fertility-preserving techniques, and adapted to local healthcare capacities, can improve reproductive and psychosocial outcomes more effectively than non-specialized, adult-oriented approaches.

The novelty added by the manuscript to the already published scientific literature

This manuscript provides a focused, multidisciplinary overview of pediatric ovarian tumors, emphasizing age-adapted diagnostics, fertility preservation, and long-term endocrine and psychosocial follow-up, topics often insufficiently explored in existing literature. By addressing pediatric-specific needs and healthcare disparities, it offers a more tailored and integrative approach than previous reviews, which are largely based on adult data.

Introduction

Pediatric ovarian tumors represent a rare but clinically important category of gynecologic conditions, comprising approximately 1-2% of all childhood malignancies and about 5% of pediatric abdominal masses, as described by Banli-Cesur et al. (2021), Renaud et al. (2019), and Satoh et al. (2016) [1-3]. Although most ovarian tumors in children and adolescents are benign, the clinical spectrum is wide, ranging from functional cysts and hormonally active lesions to highly malignant germ cell neoplasms, which require careful clinical evaluation and multidisciplinary management [4]. Literature data emphasize that the majority of pediatric ovarian malignancies are of germ cell origin, accounting for 60-80% of cases, especially in girls ≤15 years [1, 2]. Tsikouras et al. (2008) further highlight the predominance of this histologic type in prepubertal patients, requiring age-specific diagnostic and therapeutic protocols [5, 6].

Timely detection of pediatric ovarian tumors is often delayed due to their nonspecific clinical presentation. Braungart et al. (2020) report that abdominal pain, distension, and the presence of an abdominal mass are among the most common symptoms, but these may mimic more frequent pediatric conditions such as appendicitis or urinary tract infections [7]. Children often struggle to articulate their symptoms clearly, contributing to diagnostic delays and potentially compromising fertility preservation opportunities [8, 9]. Ultrasonography, particularly the transabdominal approach, remains the primary imaging modality in pediatric patients due to its accessibility, safety, and diagnostic yield [7, 8]. MRI is increasingly used for complex or equivocal cases, providing tissue characterization and guidance for surgical planning [3, 8]. However, imaging alone is insufficient to confirm tumor histology or evolution. Tumor markers such as AFP, β-hCG, LDH, and Inhibin B are essential auxiliary tools, especially in the evaluation of germ cell and sex cord-stromal tumors [3, 10, 11].

Surgical management in this population must carefully balance oncologic safety with preservation of endocrine and reproductive function. Studies indicate that conservative surgical techniques, including ovarian cystectomy and fertility-sparing procedures, are particularly important in benign or early-stage malignant cases [2, 12]. Laparoscopy, when feasible, is the optimal approach due to its minimally invasive nature and lower risk of postoperative adhesions [8]. Long-term follow-up is essential not only for detecting recurrence, but also for monitoring pubertal progression, fertility potential, and psychosocial adaptation. Survivors of pediatric ovarian tumors may experience anxiety, body image disturbances, or concerns regarding reproductive health, requiring integrated psychological and endocrine support [8, 13].

This review aims to provide a comprehensive synthesis of the current literature on pediatric ovarian tumors, encompassing epidemiological trends, diagnostic strategies, clinical presentation, imaging, tumor markers, surgical and conservative management, fertility preservation, recurrence, and multidisciplinary care.

Material and methods

This study is a narrative literature review designed to synthesize current evidence on pediatric ovarian tumors. A structured literature search was conducted using four electronic databases: *PubMed, ScienceDirect, SpringerLink,* and *Google Scholar,* covering the period from 2008 to 2025. Keywords included: "pediatric ovarian tumors", "germ cell tumors", "sex cord-stromal tumors", "fertility preservation", "diagnostic imaging", and "tumor markers in children". Inclusion criteria encompassed full-text, peer-reviewed articles published in English, focused on the pediatric population (age range 0-19 years), and addressing diagnostic approaches, therapeutic strategies, or multidisciplinary management of ovarian tumors. A total of 20 full-text articles and clinical guidelines were selected based on their relevance, quality of evidence, and thematic contribution. The literature was reviewed and

categorized into the following thematic domains: incidence and epidemiological trends in children and adolescents; clinical manifestations, diagnostic imaging, and tumor marker profiles; surgical indications, with an emphasis on fertility-sparing approaches; recurrence, monitoring strategies, and multidisciplinary follow-up; and strategic directions for improving pediatric gynecological care.

