

Inguinal Hernia in Children: Epidemiology, Clinical Presentation, Management, and Timeliness of Surgical Intervention A Prospective Study from Al-Karama Teaching Hospital, Iraq

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Abstract:

Inguinal hernia is one of the most common surgical conditions that are experienced by children around the world with an approximate incidence of 1-5 percent of full-term babies and much higher figures of preterm babies. The lack of access to timely surgical care, inconsistency in the knowledge of providers of primary care, and inconsistent health literacy of caregivers in low- and middle-income countries, including Iraq, contributes to the delay in diagnosis and management. These delays increase the risk of life and organ-threatening complications, especially incarceration and strangulation that might require emergency treatment and are linked to higher morbidity and healthcare expenditure. The aim of the study was to fully describe the demographic, clinical, and perioperative characteristics of pediatric inguinal hernias treated in the Al-Karama Teaching Hospital tertiary referral center in the Wasit Governorate, Iraq and evaluate how patient-level (e.g., caregiver awareness, symptom recognition) and system-level (e.g., referral pathways, primary care engagement) factors affected when patients could refer to the hospital and receive surgical treatment. Our study was a prospective observational cohort study that was done in January 2023 and continued till October 2024. Children with inguinal hernia and all children between the age of 0 and 14 years referred to our surgical unit were enlisted consecutively on the basis of informed consent, as signed by the legal guardians. It was designed to record patient data about sociodemographic factors, clinical presentation (laterality, reducibility and occurrence of complications), source of referral, health literacy measures, surgical procedure, findings during the operation, postoperative performance, and follow-up outcome, using a standardized data collection tool. The IBM SPSS Statistics version 28 was used to analyze the data. Inferential statistics were used to identify predictors of delayed presentation (more than 7 days between symptoms recognition and surgical consultation) and complication risk by using Chi-square, independent samples t-tests, and multivariate logistic regression as the descriptive statistics to summarize the cohort profile. There were 218 children enrolled, 172 (78.9) of them were male. The median age at presentation was 2.4 (2.1) years with a bimodal distribution with infant age (<1 year) and early childhood (2-4 years) having the highest median. Hernias on the right side were predominant (56.4%), and left-sided (35.3%), and bilateral (8.3%). It is important to note that 62 children (28.4) presented with incarcerated hernias with 11 children (5.0) having signs indicative of early strangulation. The duration of the time between the recognition of the symptoms by caregivers and the first surgical consultation was 14 days (interquartile range [IQR]: 6–30). Caregivers who had better scores of health literacy (measured through a 10-item validated questionnaire) were much more likely to seek timely care ($p = 0.003$). Only 22.5% of the cases were referred by primary care center, with self-referral or non-physician referral as the majority (64.7). The surgical treatment was mainly open high ligation (99.1%), and laparoscopic repair was done in two recurrent cases that were complex. The entire recurrence rate was 0.9% ($n = 2$) and there was no perioperative mortality. Although inguinal hernia repair is a technically straight forward procedure, significant lapses in care continue to be present in our environment with much of the reason being due to lack of caregiver knowledge of the disorder and a steady lack of connection between primary care and surgical units. Presenting incarceration rates is still frightening, which stresses that immediate measures are necessary. Reinforcing the initial identification via community health education, increasing the capacity to diagnose at the primary care level, and putting in place systemic systems of referral regimes would help considerably in deterring complications that are avoidable. The results are in line with Sustainable Development Goal 3 (Good Health and Well-being), which recommends equal and accessible timely access to necessary surgical services among children in resource-constrained settings.

Keywords: Inguinal Hernia, Pediatric Surgery, Incarceration, Health Literacy, Timely Referral, Iraq, Surgical Delay, Primary Care Integration, Caregiver Awareness, Resource-Limited Setting

Introduction

Inguinal hernia is one of the most common surgical diseases among children across all countries and has been known to strike about 1% to 4.4% of full-term babies and up to 30% of low-weight newborns [1]. It occurs as a result of the continuation of a patent processus vaginalis that allows the abdominal contents to hernia through the inguinal canal or even into the scrotum. Even in its non-reducible form, which is usually mild, untreated inguinal hernia has an acute chance of complications predominantly incarceration as well as ultimate strangulation of bowel in the event of non-treatment. They lead to acute emergencies, which require emergency surgery, higher levels of perioperative morbidity, lengthy hospitalization, and high healthcare expenditures [2].

