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Abdominal computed tomography use in the emergency department among children with abdominal pain: a retrospective analysis

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Abstract

Background Acute abdominal pain is a common cause of visits to the pediatric emergency departments (ED). In recent years, abdominal computed tomography (CT) has emerged as an increasingly used imaging modality due to its diagnostic value in the evaluation of abdominal pain. This study aimed to determine the frequency of CT use among children presenting to the ED with abdominal pain, and to identify the factors associated with CT use.

Methods A single-center, retrospective review of medical records was conducted, including children aged 3 to 15 years who presented to the ED at the American University of Beirut Medical Center (AUBMC) with abdominal pain between January 1st and December 31, 2014. Demographic, clinical and laboratory data were collected and analyzed to assess predictors of CT use.

Results A total of 451 patients were included in the study, of whom 11.8% underwent abdominal CT. Appendicitis was the most common abnormal finding (26%) seen on the abdominal CT scans followed by mesenteric adenitis (25%), while one-quarter of CT scans yielded normal findings. Older age, right lower quadrant (RLQ) pain, leukocytosis, and evaluation by an emergency medicine physician were significant predictors of CT use.

Conclusion This study sheds the light on the potential overuse of abdominal CT scan in children presenting to ED with abdominal pain, exposing this vulnerable population to unnecessary radiation and adding financial burden. Thus, these findings underscore the importance of implementing institutional guidelines and promoting the use of non-ionizing imaging modalities.

Keywords Abdominal pain, Abdominal computed tomography, Emergency department, Children

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Introduction

Acute abdominal pain is a common complaint in pediatric emergency departments (ED), accounting for approximately 3% to 8% of pediatric ED visits [1, 2]. Despite its prevalence, It frequently poses a diagnostic challenge, particularly in children, due to diverse etiologies, variations in pain location and severity, and children's limited ability to accurately describe their symptoms [1, 3]. The causes of abdominal pain in children can range from self-limiting conditions to more critical medical and surgical emergencies such as appendicitis or intestinal obstruction [1, 3]. Hence, a timely and accurate diagnosis is essential to ensure prompt and appropriate management.

Among the various diagnostic modalities available, abdominal computed tomography (CT) has emerged as one important widely used tool that is easily accessible, offering high diagnostic accuracy and rapid detection of emergent conditions [2]. In particular, CT plays a pivotal role in the evaluation of children with suspected appendicitis, where some previous studies have shown that preoperative abdominal CT was associated with lower negative appendectomy rates [4, 5]. However, the clinical diagnosis of right lower quadrant (RLQ) pain in children and adolescents is often challenging, making diagnostic imaging an indispensable tool. While acute appendicitis is the most frequent concern, a broad spectrum of other etiologies may present with similar symptoms [4].

However, in recent years, the use of CT has substantially increased, particularly in pediatric patients with non-specific abdominal pain [6]. This growing reliance on CT raises important concerns, due to increased exposure to ionizing radiation which carries potential long-term risk of cancer development, in addition to higher healthcare costs [1, 7]. Epidemiologic studies suggest that the radiation dose from CT scans may confer detectable increase in the risk of cancer, especially in children, who are more vulnerable due to higher rates of cellular division, longer life expectancy, greater cumulative lifetime radiation dose and increased radiation absorption relative to body size [1, 7–9]. Notably, a considerable proportion of these scans yielded normal findings, suggesting that many children were unnecessarily subjected to radiation exposure without meaningful diagnostic benefit [1]. In such cases, the diagnostic value of CT needs must be carefully weighed against this small but tangible risk of radiation-induced carcinogenesis resulting from its use.

Therefore, identifying factors that predict the diagnostic yield of CT imaging in pediatric abdominal pain is essential to optimize its use, limit unnecessary radiation exposure and reduce healthcare cost [10]. In this context, it is crucial to investigate the current situation regarding emergency CT use in pediatric abdominal pain, identify the predictors of potential overuse, and explore possible solutions to improve clinical practices while ensuring the safety and well-being of patients. Accordingly, the aim of this study was to evaluate the use of CT in children presenting with acute abdominal pain in the ED and to identify the clinical and demographic predictors associated with its use.

