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Original Article

Evaluation of awareness and knowledge levels of pediatric residents on brucellosis

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ABSTRACT

Objective: Brucellosis, endemic in Türkiye, requires physicians' awareness for early recognition, diagnosis, and treatment. This study aimed to assess pediatric residents' knowledge and awareness of brucellosis.

Material and Methods: Between August and September 2023, pediatric residents with 0–48 months of training at Ankara Bilkent City Hospital were surveyed using an online 15-item, cross-sectional, multiple-choice questionnaire covering demographics, clinical findings, diagnosis, treatment, and prophylaxis. Each item included four response options reflecting different diagnostic or therapeutic approaches. Incomplete or unsubmitted forms were excluded.

Results: A total of 174 residents participated (73% female). Of these, 84 (48.3%) were senior and 90 (51.7%) junior. Senior residents had significantly higher correct response rates than juniors regarding complications (88.1% vs. 83.3%), clinical symptoms (91.1% vs. 70.2%), laboratory findings (77.8% vs. 58.3%), diagnostic serology (52.2% vs. 28.6%), magnetic resonance imaging (MRI) for sacroiliitis (83.3% vs. 65.5%), antibiotic combinations (72.2% vs. 50.0%), and treatment of spondylitis (47.8% vs. 23.8%) ($p<0.050$ for all). Knowledge improved progressively with residency year (linear-by-linear association, $p<0.001$).

Conclusion: Senior residents demonstrated significantly greater knowledge of brucellosis compared to juniors. These results emphasize the importance of structured, continuous education that begins early in residency and is reinforced periodically. Given the endemic nature of brucellosis in Türkiye, targeted and regularly updated training programs for pediatric residents may improve recognition, diagnostic accuracy, appropriate treatment, and clinical outcomes. Future multi-center studies may better reflect regional differences in awareness and training.

Keywords: Awareness, brucellosis, children, knowledge, residents

INTRODUCTION

Brucellosis is a widespread and re-emerging zoonotic disease that continues to pose a significant public health challenge worldwide. In Türkiye, brucellosis remains endemic, particularly in the Central, Eastern, and Southeastern Anatolia regions (1). The disease is caused by Gram-negative coccobacilli of the genus *Brucella*, most commonly *B. melitensis*, *B. abortus, B. suis, and B. canis* (2). Transmission occurs primarily through the consumption of unpasteurized dairy products, direct contact with infected animals or their secretions, and inhalation of contaminated aerosols, while congenital transmission is rare (1). Clinical manifestations are variable and may include fever, night sweats, malaise, fatigue, arthralgia, and hepatosplenomegaly. In children, growth retardation, weight loss, and anorexia may also be observed (3). Brucellosis can mimic other zoonotic or febrile diseases, such as Crimean-Congo hemorrhagic fever or malaria, which may lead to delayed diagnosis (4). Osteoarticular involvement is among the most common complications, including sacroiliitis and spondylitis (5). Culture remains the diagnostic gold standard; however, serologic methods are more practical in routine clinical settings. The Rose Bengal test (RBT) is commonly used for screening, while the Standard Agglutination Test (SAT) is employed for diagnosis. In endemic

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regions, a SAT titer of ≥1:160 is considered diagnostic, although false-positive or false-negative results may occur due to cross-reactions or the prozone phenomenon (6). Magnetic resonance imaging (MRI) is valuable for detecting complications such as spondylitis or sacroiliitis. Treatment requires combination antibiotic therapy effective against intracellular bacteria, typically doxycycline plus rifampin for children older than eight years, or rifampin plus trimethoprim-sulfamethoxazole for younger children. The minimum treatment duration is six weeks, and an aminoglycoside may be added for focal or complicated cases (1). Prevention includes avoiding unpasteurized dairy consumption, strengthening veterinary control programs, and using protective measures for high-risk occupational groups (7). Beyond prevention, physician knowledge and awareness are crucial for early recognition, accurate diagnosis, and appropriate management. Studies from Yemen, Namibia, Saudi Arabia, Uganda, and Tanzania have shown that insufficient knowledge among healthcare workers—particularly in exposure history taking, serological testing, and recognition of clinical findings—contributes to underdiagnosis and underreporting of brucellosis (8–12).

However, studies specifically evaluating pediatric residents' awareness and knowledge are scarce. Considering that pediatric residents are on the frontline in diagnosing, treating, and following up pediatric brucellosis, evaluating their level of knowledge is essential to design targeted educational interventions. This study therefore aimed to assess the awareness and knowledge of pediatric residents regarding brucellosis and to identify areas requiring further training to improve early diagnosis, appropriate treatment, and effective prevention strategies.

