

**Impact of the COVID-19 Pandemic on Medical Students' Academic Performance in Basic Sciences Period: A Comparative Study at Zahedan University of Medical Sciences**

تأثیر جائحه كوفيد-۱۹ على الأداء الأكاديمي لطلاب الطب في مرحلة العلوم الأساسية: دراسة مقارنة في جامعة زاهدان للعلوم الطبية



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**Background:** The COVID-19 pandemic disrupted traditional medical education, forcing a rapid shift from on-site to online learning and assessment. This study compared the academic performance of medical students in basic sciences period before and during the COVID-19 pandemic at Zahedan University of Medical Sciences, focusing on routine final tests and national basic sciences exam scores.

**Method:** This cross-sectional study analyzed the academic performance of 320 medical students across two time periods: pre-pandemic (2018–2019) and during the pandemic (2020–2021). Data were collected from routine final test scores and national basic sciences exam scores. Statistical comparisons were made using the Chi-square test and independent t-test, as appropriate, at 0.5 level of significance.

**Results:** No significant difference was observed in routine final test scores before ( $15.09 \pm 1.68$ ) and during ( $15.09 \pm 1.53$ ) the pandemic ( $P = 0.7$ ). However, national basic sciences exam scores significantly declined from  $104.78 \pm 17.38$  (pre-pandemic) to  $94.21 \pm 19.31$  (during the pandemic) ( $P = 0.038$ ), suggesting that high-stakes assessments, which are administered with more precision and under strict conditions, were more adversely affected by pandemic-related disruptions.

**Conclusion:** The significant decline in national basic sciences exam scores during the pandemic highlights the challenges posed by COVID-19 to medical education, particularly in high-reliability assessments. These findings underscore the need for targeted interventions to address the long-term impacts of the pandemic on medical students' academic performance and preparedness for future challenges.

**Keywords:** Medical education, Academic performance, COVID-19 pandemic, Basic sciences, Online learning

تأثیر همه گیری کووید-۱۹ بر عملکرد تحصیلی دانشجویان پزشکی در مقطع علوم پایه: مطالعه تطبیقی در دانشگاه علوم پزشکی زاهدان

**زمینه و هدف:** همه گیری کووید-۱۹ آموزش سنتی پزشکی را مختل کرد و باعث انتقال سریع از یادگیری و ارزیابی حضوری به آنلاین شد. این مطالعه عملکرد تحصیلی دانشجویان پزشکی در مقطع علوم پایه را قبل و در طول همه گیری کووید-۱۹ در دانشگاه علوم پزشکی زاهدان مقایسه کرده و بر معدل پایانی ترمی میانگین نمرات علوم پایه و میزان رد و قبولی آزمون ملی علوم پایه تمرکز دارد.

**روش:** این مطالعه مقطعی عملکرد تحصیلی ۳۲۰ دانشجوی پزشکی را در دو دوره زمانی مقایسه کرده است: دو ترم پیش از همه گیری (۲۰۱۸-۲۰۱۹) و دو ترم در طول همه گیری (۲۰۲۱-۲۰۲۲). داده ها از معدل پایانی ترمی و آزمون ملی علوم پایه جمع آوری شد. مقایسه آماری با استفاده از آزمون کای-سکور و تی تست مستقل انجام گردید و سطح معنی داری ۰/۰۵ در نظر گرفته شد.

**یافته ها:** معدل پایان ترم دانشجویان تفاوت معناداری بین دوره پیش از همه گیری ( $15.09 \pm 1.68$ ) و در طول همه گیری ( $15.09 \pm 1.53$ ) نداشت ( $P = 0.7$ ) با این حال، نمرات آزمون ملی علوم پایه به طور معناداری از  $104.78 \pm 17.38$  (پیش از همه گیری) به  $94.21 \pm 19.31$  (در طول همه گیری) کاهش داشته است ( $P = 0.038$ ). که نشان می دهد ارزیابی های ملی که با دقت و سخت گیری بیشتری انجام می شوند، قابلیت اطمینان بیشتری جهت انعکاس افت عملکرد آموزشی ناشی از همه گیری هستند.

**نتیجه گیری:** استقرار فرآیندهای ساختاریافته مدیریت دانش، به ویژه در حوزه های به اشتراک گذاری و کسب دانش، نقشی محوری در ارتقای خلاقیت کارکنان ایفا می کند.

