

# Systematic Review Article: Mortality after Covid-19-related Mucormycosis in Critically ill Patients: A Systematic Review

Hamid Owaysee Osquee<sup>1</sup>, Ali Reza Lotfi<sup>2</sup>✉

1. Associate Professor of Infectious Disease, Department of Infectious Disease, School of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran (Email: H\_owaysee@yahoo.com/ ORCID: 0000-0002-3764-3101)
2. Associate Professor of Otorhinolaryngology, Head and Neck Surgery, Tuberculosis and Lung Disease Research Center, Tabriz University of Medical Sciences, Tabriz, Iran (ORCID: 0000-0002-3050-5937)



**Citation** H. Owaysee Osquee, A.R Lotfi, **Mortality after covid-19-related mucormycosis in critically ill patients: A Systematic Review**, *EJCMPR*. 2023; 2(5):187-193.

 <https://doi.org/10.5281/zenodo.8214315>

## Article info:

**Received:** 08 May 2023

**Accepted:** 04 August 2023

**Available Online:**

**ID:** EJCMPR-2308-1082

**Checked for Plagiarism:** Yes

**Peer Reviewers Approved by:**

Dr. Frank Rebout

**Editor who Approved Publication:**

Dr. Frank Rebout

**Keywords:** Mucormycosis, Mortality, Risk factor, Patients

## ABSTRACT

**Introduction:** Examining laboratory parameters to determine acute or less severe cases of mucormycosis after contracting covid-19, identifying patients who are at higher risk of mortality, and increasing awareness for proper practice will be useful in improving the clinical situation. So we decided to Investigate Factors Affecting Mortality From mucormycosis After Covid-19 Infection. **Methods:** This study was a systematic review (Conducted by PRISMA guideline). This study was conducted in Tabriz university of medical sciences in 2022. **Results:** From examining the results of these studies (15 studies), it was found that mortality was higher in patients hospitalized in ICU and general wards, and a significant difference was observed between the average age of recovered and deceased patients. Having high blood pressure as well as diabetes mellitus also significantly led to an increase in mortality. **Conclusion:** Hospitalization in the intensive care unit, advanced age, high severity of covid-19, high blood sugar and underlying diseases significantly increase the risk of death due to mucormycosis following covid-19.

## Introduction

Symptoms of sore throat, headache and runny nose have also been reported. Gastrointestinal symptoms such as nausea and diarrhea and abdominal pain with these symptoms may occur before respiratory symptoms in about 10% of patients. Asymptomatic patients may test positive for Covid-19 (in 30% of cases). However, most patients present with mild to moderate symptoms (55%) [1-3]. About 30% of patients show symptoms of dyspnea after 5 days

from the onset of the disease. The aggravation of symptoms in the second week of the disease is a typical phenomenon in patients with more severe involvement [4-6]. These patients usually require hospitalization for 7-8 days (19,20) and have low blood oxygen levels and may have bilateral pneumonia (75%). One of the common complications of this disease is acute respiratory distress syndrome (ARDS), which occurs especially in people with multiple organ failure. In these cases, respiratory support is unavoidable and may range from non-invasive

\*Corresponding Author: Ali Reza Lotfi (Alireza.Lotfi@yahoo.com)

high-flow oxygen to invasive mechanical ventilation [7-9]. A group of patients may have acute inflammatory conditions with fever and an increase in inflammatory markers such as cytokines. Several laboratory findings have been observed in Covid-19 disease. Although the complete blood cell count (CBC) test in these patients may be completely normal, the most common positive findings in this test include lymphopenia (63%) [10-12], leukopenia (25-9%), leukocytosis (24-30%), thrombocytopenia (is 36%). Liver enzymes are increased in 37% of cases of this disease. Other inflammatory factors including ESR, CRP, D-dimer, ferritin and IL-6 are also commonly elevated. Procalcitonin is usually normal, however, there is a possibility that it may be positive, especially in the case of bacterial infections [13-15].

