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Imaging Spectrum of Pediatric Abdominal Masses: A Radiological Study

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Abstract

Background: Pediatric abdominal masses are diagnostically challenging due to their diverse etiology and nonspecific presentation, necessitating accurate imaging for proper management. This study aimed to evaluate the imaging spectrum and diagnostic performance of radiological modalities in differentiating benign and malignant lesions. ***Methods:*** This prospective observational study was conducted at the Department of Radiology and Imaging, Bangladesh Shishu Hospital & Institute, Dhaka, Bangladesh, from January to December 2025. Ninety pediatric patients with suspected abdominal masses were included and evaluated using ultrasonography as the primary modality, with CT and MRI performed when indicated. Imaging findings were assessed for lesion characteristics and origin, and classified as benign or malignant. Diagnostic performance was analyzed using standard statistical measures. ***Results:*** A total of 90 pediatric patients with abdominal masses were evaluated, with most aged 1–5 years (40.0%) and a slight male predominance (57.8%), and abdominal swelling being the commonest presentation (82.2%). Renal origin was most frequent (35.6%), followed by hepatic (22.2%), with solid lesions predominating (66.7%) and all patients undergoing USG (100%), while CT (66.7%) and MRI (20.0%) were used selectively. Wilms tumor was the leading diagnosis (24.4%), and overall diagnostic accuracy was 86.7% with sensitivity 91.1%, specificity 79.4%, PPV 87.9%, and NPV 84.4%. ***Conclusion:*** Radiological evaluation, led by ultrasonography with complementary CT and MRI, is highly effective in characterizing pediatric abdominal masses and distinguishing benign from malignant lesions.

Keywords: Pediatric Abdominal Masses, Radiological Imaging, Diagnostic Accuracy.

INTRODUCTION

Pediatric malignancies remain one of the major contributors to morbidity among children worldwide and are associated with high mortality, particularly in low- and middle-income countries [1]. Abdominal tumors in the pediatric population comprise a heterogeneous group of diseases that vary in their site of origin, biological behavior, and clinical outcomes [2]. Collectively, these conditions represent a considerable proportion of all childhood cancers.

The clinical manifestations of these lesions are frequently non-specific, including abdominal distension, palpable abdominal mass, pain, or systemic features [2], which makes radiological assessment a key component of evaluation. Pediatric abdominal masses present a considerable diagnostic difficulty because of their wide range of etiologies and the often subtle and overlapping clinical features [3]. The presenting symptoms also vary widely depending on the primary site of origin and the degree of local invasion or metastatic spread [4].

Imaging using multiple modalities plays a crucial role in establishing an accurate diagnosis and determining the extent of disease [5]. Ultrasonography is generally the initial imaging modality of choice in children with suspected abdominal masses. However, cross-sectional imaging techniques such as computed tomography and magnetic resonance imaging are essential for further characterization, staging, and comprehensive evaluation of tumors. Detailed radiological assessment is important not only for diagnosis but also for treatment planning, staging, and follow-up of patients.

Despite its usefulness, radiological evaluation of pediatric abdominal masses remains challenging due to overlapping imaging characteristics and diverse underlying causes [6]. Computed tomography in the pediatric population carries inherent risks [7], while ultrasonography has limitations such as restricted field of view, operator dependency, and reduced ability to evaluate large retroperitoneal lesions or subtle metastatic disease.

Interestingly, reported rates of childhood cancer tend to be lower in middle- and low-income countries, which may partly reflect underdiagnosis and underreporting due to multiple contributing factors [8]. In resource-limited settings, such as South Asia, computed tomography plays an especially important role, particularly when histopathological confirmation is delayed or unavailable. Furthermore, in such healthcare environments, late patient presentation and limited access to advanced imaging modalities further complicate accurate diagnosis and optimal management.

Pediatric abdominal masses represent a diagnostically challenging group of conditions due to their wide etiological spectrum and often nonspecific clinical presentation, making early and accurate imaging-based evaluation essential for appropriate management and prognostication. Although ultrasonography, computed tomography, and magnetic resonance imaging are widely used in the diagnostic workup, variability in imaging patterns and overlap between benign and malignant lesions continue to pose difficulties in precise characterization. In addition, there is limited local data describing the imaging spectrum of pediatric abdominal masses in Bangladesh, despite the importance of such information for guiding clinical decision-making in resource-constrained settings. Therefore, this study was undertaken to evaluate the imaging spectrum of pediatric abdominal masses and to assess the diagnostic performance of imaging modalities in differentiating benign and malignant lesions in a tertiary care center.