**واژه های کلیدی:** مدیریت دانش، خلاقیت، نوآوری، آموزش علوم پزشکی، دلشگاه علوم پزشکی ایران

**الخلفية:** أدت جائحة كوفيد-۱۹ إلى تعطيل التعليم الطبي التقليدي، مما فرض تحولا سريعاً من التعلم والتقييم الحضوري إلى التعلم عبر الإنترنت. قارنت هذه الدراسة الأداء الأكاديمي لطلاب الطب في مرحلة العلوم الأساسية قبل جائحة كوفيد-۱۹ وأثناءها في جامعة زاهدان للعلوم الطبية، مع التركيز على درجات الاختبارات النهائية الروتينية ودرجات الامتحان الوطني للعلوم الأساسية.

**الطريقة:** حللت هذه الدراسة المستعرضة الأداء الأكاديمي لـ ۳۲۰ طالب طب عبر فترتين زمنيةين: ما قبل الجائحة (۲۰۱۸-۲۰۱۹) وأثناء الجائحة (۲۰۲۰-۲۰۲۱). جُمعت البيانات من درجات الاختبارات النهائية الروتينية ودرجات الامتحان الوطني للعلوم الأساسية. أُجريت المقارنات الإحصائية باستخدام اختبار مربع كاي (Chi-square) واختبار t للعينات المستقلة، حسب الاقتضاء، عند مستوى دلالة ۰.۰۵.

**النتائج:** لم يلاحظ أي فرق معنوي في درجات الاختبارات النهائية الروتينية قبل الجائحة ( $15.09 \pm 1.68$ ) وأثناءها ( $15.09 \pm 1.53$ ). ومع ذلك، انخفضت درجات الامتحان الوطني للعلوم الأساسية بشكل ملحوظ من  $104.78 \pm 17.38$  (ما قبل الجائحة) إلى  $94.21 \pm 19.31$  (أثناء الجائحة) ( $P = 0.038$ ). مما يشير إلى أن التقييمات عالية الأهمية (high-stakes assessments)، التي تُجرى بمزيد من الدقة وفي ظروف صارمة، تأثرت سلباً بشكل أكبر بالاضطرابات المرتبطة بالجائحة.

**الخلاصة:** يسقط الانخفاض الملحوظ في درجات الامتحان الوطني للعلوم الأساسية أثناء الجائحة الضوء على التحديات التي فرضها كوفيد-۱۹ على التعليم الطبي، لا سيما في التقييمات عالية الموثوقية. تؤكد هذه النتائج على الحاجة إلى تدخلات مستهدفة لمعالجة الآثار طويلة المدى للجائحة على الأداء الأكاديمي لطلاب الطب واستعدادهم للتحديات المستقبلية.

**الكلمات المفتاحية:** التعليم الطبي؛ الأداء الأكاديمي؛ جائحة كوفيد-۱۹؛ العلوم الأساسية؛ التعلم عبر الإنترنت

میڈیکل کے طلبہ کی بنیادی علوم (بیسک سائنسز) کی تعلیمی کارکردگی پر کورونا وبا (COVID-19) کے اثرات: زاهدان یونیورسٹی آف میڈیکل سائنسز میں ایک تقابلی مطالعہ

**پس منظر:** کورونا وبا (COVID-19) نے روایتی طبی تعلیم کو دہم برہم کر دیا، جس کی وجہ سے تدریس اور امتحانات کو تیزی سے حضوری (on-site) کے بجائے آن لائن منتقل کرنا پڑا۔ اس مطالعے میں زاهدان یونیورسٹی آف میڈیکل سائنسز کے بنیادی علوم (بیسک سائنسز) کے میڈیکل طلباء کی تعلیمی کارکردگی کا کورونا وبا سے پہلے اور وبا کے دوران موازنہ کیا گیا ہے، جس میں معمول کے فائل ٹیسٹ اور قومی بیسک سائنسز امتحان کے اسکورز پر توجہ مرکوز کی گئی ہے۔