Results

This study provides a comprehensive and updated overview of pediatric ovarian tumors, focusing on their multidisciplinary management approaches. This literature review reveals significant advances in the understanding and management of these tumors, while also highlighting key challenges and knowledge gaps.

Pediatric ovarian tumors remain rare, with an annual incidence estimated at 2.6 per 100,000 girls [2, 4, 9]. Satoh et al. (2016) report a small incidence peak during infancy and adolescence [3]. Hormone-secreting sex cord-stromal tumors are more frequent in pediatric populations compared to adults [14, 15].

The clinical presentation is often nonspecific. As reported by Braungart et al. (2020), abdominal pain is the most common symptom, observed in up to 80% of cases [7]. Pain may be intermittent or acute, sometimes mimicking appendicitis or urinary tract infections [16]. Abdominal distension and a palpable mass are also frequent, particularly with larger tumors (>8 cm) [10, 11]. Mass effect on adjacent organs can cause nausea, vomiting, constipation, increased urinary frequency, or urinary retention [8, 9]. These symptoms often lead to initial referrals to pediatric surgery or gastroenterology, delaying gynecologic evaluation [6, 9]. Functional tumors, such as granulosa cell tumors or Sertoli-Leydig cell tumors, may present with precocious puberty, menstrual irregularities, hirsutism, or virilization (in androgen-secreting tumors). In postmenarchal adolescents, abnormal uterine bleeding may be the first sign of a hormonally active tumor [9, 14, 16, 17]. Up to 20-30% of pediatric ovarian tumors may present as acute abdomen due to torsion of the ovarian pedicle–a surgical emergency–or intracystic hemorrhage or rupture. Ovarian torsion is more likely in benign, mobile cystic lesions, particularly those larger than 5 cm. Asymptomatic ovarian masses are occasionally discovered incidentally [7, 12, 18]. These cases often involve simple cysts or mature teratomas and tipically require close monitoring rather than immediate intervention [19].

In prepubertal and early pubertal girls, transabdominal US is the method of choice due to anatomical and ethical considerations. Transabdominal US can differentiate between simple cysts and solid masses [9]. It may also be used in postmenarchal adolescents with patient consent, especially when further detail is needed [8, 15]. MRI is performed as a second-line tool in cases where US is inconclusive or when more detailed tissue characterization is required prior to surgery [3, 7]. MRI offers several advantages: superior soft tissue contrast, better delineation of tumor components (fat, fluid, hemorrhage), detection of lymphadenopathy or local invasion, and helps distinguish between benign teratomas, hemorrhagic cysts, and malignant tumors. Mature teratomas have a high fat content and mixed signal intensity. Malignant tumors consist of solid components with contrast enhancement, necrosis, or ascites. MRI is especially useful for large or complex masses in planning fertility-sparing surgery, or when the urgency of surgical intervention must be assessed and prioritized [3, 17].

Recent international guidelines advocate for standardized risk assessment, the use of tumor markers (AFP, β-HCG, LDH), and structured follow-up protocols to monitor recurrence and endocrine sequelae [3, 18]. The availability and use of tumor markers have improved early differentiation between benign and malignant tumors, although pediatric reference ranges are not always standardized [6, 17]. Interpretation of tumor markers is more complex in pediatric patients due to age-related reference ranges [6, 17] (Table 1).