Methods

Study design

This study was a single-center, retrospective review of medical records of children aged between 3 years and 15 years, who presented with abdominal pain to the ED, at the American University of Beirut-Medical Center (AUBMC), the largest academic tertiary care center located in Beirut-Lebanon and a major local and regional referral center. This study was approved by the institutional review board (IRB) at AUBMC (*IRB Protocol Number: PED.NY.05*).

Inclusion and exclusion criteria

Children aged 3 to 15 years presenting with abdominal pain to the ED at AUBMC from January 1st, 2014 to December 31, 2014 were included in the study.

Patients with incomplete or unavailable medical records; those with a preexisting diagnosis and prior CT imaging; patients with sickle cell disease; individuals with a documented allergic reaction to contrast agents; and oncology patients receiving care at the Children's Cancer Center of Lebanon were excluded from the analysis.

Data collection

Data collection was performed using a standardized case report form. The form included demographic characteristics (age at presentation and gender) and clinical assessment of pain (location, severity, and associated symptoms). Laboratory results and imaging studies were reviewed and documented. Information regarding specialty consultations, final diagnosis, and management details were also collected.

Definitions and categorization

Pain was assessed using the numeric rating scale (NRS) or the Wong-Baker Faces Rating Scale (WBS) [11, 12]. The NRS is a numeric scale used to rate pain intensity from 0 to 10 where 0 indicates no pain and 10 the worst pain [12]. The WBS is a picture projection method used to evaluate a child's pain, in which the child selects the face that most reflects their pain intensity [11].

Total white blood cells (WBC) counts were categorized based on age-specific reference ranges defined by the American Academy of Pediatrics [13].

Pediatric patients in our ED may be evaluated either by pediatricians or by emergency medicine physicians. Pediatricians covering emergency shifts in our institution are specialists with advanced training, typically coming

from pediatric intensive care unit or neonatal intensive care unit backgrounds. As for emergency medicine physicians, they had core pediatric training during residency and fellowship, but did not have the advanced subspecialty training provided by a Pediatric Emergency Medicine fellowship. It should be noted that this situation applied during the study period; currently, our institution has dedicated Pediatric Emergency Medicine specialists in the ED.

Statistical analysis

Data were entered and analyzed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize patient demographics, abdominal pain characteristics, WBC counts, imaging findings, and final diagnoses. Continuous variables were reported as means with standard deviations (SD), while categorical variables were expressed as frequencies and percentages. Comparisons between groups were performed using the Chi-square or Fisher's exact test for categorical variables and the independent-samples *t*-test for continuous variables. Univariate logistic regression was initially performed to evaluate potential associations between individual categorical predictors and the outcome of CT use. Variables with significant or clinically relevant associations in the univariate analysis were subsequently included in multivariable logistic regression to identify independent predictors while adjusting for confounding. Logistic regression was appropriate given the binary outcome and the categorical nature of all included predictors. Several models were constructed, as it was not feasible to include all predictors simultaneously due to small sample size in the CT group and concerns of model stability and overfitting. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported. A two-sided p value of < 0.05 was considered statistically significant.

Results

During the study period from January 1 to December 31, 2014, a total of 464 children presented to the ED with abdominal pain, of whom 451 were included in the final analysis. Of the 451 included subjects, the majority ($n = 398$, 88.2%) did not undergo abdominal CT, while 53 patients (11.8%) had a CT scan done (Fig. 1).

The clinical characteristics of children presenting to ED with abdominal pain are shown in Table 1. The mean age of the study population was 8.9 ± 3.6 years, with children who underwent CT being older (10.7 ± 3.2 years) than those who did not (8.6 ± 3.6 years) ($p < 0.001$). When categorized by age groups, children aged 12–15 years were more likely to receive a CT scan compared with those aged 3–5 years, although this did not reach statistical significance. No significant differences were observed by gender. Regarding physician specialty, patients evaluated by emergency medicine physicians were 2 times more likely to undergo CT compared with those seen by pediatricians (OR 2.03, 95% CI 1.08–3.82, $p = 0.025$).

