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From classroom to clinic: evaluating a clinical pathology course to strengthen pathology report literacy of medical interns

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Abstract

Background Pathology reports serve as the primary communication tool between pathologists and clinicians, directly influencing clinical decision-making and treatment strategies. Despite their critical role, medical students may struggle with interpreting these reports, which can lead to miscommunication and potential diagnostic errors. This study investigated the impact of incorporating a clinical pathology course into the routine medical curriculum to enhance medical students' understanding of pathology reports and their satisfaction with the course.

Methods This cross-sectional study involved 92 medical students in their internship phase, who were divided into two groups: those who had completed the clinical pathology course and those who had not. The participants were provided with two pathology reports (covering malignant and benign gastrointestinal diseases) and a self-administered questionnaire consisting of 24 items. The data were analyzed via the chi-square test to assess significant differences between groups.

Results Medical interns who completed the course demonstrated significantly higher rates of moderate interpretation scores (80.43% vs. 63.04%) and lower rates of weak scores (6.53% vs. 32.61%) compared to those who did not participate ($p=0.001$). Interns who passed the clinical pathology course had a significantly greater mean number of correct answers for interpreting malignant cases reports ($p=0.04$), although no significant difference was found for benign cases reports ($p=0.93$). Most interns who completed the course reported that it helped improve their interpretation skills, although some felt that the perceived benefits were limited. Additionally, the study identified key challenges students still faced when interpreting pathology reports including difficulties with pathology report terminology, understanding cancer staging abbreviations, and applying basic pathology concepts in clinical context.

Conclusions Our findings suggest that clinical pathology courses can improve medical students' understanding of pathology reports, particularly in cases of cancer, but improvements in course content and teaching methods are needed. This research offers valuable insights into improving medical education.

Keywords Pathology report, Interpretation of diagnostic tests, Clinical pathology, Medical students, Medical education, Health education, Medical

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Introduction

Effective communication and proper comprehension of exchanged information are critical among different members of multidisciplinary medical teams consisting of different medical professionals and clinical specialties [1]. Miscommunication among health care providers has been found to play a role in approximately 80% of serious medical errors [2].

Among the different medical fields, pathology serves as a bridge between basic sciences and clinical medicine, playing a significant role in formulating effective treatment strategies [2–6]. Pathology professionals rely on pathology reports to communicate their findings [1, 3, 4, 7]. While the accuracy, completeness, and timeliness of pathology reports are important, their comprehension by clinicians is equally essential for effective patient care [3]. To address this, the pathology curriculum should not only offer robust pathology knowledge but also equip medical students—future clinicians—with other skills, such as how to communicate with pathology departments and how to interpret, comprehend, and utilize pathology reports in real practice constructively [4–6].

The clinical relevance and applicability of the pathology curriculum often underemphasized in adequately preparing medical students for real-world medical practice [7–9]. Studies indicate that approximately one-third of clinicians struggle to correctly understand and interpret pathology reports, even after years of practice [3, 9]. While their comprehension tends to improve with experience over time, this problem remains incompletely resolved. This may have originated as early as the medical school education years, when medical students face similar difficulties in interpreting pathology reports in the internship phase [10, 11]. Although practical exposure during training contributes to gradual improvement, the core problem persists even years after graduation [9, 12]. This gap in comprehension can be influenced by individual levels of knowledge and experience and prior training in skills such as interdisciplinary communications. Moreover, medical education in the pathology curriculum for medical students may lack adequate emphasis on laboratory medicine, tissue processing, and specific pathology terminology, all of which are critical for understanding pathology reports in a clinical context [10, 11, 13]. Therefore, the most effective time to address these shortcomings and prepare future clinicians to comprehend and utilize pathology reports is during medical school, when foundational knowledge is being built [14, 15].

Pathology reports should not be considered simply as definitive diagnostic tools, in contrast to the common belief held by patients and clinicians alike [3]. These reports are not unequivocal diagnoses and serve only as consultation, representing clinical interpretation shaped by the specific clinical context and the expertise of reporting pathologists. For example, these reports often contain comments or terms such as "suggestive of" or "compatible with," which are deliberately used to convey the uncertainties inherent in the findings [9, 16]. However, clinicians unfamiliar with the nuances of pathology reporting may misinterpret them as definitive diagnoses, potentially leading to errors in clinical decision-making and patient care. In addition to the inconclusive, complex, and inconsistent terminology found in pathology reports, a lack of person–person communication could also be a factor responsible for misunderstanding a pathology report [17, 18]. This highlights the need for better education and clearer communication between pathologists and clinicians to bridge the gap in understanding these complexities.