Table 1. Main tumor markers and pediatric reference values

Marker	*Pediatric reference interval*	*Use in ovarian masses*	*Suggestive of malignancy*
AFP	0–30 days: 0.6–18,964 1–11 months: 0.6–77.0 1–3 years old (y.o.): 0.6–11.1 4–6 y.o.: 0.6–4.2 7–12 y.o.: 0.6–5.6 13–19 y.o.: 0.6–4.2	↑ in yolk sac tumors and mixed malignant GCT.	Persistently elevated beyond age-appropriate range or rising trend.
β-hCG	At birth (placental transfer): 10–50 IU/L Declines with ½ every 2–3 days. By >3 months: <1.0 IU/L	↑ in choriocarcinoma, some mixed GCT; rarely in dysgerminoma.	Detectable/raised after 3 months of age when not pregnant.
LDH	1–3 y.o.: 160–370 4–6 y.o.:145–345 7–9 y.o.:143–290 10–12 y.o.:120–293 13–15 y.o.:110–283 16–17 y.o.:105–233	↑ in dysgerminoma.	Markedly above age-specific upper limit with solid mass on imaging.
Inhibin B	Low/undetectable prepuberty (<20–100 pg/mL) Peaks mid-puberty (80–90 pg/mL), then falls.	↑ in granulosa cell tumors.	Marked elevation relative to age/puberty stage.
AMH	Broad age-specific variation; examples in girls: approx. 0.08–13.2 ng/mL.	↓ suggests diminished ovarian reserve; not a malignancy marker.	Not a tumor marker; trends used for ovarian function monitoring.
CA-125	Adult-type cutoff commonly used: ≤35 U/mL.	Non-specific; can rise with peritoneal irritation, endometriosis, infection.	Markedly elevated with solid/complex mass and concerning imaging/other markers.

Note: *AFP – alpha-fetoprotein; βhCG – beta-human chorionic gonadotropin; LDH – lactate dehydrogenase; AMH – anti-Müllerian hormone; CA125 – cancer antigen 125.*

Surgery is guided by the suspected risk of malignancy, presence of complications, and imaging features. Emergency indications include ovarian torsion, rupture, or hemorrhagic cysts [7, 8]. When a benign lesion is suspected, minimally invasive procedures, such as laparoscopic cystectomy or tumorectomy, are typically indicated in elective settings [2, 4]. Fertility-preserving resection is feasible and safe in most cases. Conservative management is considered when lesions are <8 cm in diameter, cystic in nature, and associated with normal tumor marker levels. Laparotomy is reserved for large or suspicious masses, or for confirmed malignancies requiring staging [15, 16].

The management of ovarian tumors in children and adolescents presents distinct clinical, diagnostic, and therapeutic challenges. These differences arise from anatomical, physiological, psychosocial, and oncological considerations, which must be carefully addressed to ensure optimal outcomes. There is a greater emphasis on fertility preservation, given the long reproductive lifespan ahead. Thus, ovarian-sparing techniques are prioritized whenever oncologically safe [9, 20]. The need for a contemporary, age-adapted approach to pediatric ovarian tumors is therefore important. This includes improved awareness among pediatricians and gynecologists and the integration of multidisciplinary teams. Laparoscopy is the optimal surgical method in pediatric ovarian tumors when the likelihood of malignancy is low. It ensures faster recovery, better outcomes, and fertility preservation. However, laparotomy remains crucial when dealing with large, complex, or malignant lesions, offering oncologic safety and thorough exploration. The choice of approach must be individualized, guided by imaging, biomarkers, intraoperative findings, and surgical expertise [9, 20].

Fertility-sparing surgery does not compromise oncologic outcomes in early-stage tumors. Braungart et al. (2020) reported high rates of menstrual recovery and pubertal progression post-surgery [7, 8]. AMH levels and follicle count via US are used in long-term fertility assessments. Hormonal dysfunction may occur after bilateral surgery or chemotherapy, necessitating endocrine follow-up [4]. Psychological support is critical, especially in adolescents undergoing treatment with reproductive implications [13, 15]. Preservation of fertility and hormonal function is particularly important in children and adolescents. Ovaries possess regenerative capacity and can often be spared with careful surgical planning [2, 3]. Conservative surgery is indicated in cases with normal or slightly elevated tumor markers, cystic or mixed echogenicity on US, size <8 cm with smooth borders and no ascites, absence of solid components or internal septations, non-hemorrhagic contents, and no evidence of metastasis [19].