MATERIALS and METHODS

Study design and participants

This cross-sectional descriptive study was conducted among 174 pediatric residents under training for 0–48 months at Ankara Bilkent City Hospital between August and September 2023. Inclusion criteria were voluntary participation and complete submission of the questionnaire form. Residents who declined participation or submitted incomplete responses were excluded from the analysis.

Questionnaire (instrument)

A 15-item multiple-choice questionnaire, designed and administered via Google Forms, evaluated demographic characteristics, clinical manifestations of pediatric brucellosis, diagnostic approaches (including serological and imaging methods), treatment regimens, and prophylaxis practices.

Procedures (recruitment and consent)

The survey link was distributed through official departmental communication channels and closed social media groups after obtaining administrative approval. Before accessing the questionnaire, participants viewed an information and consent statement explaining the study purpose, voluntary nature, and confidentiality of responses. Electronic informed consent was obtained prior to participation. To prevent response bias, the correct answers were shared only after participants had submitted their responses.

Seniority status of pediatric residents

In Ankara City Hospital's Department of Pediatrics, residents take a seniority examination at the 24th month of training. Those who pass are designated senior pediatric residents. First and second-year residents are considered juniors, whereas third and fourth-year residents are classified as seniors.

Resident rotation structure

At Ankara Bilkent City Hospital, pediatric residents in the Department of Pediatrics rotate regularly through inpatient and outpatient services of the Pediatric Infectious Diseases Unit. Each of the two inpatient wards hosts two senior and two junior pediatric residents on rotation every month. In addition, two senior residents and one to two junior residents are assigned monthly to the two Pediatric Infectious Diseases outpatient clinics.

This rotation structure ensures that both junior and senior residents are continuously exposed to the diagnosis, management, and follow-up of pediatric infectious diseases, including brucellosis, during their residency training.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA). Categorical variables were presented as numbers and percentages and compared using the chi-square test. Continuous variables were expressed as mean and standard deviation (SD) or median (minimum–maximum), as appropriate. Linear-by-linear association tests were used to evaluate trends between residency year and correct response rates. Statistical significance was defined as two-tailed $p<0.050$. A target sample size of 170 participants was estimated to achieve 80% power at a 95% confidence level, assuming an expected response rate of 80%.

RESULTS

A total of 174 pediatric residents (73% female) completed the survey. Of these, 84 (48.3%) were junior residents (1st year: n = 40; 2nd year: n=44) and 90 (51.7%) were senior residents (3rd year: n=43; 4th year: n=47).

Responses to questions on clinical manifestations

Correct-response rates for questions addressing the clinical symptoms and complications of brucellosis are presented in

Table I: Comparison of the correct response rates of pediatric residents according to seniority status to the survey questions related to clinical symptoms and signs of brucellosis in children

	Junior residents* (n=84)	Senior residents* (n=90)	Total* (n=174)	p
Which of the following is the most common route of transmission of brucellosis?	74 (88.09)	84 (93.33)	158 (90.80)	0.232
Which of the following is not one of the complications of brucellosis?	59 (70.23)	75 (83.33)	134 (77.01)	0.034
Which is one of the frequently seen clinical symptoms and signs of brucellosis?	60 (71.42)	82 (91.11)	142 (81.61)	0.001

**: n(%)*

Table II: Comparison of correct response rates of pediatric residents according to seniority status to the survey questions related to laboratory-imaging findings of brucellosis

	Junior residents* (n=84)	Senior residents* (n=90)	Total* (n=174)	p
Which of the following is/are not one of the laboratory findings of brucellosis?	49 (58.33)	70 (77.77)	119 (68.39)	0.006
Which serologic test is used to diagnose brucellosis in clinical practice?	24 (28.57)	47 (52.22)	71 (40.80)	0.004
What titers are considered significant in non-endemic and endemic areas in the standard tube agglutination test?	23 (27.38)	53 (58.88)	76 (43.67)	0.239
Which screening test is used to detect brucellosis?	59 (70.23)	70 (77.77)	129 (74.13)	0.911
What is one of the factors that causes cross-reaction in the standard tube agglutination test?	42 (50.00)	48 (53.33)	90 (51.72)	0.660
Inhibition of agglutination at low dilutions due to excess antibodies or nonspecific serum factors is defined by which of the following and can result in a false negative result?	44 (53.57)	55 (61.11)	99 (56.89)	0.245
Which imaging modality is preferred in the diagnosis of sacroiliitis secondary to brucellosis?	55 (65.47)	75 (83.33)	130 (74.71)	0.012

**: n(%)*

Table I. Senior residents achieved significantly higher correct-response rates than juniors for the item "Which of the following is not one of the complications of brucellosis?" (88.1% vs. 83.3%; p=0.034) and for "Which of the following is a common clinical symptom/sign of brucellosis?" (91.1% vs. 71.4%; p=0.001). There was no statistically significant difference between groups for the item "Which of the following is the most common route of transmission of brucellosis?" (p=0.232). As the residency year increased, the rate of correct responses to clinical-symptom-related questions also increased (linear-by-linear association test, p<0.001).