Table 2 explores the clinical characteristics of patients with and without abdominal CT. The majority of patients presented within one day of symptom onset ($n = 232/392$, 59.2%), with no significant difference in presentation interval between those who underwent CT and those who did not ($p > 0.05$ for all comparisons). As for the abdominal pain location, RLQ pain was the most common pain location among patients who received CT (39.6%), while diffuse pain predominated in those who did not undergo CT (54.0%). Compared with diffuse pain, RLQ pain was associated with a 14-fold increased likelihood of undergoing CT. However, all other locations, including epigastric/right upper quadrant, left-sided, flank, and lower abdominal pain, were not significantly associated with CT use. Among the 154 patients with recorded pain severity, severe pain was significantly associated with CT use compared to mild pain ($p = 0.028$). Regarding associated symptoms, diarrhea and urinary symptoms were less common among patients who underwent CT (p-value 0.028 and 0.035, respectively), whereas nausea or vomiting, constipation, and fever showed no significant differences between groups.

Among the 201 children with available WBC data, 6 (3.0%) had leukopenia, 166 (82.6%) had normal WBC counts, and 29 (14.4%) had leukocytosis (Fig. 2). When compared with patients who had normal WBC counts, leukocytosis was significantly more frequent among those who underwent CT imaging (30.0% vs. 9.3%), corresponding to an odds ratio of 4.16 (95% CI: 1.83–9.44; $p = 0.040$). By contrast, leukopenia was observed at similar rates in the CT and non-CT groups (2.0% vs. 3.3%; $p = 0.820$), with no evidence of association (Fig. 2).

As shown in Fig. 3, out of 53 patients who underwent imaging, appendicitis was the most frequently diagnosed condition (26%), followed by mesenteric adenitis (25%). Normal findings were reported in 12 patients (23%), indicating no abnormal findings in nearly a quarter of cases. Less common findings included fecal loading (9%) and other miscellaneous conditions (17.0%). Furthermore, among children presenting with right lower quadrant pain, 23.8% had normal abdominal CT scans, while only 33.3% of them had findings suggestive of appendicitis. When comparing children with RLQ pain to those with pain in other locations, no statistically significant difference was observed in the distribution of imaging findings.

Specialty consultation was required in 59 patients (13.1%), occurring significantly more often in those who underwent CT compared with those who did not (58.5% vs. 7.0% respectively, $p < 0.001$) (Table 3). Ultrasound was