Objective

- To evaluate the imaging spectrum and diagnostic performance of radiological modalities in pediatric abdominal masses.

METHODOLOGY & MATERIALS

This prospective observational study was conducted at the Department of Radiology and Imaging, Bangladesh Shishu Hospital & Institute, Dhaka, Bangladesh, from January to December 2025. A total of 90 pediatric patients with clinically or radiologically suspected abdominal masses were included based on predefined inclusion and exclusion criteria. All cases were evaluated using a structured imaging protocol to characterize lesion morphology, anatomical origin, and associated radiological features. Data were collected and analyzed to determine the imaging spectrum of pediatric abdominal masses and assess the diagnostic performance of imaging modalities in differentiating benign and malignant lesions.

Inclusion Criteria:

- Children of all age groups presenting with clinically or radiologically suspected abdominal masses
- Patients who underwent complete imaging evaluation (USG, CT, and/or MRI as indicated)
- Newly diagnosed cases of abdominal masses during the study period

Exclusion Criteria:

- Patients with incomplete imaging or clinical records
- Previously treated or operated cases of abdominal tumors
- Patients with inconclusive imaging findings or poor-quality imaging studies

All enrolled patients underwent detailed clinical evaluation followed by comprehensive imaging assessment. Ultrasonography (USG) was used as the initial and primary imaging modality in all cases for detection and preliminary characterization of abdominal masses. Computed tomography (CT) and magnetic resonance imaging (MRI) were performed selectively when indicated for further lesion characterization, staging, assessment of local invasion, and detection of metastatic disease. Imaging findings were systematically evaluated to determine the anatomical site of origin and morphological features, including solid or cystic nature, presence of calcification, vascular involvement, and evidence of metastasis. Radiological diagnoses were categorized into benign and malignant lesions based on imaging characteristics and were correlated with clinical findings whenever available. The diagnostic performance of imaging modalities was assessed by calculating overall accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). All data were compiled, coded, and analyzed using appropriate statistical methods, and results were expressed in terms of frequency and percentage for categorical variables and mean ± standard deviation for continuous variables.

RESULTS

Table 1: Demographic Characteristics of the Study Population (n = 90)

Variable		Frequency (n=90)	Percentage (%)
Age Group	<1 year	14	15.6
	1–5 years	36	40.0
	6–10 years	27	30.0
	>10 years	13	14.4
	Mean age (years)	5.48 ± 3.92	
Gender	Male	52	57.8
	Female	38	42.2

The study included 90 pediatric patients with abdominal masses. The majority of patients were aged 1–5 years (36 patients, 40.0%), followed by 6–10 years (27 patients, 30.0%), >10 years (13 patients, 14.4%), and <1 year (14 patients, 15.6%). The mean age of the study population was 5.48 ± 3.92 years. Male patients predominated (52 patients, 57.8%), while 38 patients (42.2%) were female.