Recently, many medical schools have shifted their educational approach toward student-centered and problem-based learning [19, 20]. As part of this transformation, new components have been introduced, such as clinical pathology or laboratory medicine courses, which also include the correct interpretation of pathology reports and results [4, 5, 15]. Building on the identified gaps in medical education in our setting, this study was designed primarily to assess the effectiveness of a newly implemented clinical pathology course in enhancing medical students' understanding of pathology reports during their internship period. Additionally, the study aimed to identify instances of misunderstanding in the interpretation of pathology reports and to determine the optimal timing for offering this course during students' medical education. The findings can inform the development of a more robust educational strategy to better equip medical students—future clinicians—with the skills necessary to interpret pathology findings accurately in practice.

Methods

Study setting

The present study was conducted in the pathology department of Urmia Medical Sciences University (UMSU) in Urmia, Iran, between January and March 2024. It was designed to compare the knowledge and interpretative skills of medical interns who participated in a clinical pathology supplementary course with those who did not, focusing on their ability to understand and interpret pathology reports. After approval by the educational authorities of the university, a tailor-made, supplementary clinical pathology course was developed and implemented within surgical pathology education beginning in spring 2020. This study was conducted in accordance with the principles of the Declaration of Helsinki and received approval from the university's Ethics Review Committee. The confidentiality of the data was strictly

maintained throughout the study, with all the data being stored securely. Access to the data was restricted to authorized study researchers only, and no individual participant data were shared.

Clinical pathology curriculum integration in the study setting

The general medicine programme in Iran lasts seven years and is divided into four phases as follows: basic sciences (two and a half years), preclinical or physiopathology (one year), clinical clerkship or pre-internship (two years), and internship (one and a half years). The overall curriculum consists of 290 standard credits, 12 of which are dedicated to pathology [21]. While there is some variation among different medical schools, pathology is typically taught in two parts: 'General Pathology' covers topics such as cell injury and death, inflammation and healing, immunopathology, and cancer pathology during the 'basic sciences' phase, and 'Systemic Pathology' focuses on organ-specific pathology, such as cardiovascular and respiratory pathology, during the 'physiopathology' phase. At UMSU, an additional one-credit 'Clinical Pathology' course has been part of the curriculum since 2020. This course consists of 8–9 two-hour lecture-based sessions in the lecture hall, along with a two-hour visit to the pathology department to familiarize students with different sections of pathology laboratory and their roles. Since its integration into the curriculum, the course has been mandatory. Students must complete it during either their physiopathology or pre-internship phase.

This supplementary course covers a range of topics, including steps in histopathology laboratory processes, guidance in selecting appropriate laboratory tests for various patients, determining the optimal timing and method for sample collection, identifying key components of pathology reports, understanding specialized terminology and interpreting findings. Pathology reports typically include sections such as patient demographics, the number of tissue sections submitted for examination, gross and microscopic descriptions of the specimen(s), a final diagnosis, if necessary, notes or comments [16, 22].

Study participants

The target population consisted of medical students in their internship phase at UMSU in the start of 2020. Based on the percentage of report interpretation discrepancies in one study (50% in the group that participated in the educational course and 82.9% in the group that did not participate) [23], we calculated a minimum required sample size of 38 participants for each group using the following formula, considering a 95% confidence interval (Z1-α/2 = 1.96) and a test power of 90% (Z1-β = 1.28).

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2 \times [P_1\,(1-P_1) + P_2\,(1-P_2)]}{(P_1 - P_2)^2}$$

To account for potential attrition, we aimed to recruit at least 46 participants per group. The sampling method was convenience sampling. All medical interns in January 2020 were invited to participate. The inclusion criteria were being a medical intern and expressing an interest in participating in the study. The exclusion criterion was incomplete responses to the questionnaire; however, no incomplete responses were observed.

