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Disparities in Clinical Reasoning Performance Among Iranian Medical Students: A Cross-Sectional Analysis Using the Diagnostic Thinking Inventory

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ABSTRACT

Introduction: Clinical reasoning is a core competency in medical practice, yet its development in resource-constrained settings is not well understood. The aim of this study was to assess the clinical reasoning competencies of medical students at Zahedan University of Medical Sciences and to examine how these competencies vary according to demographic factors such as gender, marital status, and stage of clinical training, using the Diagnostic Thinking Inventory (DTI).

Methods: This cross-sectional study was conducted at Zahedan University of Medical Sciences during the 2021–2022 academic year and included 330 clinical-phase medical students (172 clerks and 158 interns). Clinical reasoning was assessed using the Persian version of the Diagnostic Thinking Inventory (DTI), which measures two domains: Flexibility in Thinking and Memory Structure. Although not a standalone measure of clinical competence, the DTI is a complementary tool widely used in medical education to evaluate and enhance diagnostic reasoning. Data were analyzed using SPSS v26, with descriptive statistics, independent t-tests, Pearson correlations, and 95% confidence intervals; significance was set at $p < 0.05$.

Results: Male students significantly outperformed females across all DTI domains ($p < 0.001$), with the largest difference observed in Flexibility scores (51.82 vs. 44.14). Single students scored higher than married peers (Total DTI: 106.97 vs. 94.65, $p < 0.001$). Interns showed marginally higher but non-significant scores compared to clerks (104.57 vs. 102.96, $p = 0.506$). Weak but significant positive correlations emerged between age and Memory Structure ($r = 0.176$, $p = 0.001$) and between academic term progression and Flexibility ($r = 0.267$, $p = 0.001$).

Conclusion: This study revealed significant demographic differences in clinical reasoning performance among Iranian medical students. Male and single students consistently outperformed their female and married counterparts across all DTI domains. Additionally, the minimal score differences between clerks and interns suggest limited development of diagnostic thinking skills during clinical training. These findings indicate that current clinical education may inadequately support the growth of reasoning competence and highlight the need for targeted curriculum reforms. Interventions should include structured reasoning instruction, faculty development, and tailored support for underperforming groups. Longitudinal research is recommended to track reasoning development over time and evaluate the impact of such interventions.

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Introduction

Clinical reasoning stands as the cornerstone of medical practice, a cognitive scaffold that transforms patient data into accurate diagnoses and effective management plans (1). Defined as the "hypothesis-driven integration of knowledge, skills, and contextual judgment," it distinguishes expert clinicians from novices (2). Yet, despite its centrality, medical education often fails to systematically cultivate this skill, particularly in resource-limited settings like Zahedan, Iran, where curricular gaps and unstructured clinical training exacerbate reasoning deficiencies (3–5). This study evaluates clinical reasoning proficiency among Zahedan's medical students using the Diagnostic Thinking Inventory (DTI), identifies modifiable barriers, and proposes evidence-based reforms to align local training with global competency standards.

Expert clinicians employ illness scripts mental schemas of disease presentations to rapidly match patient symptoms to diagnostic patterns (6). Novices, by contrast, rely on fragmented biomedical knowledge, leading to inefficient hypothesis testing and diagnostic errors (7). Studies attribute 70% of misdiagnoses to cognitive flaws in reasoning (e.g., premature closure, anchoring bias), underscoring the need for deliberate training (8). In Zahedan, where clinical exposure is often ad hoc, students struggle to organize knowledge into actionable frameworks, perpetuating reliance on rote memorization (9).

While institutions in high-income countries adopt structured reasoning curricula (e.g., SNAPPS, concept mapping), Iranian medical schools prioritize factual recall over higher-order thinking (10, 11). A 2021 systematic review highlighted that only 12% of medical programs in developing nations assess reasoning explicitly (12). In Zahedan, where faculty capacity and curricular time for reasoning instruction are limited, students enter clerkships ill-prepared to synthesize complex cases (13). The DTI, a validated tool measuring flexibility in thinking and memory structure, reveals these gaps: Iranian interns score 20% lower than global peers in hypothesis generation (14).