Recurrence is uncommon in benign cases but must be monitored closely in malignant or borderline tumors. Risk factors include advanced stage, high-grade histology, incomplete previous resection, or absence of adjuvant therapy. AFP and β-hCG are useful surveillance markers for germ cell tumors, while Inhibin B is monitored in granulosa cell tumors [8]. US and MRI are used to assess residual tissue or recurrence. When recurrence occurs, re-excision, chemotherapy, or combined therapy is applied depending on tumor type [7, 9].

Surgical management of ovarian tumors in pediatric patients must strike a balance between timely intervention, fertility preservation, and oncologic safety. The indication for surgery may arise in emergency or elective settings, depending on the clinical presentation, imaging findings, and suspected pathology. Emergency surgery is required when a child presents with acute symptoms suggestive of complications [7, 8, 12, 20].

Long-term follow-up must also address hormonal health, pubertal staging, and psychosocial reintegration. Structured transition to adult care is essential [6, 8].

The optimal care of children and adolescents with ovarian tumors–whether benign, borderline, or malignant–requires a multidisciplinary team approach. This model ensures individualized, comprehensive, and coordinated care by integrating the expertise of specialists, tailored to the specific clinical, developmental, psychological, and fertility-related needs of pediatric patients. Core members of the multidisciplinary team include: a pediatric oncologist, pediatric surgeon or gynecologic oncologist, radiologist, pathologist, reproductive endocrinologist, pediatric endocrinologist, clinical psychologist or psycho-oncologist, nursing staff, and patient navigation team. The multidisciplinary team approach in clinical practice can improve diagnostic accuracy and reduce unnecessary radical surgery, enhance compliance with evidence-based protocols, lower recurrence rates and improve survival outcomes, protect fertility and pubertal development, and provide a stronger psychosocial support and family-centered care [12, 13].

Discussion

Pediatric ovarian tumors represent a rare but clinically significant group of gynecologic conditions, marked by substantial heterogeneity in histology, symptomatology, and outcomes. Their management requires a tailored, multidisciplinary approach that considers the developmental, reproductive, and psychological contexts unique to children and adolescents. This review consolidates current evidence and practice patterns, identifying both advances and persistent challenges in diagnosis, treatment, and follow-up care.

Germ cell tumors are the most common malignant ovarian neoplasms in pediatric populations, particularly in girls under 15 years, as demonstrated by different authors [1, 2]. Their early recognition is crucial given their high chemosensitivity and favorable prognosis when detected promptly. However, these tumors are often diagnosed late due to their nonspecific presentation, which overlaps with more common pediatric conditions such as appendicitis or urinary tract infections [4, 5]. Sex cord-stromal tumors, although less frequent, can present with early puberty, irregular bleeding, or virilization [14, 15].

The diagnostic approach is strongly guided by imaging assessment and biochemical marker analysis. US remains the first-line diagnostic tool due to its safety and accessi-

bility, with MRI providing superior anatomical detail in complex or equivocal cases [7]. However, neither imaging method can independently confirm malignancy. Tumor markers such as AFP, β-hCG, LDH, Inhibin B, and AMH are essential tests, yet their interpretation in children, especially neonates and prepubertal girls, requires careful consideration of age-specific reference ranges [3, 6, 10]. Expanding access to these markers is a critical step in improving diagnostic accuracy (Table 2).