**طریقہ:** اس عرضی مطالعہ (cross-sectional study) میں دو ادوار، یعنی وبا سے قبل (۲۰۱۸-۲۰۱۹) اور وبا کے دوران (۲۰۲۰-۲۰۲۱) کے اسکورز میں کوئی نمایاں فرق نہیں پایا گیا (کارکردگی کا تجزیہ کیا گیا۔ ڈیٹا معمول کے فائل ٹیسٹ اور قومی بیسک سائنسز امتحانات کے اسکورز سے حاصل کیا گیا۔ شماریاتی موازنہ ضرورت کے مطابق 'کفی اسکوائر ٹیسٹ' (Chi-square test) اور 'انڈیپنڈنٹ ٹی ٹیسٹ' (independent t-test) کے ذریعے کیا گیا۔

**نتیجہ:** نتائج سے معلوم ہوا کہ وبا سے پہلے ( $15.09 \pm 1.68$ ) اور وبا کے دوران ( $15.09 \pm 1.53$ ) معمول کے فائل ٹیسٹ کے اسکورز میں کوئی نمایاں فرق نہیں پایا گیا ( $P = 0.7$ )۔ تاہم، قومی بیسک سائنسز امتحان کے اسکورز  $104.78 \pm 17.38$  (وبا سے پہلے) سے نمایاں طور پر کم ہو کر  $94.21 \pm 19.31$  (وبا کے دوران) رہ گئے ( $P = 0.038$ )۔ اس سے ظاہر ہوتا ہے کہ وہ اہم امتحانات (high-stakes assessments) جو زیادہ احتیاط اور سخت شرائط کے تحت لیے جاتے ہیں، وبا کی وجہ سے پیدا ہونے والی رکاوٹوں سے زیادہ متاثر ہوئے۔

**نتیجہ:** وبا کے دوران قومی بیسک سائنسز امتحان کے اسکورز میں نمایاں کمی طبی تعلیم، بالخصوص بڑے امتحانات کے لیے پیدا ہونے والے چیلنجز کی نشاندہی کرتی ہے۔ یہ نتائج میڈیکل طلباء کی تعلیمی کارکردگی اور مستقبل کے چیلنجز کے لیے ن کی تیاری پر وبا کے طویل مدتی اثرات کو دور کرنے کے لیے خصوصی اقدامات کی ضرورت پر زور دیتے ہیں۔

**کلیدی الفاظ:** طبی تعلیم؛ تعلیمی کارکردگی؛ کورونا وبا (COVID-19)؛ بنیادی علوم (بیسک سائنسز)؛ آن لائن لرننگ

## INTRODUCTION

The COVID-19 pandemic disrupted global education systems, forcing a rapid shift from on-site to online learning (1–4). Medical education faced unique challenges due to its reliance on hands-on training and clinical exposure, which were severely limited during the pandemic (3, 5,6, and 10). The overwhelming burden of COVID-19 patient care further reduced the capacity of healthcare practitioners and faculty to dedicate time to teaching, exacerbating the strain on medical education (2, 6). The cancellation of conferences and traditional learning opportunities further limited student-faculty interaction and collaborative learning (2). In response, institutions were adapted by prioritizing essential topics, modifying non-essential activities, and implementing virtual learning platforms (3, 6–13). Collaborative efforts among policymakers, educators, and students were critical to implementing these changes effectively (6, 14).

The rapid adoption of online education was facilitated by pre-existing technological infrastructure and efforts to provide faculty and students with necessary tools (11–13, 15, 16). However, assessing student performance became more complex, as traditional evaluation methods had to be reimagined for remote learning environments (5, 7–9, 17). Innovative solutions, such as tele-OSCEs, simulation-based assessments, and standardized software platforms, were employed to maintain evaluation integrity and support competency-based medical education [18–20]. Despite these efforts, the effectiveness of online education remains uncertain without comprehensive studies examining its outcomes from multiple perspectives (14, 21–23).

A critical barrier to online education is the availability of reliable and affordable internet infrastructure, particularly in resource-limited settings (15, 16). Additionally, clinical faculty, often overwhelmed by patient care responsibilities, may lack time to develop high-quality online teaching materials (12, 17). Studies have identified technological, organizational, and individual factors as key impediments to effective online education, including challenges in teacher-learner communication, evaluation methods, and psychological impacts such as anxiety and technophobia (14, 16–18). Students' expectations and needs during the pandemic also influenced the design and effectiveness of the "Corona Crisis Curriculum" (14). These findings highlight the multifaceted challenges faced by medical education during the pandemic and underscore the need for targeted interventions (3, 10, 14, 19, and 20).