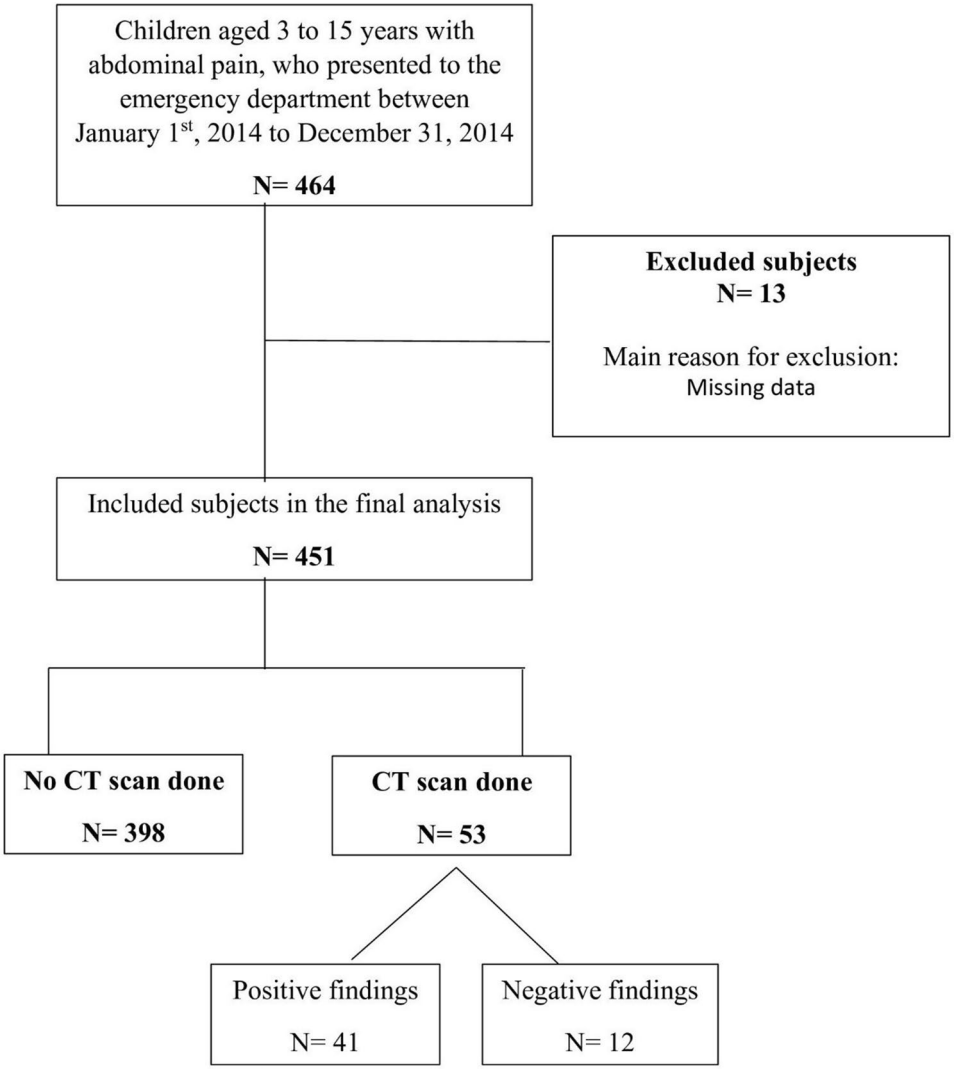

Fig. 1 Flow diagram of the study design

Table 1 Demographic characteristics of patients with abdominal pain: comparison of those evaluated with and without CT scan

	Total (*N* = 451) ***n* (%)**	**No CT scan (*N* = 398)** ***n* (%)**	**CT scan done (*N* = 53)** ***n* (%)**	**Odds Ratio (95% CI)**	***p*-value**
Mean age in years (± SD)	8.9 (± 3.6)	8.6 (± 3.6)	10.7 (± 3.2)	1.19 (1.09–1.31)	< 0.001
Age groups					
[3years-5 years]	105 (23.3)	100 (25.1)	5 (9.4)	Ref	Ref
]5 years-12 years]	254 (56.3)	225 (56.5)	29 (54.7)	2.58 (0.97–6.85)	0.058
[12 years-15 years]	92 (20.4)	73 (18.3)	19 (35.8)	5.20 (1.86–14.59)	**0.02**
Gender					
Male	244 (54.1)	218 (54.8)	26 (49.1)	Ref	Ref
Female	207 (45.9)	180 (45.2)	27 (50.9)	1.26 (0.71–2.23)	0.433
Physician's specialty					
Pediatrics	359 (79.6)	323 (81.2)	36 (67.9)	Ref	Ref
Emergency medicine	92 (20.4)	75 (18.8)	17 (32.1)	2.03 (1.08–3.82)	**0.025**

Student's t-test was used to compare the mean age between the two groups

Pearson's Chi-Square test was used (no expected count less than 5). The bold values refer to the significant factors that have a *p*-value < 0.05

Table 2 Comparison of clinical characteristics of patients with abdominal pain: without versus with CT scan

	Total (*N* = 451) *n* (%)	No CT scan (*N* = 398) *n* (%)	CT scan done (*N* = 53) *n* (%)	*p*-value
Onset-to-Presentation Interval (*N* = 392)				
Less or equal to 1 day	232 (59.2)	207 (58.8)	25 (62.5)	Ref
2–7 days	142 (36.2)	129 (36.6)	13 (32.5)	0.615
8–30 days	17 (4.3)	15 (4.3)	2 (5.0)	0.899
More than 30 days	1 (0.3)	1 (0.3)	0 (0.0)	1
Abdominal pain location				
Diffuse	234 (51.9)	215 (54.0)	19 (35.8)	Ref
Epigastric/ Right upper quadrant	79 (17.5)	72 (18.1)	7 (13.2)	0.837
Left-sided	20 (4.4)	20 (5.0)	0 (0.0)	0.998
Right lower quadrant	38 (8.4)	17 (4.3)	21 (39.6)	**< 0.001**
Flank pain	18 (4.0)	15 (3.8)	3 (5.7)	0.137
Lower abdomen	54 (12.0)	53 (13.3)	1 (1.9)	0.227
Others **	8 (1.8)	6 (1.5)	2 (3.8)	0.119
Severity (*N* = 154)				
Mild	35 (22.7)	34 (26.2)	1 (4.2)	Ref
Moderate	21 (13.6)	20 (15.4)	1 (4.2)	0.713
Severe	98 (63.6)	78 (28.5)	22 (91.7)	**0.028**
Associated symptoms				
Diarrhea	96 (21.3)	92 (23.1)	4 (7.5)	**0.009**
Constipation	32 (7.1)	28 (7.0)	4 (7.5)	0.780*
Nausea or vomiting	200 (44.3)	173 (43.5)	27 (50.9)	0.303
Fever	80 (17.7)	71 (17.8)	9 (17.0)	0.878
Urinary symptoms	31 (6.9)	31 (7.8)	0 (0.0)	**0.035**