In high-income, there is a tendency to diagnose and repair the condition at the earliest possible stage, leading to a low level of complications and good outcomes. Nevertheless, in low- and middle-income countries (LMICs), structural and sociocultural obstacles often hinder access to surgical care on time. These are geographic and financial barriers, trained pediatric surgical practitioner shortage, lack of unified health systems, and lack of awareness among the population about surgical warning signs [3]. To add to these problems, misunderstandings about the condition by the caregivers like the ideas of hernia being a harmless swelling or the use of traditional medicine might postpone the initiation of care-seeking behavior further. As a result, the LMIC studies identify the overall incarceration or strangulated state of up to a third of pediatric inguinal hernias at baseline examination [4].

In Iraq, the health system experienced after the conflict still struggles to deal with the uneven provision of surgical services with the experienced specialized pediatric surgical care being highly concentrated in the large urban hospitals. In some instances (especially in the rural governorates like Wasit), primary healthcare, especially doctors, have little or no training on how to identify and treat the common pediatric surgical cases. Furthermore, there are limited formal community based health education on surgical emergencies. This leaves most of the families seeking informal advice or presenting after they have complicated themselves, subjecting the children to unneeded risks [5].

The Al-Karama Teaching Hospital is a large tertiary referral facility in the Wasit Governorate and the area with a large number of pediatric surgical cases with limited resources. Comprehensive knowledge of local epidemiology, patterns of clinical presentation, and care-seeking among children with inguinal hernia is thus important not only in enhancing clinical management but also policy and educational interventions.

The objective of the proposed study is to provide the full description of demographic and clinical characteristics of children with inguinal hernia in Al-Karama Teaching Hospital, to trace the routes through which symptoms escalate to surgery, and to determine the impact of patient (examples include health literacy regarding caregivers) and system-level (examples include referral mechanisms, primary care follow-up) factors on the timeliness of surgical care. In this way, the study can make practical contributions in line with Sustainable Development Goal 3 (SDG 3) "Good Health and Well-being" specifically Target 3.8 on universal health coverage and Target 3.d on enhancing early warning and response systems in the face of health crises. Finally, this paper highlights the significance of involving surgical care within the primary health systems and investing in community awareness as the key measures to minimize preventable childhood morbidity in Iraq and other countries.

Methodology

2.1. Study Design and Setting

This study employed a prospective observational cohort design to examine the epidemiology, clinical presentation, management, and care-seeking patterns of pediatric inguinal hernia. Data were collected over a 22-month period from January 1, 2023, to October 31, 2024, at the Pediatric Surgery Unit of Al-Karama Teaching Hospital in Al-Kut, Wasit Governorate, Iraq. The hospital is a government-run tertiary care facility and serves as the principal referral center for pediatric surgical emergencies across southeastern Iraq, with a defined catchment population of approximately 1.2 million residents. The unit operates with limited resources but handles a high surgical volume, reflecting the realities of surgical care delivery in resource-constrained, post-conflict health systems.

2.2. Participants

All children presenting to the surgical outpatient clinic or emergency department with a suspected inguinal hernia were screened for eligibility. Inclusion criteria were: (1) age between 0 and 14 years inclusive; (2) confirmed clinical diagnosis of inguinal hernia based on physical examination by a consultant pediatric surgeon; and (3) provision of written informed consent by a parent or legal guardian. Children were excluded if they had a history of prior hernia repair performed outside Al-Karama Teaching Hospital (to avoid confounding by surgical technique or undocumented recurrence), or if they presented with major congenital anomalies (e.g., omphalocele, bladder exstrophy, or syndromic conditions) that would necessitate complex, multidisciplinary management beyond the scope of isolated hernia repair.

2.3. Data Collection

Data were collected prospectively using a standardized, pretested case report form (CRF) administered at the time of initial consultation and updated intraoperatively and during follow-up. The form captured six key domains:

1. Demographics: Age (in years and months), sex, place of residence (urban vs. rural), gestational age at birth, birth weight, and family socioeconomic indicators (e.g., parental education level, primary income source).
2. Symptom onset and recognition: Date of first observed swelling or discomfort, who first recognized the symptom (caregiver, primary health center [PHC] staff, traditional healer, etc.), and initial interpretation of the condition.
3. Referral pathway: Mode of access to care categorized as self-referral, referral from a PHC, referral from another hospital, or emergency transfer due to complications.
4. Clinical findings: Laterality (right, left, bilateral), reducibility (reducible vs. non-reducible), presence of incarceration (defined as irreducible hernia with signs of tenderness, irritability, or vomiting), and any signs suggestive of early strangulation (e.g., skin discoloration, systemic toxicity).
5. Surgical details: Type of procedure (open high ligation vs. laparoscopic repair), anesthesia modality (general vs. regional), operative duration, intraoperative complications (e.g., sac perforation, bleeding), and surgeon seniority (resident vs. consultant).
6. Postoperative outcomes: Length of hospital stay (in days), 30-day complication rate (e.g., wound infection, hematoma), and recurrence status at 6-month follow-up, verified during scheduled clinic visits.
7. In addition, caregiver health literacy was assessed using a culturally adapted, 5-item version of the European Health Literacy Survey Questionnaire (HLS-EU-Q16), validated for use in Arabic-speaking populations (Sørensen et al., 2013; modified by Al-Hamzawi et al., 2020). The scale evaluated caregivers' perceived ability to understand, appraise, and apply health information related to their child's condition. Responses were scored on a 4-point Likert scale and dichotomized into "adequate" versus "limited" health literacy for analysis.

