# Medical Science

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# Estimation of clinical phase medical students' performance in diagnosing critical findings on abdominal X-ray

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## ABSTRACT

*Objectives:* This study aims to determine the performance of medical students as they diagnose critical abdominal X-ray findings. In addition, it aims to analyze the impact of emergency medicine and radiology courses on their performance. *Methods:* A cross-sectional study was to collect data on the various aspects of undergraduate medical students' experiences in Saudi Arabia's Qassim. The data were collected through an electronic questionnaire. *Results:* 359 individuals, who were all from different medical colleges, participated in this study. Half of them, about 54.4%, correctly identified the type of bowel obstruction depicted in the image, while the other 33.3% believed it was a small bowel obstruction. Of students who had completed their radiology course, about 58.0% were more likely to acknowledge the large bowel obstruction pattern. In comparison, 44.2% of those who had not completed it were more likely to do so, which was found to be statistically significant in difference (p=0.03). The study's results revealed that the students who had completed and not the course correctly interpreted the X-ray image of small bowel obstruction about 71.6%. A total of 34.5% of them were able to identify a normal abdomen X-ray pattern among those who completed the course, while 28.5% of them did not complete the course and recognize it. *Conclusion:* The results of this study suggest that completing emergency and radiology courses in medical schools can positively impact a student's performance. Also, the findings of this study suggest that more training is needed for medical students to improve their abilities to diagnose abdominal X-rays.

**Keywords:** Abdominal X-ray, critical findings and medical student.

## 1. INTRODUCTION

An X-ray is an electromagnetic radiation that can penetrate the human body (Lisle, 2012). It can create an image of the body's internal structures using a high-energy beam (Lisle, 2012). Some commonly used types of X-rays include chest X-rays, abdominal X-rays, and radiography (Lisle, 2012). The X-ray is commonly used to diagnose various medical conditions, such as chronic and acute illnesses (Brunswick et al., 1996). It is also a routine procedure often

utilized for assessing patients in the ER (Brunswick et al., 1996). Even if a patient's condition prevents them from visiting the radiology department, a portable radiograph can be used to obtain the X-ray. This tool makes the procedure more straightforward than other imaging methods (Chen et al., 2004).

In addition to being more practical, the ability to accurately identify the findings of the X-ray can also make a significant difference in the treatment of acute diseases (Brunswick et al., 1996; Chen et al., 2004). Radiographs are used in academic medical centres to make clinical decisions. However, they should be interpreted with the correct accuracy and should be acted upon immediately. Misinterpreted readings can lead to poor patient care (Eisen et al., 2006). In an emergency setting, radiography can be challenging. Misinterpreted readings can lead to poor patient care. In previous studies, it has been shown that healthcare providers, such as primary care physicians, emergency medicine physicians and medical students, are prone to making inaccurate X-ray interpretations (Gatt et al., 2003; Jeffrey et al., 2003).

A study conducted in 2020 revealed that the competence of medical officers and residents in interpreting X-rays is moderate (Jimah et al., 2020). Due to the number of X-rays that are requested in an emergency setting, delays in the reports can occur. Junior doctors in the ER are often left to interpret the radiograph on their own. Their competency in identifying the seriousness of the conditions will determine if an intervention is needed (Bansal & Beese, 2019). A study conducted in 2006 revealed that the interpretation of radiographs by emergency medicine physicians varied from 20% to 64.9% (Eisen et al., 2006). Another study revealed that many of the physicians who attended the emergency department missed a significant number of readings. These findings suggested that continuing education should focus on areas of expertise not identified in the study (Petinaux et al., 2011). A study of 52 medical students revealed that only two thought they could adequately interpret radiographs.

On the other hand, over half of them regarded their readings as either awful or bad (Jeffrey et al., 2003). The study also noted that many students lacked confidence in their abilities. A study revealed that 22 junior doctors did not meet the minimum standards for using X-rays (Christiansen et al., 2014). Another study revealed that medical students and junior doctors have low confidence in interpreting radiograph images (Cheung et al., 2018). A previous study also revealed that around 30% of doctors and 50% of students perform poorly in making simple and common diagnoses (Miranda et al., 2019). A survey was conducted on general physicians and medical students in Iran to see how their scores compare to their colleagues (Mehdipoor et al., 2017). The study results revealed that the students performed poorly in various areas, such as distinguishing normal X-rays from abnormal ones.