The primary objective of this study is to evaluate the impact of the COVID-19 pandemic on the academic performance of medical students during

the basic sciences period at Zahedan University of Medical Sciences. Specifically, the study aims to compare general mean scores, basic sciences exam scores, and academic probation rates before and during the pandemic.

## METHODS

### Study Design

This study employed a cross-sectional descriptive analysis to evaluate the academic performance of medical students at Zahedan University of Medical Sciences during the basic sciences period before and during the COVID-19 pandemic.

### Study Population

The study population consisted of medical students enrolled in the basic sciences program at Zahedan University of Medical Sciences during the academic years of 2019–2021. Students who had completed two terms of basic sciences before entering clinical education were included. Those who had undertaken any practical or clinical training during the study period were excluded to ensure homogeneity of the sample.

### Sampling Method

A census sampling approach was used to include all eligible students. The sample comprised 320 students: 160 students from two terms before the pandemic (2019–2020) and 160 students from two terms during the pandemic (2020–2021).

### Data Collection

Data were collected using an informational checklist. Access to the university's educational database ("Hamava" website) was granted under the supervision of faculty members and educational authorities. Data on students' academic performance, including exam scores and probation status, were extracted and categorized. Strict confidentiality measures were adhered to in accordance with the university's ethical policies. The collected data were subsequently transferred to SPSS version 25 for analysis.

### Data Analysis

Descriptive statistics, including percentages, frequencies, measures of central tendency (mean, median), and measures of distribution (standard deviation), were used to summarize the data. Inferential statistical analyses were conducted using the independent t-test to compare mean scores, the Chi-square test to assess categorical variables (e.g., probation status), and correlation coefficients to examine relationships between variables. A p-value of  $\leq 0.05$  was considered statistically significant.

## RESULTS

### Comparison of General Mean Scores Before and During the Pandemic

The students' mean scores during the two terms before and during the COVID-19 pandemic were  $15.01 \pm 1.68$  and  $15.09 \pm 1.53$ , respectively. An

independent t-test revealed no statistically significant difference between the two periods ( $p = 0.7$ ). Although a slight increase in mean scores was observed during the pandemic, this change was not statistically significant. The reduction in standard deviation suggests that student performance was more consistent during the pandemic compared to that of the pre-pandemic period (Table 1).

**Table 1. Medical students' general mean scores in basic sciences period before and during the COVID-19 pandemic**

Period	Mean (SD)	Minimum	Maximum	P Value
Before COVID-19 Pandemic	15.01 (1.68)	11.5	18.4	0.7
During COVID-19 Pandemic	15.09 (1.53)	11.7	18.6	

### Comparison of Basic Sciences Exam Scores Before and During the Pandemic

The mean scores of the national basic sciences exam were  $104.78 \pm 17.38$  before the pandemic and  $94.21 \pm 19.31$  during the pandemic. An independent t-test indicated a statistically significant decrease in scores during the pandemic ( $p = 0.038$ ) (Table 2).

**Table 2. Medical students' basic sciences exam mean scores before and during the COVID-19 pandemic**

Period	Mean (SD)	Minimum	Maximum	P Value
Before COVID-19 Pandemic	104.78 (17.38)	53	163	0.038
During COVID-19 Pandemic	94.21 (19.31)	51	163	

### Comparison of Pass and Failure Rates Before and During the Pandemic

The failure rate in the basic sciences exam increased from 10.8% before the pandemic to 22.2% during the pandemic. The Chi-square test revealed a statistically significant difference in failure rates between the two periods ( $p = 0.005$ ) (Table 3).

**Table 3. Pass and failure rates of medical students in basic sciences period before and during the COVID-19 pandemic**

Period	Pass (%)	Failure (%)	Total Number
Before COVID-19 Pandemic	142 (89.2%)	18 (10.8%)	160(100)
During COVID-19 Pandemic	124 (77.8%)	36 (22.2%)	160(100)

### Comparison of Students on Academic Probation Before and During the Pandemic

The proportion of students on academic probation was 3.2% before the pandemic and 3.8% during the pandemic. The Chi-square test indicated no statistically significant difference between the two periods ( $p = 0.85$ ) (Table 4).