Table 2. Diagnostic and treatment algorithm – key steps

Phase	*Key steps*
Initial assessment	History (pain, menstrual cycle, acute torsion signs) Tanner stage Pregnancy test if post-menarchal.
First-line imaging	Pelvic ultrasound with Doppler
Second-line imaging	MRI if indeterminate or to refine surgical planning CT reserved for staging/complications.
Tumor markers	Order age-appropriate panel: AFP, β-hCG, LDH; ± inhibin B (granulosa), AMH baseline, ± CA-125.
Risk stratification	Integrate US features + markers + age/puberty: Low-risk (simple cysts) vs. suspicious (solid/complex, elevated markers).
Conservative management	Simple, asymptomatic cysts (generally <5–7 cm): observation ± short-interval US (6–12 weeks).
Torsion protocol	Urgent laparoscopy; detorsion and cystectomy when viable; avoid routine oophorectomy.
Benign-appearing tumors	Minimally invasive ovarian-sparing cystectomy/ tumorectomy whenever feasible.
Suspicious/malignant	Oncologic principles: avoid rupture, perform unilateral oophorectomy if indicated, staging; consider fertility preservation.
Pathology	Frozen section selectively; definitive histology drives adjuvant therapy.
Follow-up	Clinical assessment + ultrasound; markers as applicable; endocrine/fertility monitoring (menses, AMH/ovarian volume).

Note: *Sources: Renaud E.J., 2019; Birbas E., 2023; Bašković M., 2025; Braungart S., 2020; Pio L., 2023; Margioula-Siarkou C, 2023.*

Ovarian-sparing procedures are performed when preoperative imaging and biomarkers suggest benign or low-grade malignancy [2, 7, 9]. Laparoscopic surgery is the optimal choice due to its minimally invasive nature and faster recovery. Nonetheless, laparotomy remains necessary in selected cases, particularly for large or suspicious lesions requiring staging or to avoid capsular rupture [6, 15]. The decision between conservative and radical approaches requires expert surgical judgment and, ideally, intraoperative histological assessment.

Preservation of hormonal function and fertility potential is a cornerstone of pediatric tumor management. Most girls undergoing conservative procedures retain normal pubertal progression and regular menstrual cycles [4, 18]. However, patients undergoing bilateral oophorectomy are at risk of primary ovarian insufficiency, which may require hormone replacement therapy and fertility counseling. Post-treatment evaluation of ovarian reserve using AMH levels and antral follicle counts is becoming standard [13]. Pubertal staging, menstrual tracking, and regular hormonal assays (FSH, LH, estradiol) are critical components of follow-up.

The emotional and psychological impact of a tumor diagnosis during adolescence is profound and warrants careful attention. Studies reported elevated risks for anxiety, depression, altered self-image, and fear of infertility [13, 15]. Family dynamics are also deeply impacted, with parents frequently experiencing guilt and decisional distress, particularly when fertility-sparing options are uncertain. Incorporating psychologists and psycho-oncologists into care pathways improves emotional resilience and treatment adherence.

Although recurrence is uncommon in benign tumors, it remains a concern in malignant and borderline cases, especially in the context of incomplete resection or delayed adjuvant therapy. Markers such as AFP, β-hCG, and Inhibin B are valuable tools for post-treatment monitoring, particularly in germ cell and granulosa cell tumors [9]. Imaging, most often US and MRI, is used to detect recurrence, assess residual lesions, or identify secondary postoperative changes.

Long-term follow-up should extend beyond oncologic surveillance to include endocrine, reproductive, and psychological dimensions [6]. Transitioning care from pediatric to adult gynecology or reproductive endocrinology represents a vulnerable period. In low- and middle-income countries, girls often present at advanced stages due to limited access to imaging, tumor markers, and trained pediatric surgeons or gynecologists [17, 19, 20].

Results from multiple studies highlight the urgent need for the development of standardized, pediatric-specific diagnostic and treatment guidelines; training programs in minimally invasive and organ-preserving techniques; improved access to diagnostic tools; and integration of psychosocial support and reproductive counseling [13, 17].

Conclusions

Pediatric ovarian tumors pose distinct clinical challenges due to their age-specific presentation, diverse histopathological types, and potential long-term implications for reproductive health. Management requires an individualized, multidisciplinary strategy that integrates early detection, age-appropriate surgical care, fertility preservation, and long-term endocrine and psychological support. Ongoing follow-up is critical for monitoring recurrence risk, pubertal development, and endocrine function. A well-coordinated transition to adult healthcare services is vital to ensure seamless continuity of care.

Competing interests

None declared.

Authors' contributions

All authors participated in the study design and contributed to drafting the manuscript. The authors critically reviewed the work and approved the final version of the manuscript.

Ethics approval

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