The bold values refer to the significant factors that have a *p*-value < 0.05

Pearson's Chi-Square test was used (no expected count less than 5)

* Fisher's exact test was used when expected count was less than 5

**Others: unspecified right-sided (*n*=5), unspecified upper abdomen (*n*=1), mixed locations (right flank and inguinal (*n*=1), right upper and lower quadrant (*n*=1))

performed in 23 patients (5.1%), all of whom were exclusively in the non-CT group. Regarding outcomes, 30 patients (6.7%) were admitted to the hospital, with a substantially higher admission rate among those who underwent CT compared with those who did not ($p < 0.001$), while the remaining 421 patients (93.3%) were discharged (Table 3).

In the multivariable logistic regression represented in Table 4, several factors independently predicted CT use in children presenting with abdominal pain. Overall, older age, right lower quadrant pain, elevated WBC, and evaluation by an emergency medicine physician were strongly associated with the decision to perform abdominal CT scan. In Model 1, adjusted for age, gender, physician specialty, and abdominal pain location, children aged [12–15] years had higher odds of undergoing CT than those aged [3–5] years (aOR 3.67, 95% CI (1.23–10.93); $p = 0.019$). Right lower quadrant abdominal pain (aOR 13.46, 95% CI (6.23–29.08); $p < 0.001$) and evaluation by an emergency medicine physician (aOR 2.19, 95% CI (1.08–4.42); $p = 0.029$) were also significant predictors. In Model 2, additionally adjusted for pain severity and WBC counts, right lower quadrant pain, evaluation by an emergency medicine physician, and leukocytosis remained independently associated with CT use. In Model 3 (adjusted for age, pain location, WBC counts, diarrhea, and urinary symptoms), RLQ pain (aOR 6.54, 95% CI (2.70–15.83); $p < 0.001$) and leukocytosis (aOR 4.51, 95% CI (1.77–11.51); $p = 0.002$) were significant predictors for the use of abdominal CT scan.

In our study, the analyses of factors associated with positive CT findings were not performed because of the small number of patients who underwent abdominal CT ($n = 53$) during the study period and the limited number of positive imaging findings.

Discussion

In this study, we investigated the use of abdominal CT among children presenting with abdominal pain to a tertiary care ED and identified the factors associated with its use. Although the CT use trend and its predictive factors have been previously explored in the literature, this study provides relevant data on the frequency and predictors of CT use among the pediatric population in Lebanon, a lower-middle income country [14]. Our findings showed that CT was performed in 11.8% of children with abdominal pain. Older age, RLQ pain, leukocytosis, and evaluation by emergency medicine physicians were significant predictors of CT use. Appendicitis was the most common abnormal finding seen on the abdominal CT scans followed by mesenteric adenitis. Notably, nearly one-quarter of CT scans yielded normal findings, suggesting a potential overuse of this imaging modality in certain cases.

During the study period, 11.8% of children presenting to ED with abdominal pain underwent abdominal CT scan. This percentage partially aligns with the most recently reported rates in the United States [15]. Data from the National Hospital Ambulatory Medical Care Survey (1997–2016) showed that CT use for abdominal pain increased from 1.2% in 1997, to 16.6% in 2020 followed by a slight decline in 2016 [15]. The widespread use of CT can be attributed to its increased availability, rapid acquisition, non-invasiveness, and improved diagnostic capabilities, precision and accuracy [1, 9]. Furthermore, other factors can influence the growing reliance on CT such as the defensive medicine practices driven by fear of malpractice among healthcare practitioners, as well as the increased desire on the part of both physicians and patients for diagnostic certainty [1, 9]. However, the frequent use and the excessive dependence on emergency CT scans in children has raised significant concerns due