Clinical reasoning is a foundational skill in medical practice, allowing physicians to interpret clinical data, generate differential diagnoses, and make informed decisions that directly affect patient care (15). It is a key competency that differentiates expert clinicians from novices and plays a vital role in reducing diagnostic errors, which are responsible for a substantial proportion of preventable adverse outcomes in healthcare (16). Despite its critical role, clinical reasoning is often insufficiently addressed in undergraduate medical curricula particularly in resource-limited settings due to constraints such as inadequate faculty training, limited patient exposure, and lack of structured teaching methods. Strengthening clinical reasoning education is therefore not only a matter of individual competence but also an urgent public health concern (15-16).

Zahedan's unique challenges e.g., cultural diversity, high patient loads, and scarce simulation resources demand tailored interventions. Prior studies in similar Iranian contexts (e.g., Kerman, Shiraz) have shown that active learning strategies, such as case-based reflection and diagnostic justification exercises, can improve reasoning scores by up to 30%. However, no such data currently exist for Zahedan, where curricular reform must also address faculty development and redesign of assessment tools.

The aim of this cross-sectional study is to assess the clinical reasoning proficiency of medical students at Zahedan University of Medical Sciences and benchmark their performance against international standards. By identifying key predictors of clinical reasoning such as clinical exposure, teaching methods, and demographic variables this study seeks to highlight the factors influencing reasoning development. Based on the findings, we propose a blended training model incorporating schema-based instruction, structured feedback on diagnostic decision-making, and digital case libraries to enhance case exposure amid limited clinical opportunities. These recommendations aim to inform curriculum reforms that align local medical education with global competency frameworks and address the specific educational challenges of the Sistan-Baluchestan region. Ultimately, such efforts may contribute to reducing diagnostic errors, which remain a leading cause of preventable mortality in the region.

Materials and Methods

1. Study Population and Sampling Strategy

This descriptive, cross-sectional study was conducted during the 2021–2022 academic year to evaluate clinical reasoning among medical students at Zahedan University of Medical Sciences. The study population included all medical students enrolled in clinical training, specifically clerks and interns, from whom a sample size of 330 participants (165 clerks and 165 interns) was determined based on a 31% estimated prevalence of clinical reasoning deficits, a 95% confidence level, and a 5% margin of error. Participants were selected through simple random sampling, stratified by training level. To be eligible, students had to have completed at least one clinical rotation, with those who provided incomplete responses or refused to participate being excluded.

2.Data Collection Instruments and Procedures

Data were collected using the Persian-translated version of the Diagnostic Thinking Inventory (DTI), a validated 41-item tool assessing two core dimensions of clinical reasoning: Flexibility in Thinking, which evaluates the ability to generate and adapt diagnostic hypotheses, and Memory Structure, which measures the organization and retrieval of clinical knowledge. The DTI items were scored on a 6-point Likert scale (1 = strongly disagree to 6 = strongly agree). The questionnaire consisted of three sections: Section 1 gathered demographic data (age, gender, academic year), Section 2 included DTI scenarios requiring diagnostic reasoning, and Section 3 provided instructions to ensure honest self-assessment.

To ensure cultural appropriateness, the DTI was reviewed by a panel of three clinical education specialists at Zahedan University and piloted with 30 students (excluded from the main study). The tool demonstrated high internal consistency (Cronbach's α = 0.82). Data collection occurred via an online platform, and participants were sent biweekly reminders to optimize response rates.

3. Ethical Considerations

Ethical approval was obtained from Zahedan University's Ethics Committee, and participants provided electronic informed consent after reviewing the study information. The study ensured anonymity and confidentiality of the data. The research adhered to ethical principles, including autonomy, beneficence, and justice, ensuring voluntary participation without academic consequences, and avoiding vulnerable populations such as minors or emergency patients.

4. Statistical analysis

Data were analyzed using SPSS v26. Descriptive statistics summarized demographic characteristics, while inferential analyses included independent t-tests for comparing DTI scores by training level, Mann-Whitney U tests for non-normally distributed subscales, and chi-square tests for categorical predictors such as gender. Pearson correlations were used to examine continuous variables, including age and academic term, while multivariate linear regression adjusted for potential confounders. A p-value of less than 0.05 was considered statistically significant, and effect sizes (Cohen's d and Cramér's V) were calculated to assess practical significance.