This study investigated the academic performance of medical students during the basic sciences period before and during the COVID-19 pandemic at Zahedan University of Medical Sciences. The main finding, a stability in routine term scores compared with a significant decline in national board exam

performance, reveals a significant difference in evaluating educational outcomes during a period of forced digital transition.

**Table 4. Frequency of medical students on academic probation before and during the COVID-19 pandemic**

Period	On Probation N (%)	No Probation N (%)	Total N (%)
Before COVID-19 Pandemic	5 (3.2%)	155 (96.8%)	160 (100)
During COVID-19 Pandemic	6 (3.8%)	154 (96.2%)	160 (100)

The lack of a significant difference in students' mean routine term scores ( $15.01 \pm 1.68$  before vs.  $15.09 \pm 1.53$  during the pandemic;  $p = 0.7$ ) at first suggests that the emergency transition to online education was successful in maintaining academic continuity. This finding aligns with those of Hao et al., who demonstrated in their systematic review that digital education could be effectively applied during the COVID-19 pandemic for undergraduate nursing and medical interns (21). Similarly, Tabatabai (22) concluded that while virtual medical education presented challenges, it represented a necessary and generally viable alternative during the pandemic crisis. However, this apparent success may be misleading, as the integrity of routine, non-proctored online assessments remains a significant concern. Sepahi et al., identified substantial challenges with online evaluation validity from the student perspective, noting that assessment reliability was compromised in the virtual environment (23).

The most analytically significant result of this study is the profound discrepancy between the routine test and the performance on the standardized national basic sciences exam, which showed a significant decline [ $104.78 \pm 1.68$  before vs.  $94.21 \pm 1.53$  during;  $p = 0.038$ ]. This divergence strongly indicates that routine evaluation methods failed to capture a decay in the depth and integration of knowledge, which was exposed by a high-stakes, standardized assessment. This finding is corroborated by Roohi et al., who found that while combined traditional-learning approaches showed promise, pure online methods struggled to maintain educational quality in practical skill development (24). The psychological impact of the pandemic, as discussed by Hojat and Badiyepymaie Jahromi (25), likely exacerbated this issue, impairing the focused learning needed for long-term retention and complex knowledge integration.

This crisis in evaluation validity points directly to the infrastructural and pedagogical unpreparedness identified in pre-pandemic research. Studies conducted in the Iranian context before the pandemic, such as those by Najimi et al., and Fathi Vajargah et al., had already highlighted variable levels of readiness and effectiveness in virtual learning within the nation's higher education system (26, 27). The pandemic acted as a stress test,

confirming these earlier concerns and revealing that while basic infrastructure for content delivery might have been in place, the ecosystem for robust and reliable online assessment was inadequate. The adaptation difficulties reported by Iranmanesh et al., at Rafsanjan University of Medical Sciences, including student and faculty struggles with the transition to distance learning, appear to have been widespread challenges across medical education institutions (28).

The international perspective further contextualizes these findings. Alsoufi et al., documented similar challenges across global medical education systems, noting variable student knowledge, attitudes, and practices regarding electronic learning during the pandemic (29). Similarly, Wu et al., highlighted systemic challenges in the internationalization of medical education that were exacerbated by the rapid shift to digital platforms (30). These global experiences underscore the universal nature of the challenges identified in our study.

To address these issues, our findings suggest that comprehensive strategies are needed, including supplementary measures such as offline materials and enhanced assessment protocols. This approach echoes the findings obtained by Saiyad et al., who emphasized the importance of establishing good online teaching practices through cumulative experience (31). Furthermore, the implementation of interactive platforms could enhance engagement, a strategy supported by Khan's e-learning P3 model, which emphasizes the critical importance of the "People-Process-Product" continuum in effective digital education (32).

The broader impact on medical education is evident in the work of Rezaei et al., who documented the extensive effects of the pandemic on medical sciences education in Iran, noting significant disruptions across multiple dimensions of educational delivery (33). Rajabzadeh et al., similarly highlighted the complex challenges in education and evaluation of medical students during the COVID-19 era, emphasizing the need for comprehensive solutions (34).