Responses to questions on laboratory findings and diagnosis

Correct responses to items assessing diagnostic approaches and laboratory tests are summarized in Table II. Senior residents demonstrated higher accuracy for the item "Which of the following is not a laboratory finding of brucellosis?" (77.8% vs 58.3%; p=0.006) and for "Which serological test is used in the diagnosis of brucellosis in clinical practice?" (52.2% vs 28.6%; p=0.004). Similarly, for the question "Which of the following imaging modalities is preferred for the diagnosis of sacroiliitis secondary to brucellosis?", senior residents provided more correct answers (83.3% vs. 65.5%; p=0.012). These results indicate that senior residents possess stronger diagnostic knowledge and familiarity with both serologic and imaging-based evaluation of brucellosis.

Responses to questions on treatment and prophylaxis

Responses to items on treatment regimens and prophylactic measures are displayed in Table III. Senior residents outperformed juniors on the question "Which antibacterial combination is commonly used in the treatment of brucellosis?" (72.2% vs. 50.0%; p=0.003) and on "Which antibiotic is commonly added to the combination therapy in Brucella spondylitis?" (47.8% vs. 23.8%; p=0.001). Overall, senior residents demonstrated a significantly higher understanding of appropriate antibiotic combinations and adjunctive therapy for complicated cases.

Trend by residency year

When analyzed by residency year, knowledge scores improved progressively from first-year to fourth-year residents, while the proportion of incorrect responses declined correspondingly (linear-by-linear association, p<0.001).

Table III: Comparison of correct response rates of pediatric residents according to seniority status to the survey questions related to treatment and prophylaxis in cases of brucellosis

	Junior residents* (n=84)	Senior residents* (n=90)	Total* (n=174)	p
Which combination of the following is commonly used in clinical practice in the treatment of brucellosis	42 (50.00)	65 (72.22)	107 (61.49)	0.003
Which of the following antibiotics is commonly added to the combined treatment of brucella spondylitis in clinical practice?	20 (23.80)	43 (47.77)	63 (36.20)	0.001
Which agents are used and for how long after high-risk exposure to brucellosis?	29 (34.52)	41 (45.55)	70 (40.23)	0.138

***:** *n(%)*

DISCUSSION

This study is one of the first to evaluate the awareness and knowledge levels of pediatric residents regarding the diagnosis, treatment, and follow-up of brucellosis in children. Brucellosis remains a major zoonotic infection with significant implications for child health, particularly in endemic regions such as Türkiye, where timely diagnosis and appropriate management are essential for reducing morbidity (1). The present findings demonstrated that senior pediatric residents had significantly higher knowledge and awareness scores than junior residents, reflecting the positive impact of cumulative clinical exposure and residency-based infectious diseases training. This trend aligns with prior literature showing that physicians' diagnostic accuracy and confidence in managing brucellosis improve with experience and targeted education (8–10). However, most earlier studies have focused on general practitioners or primary healthcare physicians, while data on pediatric residents remain scarce (11,12). Therefore, our study fills an important gap by specifically assessing knowledge within a pediatric training context, where early recognition and management of brucellosis are vital for preventing complications and long-term sequelae in children.

An important finding of our study was that senior pediatric residents demonstrated greater awareness of the clinical manifestations of brucellosis than junior residents. Previous studies from endemic regions have reported similar challenges in clinical recognition among healthcare providers. In Yemen, physicians had high theoretical awareness but frequently failed to inquire about exposure or consider brucellosis in cases of prolonged fever (8). In Namibia, nearly all physicians (98.4%) did not include brucellosis in the differential diagnosis of persistent fever (9). Significant deficiencies in case recognition were also noted among Saudi primary care physicians, while only 15.3% of Ugandan medical workers demonstrated adequate knowledge of transmission and symptoms (10,11). In Tanzania, insufficient understanding among practitioners contributed to underdiagnosis and underreporting (12). Moreover, inadequate familiarity with diagnostic algorithms and limited awareness of serologic interpretation have been highlighted as contributing factors to delayed or missed diagnoses (13,14). Compared with these studies, our cohort—particularly senior residents—showed higher recognition rates of clinical features (91.1% vs 70.2%), reflecting the potential benefit of structured pediatric residency curricula that emphasize infectious diseases training. This suggests that clinical experience and formal instruction during residency play key roles in improving disease recognition. Consistent with our findings, a previous study among Saudi primary healthcare physicians also demonstrated that awareness of clinical symptoms increased with professional experience (15). However, several reports have highlighted that nonspecific and diverse presentations of brucellosis often lead to delayed or missed diagnoses (16).