We non-randomly recruited students and categorized them into two groups: those who participated in the course (Group A) and those who did not (Group B). Group B consisted of students from the year before Group A, prior to the course's introduction. Recruitment stopped when we reached 46 students in each group. Participation in the study was voluntary and without compensation.

Data collection process

Data were collected via a researcher-designed questionnaire developed on the basis of previous similar studies [10, 21, 23, 24]. Pathologists working at our pathology department reviewed the questionnaire items, and their feedback was incorporated into the final version. The questionnaire is available in the Supplementary Material 1.

Prior arrangements were made to ensure a quiet environment for participants to complete the questionnaire. At least one member of the research team was present to briefly explain the study objectives. Paper-based questionnaires were distributed, and participants were given unlimited time to complete them.

The questionnaire consisted of 24 questions. The first four questions collected demographics (age and gender) and asked whether participants had attended the clinical pathology course and, if so, in which phases of their program. The next 15 multiple-choice questions assessed participants' understanding of two pathology reports distributed along with the questionnaire (details below). These questions focused on standard components of pathology reports and specific terminologies used by pathologists. The final five questions covered general topics: two questions addressed the 'comment' section of the pathology report; one question asked about participants' overall satisfaction with the clinical pathology course and its impact on their understanding and interpretation of pathology reports; another question solicited opinions on whether the course duration should be increased; and the last question asked participants to suggest the optimal timing for the course (i.e., physiopathology,

pre-internship, or internship phases). Given the high prevalence of gastrointestinal cancers in West Azerbaijan Province [25, 26], which is located within the Asian esophageal and stomach cancer belt, two pathology reports related to these diseases were selected: one on a gastrectomy specimen due to gastric cancer (with 10 associated questions) and another on a gastric biopsy of a benign disease (with five associated questions) (Supplementary Materials 2 and 3). These structured pathology reports, stripped of patient identifiers, were distributed alongside the questionnaires. The participants completed the questionnaires anonymously.

For the 15 multiple-choice questions, each correct answer was awarded 1 point, whereas the incorrect answers were awarded 0 points (the highest possible score of 15). The participants' levels of understanding and interpretation skills were categorized on the basis of the total score as follows: weak (≤ 5), moderate (6--10), and good (11- 15).

Data analysis

Quantitative variables are presented as the means ± standard deviations, while qualitative variables (e.g. gender and responses to multiple-choice questions) are reported as frequencies (percentages). The chi-square test (or Fisher's exact test, if applicable) was used to compare qualitative variables, and the independent Student's t test (or Mann–Whitney U test, if applicable) was used for quantitative variables. A p value of less than 0.05 was considered statistically significant. To assess reliability, the Cronbach's alpha coefficient was calculated and found to be 90%. All the statistical analyses were performed via SPSS software (version 17).

Results

In total, 92 medical students participated in our study: 46 participants in Group A and 46 participants in Group B. Most of the participants were male (65.2%). There were no significant differences between the two groups in terms of sex or age (Table 1). In Group A, 97.8% of the students took part in the course in the physiopathology phase, and a small Group of 2.2% took part in the pre-internship phase.

Comparison of participants' understanding and interpretation skills

With respect to students' understanding of the core content and their interpretation skills, the total mean scores were 7.98 ± 1.83 (mean ± standard deviation (SD) (median = 8, minimum = 5, and maximum = 12) for Group A and 7.21 ± 2.58 (median = 7, minimum = 2, and maximum = 12) for Group B ($p = 0.11$). Although most participants in both groups were categorized as having moderate scores, the percentage of students at the moderate level was significantly greater in Group A (80.43%) than in Group B (63.04%) ($p = 0.001$, Fisher's exact test) (Fig. 1) (Table 2). After applying the Bonferroni correction, the difference remained significant. Furthermore, the percentage of students at the weak level was significantly greater in Group B (32.61%) than in Group A (6.53%) ($p = 0.001$, Fisher's exact test), with significance preserved after Bonferroni correction.