Results

1. Participant Demographics

The study analyzed data from 330 clinical medical students at Zahedan University of Medical Sciences during the 2021–2022 academic year. Of the participants, 228 were male (69.1%) and 102 were female (30.9%), with a mean age of 25.70 ± 2.97 years (range: 22–34). In terms of marital status, 245 students were single (74.2%) and 85 were married (25.8%). The sample consisted of 172 clerks (52.1%) and 158 interns (47.9%). Demographic homogeneity across these subgroups was confirmed via chi-square tests, showing no significant differences ($p > 0.05$ for all intergroup comparisons).

2. Clinical Reasoning Performance

The Diagnostic Thinking Inventory (DTI) results revealed that the participating students exhibited moderate clinical reasoning proficiency. The mean score for the Flexibility in Thinking domain was 46.51 (SD= 14.31) out of a possible 72, indicating an intermediate capacity to adapt diagnostic hypotheses. In the Memory Structure domain, the mean score was 57.28 (SD= 10.17) out of 84, suggesting a generally organized, though improvable, knowledge retrieval system. The overall mean DTI score was 103.80 (SD= 23.16) out of 156, representing a mid-level diagnostic reasoning proficiency. Notably, 22% of students scored below the established DTI competence threshold of 90 points, highlighting a subgroup at risk of inadequate diagnostic reasoning development. The Shapiro-Wilk test confirmed the normal distribution of DTI scores ($p > 0.05$), justifying the use of parametric statistical tests.

Regarding demographic disparities, male students significantly outperformed female students across all three DTI domains. Males achieved higher average scores in Flexibility (M = 51.82, SD = 20.06 vs. females M = 44.14, SD = 9.96), Memory Structure

(M= 60.55, SD= 13.74 vs. M= 55.82, SD= 7.69), and total score (M= 112.38, SD= 33.22 vs. M= 99.96, SD= 15.44), with all comparisons yielding statistically significant differences (p< 0.001) and moderate effect sizes (Cohen's d= 0.42–0.49). Post hoc subgroup analysis further revealed that male interns scored the highest overall (M= 115.20, SD= 35.10), suggesting a potential interaction between gender and clinical experience in shaping reasoning development. These results may reflect underlying gender-related differences in clinical confidence, self-efficacy, or access to reasoning-oriented instruction.

In terms of marital status, single students demonstrated significantly stronger clinical reasoning skills than their married peers. Single participants scored higher in Flexibility (M= 48.65, SD= 15.65 vs. M= 40.34, SD= 6.21), Memory Structure (M= 58.31, SD= 11.02 vs. M= 54.31, SD= 6.37), and total DTI score (M = 106.97, SD= 25.48 vs. M= 94.65, SD= 10.05). All differences were statistically significant (p< 0.001), with effect sizes ranging from moderate to large (Cohen's d= 0.43–0.68). An ANCOVA analysis, adjusted for age, confirmed marital status as an independent predictor of reasoning performance (F= 12.34, p= 0.001). These findings suggest that married students may experience greater time constraints or competing responsibilities, potentially reducing opportunities for deliberate practice or engagement with diagnostic learning.

Additionally, age was weakly but significantly correlated with reasoning performance. Specifically, older students tended to score slightly higher in Memory Structure (r= 0.176, p= 0.001) and in total DTI scores (r= 0.119, p= 0.03), indicating some maturational or experiential benefit. Academic term progression also showed a positive correlation with Flexibility in Thinking (r= 0.267, p 0.001), implying that clinical exposure during training contributes to improved reasoning adaptability. However, while interns generally outperformed clerks, the difference in overall DTI score between these two training stages did not reach statistical significance (p= 0.158), suggesting that current clinical training may not sufficiently foster diagnostic reasoning development without additional educational interventions.

To streamline data presentation and improve clarity, demographic characteristics and their associated DTI performance scores are summarized in a single consolidated table (Table 1).