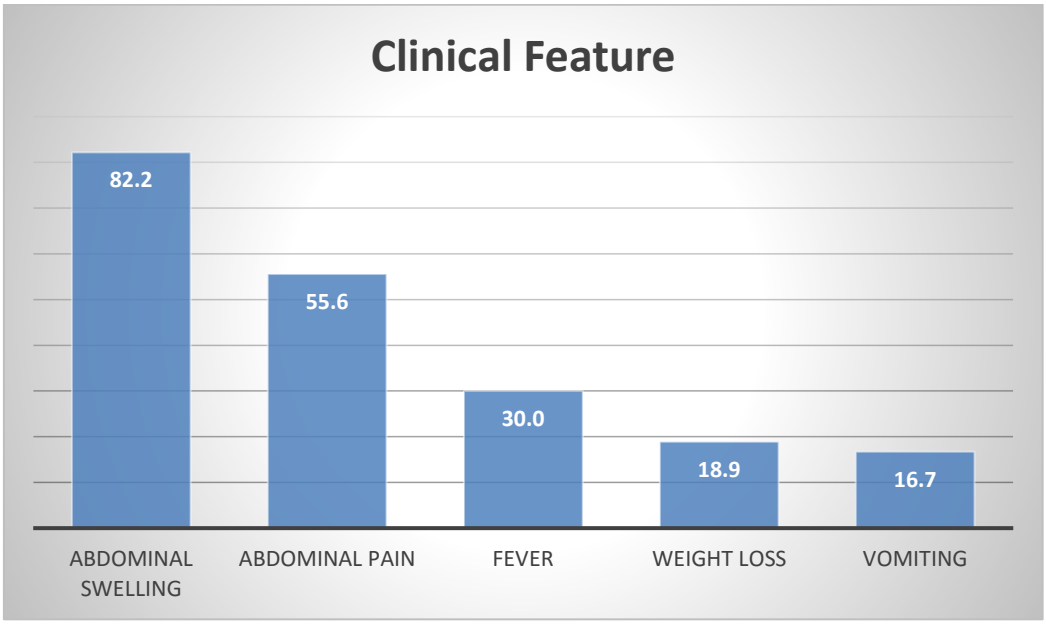

Figure 1: Clinical Presentation of Pediatric Patients with Abdominal Masses

Abdominal swelling was the most common presenting symptom, observed in 74 patients (82.2%). This was followed by abdominal pain in 50 patients (55.6%), fever in 27 patients (30.0%), weight loss in 17 patients (18.9%), and vomiting in 15 patients (16.7%).

Table 2: Anatomical Site of Origin of Pediatric Abdominal Masses (n = 90)

Site of Origin	Frequency	Percentage (%)
Renal	32	35.6
Hepatic	20	22.2
Retroperitoneal	17	18.9
Gastrointestinal	11	12.2
Pelvic	10	11.1
Total	**90**	**100.0**

Renal masses were the most frequent site of origin, observed in 32 patients (35.6%), followed by hepatic masses in 20 patients (22.2%) and retroperitoneal masses in 17 patients (18.9%). Gastrointestinal and pelvic origins were less common, accounting for 11 patients (12.2%) and 10 patients (11.1%), respectively, with a total distribution of 90 patients (100.0%).

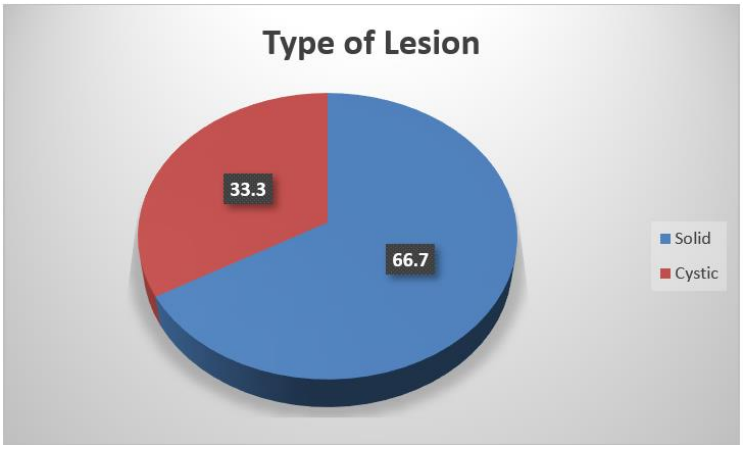

Figure 2: Type of Lesion in Pediatric Abdominal Masses

Solid lesions were more common than cystic lesions. Solid masses were observed in 60 patients (66.7%), whereas cystic lesions were seen in 30 patients (33.3%).

Table 3: Imaging Modalities Used in Evaluation of Pediatric Abdominal Masses

Imaging Modality	Frequency	Percentage (%)
Ultrasonography (USG)	90	100.0
Computed Tomography (CT)	60	66.7
Magnetic Resonance Imaging (MRI)	18	20.0

All patients underwent ultrasonography (90 patients, 100%) as the primary imaging modality. Computed tomography (CT) was performed in 60 patients (66.7%) for further evaluation and staging, while magnetic resonance imaging (MRI) was utilized in 18 patients (20.0%) for better soft tissue characterization and assessment of complex lesions.

Table 4: Radiological Spectrum of Diagnoses in Pediatric Abdominal Masses

Diagnosis		Frequency	Percentage (%)
Malignant Lesions (n=56)	Wilms tumor	22	24.4
	Neuroblastoma	14	15.6
	Hepatoblastoma	9	10.0
	Lymphoma	8	8.9
	Ovarian teratoma (malignant)	3	3.3
Benign Lesions (n=34)	Ovarian cyst / benign teratoma	3	3.3
	Hydronephrosis	12	13.3
	Mesenteric/omental cyst	8	8.9
	Liver abscess	6	6.7
	Appendicular mass	5	5.5

Among malignant lesions (56 patients), Wilms tumor was the most common diagnosis (22 patients, 24.4%), followed by neuroblastoma (14 patients, 15.6%), hepatoblastoma (9 patients, 10.0%), lymphoma (8 patients, 8.9%), and malignant ovarian teratoma (3 patients, 3.3%). Among benign lesions (34 patients), hydronephrosis was most frequent (12 patients, 13.3%), followed by mesenteric/omental cyst (8 patients, 8.9%), liver abscess (6 patients, 6.7%), appendicular mass (5 patients, 5.5%), and ovarian cyst/benign teratoma (3 patients, 3.3%).