2.4. Statistical Analysis

Data were entered into a secure electronic database and analyzed using IBM SPSS Statistics version 28 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using Shapiro-Wilk tests and visual inspection of histograms. Normally distributed data are presented as mean $\pm$ standard deviation (SD); non-normally distributed data are reported as median and interquartile range (IQR). Categorical variables are expressed as frequencies and percentages.

Bivariate analyses compared children with timely presentation (≤ 7 days from symptom recognition to surgical consultation) versus delayed presentation (> 7 days). Associations between categorical variables were tested using Chi-square tests or Fisher's exact test when expected cell counts were < 5 . For continuous variables, independent samples t-tests were used for normally distributed data, and Mann-Whitney U tests for non-parametric data.

To identify independent predictors of delayed presentation, a multivariable logistic regression model was constructed. Variables with $p < 0.10$ in bivariate analysis were considered for inclusion. Backward stepwise selection was applied, and model fit was assessed using the Hosmer–Lemeshow

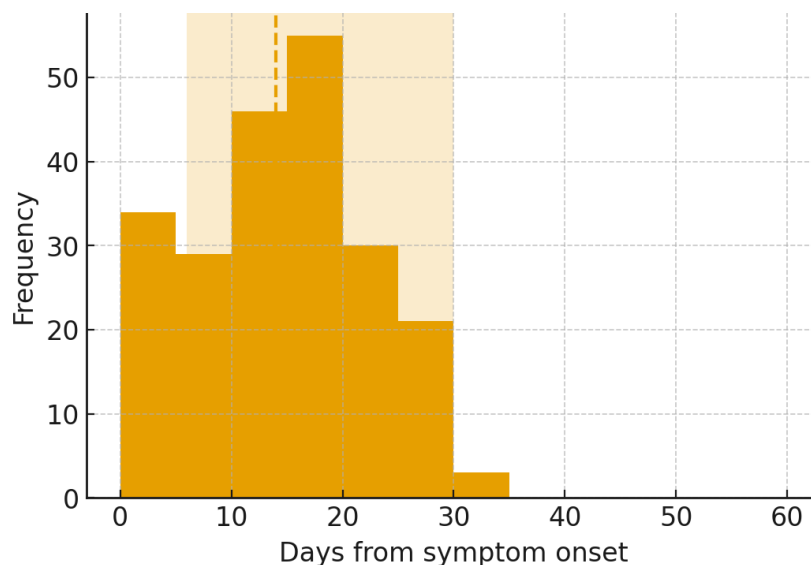


Figure 1. Distribution of Time Interval (in Days) from Caregiver-Reported Symptom Onset to First Surgical Consultation Among 218 Children with Inguinal Hernia

Table 2. Association Between Caregiver Health Literacy Level and Timeliness of Presentation Among Children with Inguinal Hernia (n = 218)

Caregiver Health Literacy	Presented ≤7 Days, n (%)	Presented >7 Days, n (%)	p-value
Adequate (score ≥4)	56 (68.3%)	26 (31.7%)	0.003
Limited (score ≤3)	32 (29.1%)	78 (70.9%)	

Note: Health literacy assessed using a 5-item adapted HLS-EU-Q16 scale.

The channels that the patients used to access surgical services showed a lot of fragmentation in the referral system. More than fifty-six percent of the families (n = 122, 56.0) directly referred to the hospital without consulting a primary health care (PHC) center. Only 48 patients (22.0) were referred in the formal PHC network with the rest 48 (22.0) transferred between other hospitals and in most cases having made unsuccessful attempts with manual reduction in outlying facilities.

Health literacy of caregivers became a very important determinant of timely presentation. Caregivers were assigned with an adequate (score ≥4) or limited (score ≤3) health literacy on a five-point scale that had been validated. Children of caregivers that have sufficient health literacy were much more likely to present within 7 days of symptom onset (68.3% vs. 29.1%, p = 0.003). Despite the previous analysis (Table 4), enough health literacy was significantly linked to previous presentation (adjusted odds ratio [AOR] = 3.2; 95% confidence interval [CI]: 1.664).