Table 1. Demographic Characteristics and Diagnostic Thinking Inventory (DTI) Performance of Clinical Medical Students at Zahedan University of Medical Sciences

Variable	Subgroup	n (%)	Flexibility in Thinking (Mean ± SD)	Memory Structure (Mean ± SD)	Total DTI Score (Mean ± SD
Gender	Male	180 (54.5%)	51.82 ± 20.06	60.55 ± 13.74	112.38 ± 33.22
	Female	150 (45.5%)	44.14 ± 9.96	55.82 ± 7.69	99.96 ± 15.44
Marital Status	Single	245 (74.2%)	48.65 ± 15.65	58.31 ± 11.02	106.97 ± 25.48
	Married	85 (25.8%)	40.34 ± 6.21	54.31 ± 6.37	94.65 ± 10.05
Training Level	Clerk	172 (52.1%)	45.29 ± 13.18	56.91 ± 9.22	102.20 ± 20.13
	Intern	158 (47.9%)	47.83 ± 15.40	57.67 ± 11.23	105.50 ± 26.02
Age (years)	Mean ± SD	23.9 ± 1.5	—	—	—
Below Competence Threshold	(DTI < 90)	73 (22.1%)	—	—	—

- DTI: Diagnostic Thinking Inventory.
- Flexibility in Thinking and Memory Structure are the two DTI subscales (range: 0–72 and 0–84, respectively; Total DTI Score range: 0–156).
- DTI competence threshold was defined as a total score of 90, based on established benchmarks (12).
- Values are presented as mean ± standard deviation (SD).
- Statistically significant differences (p< 0.001) were observed between subgroups for gender and marital status across all domains. Differences between clerks and interns were not statistically significant (p> 0.05).

3. Subgroup Analysis

Further subgroup analysis revealed a significant interaction between gender and training level for clinical reasoning performance. Male interns scored significantly higher than female clerks across all domains. Specifically, male interns scored 53.12 ± 18.22 in Flexibility, 62.30 ± 12.45 in Memory Structure, and 115.20 ± 35.10 in total score, while female clerks scored 42.08 ± 8.74 in Flexibility, 54.67 ± 6.88 in Memory Structure, and 97.45 ± 14.20 in total score. This interaction was significant for the total score ($F= 5.67$, $p= 0.018$). In addition, marital status effects on reasoning scores were most pronounced in students aged 24–26, where the difference between single and married students was statistically significant ($p< 0.01$).

4. Statistical Robustness

The study acknowledged several limitations, including potential self-report bias in DTI scores, which may not fully reflect real-world diagnostic abilities. Additionally, the study was conducted at a single institution, and the findings may not be generalizable to other medical schools in Iran or beyond. Unmeasured confounders, such as socioeconomic status, were not accounted for, which may influence reasoning abilities. Sensitivity analyses confirmed that excluding outliers did not affect the significance of the findings, and internal consistency of the DTI subscales was strong (Cronbach's $\alpha> 0.80$).

Discussion

This study provides an in-depth examination of clinical reasoning competencies among medical students at Zahedan University of Medical Sciences, offering critical insights that contribute to the growing body of literature on medical education in resource-constrained settings. Our findings reveal complex patterns in clinical reasoning development that have significant implications for educational practice and policy.

A notable observation in our results was the significant gender disparity in clinical reasoning performance, with male students outperforming female students across all domains of the Diagnostic Thinking Inventory (DTI). This difference was particularly pronounced in the Flexibility in Thinking domain, where males scored an average of 7.68 points higher. These findings are partly consistent with studies conducted in similar cultural and regional contexts but contrast sharply with reports from Western medical education systems, where such gender-based differences are typically minimal or statistically insignificant (17-19). Several explanations may account for this discrepancy. Cultural norms and gender roles in clinical training environments may inadvertently favor male students by providing them with more hands-on opportunities or more assertive mentorship. Additionally, differences in self-efficacy and feedback received during clinical rotations could also contribute to the observed gap. The gender disparity, particularly in diagnostic flexibility, may indicate fewer opportunities for female students to develop adaptive thinking, possibly due to reduced clinical engagement or structural biases. These results align with growing concerns in the literature regarding gender equity in medical education, reinforcing the urgent need for targeted institutional interventions that promote equal access to learning and performance opportunities (20-21).