At the individual question level, none of the questions were answered correctly by all the students in either group. Similarly, no student in either group was able to correctly answer all the questions. When the two groups were compared, a significant difference was found in students' scores regarding the malignant case pathology report, with Group A scoring significantly higher than Group B (5.13 ± 1.55 (mean ± SD) vs. 4.39 ± 1.84; $p = 0.04$) (Table 1). However, no significant difference was observed between the groups for the noncancer pathology reports.

Although Group A generally performed better than Group B did, the main significant differences between the groups were found in only three questions: the number of specimen containers as part of gross evaluation (Q 3: 93.5% vs. 45.7%; $p < 0.001$), involvement of surgical margins (Q 5: 54.3% vs. 32.6%; $p = 0.035$), and perineural invasion by cancer (Q 7: 54.3% vs. 4.3%; $p < 0.001$) (Table 1). Notably, fewer than half of the 92 study participants, regardless of course participation, correctly answered six out of the 12 remaining questions (Q2, Q4, Q6, Q10, Q11, and Q14), with the poorest results observed for Q2, Q4, and Q 10, underscoring persistent gaps in understanding. Similarly, in other questions, such as the one involving pathology abbreviations (Q9; "MX" referring to unknown metastasis in "Pathologic Staging"): 65.2% of Group A respondents provided correct answers, while 34.8% answered incorrectly. The performance in Group B was even lower, with only 47.8% responding correctly, leaving 52.2% unable to accurately interpret this critical component of pathology reports.

Overall, these results pointed to difficulties in understanding pathology report terminology (e.g., tissue slices, paraffin blocks, and blood vessel involvement in metastasis), cancer staging abbreviations (such as 'y' in the TNM system), and the application of basic pathology concepts (e.g., metaplasia, dysplasia, and gastritis) in a clinical context.

Comparison of the two groups regarding the general questions

When participants were asked whether they always read the "Note" section (Q16), 71.7% of Group A and only 19.6% of Group B indicated that they did so ($p < 0.001$).

Table 1 Comparison of Group A (participants in the clinical pathology course) and Group B (nonparticipants)

Demographic information and questionnaire responses	Group A (46 students) n (%)*	Group B (46 students) n (%)*	*p value***
Gender			
Male	30 (65.2)	30 (65.2)	1
Female	16 (34.8)	16 (34.8)	
Age (mean ± SD)	25.91 ± 1.18	24.82 ± 1.74	0.68
Scores for pathology reports core content (15 questions) (mean ± SD)			
Total score[¥]	7.98 ± 1.83	7.21 ± 2.58	0.11
First pathology report[§]	5.13 ± 1.55	4.39 ± 1.84	**0.04**
Second pathology report[£]	2.85 ± 1.24	2.82 ± 1.14	0.93
Q 1: What does the number S-01-05952 refer to?	35 (76.1%)	31 (67.4%)	0.35
Q 2: In the "Summary of Specimen", what do the numbers in the denominator of fractions refer to?	18 (39.1%)	14 (30.4%)	0.38
Q 3: In how many containers has this patient's sample been sent to the pathology laboratory?	43 (93.5%)	21 (45.7%)	**<0.001**
Q 4: In the "Summary of Specimen", what do the numbers in the numerator of the fractions refer to?	19 (41.3%)	17 (37%)	0.67
Q 5: What is the status of surgical margins in terms of tumor involvement?	25 (54.3%)	15 (32.6%)	**0.035**
Q 6: Was there any involvement of blood vessels with cancer?	22 (47.8%)	21 (45.7%)	0.67
Q 7: What is the status of nerves in terms of cancer involvement?	25 (54.3%)	2 (4.3%)	**<0.001**
Q 8: How many lymph nodes are involved with cancer?	31 (67.4%)	28 (60.9%)	0.51
Q 9: What does "MX" mean in "Pathologic Staging"?	30 (65.2%)	22 (47.8%)	0.09
Q 10: Has the patient been treated prior to surgery?	15 (32.6%)	13 (28.3%)	0.65
Q 11: Based on the endoscopy report, what diagnosis has been made for the patient?	21 (45.7%)	16 (34.8%)	0.29
Q 12: How many tissue pieces does the biopsy sample (s) consist of?	29 (63%)	28 (60.9%)	0.83
Q 13: How much of the biopsy sample has been embedded in a paraffin block?	30 (65.2%)	26 (56.5%)	0.39
Q 14: How many paraffin blocks have been made from this patient's sample (s)?	22 (47.8%)	20 (43.4%)	0.83
Q 15: What is the pathologist's final recommendation?	38 (82.6%)	37 (80.4%)	0.79
Q 16: How often do you read "Note" in the pathology reports?			**<0.001**
Always	33 (71.7)	9 (19.6)	
Never	2 (4.39)	9 (19.6)	
Occasionally	11 (23.91	28(60.9)	
Q 17: How much does reading the Note help clarify the diagnosis for you?			**<0.001**
Very Much	30 (65.2)	14 (30.4)	
Somewhat	16 (34.8)	28 (60.9)	
None	0 (0)	4 (8.7)	
Q 18: When do you think is the best time to offer the clinical pathology course?			**<0.001**
Physiopathology	32 (69.6)	15 (32.6)	
Pre-internship	13 (28.3)	20 (43.5)	
Internship	1 (2.1)	11 (23.9)	
Q 19: Do you feel the need to increase the number of sessions for the clinical pathology course?[√]			
Very Much	5 (10.9)	–	–
Somewhat	35 (76.1)		
None	6 (13)		
Q 20: Are you satisfied with the clinical pathology course in improving your understanding and interpretation of pathology reports?[√]			
Yes	17 (37)	–	–
Somewhat	16 (34.8)		
No	13 (28.3)		