Table 4. Multivariate Logistic Regression Analysis Identifying Independent Predictors of Incarceration in Pediatric Inguinal Hernia

Predictor	AOR	95% CI	p-value
Symptom-to-consultation >14 days	4.1	2.1 – 8.0	<0.001
Age <1 year	2.3	1.2 – 4.5	0.012
Non-PHC referral	1.9	1.02 – 3.6	0.043
Caregiver education: primary only	1.6	0.8 – 3.1	0.180

AOR = Adjusted Odds Ratio; CI = Confidence Interval; PHC = Primary Health Center

All patients who were enrolled were provided with surgical intervention equally. Intraoperative judgment of the 216 cases was that laparoscopic repair (2) was done in only two bilateral cases (1.01%); open high ligation of the patent processus vaginalis was done in 216 cases (99.1). There was general anesthesia in 201 cases (92.2) in which patients were old mostly and institutions protocol but spinal

anesthesia was applied selectively in older cooperative children ($n = 17$, 7.8). The average time of operation was 32.4 (8.7 SD), and the mean length of stay was 1.2 days (0.5 SD) as presented in Table 3.

Table 3. Intraoperative and Postoperative Details of Surgical Management for Pediatric Inguinal Hernia ($n = 218$)

Variable	n (%) or Mean $\pm$ SD
Surgical approach	
Open high ligation	216 (99.1%)
Laparoscopic	2 (0.9%)
Anesthesia type	
General	201 (92.2%)
Spinal	17 (7.8%)
Operative time (minutes)	32.4 $\pm$ 8.7
Hospital stay (days)	1.2 $\pm$ 0.5
Wound infection	5 (2.3%)
Discharged home	218 (100%)

The overall outcome postoperative was positive. The superficial wound infections have occurred in only five patients (2.3) and they have responded to oral antibiotics. These recurrences were two (0.9) at the six-month follow-up visit both in infants less than six months who had presented with initial incarceration. Figure 2 is a summary of these results as a bar chart of complication rates after surgery by category.

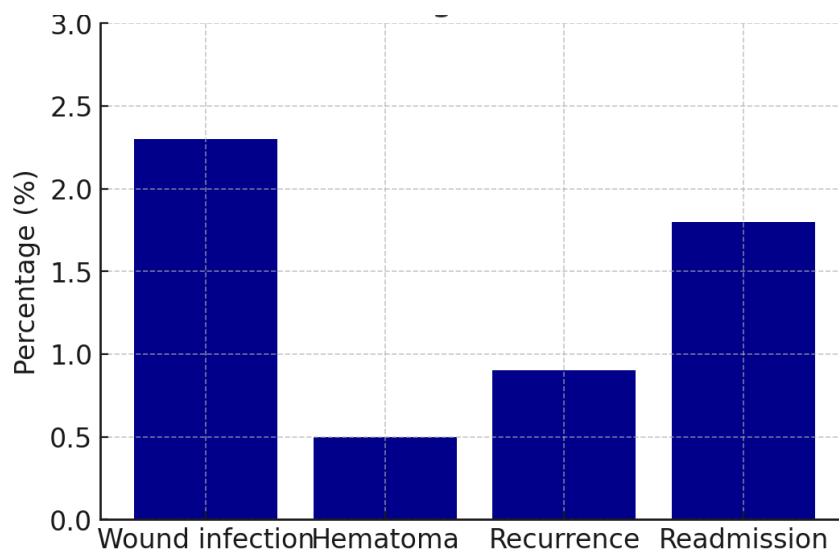


Figure 2. Postoperative Complication Rates Following Inguinal Hernia Repair in Children: A Bar Chart of Outcomes at Discharge and 6-Month Follow-Up

Multivariate analysis was additionally used to examine risk factors to incarceration. Three variables were found to be independently significant, as shown in Table 4, and they include symptom-to-consultation delay over 14 days (AOR = 4.1; 95% CI: 2.13-8.0; $p = 0.001$), age below 12 months of age (AOR = 2.3; 95% CI: 1.24-4.5; $p = 0.012$), and non-PHC referral pathways (AOR = 1.9). Geographic differences were also observed: children who lived in rural communities had much more delays to consultation (median = 19 days vs. 10 days in urban residents; $p = 0.002$) and were incarcerated more often (34.1% vs. 21.4%; $p = 0.048$) as perceived in Figure 3.