A similar study was then conducted on 530 medical students in Jordan to see how their knowledge of X-rays compared to their colleagues. It revealed they have high confidence levels in diagnosing life-threatening conditions (Samara et al., 2021). The results of these studies revealed that junior doctors and medical students are prone to making inaccurate interpretations of X-rays (Jeffrey et al., 2003; Christiansen et al., 2014; Cheung et al., 2018; Mehdipoor et al., 2017). These findings suggest that improving the skills of medical students and junior doctors in interpreting X-rays is needed (Gatt et al., 2003). For our study, we focused on assessing the competency and skills of medical students in identifying emergency conditions using an abdominal x-ray. The goal of this study was to analyze how the completion of radiology and emergency medicine courses affected the skills of medical students when it came to identifying emergency conditions using an abdominal x-ray.

## 2. MATERIALS AND METHODS

A cross-sectional study objective of this study was to describe the characteristics of undergraduate medical students in Qassim, Saudi Arabia. It was conducted from the 7th of April 2022 to the 18th of April 2022. The participants were all fourth- and fifth-year students.

The study was conducted on medical students' years of study, their college GPA and whether or not they have previously taken radiology or emergency medicine courses. It was administered through a survey that was made available through social networks. The survey was divided into demographics and a section that included attached X-ray images of various medical conditions. The questions were then followed by a series of assessments evaluating participants' confidence levels. The mean confidence score was then computed by taking into account the percentage of completely confident individuals and one who were not. The information given to the participants about the study's objectives and benefits was explained to them. They were also allowed to withdraw from the study without any consequences.

The data collected during the study were then exported to Microsoft Excel and entered into IBM's SPSS software. Descriptive analyses were then performed to analyze the results. The results were presented in percentages and frequencies. The participants' differences were then tested using Chi-square tests. A statistical significance was computed by considering the p-value of ≤ 0.05.

## 3. RESULTS

The socio demographic Data is 359 individuals who participated in this study. The majority were men, with around (n=207, 57.7%), and females 152, about 42.3% (Figure 1). As the study focused on medical students, about half were fifth-year students, while the other half were fourth-year students. Most of the medical students are currently studying at the main branch of Qassim University (Figure 2). Over half of them did not finish the Emergency Medicine course (Figure 3). While over 69.9 % completed the radiology course (Figure 4). The rest of the information is detailed in (Table 1). The performance of the abdominal X-ray in identifying a large bowel obstruction is assessed. Half of the respondents correctly answered the question about 54.4%, while the remaining 45.6% could not identify the correct answer. About a third, 33.3%, of the respondents, believed that the image was of a small bowel obstruction. The students' mean confidence in their choice of an answer was 7.2. They were then presented with a second X-ray image, a typical image of small bowel obstruction. Out of the 28.4% who did not choose the correct diagnosis, 71.6% chose small intestine obstruction. The third X-ray showed a normal abdomen radiograph with no anatomical distortion or abnormalities.

However, 65.7% of the respondents chose incorrect diagnoses. While 31.7% of the respondents thought that the image showed large bowel obstruction, 23.9% thought it was a Pneumoperitoneum and only 10% thought it was a small intestine obstruction. The fourth image, a foreign body, was given to the students with the correct answer of about 71.6%. However, almost 28.4% of them chose the incorrect answer. The mean confidence level was 6.9. The fifth image, a volvulus, was presented with the same results, with 45.9% of the respondents correctly selecting the correct option, while 54.1% chose the incorrect one. 27% of the respondents thought that the object in the fourth image was a large bowel obstruction, while only 23.9% thought it was a small intestine obstruction. The sixth image, which was a case of pneumoperitoneum, was correctly answered by 76.4% of the students. However, 22.6% did not know the correct diagnosis, with a mean confidence rate of 8.1. The last image, a picture of a ureteric stone, was correctly identified by 72.2% of the students and only 27.8% misdiagnosed it. The 16.4% who thought it was an X-ray image of a foreign body had a mean confidence rate of 7.9.
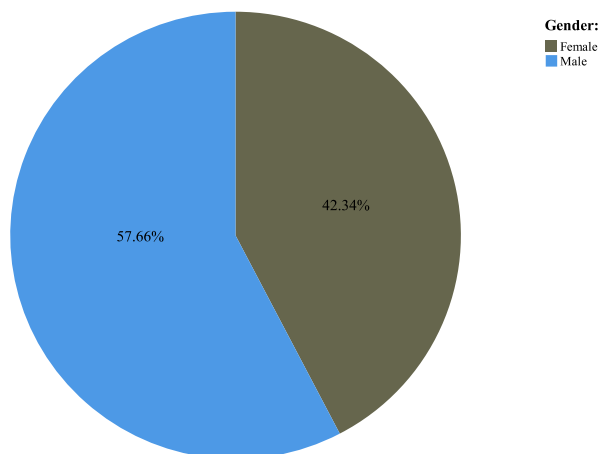