AbbreviationsSD Standard deviation, *Q* Question

[*] All values in the columns are presented as n (%), unless otherwise indicated

[**] All analyses were conducted via the chi-square test, except for "Age" and "Scores for pathology reports core content", which were performed via the independent t test. Significant values are highlighted in bold

[¥] With possible scores ranging from a minimum of 0 to a maximum of 15

[§] With possible scores ranging from a minimum of 0 to a maximum of 10

[£] With possible scores ranging from a minimum of 0 to a maximum of 5

[√] Only Group A was asked and answered questions 19 and 20

Table 2 Comparison of total scores for interpreting the two pathology reports

Total interpretation score categories[¶]	All study cohort *n* = 92 n (%)	Group A *n* = 46 n (%)	Group B *n* = 46 n (%)	*p value**
Good (11–15)	8 (8.7)	6 (13.04)[a]	2 (4.35)[a]	0.001
Moderate (6–10)	66 (71.7)	37 (80.43)[a]	29 (63.04)[b]	
Weak (< = 5)	18 (19.6)	3 (6.53)[a]	15 (32.61)[b]	

[¶] Based on the aggregate score of core content questions 1 to 15

[*] Using Fisher's Exact test

Superscript letters of [a] and [b] indicate statistical significance: identical superscript letters denote no significant difference, while different letters signify a significant difference

Regarding the effect of the "Note" on clarifying the diagnosis (Q 17), 65.2% of the participants in Group A and 30.4% of the participants in Group B indicated "very much" ($p = 0.001$). When participants were asked about the optimal time to take the course (Q 18), 47 out of 92 participants (51.08%), including 69.6% in Group A and 32.6% in Group B, identified the physiopathology (preclinical) phase as the ideal time. In both groups, the internship period was the least selected phase to offer the course (only 12 out of 92 participants (13.04%)).

The last two questions were asked only of Group A participants. Regarding the need to increase the number of sessions for the course (Q 19), the majority of participants answered "somewhat" (76.1%). With respect to participants' satisfaction with the course's impact on their ability to interpret reports (Q 20), the majority of participants expressed positive feedback, with 37% answering "yes" and 34.8% answering "somehow", whereas only 28.3% responded "no".

Discussion

We compared the understanding and interpretation of pathology reports between two groups: one group that participated in the clinical pathology course and one that did not. The results indicated a positive impact of the course on students, as evidenced by the greater proportion of moderate-level scores among participants who completed the course (Group A) than among those who did not (Group B). Despite these positive results, our study also revealed persistent knowledge gaps, with students—including those who participated in the course—still struggling when evaluating pathology reports. Many students viewed the course's impact positively, expressing favor toward it. More than half of the participants preferred the 'physiopathology' phase as the optimal time to offer this course.