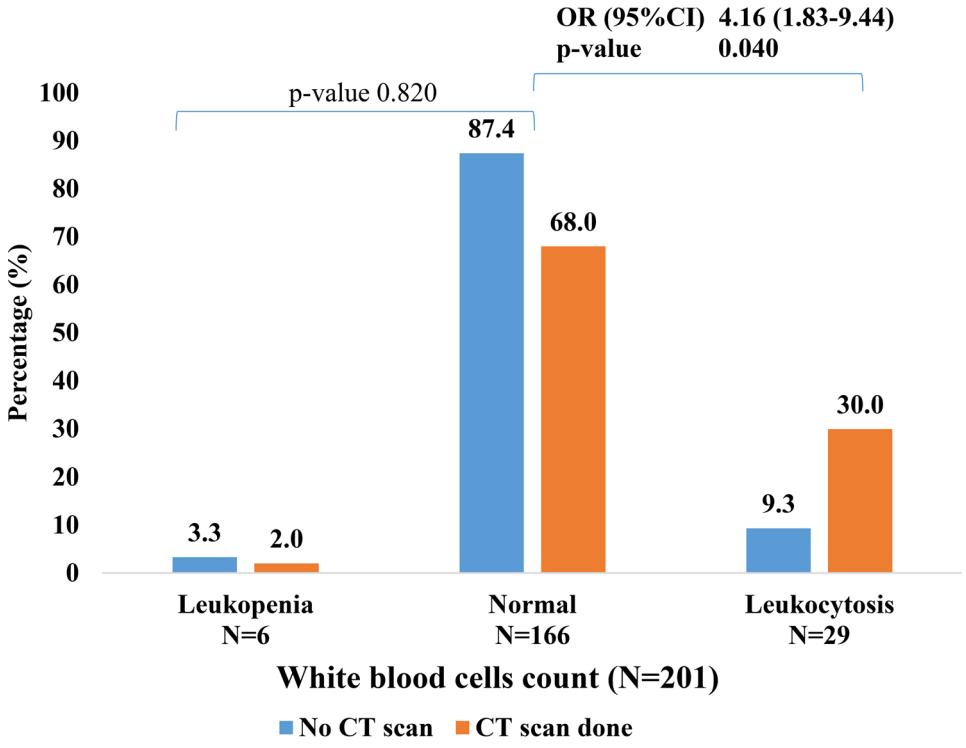

Fig. 2 Association between white blood cell count and CT scan use in patients presenting with abdominal pain. Total WBC counts were categorized based on age-specific reference ranges defined by the American Academy of Pediatrics [13]

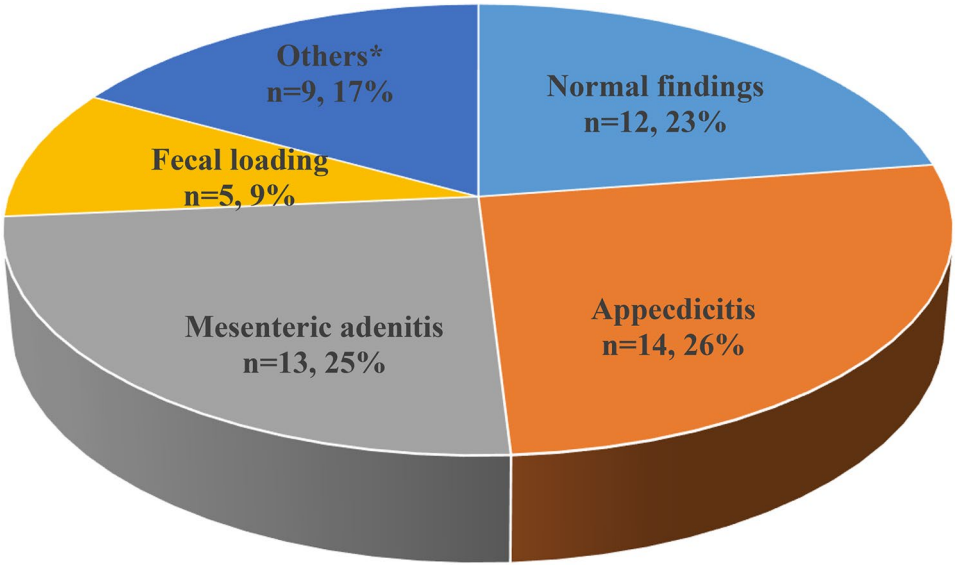

Fig. 3 CT scan findings. *Others: Ovarian cysts ($n=2$), Renal etiologies ($n=2$), gastroenteritis ($n=2$), pneumonia ($n=1$), pancreatitis ($n=1$), small bowel obstruction ($n=1$)