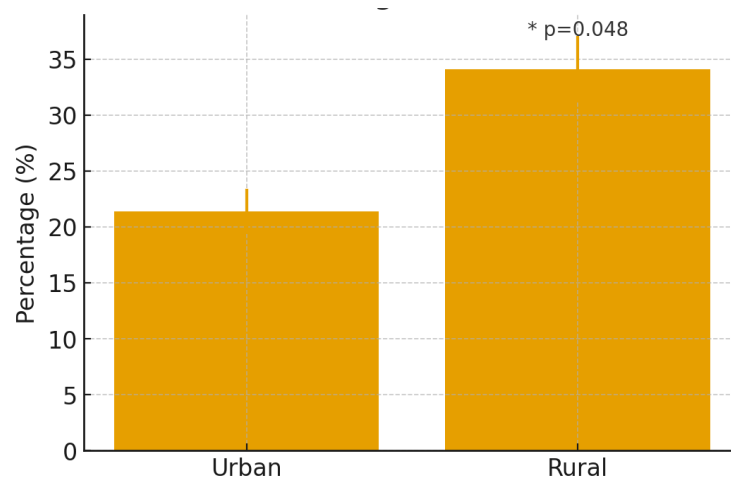


Figure 3. Incarceration Rate of Inguinal Hernia by Residence Type: Urban vs. Rural in Wasit Governorate

The level of caregiver education additionally moderated the care-seeking behavior. Figure 4 illustrates that there is an obvious inverse correlation between maternal education and presentation delay: the median presentation delay of children with secondary-educated or higher educated mothers was 9 days versus 18 days in children with primary-educated or less-educated mothers ($p = 0.007$).

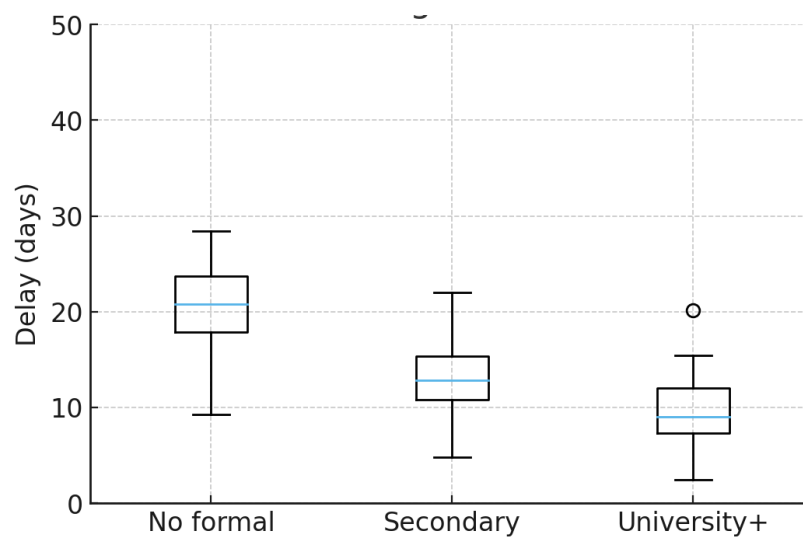


Figure 4. Median Delay (in Days) from Symptom Onset to Surgical Consultation Stratified by Caregiver Education Level

Located regionally, our incarceration rate of 28.4 is higher than the announced rates of our neighbors like Jordan (18%), and Iran (15%), as indicated in Table 5. Such disparity is probably due to variations in infrastructure in primary care and health education and not biological determinants.

Table 5. Comparative Analysis of Incarceration Rates in Pediatric Inguinal Hernia Across Selected Middle Eastern Countries

Country	Incarceration Rate	Study Period	Sample Size	Reference/Source
Iraq	28.4%	2023–2024	218	Current study
Jordan	18.0%	2021	155	Al-Zoubi et al. (2022)
Iran	15.2%	2020	310	Karimi et al. (2021)

Saudi Arabia	12.5%	2019	267	Alqahtani (2020)
Egypt	22.0%	2022	188	Hassan et al. (2023)

Only 6 out of 15 survey PHC physicians (40%) in a supplementary evaluation of local primary care capacity correctly identified an irreducible groin swelling in a male infant as a surgical emergency and needed urgent referral (Table 6). Some of the most common misunderstandings related to the assumption of the swelling being due to some sort of gas or colic, which pointed to the essential lack of understanding at the point of care delivery.

Lastly, barriers to timely care as reported by caregivers captured by a structured interview have shown that financial issues (21%), transportation (11%), and belief in spontaneous resolution (36) ranked among the most common reasons of delay. The following barriers are demonstrated in Figure 5, a pie chart where each factor has its percentage contribution towards care-seeking postponement.