Our findings highlight both the strengths and gaps in students' ability to interpret pathology reports, offering valuable insights to refine such courses and guide the development of a more effective educational strategy, which would enhance medical students' ability to assess pathology findings confidently and accurately in their future clinical practice. Previous studies have shown that many physicians lack a correct understanding of pathology reports [3, 9, 10]. To our knowledge, this study is the first in Northwest Iran to assess the challenges in interpreting pathology reports and to evaluate the role of targeted education and training in mitigating these issues. In our study of medical students during their internship phase, only a small proportion (8.7%) demonstrated

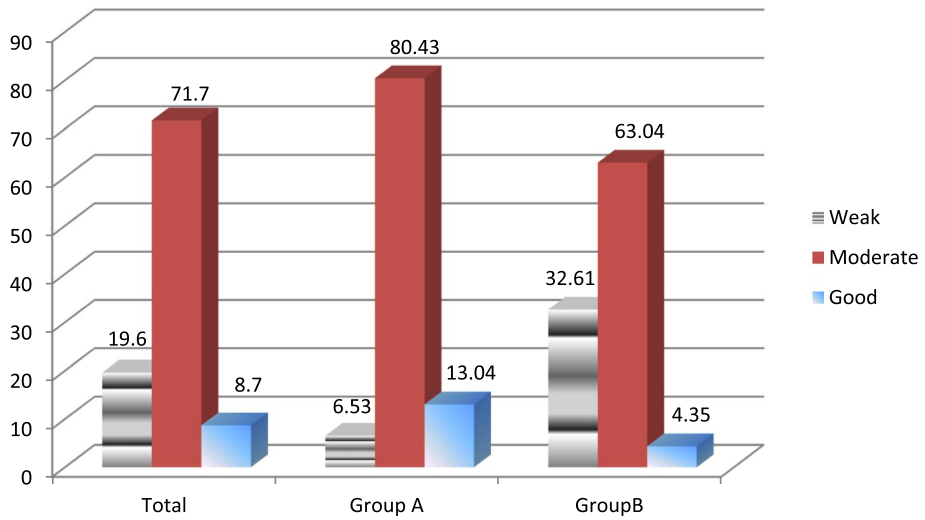

Fig. 1 Percentage distribution of participants' understanding level and interpretation skill based on total scores: Group A (participants in the clinical pathology course) vs. Group B (non-participants)

a good overall understanding of pathology reports. Although the clinical pathology course appeared to have a positive impact by reducing the proportion of students with weak understanding, a notable percentage (19.6%) still demonstrated weak understanding across the entire cohort. These findings concern and underscore the need for further efforts, as they imply that simply offering a course is not sufficient to fully address the problem.

In the study by Zare-Mirzaei et al., 39% of medical interns faced difficulties interpreting pathology reports, particularly cancer-related reports [10]. Similar challenges were observed in our study among those who had not participated in the course. Interestingly, our study suggests an association between participation in the clinical pathology course and improved understanding of cancer pathology reports. However, we also identified areas of knowledge gaps in key concepts related to gastrointestinal pathology reports, even among course participants. These included gaps in understanding the terminology used in these reports, such as the number of tissue slices and paraffin blocks, and evaluating blood vessel involvement for metastasis. Another identified gap was understanding the abbreviation 'y' in cancer staging, which denotes the stage of a tumor following neoadjuvant therapy, such as chemotherapy or radiation given before surgery. This abbreviation is part of the tumor, node, metastasis (TNM) staging system, where prefixes such as 'y' provide a critical context for staging after treatment. Although, the use of abbreviations in medical reports and notes is controversial and generally discouraged [27, 28], in the field of pathology, they are used extensively for example for communicating accurate cancer staging and diagnosis and are detailed in guidelines such as the College of American Pathologists (CAP) protocols. The gaps seen in comprehension of pathology terminology highlight the importance of familiarizing students with the terminology essential for correct clinical interpretation and decision-making. Additionally, while we expected the students to be familiar with basic concepts such as metaplasia, dysplasia, and gastritis, the responses to question 11 revealed a significant gap in their ability to apply these terms in a clinical context. The participants struggled to understand these critical terms, which are essential for distinguishing between benign and malignant conditions. This suggests that while students may possess basic knowledge, they still struggle to apply it in clinical practice. Identifying such gaps, especially for common and clinically significant diseases, and addressing them in future course iterations will be crucial for fully achieving their objectives and better preparing students to interpret pathology findings effectively.