In a study conducted on patients with MERS-CoV, Hin Chu and his colleagues reported that MERS-CoV virus, but not SARS-CoV virus, effectively engages patients' T cells and induces apoptosis in these cells [16-18]. These findings show that the viremia in SARS patients may have different clinical significance than the viremia in MERS patients, in such a way that patients with MERS usually have a worse outcome due to the destructive nature of T cells in this disease [19]. Alfonso and colleagues conducted a systematic review with meta-analysis of 19 articles in the field of the disease of Covid-19 to obtain information about the clinical, laboratory and imaging characteristics of the disease. In this study, the most common laboratory changes included decreased albumin level (75.8%), increased CRP (58.3%), increased lactate dehydrogenase level (57.0%), lymphopenia (43.1%), high ESR (41.8%) [20-22].

According to these findings, it can be concluded that nearly half of the people with Covid-19 have lymphopenia [23-25].

Despite the previous study that showed a decrease in the number of leukocytes and lymphocytes in patients with covid-19, Nanshan

and his colleagues in a study conducted on 99 patients with covid-19 reported that the rate of leukopenia in these patients was only about 9%. Other findings in the CBC test of these patients included leukocytosis (24%), increased number of neutrophils (38%), leukopenia and anemia in 33% and 50% of patients [26-28], respectively. According to the results of this study, it can be said that leukopenia and lymphopenia do not necessarily exist together in covid-19 patients and the incidence of lymphopenia in these patients is higher than leukopenia [29-31].

Ali Mohammadi and colleagues also state in their research results that the rate of spread of infection caused by covid-19 in Iran can be reduced by interfering with effective factors such as: health education, preventing the formation of human gatherings, active disease detection and contact tracing, isolation of sick people. During the period of disease transmission from the rest of the community and quarantine, it reduced to a great extent [32]. However, the researchers' information about the different aspects of this disease as well as the diseases resulting from this disease such as mucormycosis are being updated (fig 1), and accurate information is limited due to the global geographical features [33].

Therefore, for a more detailed analysis of such data, attention should be paid to the available data related to patients with mucormycosis after contracting Covid-19. Therefore, systematic review studies can be mentioned among the methods that can be effective in this field. Therefore, the current study was conducted as a review with the aim of investigating the mortality rate due to mucocormycosis after contracting covid-19 [34-36].



**Figure 1.** Mucormycosis picture

### Method

This study was a systematic review (Conducted by PRISMA guideline). This study was conducted in Tabriz university of medical sciences in 2022. Inclusion criteria included definitive diagnosis of Covid-19 through lung CT scan or polymerase chain reaction (PCR) test or doctor's diagnosis. The exclusion criteria also included patients for whom more than half of the examined variables were unclear before or after contracting the corona virus. To find articles, use the keywords "2019-nCoV", "COVID-19", "SARS-CoV-2", "Coronaviruses", "mortality", "risk factor" and "Mucormycosis", all possible combinations.

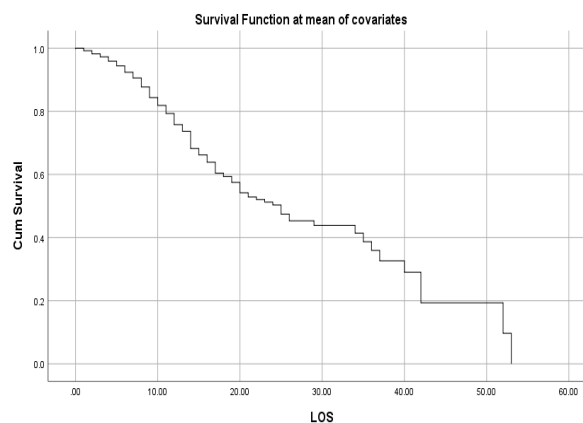
### Results

From examining the results of these studies (15 studies), it was found that mortality was higher in patients hospitalized in ICU and general wards, and a significant difference was observed between the average age of recovered and deceased patients. Having high blood pressure as well as diabetes mellitus also significantly led to an increase in mortality. A mean age of 54.2 years, 73.7 of whom were male, and infected with COVID-19 were reviewed (14 articles included). The most reported symptoms in these patients were respectively fever (82.3%), cough (58%), shortness of breath (33.2%) and fatigue