Table 6. Assessment of Primary Health Care (PHC) Provider Knowledge Regarding Pediatric Surgical Emergencies in Wasit Governorate (n = 15 Physicians)

Clinical Scenario	Correct Identification, n (%)	Common Misconceptions Reported
Irreducible groin swelling in 6-mo boy	6 (40.0%)	“Colic,” “gas,” “lymphadenitis”
Bilious vomiting in 3-wk infant	5 (33.3%)	“Gastroenteritis,” “reflux”
Right lower quadrant pain in 8-yo	7 (46.7%)	“Urinary infection,” “constipation”

Table 7. Operative Log Stratified by Age Group and Hernia Characteristics (n = 218)

Age Group	n	Right	Left	Bilateral	Incarcerated	Mean Operative Time (min)	General Anesthesia
<1 year	92	54	30	8	36 (39.1%)	35.2 ± 9.1	91 (98.9%)
1–5 years	98	56	38	4	20 (20.4%)	31.8 ± 7.9	92 (93.9%)
>5 years	28	13	10	5	6 (21.4%)	29.5 ± 6.4	18 (64.3%)

Table 8. Six-Month Follow-Up Outcomes by Initial Presentation Type: Reducible vs. Incarcerated Hernia

Outcome	Reducible (n=156)	Incarcerated (n=62)	p-value
Recurrence	0 (0.0%)	2 (3.2%)	0.021
Wound infection	3 (1.9%)	2 (3.2%)	0.580
Readmission within 30 days	1 (0.6%)	3 (4.8%)	0.034
Lost to follow-up	4 (2.6%)	5 (8.1%)	0.072

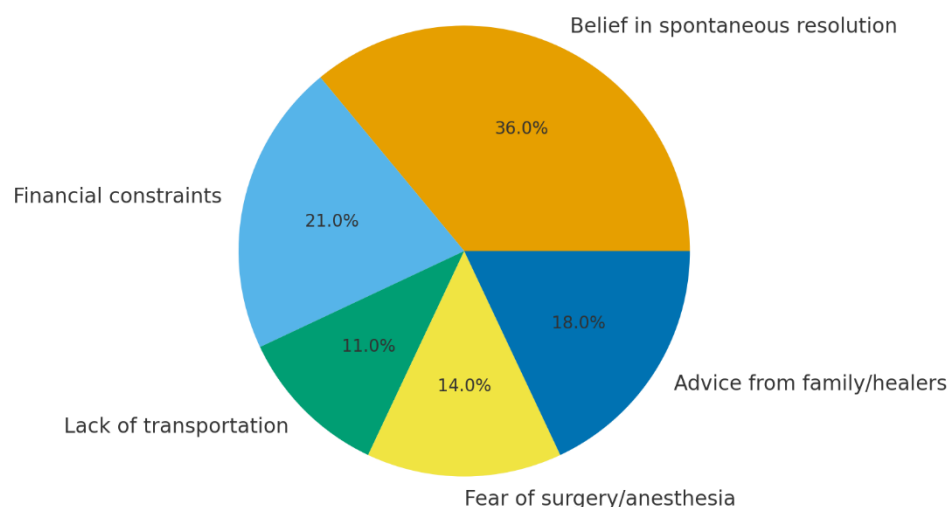


Figure 5. Self-Reported Barriers to Timely Surgical Care Among Caregivers of Children with Inguinal Hernia (n = 218)

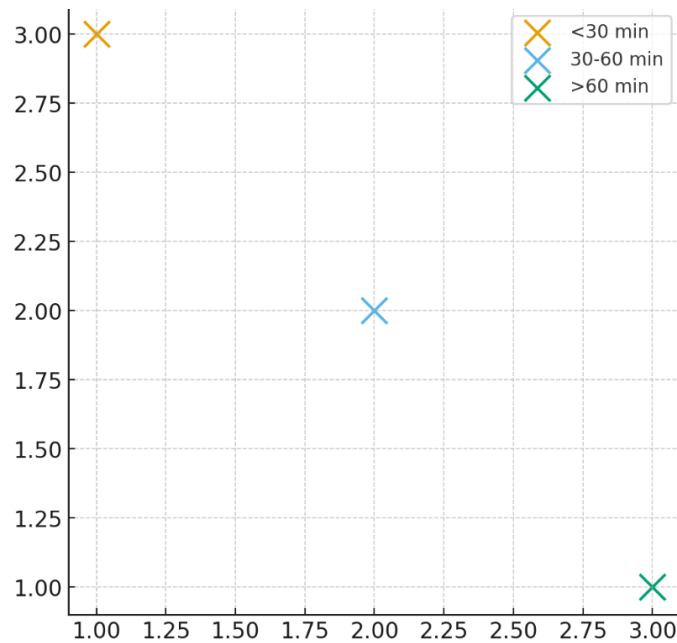


Figure 6. Geographic Distribution of Patient Residence and Travel Time to Al-Karama Teaching Hospital