**Figure 1** A pie chart visualizing the percentage of male-to-female participants in the study.
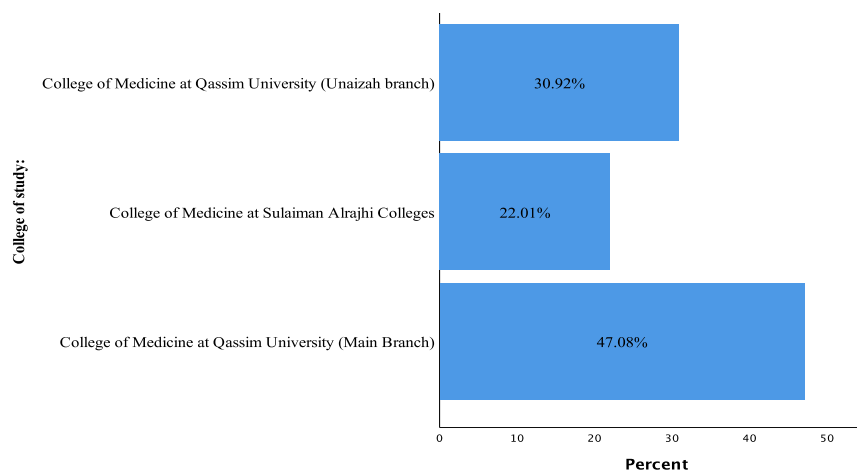


**Figure 2** The breakdown of the percentage of students participating from the different colleges of medicine in the Qassim region.
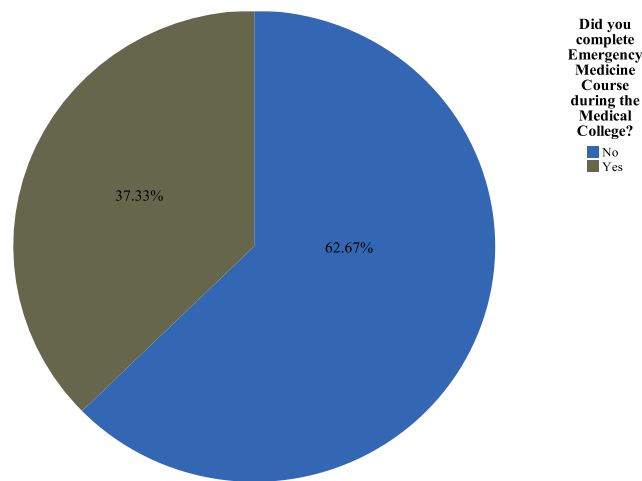
**Figure 3** A pie chart visualizing the percentage of undergraduates who have completed and not completed the course of emergency medicine
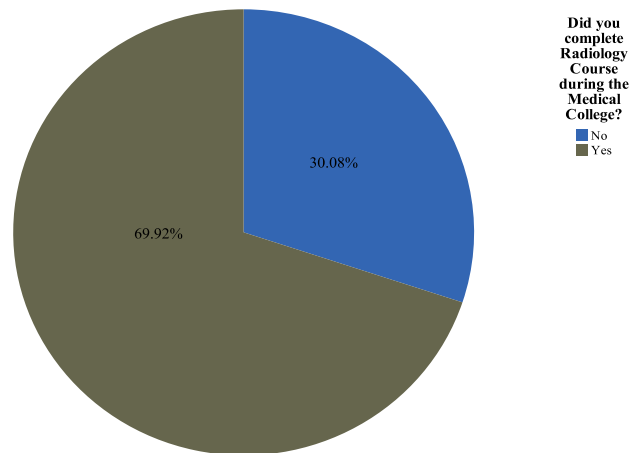


**Figure 4** A pie chart visualizing the percentage of undergraduates who have completed and not completed the course of radiology