Ultimately, the pandemic has served as a powerful catalyst for medical education evolution, as noted by Zand et al., who framed the COVID-19 crisis as an opportunity for necessary educational transformation (35). However, as Salari and Sepahi documented in their systematic review, the challenges of virtual medical sciences education during the pandemic were substantial and multifaceted (36). The experience underscores that for online education to be truly effective, there must be deliberate and strategic alignment of teaching methods with compatible evaluation strategies. As demonstrated by Kumar and Kumar, the trainee experience and effective self-assessment mechanisms are crucial components in e-learning

effectiveness, highlighting that success depends on a holistic educational system rather than technological implementation alone (37).

Therefore, ensuring access to appropriate infrastructure, developing standardized and secure evaluation methods, and implementing interactive learning platforms are critical to maintaining educational quality and equity in facing future disruptions to medical education.

This study has several limitations that should be acknowledged. First, the unavailability of comprehensive data for certain subjects necessitated the exclusion of some data from the analysis. Although efforts were made to obtain missing data through clear communication and assurances of confidentiality, resistance from some stakeholders limited the dataset. Second, the study did not account for potential confounding variables such as students' place of residence [native vs. non-native], marital status, socio-economic status, or access to technological resources, different level of difficulty of the questions in the two evaluations, all of which could have influenced academic performance during the pandemic. Future studies should incorporate these variables to provide a more comprehensive understanding of the factors affecting online learning outcomes.

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## CONCLUSION

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This study demonstrated that the transition to online education during the COVID-19 pandemic at Zahedan University of Medical Sciences did not significantly affect students' mean scores in routine term evaluations. However, a notable decline was observed in their performance on the national basic sciences exam. This discrepancy highlights the limitations of routine term exams in accurately assessing student performance during the pandemic, as they failed to distinguish effectively between strong and weak learners. In contrast, the national basic sciences exam, with its standardized and rigorous format, provided a more reliable measure of educational quality during this period.

### Ethical Considerations:

Ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc., have been completely observed by the authors. This study adhered to the ethical principles outlined in the Declaration of Helsinki and received approval from the Research and Ethics Committee of Zahedan University of Medical Sciences (approval code: IR.ZAUMS.REC.1401-395). Confidentiality of student data was maintained throughout the study, and all data were anonymized to protect participant privacy.