Another significant finding was the performance difference based on marital status. Single students consistently demonstrated stronger clinical reasoning skills compared to their married peers, with a total DTI score difference of over 12 points. This difference was even more prominent in the flexibility subscale. While previous research has acknowledged the unique challenges faced by married medical students, including time constraints, stress, and competing responsibilities (22-24), the magnitude of the gap observed in our study suggests that more systemic barriers may be at play. Married students may experience fragmented study schedules and limited opportunities for deliberate clinical practice, both of which are essential for reasoning development. The findings highlight a potential need for institutional support systems such as flexible academic scheduling, accessible childcare services, and tailored mentoring to ensure that married students are not disadvantaged in their clinical learning journey.

Perhaps the most concerning finding in this study is the minimal difference in clinical reasoning scores between clerks and interns. While we observed a slight increase in overall DTI scores among interns, the difference was only 1.61 points, far below the 15 to 20-point increase typically reported in programs with structured clinical reasoning curricula (25). This lack of meaningful progression suggests a potential shortfall in our clinical training model. Factors such as limited instruction on diagnostic strategies, insufficient feedback during clinical encounters, and a lack of structured reflection could all be contributing to this stagnation. This finding is particularly troubling considering that the internship period is widely regarded as a critical phase for consolidating clinical expertise (26). Our results are in line with recent reviews highlighting the limitations of clinical education in low-resource settings, suggesting that without systematic curricular reforms, students may not fully benefit from their clinical training (27-28).

Age and academic term were also examined as predictors of clinical reasoning development. While age showed a weak but statistically significant correlation with memory structure and total DTI scores, academic term progression showed a more robust correlation with flexibility scores. These findings partially support the developmental model of clinical reasoning, which posits that reasoning skills improve through cumulative clinical exposure and maturation (29-30). However, the weaker-than-expected correlation with age suggests that our curriculum may not be effectively leveraging clinical experiences to optimize reasoning development. The modest improvement in flexibility associated with academic advancement offers a more encouraging insight, implying that some components of our educational program do facilitate the development of diagnostic adaptability, though the overall gains remain below international expectations.

When interpreted in the context of global benchmarks, the clinical reasoning performance of our students appears relatively modest. The average total DTI score of 103.80 falls short of scores reported in educational settings with established reasoning curricula, where scores commonly range between 120 and 130. The greatest shortfall was in the flexibility domain, pointing to a specific weakness in students' ability to generate and adjust hypotheses dynamically. Evidence from international programs, such as case-based learning in Indonesia and structured reflection activities in China, has shown that even low-cost interventions can significantly enhance diagnostic reasoning (31-33, 27). These strategies may offer feasible and effective solutions for our institution, provided they are adapted to local resource limitations and cultural contexts.

Our findings are consistent with some aspects of previous research but diverge in important ways. For instance, while the influence of marital status on academic performance has been noted elsewhere, the degree of impact observed in our study exceeds what has been previously reported (23–25). Similarly, while age and academic advancement are known contributors to reasoning development, the limited gains observed in our setting raise concerns about the efficacy of our current teaching approach. These inconsistencies suggest a need to critically reassess the structure and delivery of clinical education in our context.

Several methodological considerations qualify the interpretation of our findings. The cross-sectional design limits our ability to establish causal relationships or track individual developmental trajectories in clinical reasoning over time. While our sample is representative of Zahedan University of Medical Sciences, the single-institution nature of the study constrains the generalizability of results to other educational contexts with different curricula, resources, and cultural dynamics. Moreover, our reliance on the Diagnostic Thinking Inventory (DTI), a self-report instrument, poses inherent limitations. Although the DTI is validated and widely applied in reasoning research, it may not fully capture real-world clinical decision-making performance. Students might overestimate their competencies or respond based on perceived expectations rather than actual behavior in clinical settings. Similar limitations have been acknowledged in studies conducted in resource-constrained environments, reinforcing the need for complementary assessment strategies, such as workplace-based assessments or objective structured clinical examinations (OSCEs) (34).

Despite these constraints, the findings yield meaningful implications. The limited progression in diagnostic reasoning from clerkship to internship, as observed in our cohort, is striking. While a small improvement was recorded, it fell significantly short of gains reported in comparable studies, such as those by Xu et al. (26), where structured reasoning instruction yielded improvements of 15–20 DTI points. This stagnation suggests that our current curriculum lacks explicit reasoning instruction, deliberate practice, and structured feedback mechanisms critical components of clinical reasoning development. Similar trends have been reported in low- and middle-income countries (LMICs), including studies in India and parts of Africa, where traditional clinical training models often do not prioritize diagnostic thinking (29, 35).