**Table 1** Socio demographic information of the study participants

| Variable | Number (%) |
|---|---|
| Age (mean, years) | 24.1 years |
| Male | 207 (57.7%) |
| Female | 152 (42.3%) |
| Fourth-year | 177 (49.3%) |
| Fifth year | 182 (50.7%) |
| College of Medicine at Qassim University (Mainbranch) | 169 (47.1%) |
| College of Medicine at Sulaiman Alrajhi Colleges | 79 (22.0%) |
| College of Medicine at Qassim University (Unaizah Branch) | 111 (30.9%) |
| Did you complete the Emergency Medicine course during medical school? Yes | 134 (37.3%) |
| Did you complete the Emergency Medicine course during medical school? No | 225 (62.7%) |
| Did you complete a Radiology course during medical school? Yes | 251 (69.0%) |
| Did you complete a Radiology course during medical school? No | 108 (30.1%) |

**Table 2** A table presenting the subjects' responses to the different X-ray images attached for interpretation

| X-ray diagnosis | Choice 1 | Choice 2 | Choice 3 | Choice 4 | P value | Mean confidence rate |
|---|---|---|---|---|---|---|
| Large bowel obstruction | Correct answer | Small bowel obstruction | Volvulus | Normal | <0.001 | 69.0% |
| Number (%) | 196 (54.4%) | 120 (33.3%) | 28 (7.8%) | 15 (4.5%) | | |
| Small bowel obstruction | Correct answer | Ureteric stone | Volvulus | Normal | <0.001 | 66.4% |
| Number (%) | 257 (71.6%) | 44 (12.3%) | 51 (14.2%) | 7 (1.9%) | | |
| Normal abdomen X-ray | Correct | Small bowel obstruction | Pneumoperitoneum | Large bowel obstruction | <0.001 | 65.8% |
| Number (%) | 123 (34.3%) | 86 (23.9%) | 36 (10%) | 114 (31.7%) | | |
| Foreign body | Correct | Pneumoperitoneum | Ureteric stone | Normal | <0.001 | 71.3% |
| Number (%) | 257 (71.6%) | 37 (10.3%) | 52 (14.5%) | 13 (3.6%) | | |
| Volvulus | Correct answer | Large bowel obstruction | Small bowel obstruction | Normal | <0.001 | 62.5% |
| Number (%) | 165 (45.9%) | 97 (27%) | 86 (23.9%) | 11 (3.1%) | | |
| Pneumoperitoneum | Correct answer | Large bowel obstruction | Small bowel obstruction | Normal | <0.001 | 75.4% |
| Number (%) | 278 (77.4%) | 35 (9.7%) | 28 (7.8%) | 18 (5%) | | |
| Ureteric stone | Correct answer | Foreign body | Volvulus | Normal | <0.001 | 82.0% |
| Number (%) | 259 (72.2%) | 59 (16.4%) | 37 (10.3%) | 4 (1.1%) | | |
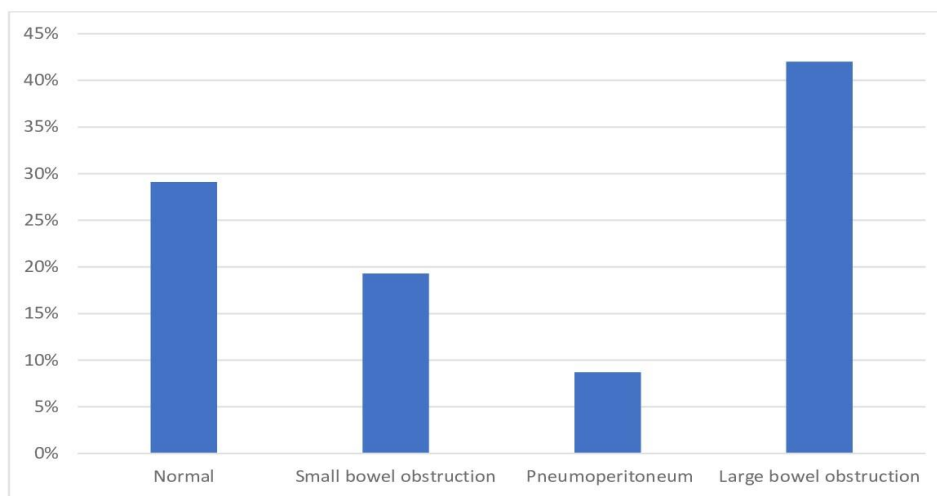