Table 5: Imaging Features of Pediatric Abdominal Masses

Imaging Feature	Frequency	Percentage (%)
Solid mass	60	66.7
Cystic mass	30	33.3
Calcification	13	14.4
Vascular involvement	10	11.1
Metastasis	9	10.0

Solid masses were the predominant imaging pattern, observed in 60 patients (66.7%), while cystic masses were seen in 30 patients (33.3%). Calcification was noted in 13 patients (14.4%), vascular involvement in 10 patients (11.1%), and evidence of metastasis in 9 patients (10.0%).

Table 6: Diagnostic Performance of Imaging in Pediatric Abdominal Masses

Parameter	Value
Radiological accuracy (overall)	86.7% (78/90)
Sensitivity (malignant masses)	91.1% (51/56)
Specificity (benign masses)	79.4% (27/34)
Positive predictive value (PPV)	87.9%
Negative predictive value (NPV)	84.4%

The overall radiological diagnostic accuracy was 86.7% (78/90 patients). Sensitivity for detecting malignant masses was 91.1% (51/56), while specificity for benign masses was 79.4% (27/34). The positive predictive value was 87.9%, and the negative predictive value was 84.4%.

DISCUSSION

In this prospective observational study conducted at the Department of Radiology and Imaging, Bangladesh Shishu Hospital & Institute, a wide spectrum of pediatric abdominal masses was evaluated using a structured imaging approach. The study demonstrated a predominance of early childhood cases with male preponderance, with abdominal swelling as the most common clinical presentation, and renal origin and solid lesions being the most frequent findings. Multimodality imaging, led by ultrasonography and complemented by CT and MRI, showed high diagnostic accuracy in differentiating benign and malignant lesions, highlighting its crucial role in comprehensive evaluation and clinical decision-making.

In the present study, the majority of pediatric abdominal mass patients were in the 1–5 years age group (40.0%), followed by 6–10 years (30.0%), >10 years (14.4%), and <1 year (15.6%), with a mean age of 5.48 ± 3.92 years. A clear male predominance was observed (57.8%). This age distribution is consistent with findings reported by Garg *et al.,* [9], who noted that most pediatric abdominal masses are diagnosed before 5 years of age, with common malignant tumors such as Wilms tumor, neuroblastoma, and hepatoblastoma predominantly clustering in early childhood. Similarly, Khan *et al.,* [10] reported that the majority of pediatric abdominal tumors occur between 1–5 years of age, particularly renal tumors, which aligns closely with the current study where renal lesions were also the most frequent site of origin. The male preponderance observed in the present study is also in agreement with previously published literature, which has demonstrated a consistent male predominance in pediatric abdominal tumor cohorts, likely reflecting both biological susceptibility and referral patterns. Overall, the demographic profile of the present study closely mirrors established global and regional trends in pediatric abdominal masses, particularly the early childhood peak incidence and male predominance.

In the present study, abdominal swelling was the most common presenting feature among pediatric patients with abdominal masses, observed in 82.2% of cases, followed by abdominal pain (55.6%), fever (30.0%), weight loss (18.9%), and vomiting (16.7%). This clinical pattern is broadly consistent with findings reported in the literature, where abdominal swelling or distension is consistently described as the predominant presenting symptom. Ni *et al.,* [11] reported abdominal mass or swelling in 39.3% of cases, with abdominal pain (14.5%), fever (3.9%), and vomiting occurring less frequently but still recognized as associated symptoms across different tumor types. Similarly, Adhiambo *et al.,* [12] demonstrated a very high frequency of abdominal swelling (95.9%), along with abdominal pain (30.1%), weight loss (27.6%), fever (17.9%), and vomiting (1.6%), highlighting that abdominal distension remains the most consistent clinical indicator of underlying pediatric abdominal pathology. The relatively higher proportions of pain, fever, and vomiting observed in the present study compared with Ni et al. may reflect differences in case mix, stage at presentation, and inclusion of both benign and malignant lesions, whereas the overall pattern still aligns closely with previously published pediatric cohorts. Thus, the present findings reinforce that abdominal swelling is the hallmark presenting feature of pediatric abdominal masses, with systemic and gastrointestinal symptoms serving as important but less frequent associated manifestations.