to the unnecessary radiation exposure to this vulnerable population and increased healthcare costs [1].

Notably, the overuse of CT is frequently evident in the diagnosis of appendicitis in children which is the most common pediatric surgical emergency, frequently encountered with RLQ pain, and one of the leading causes of malpractice litigation in children [4, 16, 17]. Similar to our findings, a study conducted by Hwang et al. on 734 pediatric patients presenting for non traumatic abdominal pain to the ED and undergoing abdominal CT at Kangwon National University Hospital showed that 73.4% of those patients had positive findings on the CT with the most common diagnoses being acute appendicitis followed by mesenteric adenitis [10]. A meta-analysis

Table 3 Management and outcomes of patients with abdominal pain, with and without CT scan evaluation

	Total (*N* = 451) *n* (%)	No CT scan (*N* = 398) *n* (%)	CT scan done (*N* = 53) *n* (%)	*p*-value
Specialty consultation needed	59 (13.1)	28 (7.0)	31 (58.5)	**< 0.001**
Ultrasound performed	23 (5.1)	23 (5.8)	0 (0.0)	0.093*
Outcome				**< 0.001***
Admitted	30 (6.7)	11 (2.8)	19 (35.8)	
Discharged	421 (93.3)	387 (97.2)	34 (64.2)	

Pearson's Chi-Square test was used (no expected count less than 5)

* Fisher's exact test was used when expected count was less than 5

The bold values refer to the significant factors that have a *p*-value < 0.05

Table 4 Predictors of CT scan use in children presenting with abdominal pain, using multivariable logistic regression across different adjustment models

Predictors	Reference group	aOR (95% CI)	*p*-value
Model 1: Adjusted for age groups, gender, physician's specialty and abdominal pain location			
Age group [12 years-15 years]	[3 years-5 years]	3.67 (1.23–10.93)	**0.019**
Emergency medicine physician	Pediatrician	2.19 (1.08–4.42)	**0.029**
Right lower quadrant pain	Other locations	13.46 (6.23–29.08)	**< 0.001**
Model 2: Adjusted for age groups, physician specialty, abdominal pain location, severity and WBC counts			
Right lower quadrant	Other locations	7.04 (1.49–33.28)	**0.014**
Emergency medicine physician	Pediatrician	15.05 (2.09-108.43)	**0.007**
Leukocytosis	Normal WBC counts	18.43 (1.40-242.31)	**0.027**
Model 3: Adjusted for age groups, abdominal pain location, WBC counts, diarrhea and urinary symptoms			
Right lower quadrant	Other locations	6.54 (2.70-15.83)	**< 0.001**
Leukocytosis	Normal WBC counts	4.51 (1.77–11.51)	**0.002**

aOR: adjusted odd ratio; CI: Confidence interval; WBC: White blood cells

conducted by Krajewski et al. evaluating the impact of abdominal CT on clinical outcomes in patients with acute RLQ pain, revealed that preoperative abdominal CT was associated with lower negative appendectomy rates, suggesting that the routine CT in all patients presenting with suspected appendicitis could reduce the rate of unnecessary surgery without increasing morbidity [5]. Although CT use may be justified in some cases, the overuse remains a major problem. In our study, RLQ was found to be an independent predictor of CT use in children with abdominal pain; nevertheless, nearly 23% of patients presenting with abdominal pain and in particular RLQ who underwent abdominal CT had normal findings. This observation suggests potential overuse of abdominal CT and unnecessary radiation, in addition to further financial implications.

Consequently, these findings underscore the importance of strictly following clinical guidelines in order to prevent unnecessary radiation exposure and surgical interventions. The American College of Radiology (ACR) endorses ultrasound as the first-line imaging modality for children with suspected acute appendicitis, given its availability, lower cost and absence of ionizing radiation exposure [4].