**Figure 5** A simple bar chart visualizing the percentage of medical students who have taken the emergency medicine course when providing an image of a normal abdomen x-ray

The table presenting the subjects' responses to the different X-ray images attached for interpretation is shown in detail in (Table 2). Among the students who previously took an emergency medicine course revealed that almost 59.7% of them had the necessary knowledge to recognize the X-ray image of large bowel obstruction. In comparison, only 50.3% of those who did not complete the program could do so. The study's results revealed that 73.9% of the students who took the course correctly identified the small bowel obstruction X-ray image. 67.7% of the participants who did not finish the program also correctly answered the question. However, only 29.1% of the students who completed the course knew the normal abdomen X-ray pattern (Figure 5). Interestingly, 34.8% of those who did not complete the course also knew this pattern (Figure 6). After an X-ray image of a foreign body was shown to the participants who had previously taken the course, 76.9% correctly identified the correct diagnosis. In comparison, 68.1% of those who did not take the course knew the correct diagnosis (p=0.004). The difference between the students who took the course and those who did not finish the program was considered significant, as the difference was statistically significant with a chi-

square non-parametric test. Half of the students who participated in the course (49.2%) knew that a volvulus X-Ray was present, while 41.9% of those who did not take the course identified it as the correct diagnosis.
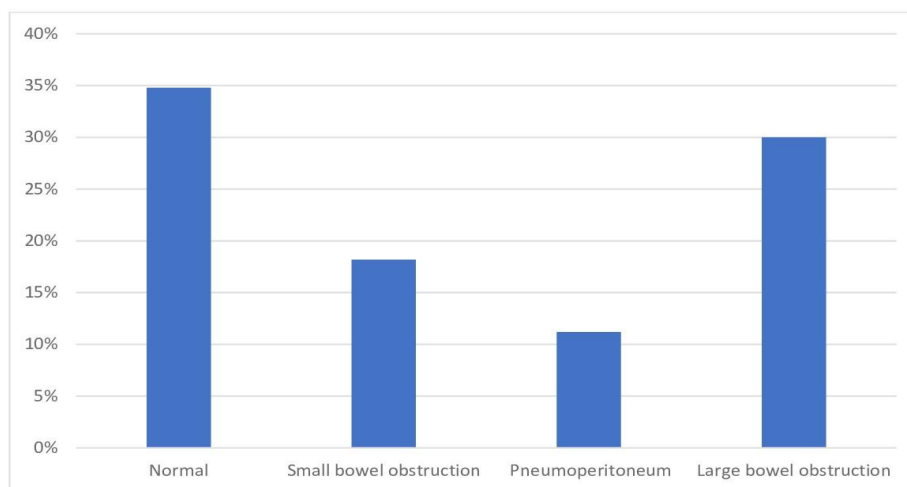


**Figure 6** A simple bar chart visualizing the percentage of medical students who have taken the Radiology course when providing an image of a normal chest x-ray

When the patient had an X-ray of a pneumoperitoneum, 79.8% of the participants who had taken the course capable of correctly responding to the question, while 76.1% of those who had not taken the course also chose the correct diagnosis. The last image the participants saw was a type of stone that can be considered a ureteric stone. 79.1% of the participants who took the course correctly identified it, while 66.3% of those who had not also chose the correct diagnosis (p=0.057). Among the students who took a radiology course compared those who did not finish the program to those who did. About 58.0% of the students acknowledged the presence of a large bowel obstruction X-ray. In comparison, 44.2% of those who had not completed it also acknowledged it, and the difference was statistically significant (p=0.03). The study's results revealed that 69.5% of the students could correctly interpret the X-ray image of a small bowel obstruction of those who have completed course. 71.1% of the participants who did not finish the course had the right answer. Also, 34.5% of the students were able to identify a normal abdomen X-ray pattern among those who completed the course, while 28.5% of those who had not completed the course recognized it. The study's results revealed that 71.5% of the students who took the course could interpret the X-ray image of a foreign body correctly.