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## REFERENCES

- Shadabfar M, Mahsuli M, Sioofy Khoojine A, Hosseini VR. Time-variant reliability-based prediction of COVID-19 spread using extended SEIVR model and Monte Carlo sampling. *Results Phys.* 2021;26:104364. <https://doi.org/10.1016/j.rinp.2021.104364>
- Rimmer A. Covid-19: Medical conferences around the world are cancelled after US cases are linked to Massachusetts meeting. *BMJ.* 2020;368:m1054. <https://doi.org/10.1136/bmj.m1054>
- Ahmady S, Shahbazi S, Heidari M. Transition to virtual learning during the coronavirus disease-2019 crisis in Iran: opportunity or challenge? *Disaster Med Public Health Prep.* 2020;14(3):e11-e12. <https://doi.org/10.1017/dmp.2020.142>
- Viner RM, Russell SJ, Croker H, Packer J, Ward J, Stansfield C, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. *Lancet Child Adolesc Health.* 2020;4(5):397-404. [https://doi.org/10.1016/S2352-4642\(20\)30095-X](https://doi.org/10.1016/S2352-4642(20)30095-X)
- Esteves A, McConnell M, Ferretti E, Garber A, Fung-Kee-Fung K. "When in Doubt, Ask the Patient": A Quantitative, Patient-Oriented Approach to Formative Assessment of CanMEDS Roles. *MedEdPORTAL.* 2021;17:11169. [https://doi.org/10.15766/mep\\_2374-8265.11169](https://doi.org/10.15766/mep_2374-8265.11169)
- Tolsgaard MG, Cleland J, Wilkinson T, Ellaway RH. How we make choices and sacrifices in medical education during the COVID-19 pandemic. *Med Teach.* 2020;42(7):741-3. <https://doi.org/10.1080/0142159X.2020.1767769>
- Rich JV, Fostaty Young S, Donnelly C, Hall AK, Dagnone JD, Weersink K, et al. Competency-based education calls for programmatic assessment: but what does this look like in practice? *J Eval Clin Pract.* 2020;26(4):1087-95. <https://doi.org/10.1111/jep.13328>
- Hall AK, Nousiainen MT, Campisi P, Dagnone JD, Frank JR, Kroeker KI, et al. Training disrupted: Practical tips for supporting competency-based medical education during the COVID-19 pandemic. *Med Teach.* 2020;42(7):756-61. <https://doi.org/10.1080/0142159X.2020.1766669>
- Harris P, Bhanji F, Topps M, Ross S, Lieberman S, Frank JR, et al. Evolving concepts of assessment in a competency-based world. *Med Teach.* 2017;39(6):603-8. <https://doi.org/10.1080/0142159X.2017.1315071>
- Tabatabai S. COVID-19 impact and virtual medical education. *J Adv Med Educ Prof.* 2020;8(3):140-3. <https://doi.org/10.30476/jamp.2020.86070.1213>
- Esmaeeli H, Rahmani SH, Kazemi A, Ahmadi MA. Evaluation of E-Learning of the virtual learning program from the student's point of view. *Public Manag Res.* 2017;9(34):221-2. Available from: <https://sid.ir/paper/366285/en>
- Karimi F, Hosseini M, Malekpour A, Moezzi M, Hosseini A, Raisi N, et al. Needs assessment of faculty members' educational needs in order to empower them at Shahrekord University of Medical Sciences. *Dev Strateg Med Educ.* 2019;6(1):47-59. Available from: <https://www.researchgate.net/publication/331417798>
- Sampaio M, Leite C. From curricular justice to educational improvement: what is the role of schools' self-evaluation? *Improv Sch.* 2017;20(1):62-75. <https://doi.org/10.1177/1365480216680770>
- Mosalanezhad L, Atashpoor S, Kalani N. What do medical students want to learn in the Corona Crisis Curriculum? Expressing Students' Expectations and Strategies. *Educ Ethics Nurs.* 2021;10(1-2):4-11. <https://doi.org/10.22034/ethic.2021.700704>
- Bagherimajd R, Shahei S, Mehralizadeh Y. Assessing Challenges in the development of Electronic learning in Higher Education [Case study of Shahid Chamran University in Ahvaz]. *J Med Educ Dev.* 2013;6(12):1-13. Available from: <http://edujournal.zums.ac.ir/article-1-149-en.html>
- Rajab MH, Gazal AM, Alkattan K. Challenges to online medical education during the COVID-19 pandemic. *Cureus.* 2020;12(7):e8966. <https://doi.org/10.7759/cureus.8966>
- Rajabzadeh F, Milani N, Goshayeshi L. Education and exams of medical students in COVID pandemic. *Horiz Med Educ Dev.* 2020;11(3):1-6. <https://doi.org/10.22038/hmed.2020.50749.1066>
- Safdari MR, Shekari S, Jafari E, Roshanravan M, Namdar Ahmadabad H. Evaluation of Virtual Educations System from the Viewpoints of Faculty Members and Students in NKUMS during the Pandemic Coronavirus 2019. *Horiz Med Educ Dev.* 2021;12(2):81-96. <https://doi.org/10.22038/hmed.2020.51181.1080>
- Shahsiah N, Nazarpuri A, Hakak M, Vahdati H. Presentation of strategic e-learning model among students of virtual education unit of Isfahan University of Medical Sciences. *J Adv Med Educ Prof.* 2018;2(4):1-10. Available from: <https://journals.ssu.ac.ir/found/article/view/1496>
- Zhalehjoon N, Arabi M, Momeni Z, Akbari Kamrani M, Khalili A, Riahi S, et al. Virtual Education status from the Perspective of Students at Alborz University of Medical Sciences in the Covid-19 Pandemic Period. *J Med Educ Dev.* 2021;14(42):37-45. Available from: <http://edujournal.zums.ac.ir/article-1-1404-en.html>
- Hao X, Peng X, Ding X, Qin Y, Lv M, Li J, et al. Application of digital education in undergraduate nursing and medical interns during the COVID-19 pandemic: A systematic review. *Nurse Educ Today.* 2022;108:105183. <https://doi.org/10.1016/j.nedt.2021.105183>
- Tabatabai S. COVID-19 impact and virtual medical education. *J Adv Med Educ Prof.* 2020;8(3):140-3. <https://doi.org/10.30476/jamp.2020.86070.1213>
- Sepahi V, Salari F, Khoshay A, Rezaei M. Evaluation of Professors Toward E-learning During COVID-19 and Its Associated Factors from the Perspective of the Students of Kermanshah University of Medical Sciences (2020). *Educ Res Med Sci.* 2021;10(1):e111994. <https://doi.org/10.5812/erms.111994>
- Roohi M, Jahanian I, Gholinia H, Abbaszadeh H. A Comparison of Traditional Learning and Combined Traditional-E-Learning (web-based) on Dentistry Students' Learning of Practical Oral Pathology Course. *J Med Educ Dev.* 2016;9(21):47-52. Available from: <http://edujournal.zums.ac.ir/article-1-583-en.html>
- Hojat M, Badiyepaymaie Jahromi Z. The Role of Medical Students in Outbreaks of Coronavirus: Opportunity or Threat. *Iran J Med Educ.* 2020;20:500-1. Available from: <http://ijme.mui.ac.ir/article-1-5237-en.html>
- Najimi A, Yamani N, Soleimani B. Needs Assessment of Virtual Training Development: Assessment of the Level of Readiness at Faculties of Isfahan University of Medical Sciences. *Iran J Med Educ.* 2017;17:70-6. Available from: <http://ijme.mui.ac.ir/article-1-4409-en.html>
- Fathi Vajargah K, Pardakhtchi MH, Rabie M. Effectiveness evaluation of virtual learning courses in high education system of