In the present study, renal origin was the most common anatomical site of pediatric abdominal masses, accounting for 35.6% of cases, followed by hepatic (22.2%), retroperitoneal (18.9%), gastrointestinal (12.2%), and pelvic (11.1%) lesions. This distribution is in keeping with established pediatric literature emphasizing the predominance of renal and retroperitoneal pathology in children presenting with abdominal masses. Kader *et al.,* [13] reported that in neonates and young children, most abdominal masses are benign and primarily of renal origin, reflecting the high frequency of conditions such as hydronephrosis and congenital renal anomalies. Similarly, Kliegman *et al.,* [14] highlighted that approximately 90% of pediatric abdominal masses are retroperitoneal in location, with nearly half originating from the urinary tract, underscoring the central role of renal pathology within this compartment. The findings of the present study align

closely with these observations, as renal lesions constituted the largest proportion of cases and retroperitoneal masses formed a significant subgroup. Although hepatic, gastrointestinal, and pelvic lesions were comparatively less frequent, their presence reflects the broad differential spectrum of pediatric abdominal masses described in the literature. Overall, the current study reinforces the well-established pattern that renal and retroperitoneal regions represent the predominant anatomical origins of abdominal masses in children.

In the present study, solid lesions were more frequently observed than cystic lesions among pediatric abdominal masses, accounting for 66.7% (60 patients) compared to 33.3% (30 patients), indicating a clear predominance of solid pathology in the studied cohort. This distribution is consistent with findings reported by Adedayo *et al.,* [15], who demonstrated a similar pattern with solid lesions being slightly more common (~31.8%) than cystic lesions (~26.7%), while also highlighting a substantial proportion of mixed lesions (~28%), reflecting the heterogeneous nature of pediatric abdominal masses. The predominance of solid lesions in the current study is likely attributable to the high proportion of solid organ tumors such as Wilms tumor, neuroblastoma, and hepatoblastoma, which are known to constitute the majority of pediatric abdominal masses. In contrast, cystic lesions such as mesenteric cysts, ovarian cysts, and lymphangiomas represent a smaller but clinically significant subgroup. Overall, the present findings align with existing literature in demonstrating that solid lesions are the dominant morphological type in pediatric abdominal masses, while cystic lesions form a consistent but lesser proportion of cases.

In the present study, ultrasonography (USG) was performed in all patients (100%) as the primary imaging modality, followed by computed tomography (CT) in 66.7% and magnetic resonance imaging (MRI) in 20.0% of cases for further evaluation and characterization. This stepwise imaging approach is strongly supported by existing literature, where USG is consistently described as the first-line investigation for pediatric abdominal masses due to its wide availability, lack of ionizing radiation, and high diagnostic utility in differentiating solid and cystic lesions. Stein *et al.,* [16] emphasized that ultrasonography is the most commonly used initial imaging modality in pediatric abdominal tumors, with CT and MRI reserved for further characterization, staging, and assessment of tumor extent following initial detection. Similarly, Kim *et al.,* [17] reported that ultrasound remains the primary diagnostic tool for suspected pediatric abdominal masses, while CT and MRI are subsequently employed for detailed anatomical delineation, staging, and surgical planning. The relatively high use of CT in the present study reflects its role in evaluating lesion extent and detecting metastatic disease, particularly in malignant cases, whereas MRI was used selectively for superior soft tissue resolution and complex lesion characterization. Overall, the findings of the present study closely align with established guidelines, reinforcing the central role of ultrasonography as the initial imaging modality, with CT and MRI serving complementary roles in comprehensive evaluation of pediatric abdominal masses.