On the other hand, 71.1% of the students who did not finish the program knew about it. The students who took the course were more accurate than those who did not. 44.8% of them correctly interpreted an X-ray of the volvulus, while 44.2% of participants who did not take the course correctly interpreted it. In an X-ray of a patient with pneumoperitoneum, 80.7% of those who took the course correctly responded to the image, while 70.1% of the participants who did not take the course chose the correct diagnosis (p=0.01). The final X-ray image presented for interpretation was a picture of a stone; 74.3% of the students who took the course could properly interpret it, while 63.7% of the participants who did not finish the program knew the correct diagnosis. Out of 107 medical students who have neither completed the emergency medicine course nor taken the radiology course. 46.7% of the participants were able to interpret a radiograph image of a large bowel obstruction as normal, while 70.8% were able to detect a small bowel obstruction pattern. Only 27.8% could identify the X-ray image of the abdomen correctly. 33.4% of the students believed that the image was of large bowel obstruction, with a 56.7% confidence rate. The majority correctly interpreted the foreign body radiograph, with a mean confidence rate of 68 %. 70.8% of the students correctly identified the pneumoperitoneum on a radiographic image. 63.4% correctly identified the ureteric stone on radiography, with a mean confidence rate of 73.3%.

## 4. DISCUSSION

The field of radiology has been growing rapidly, making it one of the most popular medical specialties. Although medical students must have the necessary knowledge to interpret X-rays correctly, many believe they need to be sufficiently taught in this field (Nyhsen et al., 2013). A study conducted in 2013, revealed that many medical students have low confidence levels when assessing the images of a normal radiograph, about 65.8% (Satia et al., 2013). The authors noted that medical students should be aware of the various conditions affecting their ability to interpret X-rays (Sait & Tombs, 2021). For instance, pneumoperitoneum was one of the

conditions evaluated in the study; 77.4% of our study subjects could evaluate an X-ray image of the pneumoperitoneum. In a study conducted in 2006, the authors of the study noted that only 26% of the participants could correctly identify pneumoperitoneum when presented to them (Eisen et al., 2006). They also found that only 15% of the students believed their training in the X-ray reading technique needed to be improved. The ability to interpret X-rays is a significant skill most emergency medicine physicians and trainees have. According to a study conducted by Mitchell, Blazar and Townzen in 2020, a group of physicians noted that they needed to be fully prepared for the task when they started their residency training (Blazar et al., 2020). The variables identified in the study, which included the training environment and the level of confidence the participants had in their abilities, affected the interpretation of X-rays (Blazar et al., 2020).

For instance, the participants trained in tertiary care facilities had lower confidence in their abilities. The various factors that can improve the confidence of medical students and practitioners in radiology include training in a healthcare facility that does not have a residency program. This type of training can also help them interpret images during the working shifts of emergency medicine physicians. Several studies have been conducted on the clinical accuracy of emergency physicians when it comes to interpreting X-rays. Although some of these studies found a low rate of errors, other studies noted significant discrepancies when it came to the interpretation of certain types of images (Gatt et al., 2003; Nitowski et al., 1996). A study conducted in 1996 in a pediatric emergency department revealed that 89.4% of the analyzed images agreed with the clinical interpretation (Brunswick et al., 1996). However, the researchers noted that the level of training the physicians had at the time of the study did not affect their ability to interpret the images.

A study conducted in 2003 revealed that the accuracy of emergency physicians when identifying abnormalities in patient radiographs varied significantly. For instance, the sensitivity rate for detecting various abnormalities ranged from 20% to 64.9% (Gatt et al., 2003). The study conducted in 2003 noted that emergency physicians often fail to spot abnormalities on radiographs (Gatt et al., 2003). This study is similar to another study conducted in 1996, which found that only around 35.7% of the participants could correctly identify normal X-rays (Nitowski et al., 1996).

The results of the present study revealed that completing the courses in radiology and emergency medicine in medical colleges can positively impact students' performance. The current study's findings revealed that increasing the number of clinical phase medical students who complete the courses in emergency medicine and radiology can improve their abilities to diagnose certain types of conditions.

# 5. CONCLUSION

Despite their lack of experience in diagnosing emergency abdominal conditions, medical students were still able to perform well on the abdominal x-ray. The average confidence rate was also acceptable at 6.2 out of 10. However, only 34.3% of the participants correctly answered the normal abdominal x-ray question. However, the results indicate that completing radiology and emergency courses in medical schools can positively impact a student's performance. The findings of this study suggest that more clinical-phase medical students should complete emergency courses to improve their abilities to diagnose abdominal conditions.

**Conflict of interest**

The authors declare that there is no conflict of interests.

**Data and materials availability**

All data sets collected during this study are available upon reasonable request from the corresponding author.

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