Although CT scan can, in certain situations, effectively rule out serious conditions and minimize diagnostic uncertainty, thereby allowing discharge of patients rather than admission, the significant association between the admission rate and CT use reported in our study is not surprising or unexpected as it could be related to illness severity [6].

Among the significant predictors identified, leukocytosis was strongly and independently associated with CT use in children presenting with abdominal pain, which is consistent with prior studies [10, 18]. For instance, a prospective study conducted by Malia et al. on children presenting to the pediatric ED with suspected appendicitis demonstrated that a WBC count greater than 10,000/μL significantly increased the odds of having appendicitis [18]. Interestingly, evaluation by an emergency medicine physician rather than a pediatrician was also reported as a significant predictor of CT use in both univariate and multivariate analyses. Similarly, a study published in 2017 on the US ED trends in imaging in pediatric abdominal pain reported a higher likelihood of CT scan imaging in general ED compared with pediatric ED [19]. Moreover, Grim et al. observed a significantly higher use of CT scan by emergency medicine physician compared with pediatricians, in the evaluation of abdominal pain in pediatric patients, potentially reflecting the adoption of adult medical practices to children [20, 21]. The higher CT use among emergency medicine physicians could be explained by the fact that in certain clinical settings there is a higher medico-legal risks for malpractice claims [22]. In addition, diagnostic uncertainty and workflow pressure and the need to triage patients between conditions that require hospital admission, those that can be managed on outside basis and the urgent surgical conditions, further contribute to this difference across specialties [22].

This study has several strengths, including the comprehensive evaluation of clinical, laboratory, and demographic predictors of CT use. Nevertheless, some limitations should be acknowledged. The retrospective, single-center design limits the generalizability of our findings to other ED practice settings. Moreover, the

relatively small sample size of patients undergoing CT, along with an even smaller subset of positive findings, limited our ability to identify the predictors of positive CT results and to detect less weak albeit significant associations. In addition, there was a class imbalance, with 53 patients undergoing CT compared with 398 who did not, which may limit statistical power and the precision of effect estimates. Additionally, due to the retrospective aspect of this study, recording bias may have occurred particularly regarding the choice of ultrasound versus CT for diagnostic evaluation. Furthermore, missing data for some variables, such as WBC counts, may have introduced selection bias. Detailed information on radiation dose, contrast administration, and specific CT scanning parameters was not consistently available and could not be analyzed. Finally, the dataset is more than 10 years old, as publication was delayed due to exceptional local circumstance, including the COVID-19 pandemic, financial crisis, and periods of significant unrest and regional conflict. Despite these challenges, these data remain relevant as a pilot study establishing baseline CT use patterns in our region, which can inform future studies evaluating current practice changes, particularly with the increasing availability of point-of-care ultrasound and adoption of contemporary imaging guidelines.

Conclusion

In summary, this study identified specific clinical and demographic predictors of abdominal CT use in children with acute abdominal pain, including older age, RLQ pain, leukocytosis, and physician specialty. Despite its diagnostic value, CT imaging remains overused in some cases, posing a huge burden on the healthcare system and exposing children to unnecessary radiation and cost. Reinforcing the use of ultrasound as the first-line imaging modality, and implementing institutional guidelines for imaging decision-making may help optimize CT utilization and enhance patient safety.

Abbreviations

ED	Emergency department
CT	Computed tomography
AUBMC	American University of Beirut-Medical Center
IRB	Institutional review board
NRS	Numeric rating scale
WBS	Wong-Baker Faces rating scale
WBC	White blood cells

Author contributions

N.Y. contributed to the conception and design of the study. S.K., S.E.H. and S.S.R. collected data and participated in data analysis and interpretation. S.K., S.E.H, and S.S.R. wrote the initial draft of manuscript. N.Y. critically revised the manuscript. All authors read and approved the final version of the manuscript.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This retrospective study involving human participants was reviewed and approved by the American University of Beirut (AUB) Human Research Protection Program (HRPP) Institutional Review Board (IRB). Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study, in accordance with the national legislation and the institutional AUB IRB requirements. All data collected were stripped of patient identifiers, and there is no risk to the subjects.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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