In the present study, Wilms tumor was the most common malignant lesion, accounting for 24.4% of cases, followed by neuroblastoma (15.6%), hepatoblastoma (10.0%), lymphoma (8.9%), and malignant ovarian teratoma (3.3%). Among benign lesions, hydronephrosis was the most frequent (13.3%), followed by mesenteric/omental cyst (8.9%), liver abscess (6.7%), appendicular mass (5.5%), and ovarian cyst/benign teratoma (3.3%). This radiological spectrum is in close agreement with findings reported in previous studies. Gbadamosi *et al.,* [18] similarly demonstrated Wilms tumor as the predominant pediatric abdominal malignancy (30.4%), followed by neuroblastoma (17.9%), lymphoma (16.1%), and hepatoblastoma (10.7%), reflecting a comparable hierarchical distribution of common pediatric solid tumors. Likewise, Adhiambo *et al.,* [12] reported Wilms tumor as the leading diagnosis (24.28%), with lymphoma and neuroblastoma also contributing significantly, while hepatoblastoma and ovarian teratoma were less frequent, supporting the overall pattern of renal tumor predominance and relative rarity of other malignant and benign lesions. The consistency between the present study and these published cohorts reinforces that Wilms tumor remains the most frequent pediatric abdominal malignancy, followed by neuroblastoma and hepatoblastoma, while benign conditions such as hydronephrosis and cystic lesions constitute a smaller but clinically relevant proportion of abdominal masses in children.

In the present study, solid masses were the predominant imaging feature, observed in 66.7% of cases, followed by cystic masses in 33.3%, while calcification, vascular involvement, and metastasis were identified in 14.4%, 11.1%, and 10.0% of patients, respectively. This distribution closely aligns with the findings reported by Adedayo *et al.,* [15], who similarly observed a predominance of solid lesions accounting for approximately 60–70% of pediatric abdominal masses, with cystic lesions comprising about 25–35% of cases. The presence of calcification in the present study (14.4%) is also consistent with their observation that calcific foci are typically seen in a minority of cases, particularly in neuroblastoma and other malignant tumors. Likewise, vascular involvement (11.1%) and metastatic disease (10.0%) in the current study reflect the known imaging behavior of malignant pediatric abdominal tumors, where vascular encasement and distant spread are important radiological indicators of advanced disease. Overall, the present findings are in strong agreement with existing literature, reinforcing that solid lesions are the dominant imaging pattern in

pediatric abdominal masses, while cystic components, calcification, vascular invasion, and metastasis represent important but less frequent features associated mainly with malignant pathology.

In the present study, the overall radiological diagnostic accuracy for pediatric abdominal masses was 86.7%, with a sensitivity of 91.1% for malignant lesions, specificity of 79.4% for benign lesions, a positive predictive value (PPV) of 87.9%, and a negative predictive value (NPV) of 84.4%. These findings demonstrate a high diagnostic performance of imaging modalities, particularly in identifying malignant lesions, while showing comparatively moderate specificity for benign conditions due to overlapping radiological features. The present results are in close agreement with Kocaoglu *et al.,* [19], who reported excellent diagnostic performance of imaging with a sensitivity of approximately 92%, specificity of 94%, PPV of 94%, NPV of 92%, and an overall accuracy of about 93%, thereby reinforcing the strong capability of radiological evaluation in characterizing pediatric abdominal masses. Similarly, Servaes *et al.,* [20] demonstrated that while CT and MRI show variable sensitivity (approximately 68–77% and 52–62%, respectively), both modalities maintain relatively high specificity (83–92%) and overall moderate-to-high diagnostic performance, supporting their complementary role in lesion characterization and staging. The slightly lower specificity observed in the present study compared to Kocaoglu *et al.,* [19] may be attributed to differences in study design, case mix, and inclusion of a broader spectrum of benign and malignant lesions. Overall, the findings of the current study are consistent with existing literature, confirming that imaging provides excellent sensitivity for detecting malignant pediatric abdominal masses with good overall diagnostic accuracy and acceptable predictive values.

Limitations of the study

The study had a few limitations:

- The study was conducted at a single tertiary care center, which may limit the generalizability of the findings.
- The sample size was relatively small, which may affect the strength of statistical conclusions.
- Advanced imaging modalities such as MRI were not performed in all patients, which may have limited comprehensive lesion characterization in some cases.

CONCLUSION

Pediatric abdominal masses represent a diverse group of conditions that commonly present in early childhood and require prompt clinical and radiological evaluation for accurate diagnosis and management. This study found that abdominal swelling was the predominant presenting feature, with renal origin being the most frequent site and solid lesions occurring more commonly than cystic ones, while Wilms tumor was the leading malignant diagnosis and hydronephrosis the most common benign lesion. Ultrasonography served as the primary imaging modality in all cases, with CT and MRI providing important complementary roles in further characterization and staging. Overall, radiological assessment demonstrated strong diagnostic performance in differentiating malignant and benign lesions, highlighting its essential role in the evaluation of pediatric abdominal masses.

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