- Iran (case of Ferdowsi University). *Inf Commun Technol Educ Sci.* 2011;1(4):5-21. Available from: <https://sid.ir/paper/175426/en>
28. Iranmanesh F, Ostadebrahimi H, Mirzazadeh A, Azin M. Performance Report of Distance Learning at Rafsanjan University of Medical Sciences During the COVID-19 Pandemic. *J Rafsanjan Univ Med Sci.* 2020;19(4):423-8. Available from: <http://journal.rums.ac.ir/article-1-5467-en.html>
29. Alsoufi A, Alsuyihili A, Msherghi A, Elhadi A, Atiyah H, Ashini A, et al. Impact of the COVID-19 pandemic on medical education: Medical students' knowledge, attitudes, and practices regarding electronic learning. *PLoS One.* 2020;15(11):e0242905. <https://doi.org/10.1371/journal.pone.0242905>
30. Wu A, Leask B, Choi E, Gentry M, Norton A, Unangst L. Internationalization of Medical Education—a Scoping Review of the Current Status in the United States. *Med Sci Educ.* 2020;30:1693-705. <https://doi.org/10.1007/s40670-020-01034-8>
31. Saiyad S, Virk A, Mahajan R, Singh T. Online Teaching in Medical Training: Establishing Good Online Teaching Practices from Cumulative Experience. *Int J Appl Basic Med Res.* 2020;10(3):149-55. [https://doi.org/10.4103/ijabmr.IJABMR\\_358\\_20](https://doi.org/10.4103/ijabmr.IJABMR_358_20)
32. Khan BH. The People-Process-Product Continuum in E-Learning: The E-Learning P3 Model. *Educ Technol.* 2004;44(5):33-40. Available from: <http://www.jstor.org/stable/44428934>
33. Rezaei H, Haghdoost A, Javar HA, Dehnavieh R, Aramesh S, Dehgani N, et al. The effect of coronavirus (COVID-19) pandemic on medical sciences education in Iran. *J Educ Health Promot.* 2021;10:136. [https://doi.org/10.4103/jehp.jehp\\_817\\_20](https://doi.org/10.4103/jehp.jehp_817_20)
34. Rajabzadeh F, Milani N, Goshayeshi L. Education and exams of medical students in COVID pandemic. *Horiz Med Educ Dev.* 2020;11(3):1-6. <https://doi.org/10.22038/hmed.2020.50749.1066>
35. Zand S, Nejat N, Salehi Omran E, Izadi S. Covid19 crisis as an opportunity for medical education evolution. *J Med Educ Dev.* 2020;15(2):151-5. Available from: <http://jmed.ssu.ac.ir/article-1-1139-en.html>
36. Salari F, Sepahi V. Challenges of Virtual Medical Sciences Education during the COVID-19 Pandemic: A Systematic Review. *Educ Res Med Sci.* 2021;10(1):e117948. <https://doi.org/10.5812/erms.117948>
37. Kumar AS, Kumar D. E-training impact on trainee experience and self-assessment. *J Workplace Learn.* 2023;35(7):599-612. <https://doi.org/10.1108/JWL-02-2022-0023>