Laboratory investigations are fundamental to the diagnosis of brucellosis. In our study, senior pediatric residents demonstrated significantly higher accuracy than junior residents in laboratory-related questions, particularly those concerning serologic screening and cross-reaction mechanisms. Previous studies have confirmed that adequate physician knowledge of serologic testing is essential for diagnostic precision (14,17,18). In Yemen, only one-third of physicians routinely employed serologic testing for prolonged fever cases, while similar underutilization was observed among physicians in Namibia (8,9). Significant deficiencies in confirmatory test requests were also reported among Saudi primary care physicians (10). In Uganda, despite positive attitudes, only 13.6% of medical workers performed routine serologic testing, and comparable diagnostic gaps were observed in Tanzania (11,12). Compared with these reports, our senior residents achieved notably higher correct response rates for serologic screening (52.22% vs. 28.57%) and recognition of cross-reactions (77.77% vs. 58.33% for juniors). These findings suggest that structured pediatric residency training, with its emphasis on infectious disease diagnostics, may enhance both conceptual understanding and practical application. However, several studies have indicated persistent deficiencies in the interpretation of serologic results and recognition of diagnostic pitfalls—particularly the prozone phenomenon—which may still lead to misdiagnosis or delayed treatment (19).

The use of correct antibiotic combinations is crucial for the effective treatment of brucellosis. In our study, senior

pediatric residents demonstrated higher accuracy in identifying appropriate antimicrobial regimens and adjunctive agents for focal disease compared to junior residents (72.22% vs. 50.00% and 47.77% vs. 23.80%, respectively). Previous studies from endemic countries have revealed considerable variability in adherence to guideline-based therapy. In Yemen, 72% of physicians recognized the doxycycline–rifampin regimen, but only half were aware of the recommended duration (8). In Namibia, poor compliance with standardized treatment protocols was reported, and inconsistent prescribing patterns were observed among Saudi primary care physicians (9,10). Similarly, in Uganda, although general attitudes were positive, actual treatment practices were suboptimal (11). Comparable deficiencies in antimicrobial knowledge and application have also been documented among healthcare professionals in other endemic settings (14). These discrepancies may be attributed to differences in structured training exposure. Pediatric residents benefit from systematic guideline-based instruction, whereas practicing physicians often rely on experiential learning and may lack regular educational updates. Our findings thus reinforce that structured residency programs incorporating evidence-based infectious disease management can improve both theoretical and practical competence. Consistent with prior studies, inappropriate or incomplete antimicrobial use remains a key contributor to treatment failure and relapse (20). In pediatric cases, it has been further emphasized that antibiotic combinations and treatment duration should be individualized according to disease course and clinical response (21,22).

Awareness of brucellosis management among pediatric residents is critical to reducing disease burden in endemic regions. Insufficient awareness and diagnostic delays have been widely reported among primary healthcare workers and general physicians (23). Our findings indicate that knowledge gaps persist even within pediatric training programs, particularly in early diagnosis and treatment decision-making. Previous studies have consistently emphasized the necessity of continuous education and professional development for healthcare providers (24,25). Evidence from endemic countries demonstrates that limited familiarity with diagnostic protocols, poor case reporting, and inadequate clinical suspicion remain major barriers to disease control (8–12). Our results, showing stepwise improvement in knowledge with increasing residency seniority, complement these observations by highlighting the positive impact of structured, guideline-based education. Taken together, these data underscore that sustained, repetitive, and standardized training interventions are essential not only within pediatric residency curricula but also across broader healthcare systems in endemic regions.

This study has certain limitations. First, it was conducted among pediatric residents from a single tertiary center, which may limit the generalizability of the findings. Second, the online survey format may have allowed some participants to consult additional resources, potentially inflating accuracy rates. Nevertheless, this work represents one of the first focused evaluations of pediatric residents' knowledge and awareness of brucellosis.

To enhance early recognition, accurate diagnosis, and evidence-based management of brucellosis, structured and regularly reinforced educational modules should be integrated into pediatric residency curricula. Considering Türkiye's endemic status, implementing targeted, case-based learning and refresher programs from the early years of training may significantly improve diagnostic precision, guideline adherence, and clinical outcomes.

Ethics committee approval

This study was conducted in accordance with the Helsinki Declaration Principles. The study was approved by Ankara Bilkent City Hospital (16.08.2023, reference number: E2-23-4862).

Contribution of the authors

Concept;ÖG, AÖP; Design: ÖG, AÖP, Data Collection or Processing: AYG, SKY, BG; Analysis or Interpretation: FÜ, AYG; Database and Informatics Support: FÜ, AYG; Literature Search: ÖG, AYG, SKY, BG; Writing – Original Draft: ÖG, AÖP, AYG; Writing – Review & Editing: ÖG, AÖP, AYG, FÜ, BG, SKY

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Conflict of interest

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