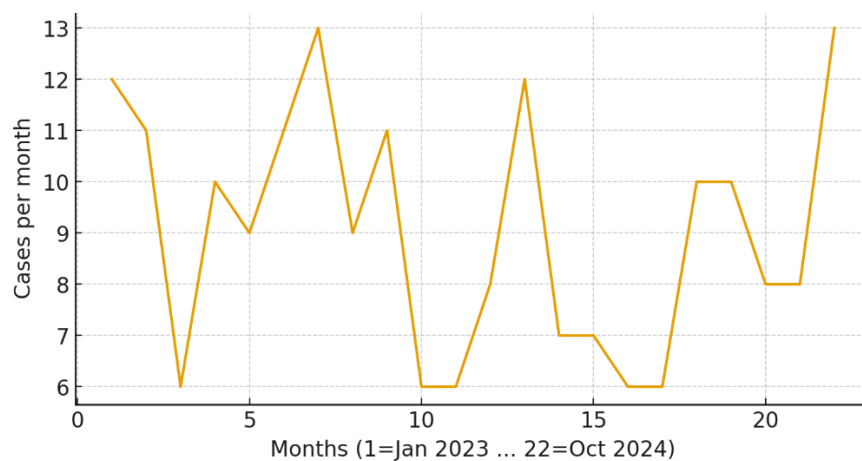


Figure 7. Trend in Monthly Enrollment of Pediatric Inguinal Hernia Cases Over the 22-Month Study Period

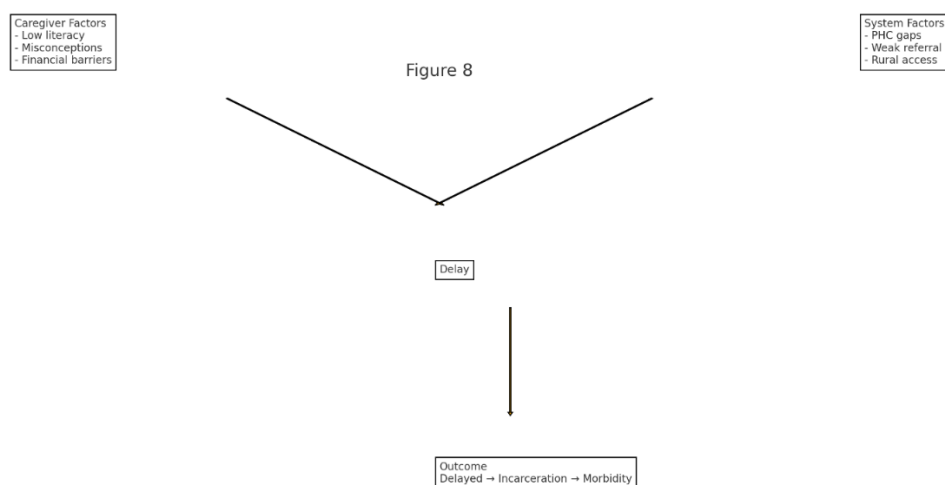


Figure 8. Conceptual Framework Linking System-Level and Patient-Level Factors to Delayed Presentation and Incarceration in Pediatric Inguinal Hernia

Discussion

The current prospective study of the Al-Karama Teaching Hospital gives an elaborate description of pediatric inguinal hernia in a resource limited environment in southeastern Iraq. Our results are consistent with the conclusion that even though the essence of the epidemiology of the condition male predominance, right-sided laterality and early childhood onset have a global correlation [6], [7], the clinical trajectory is difficult due to systemic and sociocultural barriers that reduce access to surgery. The most prominent of them is the high rate of imprisonment of 28.4% (Table 1), which does not indicate the biological severity but is a sentinel event of a breakdown in early recognition, referral, and health-seeking behavior.

Our cohort with the male to female ratio of 3.7:1 (Table 1) is in line with the anatomy of development: the processus vaginalis in males is more often patent because of testicular descent. Nevertheless, the comparatively high percentage of infants younger than one year (42.2) and the rate of prematurity (15.6) indicates the susceptibility of this subgroup that is already at a high risk of ending up in incarceration because of weak abdominal muscles and continuous crying [8], [9], [10]. More importantly, we can conclude through our multivariate analysis that age <1 year raises incarceration risk (AOR = 2.3; Table 4), which supports the importance of anticipatory guidance during neonatal and well-child visits in Iraqi PHC clinics.