Pathology reports often have standardized formats and use highly specialized, technical language, which can be unfamiliar or overwhelming for medical students and even some clinicians [17]. This challenge is compounded when diagnostic uncertainty is communicated, as discrepancies between how pathologists convey uncertainty and how it is interpreted can further hinder understanding [29]. Mastering this complex and sometimes variable terminology is essential for effective interprofessional communication and accurate interpretation of critical diagnostic information [30]. One specific issue is the use of abbreviations in pathology reports, which can confuse clinicians unfamiliar with them. For example, in specimen embedding in paraffin block, the percentage of the sampled specimen for evaluation is denoted as "E: …%", where "E" stands for "embedded". If the specimen is fully sampled, it is labelled "T", an abbreviation for "Totally". In our study, a substantial number of participants in both groups faced challenges with abbreviations used in our study setting. Similarly, in another study, a large percentage of participants (40%–75%) struggled with abbreviations [10]. These findings underscore the knowledge gaps that persist even after training, further highlighting the need to improve education around pathology reports.

Another critical element is the "Note" or "Comment" section in pathology reports, which provides explanations from pathologists to clarify findings, especially when diagnoses are complex or require additional investigations, especially stains or cytogenetic studies [16, 31, 32]. In our study, a significantly greater proportion of participants in Group A (71.7%) than in Group B (19.6%) stated that they always read the "Note" section. Similarly, in the study of Bracamonte et al. [32], 72% of clinicians and 50% of non-pathology residents reported routinely consulting the "Comment" section. Similarly, Gibson's study reported figures of 64% and 46% for staff and non-staff clinicians, respectively [24]. However, it is important to note that merely reading the "Comment" or "Note" section does not necessarily mean that clinicians find it helpful or meaningful [24]. Therefore, it is equally important to assess whether clinicians find the information in the "Comment" section useful in clarifying diagnoses. In our study, participants in Group A were significantly more likely than those in Group B were to find the "comments" helpful in clarifying the diagnosis. These results suggest that targeted educational efforts could enhance the perceived usefulness of this section for clinicians, fostering better diagnostic interpretation.

Regarding the optimal timing for taking the clinical pathology course, a majority considered the physiopathology period to be the optimal time, highlighting the importance of early training in providing a solid foundation for understanding pathology reports. In their view,

gaining this knowledge during this phase can enhance future clinical practice and foster better collaboration between medical disciplines. In contrast, the fewest participants from both groups believed that the internship period was the optimal time for this course. In a study by Jafari et al., 40.5% of medical students who completed the course during the pre-internship period thought it was the most suitable time to take it, whereas only 21.6% felt the internship period was appropriate [23]. Similarly, 59.5% of interns who did not take the course chose the pre-internship period as the optimal time. Omidifar et al. reported that a majority of participants (57.1%) favored the pre-internship period, with many students who had completed the course reporting high levels of satisfaction: 44.4% rated it as "great" and 41.3% as "good" [21]. These studies suggest that the preclinical phase might be the most suitable time for a clinical pathology course, as it provides students with foundational knowledge of critical aspects of treatment, including pathology reports, before they engage directly in patient care during their clinical training. However, our participants had different views. These discrepancies between our study findings and others could be due to several factors, including variations in educational quality, teaching methodologies, and contextual differences that warrant further investigation.

We asked two questions exclusively from the participants of the clinical pathology course (Group A). When asked about the necessity of continuing the course, most participants responded "somewhat", and only 10.9% stated "very much". From an honest perspective, this could indicate that the course did not fully address all points of ambiguity in understanding the pathology report, as many participants did not feel a strong need for further continuation of the course. On the other hand, if we take an optimistic view, this response might reflect the success of the course in resolving some of the key uncertainties, with fewer participants feeling the need for additional sessions. A similar study involving all laboratory tests (not just surgical pathology) revealed that only 19.5% of internship students felt a "very much" need for further training [23]. With respect to the effectiveness of the course in improving the interpretation of pathology reports, most participants in Group A agreed that it was helpful. However, 34.8% of the participants described the impact as "somewhat", indicating that the effect was not as pronounced for all. This suggests that, while the course was beneficial, it may not have fully addressed all aspects of the content that could improve interpretation skills. Further investigation is needed to explore the reasons behind the dissatisfaction among the 28.3% who were not fully satisfied with the course's impact. In a similar study, 50% of the participating interns felt that the course significantly improved their clinical performance, whereas the other 50% considered its impact minimal [23].