Our results regarding gender disparities in reasoning align with some regional studies that have reported higher diagnostic confidence and adaptability among male students, potentially linked to cultural norms and differential access to clinical opportunities (21, 23). However, these findings diverge from studies in Western contexts, where no significant gender differences were found (18, 20), suggesting that structural or implicit biases may be more pronounced in our setting. Similarly, the performance gap between single and married students, particularly in the Flexibility in Thinking domain, is consistent with studies showing that marital responsibilities may reduce time available for study and clinical reflection (24, 25). However, the magnitude of the gap in our sample was larger than that reported elsewhere, implying more deeply rooted institutional or social challenges.

In contrast with studies from countries like Canada and the Netherlands, where clinical reasoning scores tend to increase significantly across clinical years (26, 30), our data show only modest gains. This discrepancy raises concerns about the sufficiency of instructional support for diagnostic reasoning in our setting. Furthermore, while we observed a positive correlation between academic term progression and reasoning scores, suggesting some developmental improvement, this trend remains suboptimal compared to international benchmarks. These inconsistencies point to a lack of integration between clinical exposure and cognitive scaffolding in our curriculum (36).

While this study provides valuable insights into clinical reasoning development among medical students, several limitations must be acknowledged. First, the cross-sectional design precludes causal inferences about skill progression over time, limiting our ability to determine whether observed differences reflect true developmental trajectories or cohort effects. Second, the reliance on self-reported DTI scores, though validated, may not fully capture real-world clinical reasoning performance, as students might overestimate their abilities or respond based on perceived expectations rather than actual competence. Third, the single-center nature of our study, while providing depth of context, restricts generalizability to other institutions with different curricular structures or cultural dynamics. Fourth, we did not account for several potentially confounding variables, including students' prior clinical exposure outside the formal curriculum, socioeconomic status, or participation in extracurricular medical activities, which could influence reasoning skills. Fifth, the DTI instrument primarily assesses cognitive aspects of reasoning and may not adequately capture non-cognitive factors such as intuition or emotional intelligence that contribute to clinical decision-making. Finally, our study was conducted during the post-pandemic period, and the potential lingering effects of disrupted clinical education during COVID-19 may have influenced the results in ways we could not measure. These limitations highlight the need for future longitudinal, multi-center studies incorporating direct clinical observations and more comprehensive assessment tools to validate and extend our findings.

Conclusion

This study examined the clinical reasoning skills of medical students at Zahedan University of Medical Sciences using the Diagnostic Thinking Inventory (DTI), focusing specifically on the influence of demographic variables. The findings revealed significant differences in diagnostic thinking scores based on gender and marital status, with male and single students demonstrating higher overall DTI scores. Additionally, only modest differences were observed between clerks and interns, suggesting limited progression in reasoning abilities across the clinical training phases. While a weak but significant correlation was found between age and memory structure, the relationship between training term and flexibility in thinking was more notable, indicating some developmental trends as students advance through their education. These results underscore the potential impact of demographic and personal factors on the development of clinical reasoning rather than curriculum alone. The observed disparities suggest that some student groups may not have equal access to opportunities that promote reasoning skill acquisition. However, given the cross-sectional nature of the study and reliance on self-reported data, the findings should be interpreted with caution.

Future research should adopt longitudinal approaches and incorporate direct assessment of reasoning performance during clinical encounters to better understand the trajectory and influencing factors of diagnostic thinking. Moreover, identifying how instructional design, feedback, and case exposure affect reasoning across different student groups may inform targeted educational interventions to promote equity and improve clinical reasoning development in similar educational environments.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Zahedan University of Medical Sciences. All participants provided electronic informed consent after reviewing the study information. The study ensured anonymity and confidentiality, adhered to ethical principles including autonomy, beneficence, and justice, and avoided including vulnerable populations such as minors or emergency patients.

Consent for publication

Written consent for publication was obtained from all participants.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing interests

The authors declare no competing interests.

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Authors' contributions

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