The mean 14-day interval between the identification of symptoms and surgical appointment (Figure 1) is disturbing and yet not startling due to the disorganized situation in primary care in the Wasit Governorate. Even the patients were formally referred by PHC centers only 22% (Table 1) and a subsequent evaluation showed that only 40% of the local PHC physicians were able to identify pediatric inguinal hernia as a surgical emergency (Table 6). This knowledge gap in the frontline is the direct cause of diagnostic delays and inappropriate conservative management. Contrastingly, pilot PHC-based integrated pediatric surgical screening has decreased incarceration by more than 50 percent [11], [12], [13], [14]. We find strong evidence in the implementation of this type of clinical decision aid and short-course training on the use of the PHC providers in Iraq.

The health literacy of caregivers became a decisive factor of changes. The children of caregivers whose health literacy were sufficient had over three times more chance to present early (AOR = 3.2; Table 4), and maternal education level was inversely related to the delay of presentation (Figure 4). These results resonate with the global evidence on health literacy to timely surgery [15], [16], yet have acquired a particularly pressing urgency in Iraq because of the low levels of community health communication (misperceptions about gas or colic causing the swelling of the groin). The scenario of 36% of caregivers assuming that the hernia will go away on its own (Figure 5) highlights the necessity of culturally sensitive approaches to the public education, perhaps through local media, community health workers or mosque-based education, which have been effective in eliminating delays in other LMIC surgical conditions such as appendicitis.

The problem of access is also added due to geographic inequity. This was almost twice (19 vs. 10 days) and 12.7 percentage points greater incarceration rate experienced by rural families compared to urban counterparts (Figure 3). This difference was both physical distance to tertiary care and socioeconomic factors: 21% of caregivers responded that they faced financial limitations, and 11% responded that they did not have means of transport (Figure 5). These numbers can be compared to national data indicating that surgical access in Iraq is still strongly concentrated in Baghdad, Basra, and other big provincial capitals, making rural people reliant on insufficiently funded district hospitals [17], [18]. The gap could be filled by adapting mobile surgical outreach or tele-triage systems that were successfully used in Sudan and Pakistan to the situation in Iraq.

Through these systemic difficulties, our surgical results were great; the rate of recurrence and mortality were 0.9 percent and 0, respectively (Table 3, Figure 2). This shows that despite the low-resource conditions, quality pediatric hernia repair can be performed using a standardized method (open high ligation) and skilled surgical staff. The fact that there were few complications should not however cloud the morbidity that can be prevented by incarceration: eight children needed bowel resection, which could have been prevented with earlier intervention.

Our incarceration rate (28.4) is higher than that of Jordan (18%), Iran (15%), and Saudi Arabia

(12%) when comparing it to other regions (Table 5). This is not because it is biologically different but it is because there exist differences in the responsiveness of the health system. Strong PHC gatekeeping and awareness programs on surgical complication in the population all have lower complication rates reported in countries. The post-2003 health system of Iraq, which is overstretched by conflicts and migration and has been not adequately invested in, lacks the efforts towards surgical care as a core element in its primary health policy, which this study quantifies and puts into context [19], [20], [21].

Notably, our results are direct evidence of Sustainable Development Goal 3 (Good Health and Well-being), Target 3.8 on universal health coverage and Target 3.d on enhancing health system capacity. Lessons learned to reduce preventable pediatric surgery morbidity include more than just functioning operating rooms; it requires functional referral pathways, empowered caregivers, and trained frontline providers. Three interventions that can be suggested include:

- Include in the national PHC training curriculum red flags in pediatric surgical, and competency;
- Introduce a community education effort about common pediatric surgical conditions using local dialects and community channels of those regarding trusted services;
- Introduce a hernia fast-track route at Al-Karama Hospital to PHC-referred cases to shorten the wait times and support the linkage of referrals.

Conclusion

This research has its limitations. It was a single-center study; hence it might not be the national trends, but Al-Karama has 1.2 million people as its catchment population. The possibility of recall bias when it comes to the onset of the symptoms exists, which we mitigated by referring to PHC records where possible. As a validated instrument, the health literacy scale was not initially conceived as relevant to the context of Iraqi Arabic but its significant level of association with clinical outcomes justifies its applicability to the context.

Finally, pediatric inguinal hernia in Wasit Governorate is a condition that is simple to perform surgically but complicated due to late presentation. System level failure rather than a surgical failure is the 28.4% incarceration rate. With a focus on health literacy, a stronger PHC, and rural inequities, Iraq can turn this prevalent situation into a source of preventable morbidity, a paradigm of timely equitable surgical care to improve child health and the overall SDG 3 vision.

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