To further enhance clinical pathology courses, it is beneficial to revisit both the content, teaching methods, and time of offering, incorporating active learning strategies such as case-based discussions and clinicopathological conferences, hands-on sessions in pathology departments, short-term pathology rotations with junior-senior partnerships, and simulation-based exercises on clinical cases [33, 34]. Addressing the most prevalent diseases in the region, as reflected in the geographic patterns and disease atlas, through practical, interactive components could significantly improve comprehension and help students connect pathology reports more effectively to clinical practice. Since many new generation trainees prefer "learning by doing" styles, integrating active and practical learning strategies would cater to diverse learning preferences and promote skill acquisition [35]. With the growing expansion of blended learning methods, incorporating self-directed, blended strategies at various stages of medical education can ensure that recurring themes or challenges—particularly those related to prevalent regional diseases—are addressed in greater depth. Including training at different points throughout medical education, aligned with clinical experience, may enhance understanding [36–38]. These approaches could help reduce the remaining gaps in comprehension, foster active learning, and increase satisfaction among future cohorts.

Limitations

Our study focused exclusively on two pathology reports from benign and malignant gastrointestinal diseases. However, pathology is a critical diagnostic tool across a wide range of medical conditions. Depending on the type of disease, medical students' and physicians' understanding and interpretation of pathology reports may vary. Future studies should examine a broader variety of reports to identify medical domains requiring increased educational efforts to improve report interpretation by medical students and clinicians. Additionally, the study did not account for variations in participants' overall academic performance, pathology-related coursework or scores, clinical experience (e.g., number of months into the internship phase), or exposure to pathology cases prior to the study participation (e.g., in oncology and surgery wards *versus* psychiatry and pediatrics wards), all of which could have influenced their ability to interpret reports effectively. Although both groups were in the internship phase, one can anticipate that Group B had more clinical experience due to their rotations in multiple clinical

departments, as they were one year ahead of Group A, who started their internship later and had limited ward rotations by the time of the study. This difference in clinical exposure could have minimized the potential effect of the pathology course, making it more difficult to observe distinct differences in pathology report interpretation between the two groups. Therefore, it is plausible that the course's impact could have been more pronounced had the study participants had similar clinical exposure or experience, with the only difference being participation in the course. Next, while we did not assess how such misunderstandings might translate into actual clinical errors, our findings concerning weak understanding highlight the significant potential for such errors, underscoring the need to address these gaps to safeguard patient diagnosis and treatment by physicians. Furthermore, the study's design did not evaluate the long-term retention of pathology report interpretation skills or the impact of specific educational interventions on improving these skills over time. Investigating the sustainability of educational outcomes would provide valuable insights into curriculum planning. Finally, as the study was conducted within a specific institutional and cultural context, the generalizability of the findings to other healthcare settings may be limited, necessitating broader investigations across diverse educational and healthcare systems.

Conclusion

Our study revealed instances in which medical interns face challenges in understanding and interpreting pathology reports, which could lead to errors in case management and increased healthcare costs. While these misunderstandings were less frequent among interns who had completed the clinical pathology course, other factors influencing report interpretation even after such courses remain unclear and warrant further investigation.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-025-07001-4.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

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Clinical trial number
Not applicable.

Authors' contributions
FA, PA, and ZN designed the study. FA and PA collected and analyzed the field data. ZN helped in the interpretation of the data. FA wrote the initial draft of the manuscript, and ZN substantially revised and expanded it. All the authors approved the final version.

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Data availability
The raw dataset on which the study is based is available upon reasonable request.

Declarations

Ethics approval and consent to participate
This study adhered to the principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of Urmia University of Medical Sciences (ethics reference number: IR.UMSU.HIMAM.REC.1402.005). All participants provided informed consent to participate in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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