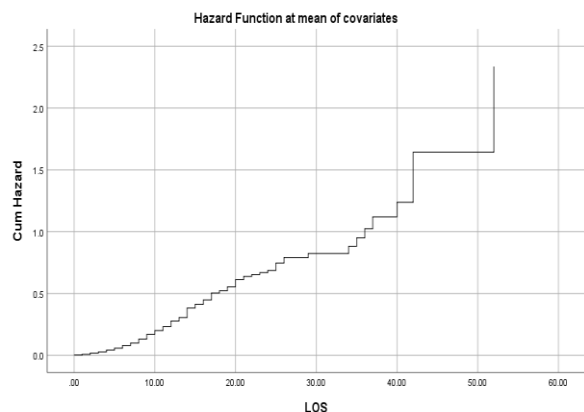
(30.7%) (6). Acute kidney injury was observed in 34.1% of patients. Mucormycosis patients with COVID-19 were treated with prednisone (77%). Overall, 20% of patients required intensive care unit (ICU) admission and 24.6% of patients required mechanical ventilation. Overall, 18.8% of patients with mucormycosis had died, which was much higher than the overall mortality due to COVID-19, which was reported at 3.4%. Clinical manifestations of COVID-19 in patients with mucormycosis may differ from the general population in terms of disease severity, complications including renal failure, and mortality.

### Discussion

About 20% of the patients in the study had died. The mortality rate is different in different studies. In different studies, percentages between 9 and 21 percent have been reported. The results of multiple Cox regression showed that increasing one year of age increases the chance of death by 5% (Fig 2) [37-39]. Based on the single Cox regression test, it also showed that increasing one year of age increases the chance of death by 6% (fig 3) [40-42]. The results of a study in America showed that 80% of the deaths of Covid-19 patients were in people over 65 years old. These findings are similar to Chinese data, which show that 80% of deaths occurred among people over 60 years old [43].



**Figure 2.** Mortality prediction By Cox regression



**Figure 3.** Single Cox regression results for mortality prediction

In studies conducted in America and European countries, the average length of stay of the examined patients was between 16 and 25 days [44-46]. The difference in the results of the studies can be related to the difference in the strategies used by different countries in the prevention and treatment of the disease, the time of occurrence and peak of the disease in the countries and the treatment facilities in the hospitals [47].

The results of hospitalization in the special care department also show that 30% of patients have used special care services [48]. The results of the meta-analysis study by Taylor et al showed that the mortality rate of patients under mechanical ventilation was 72%. In similar studies, mortality and length of stay of patients under mechanical ventilation were higher than other patients [49-51]. Patients who need mechanical ventilation are admitted to special care units, which are usually associated with acute respiratory problems and therefore need more care than other patients. In these people, the length of stay and the percentage of death are higher [52].

In another study by Goffin and his colleagues, the mortality rate and outcome of covid-19 disease in dialysis patients as well as patients with mucormycosis were investigated. Among the patients studied in this study, which was equal

to 1670 patients, 16.9% of kidney transplant patients and 23.9% of hemodialysis patients died within 28 days of the onset of the disease. The risk of mortality in mucormycosis patients was significantly higher in the first year after the disease. Mortality risk in mucormycosis patients was 78% higher than hemodialysis patients after adjustment for multiple factors [53].

In a case report study by Qiu and colleagues, the clinical status of a 30-year-old male patient with mucormycosis after developing severe COVID-19 disease in Wuhan, China was investigated. This patient suffered from an acute lung and kidney injury and therefore required systemic treatment, including readjustment of the immunosuppressive drug regimen. In this study, the patient was followed up for 1 year after discharge from the hospital [54-56]. There was no evidence for pulmonary fibrosis or lung dysfunction in this individual. Unlike the damage caused by the Covid-19 disease to the person's kidney, transplant rejection did not occur. The immunological profile of this patient showed the activity of cellular and humoral immunity against this virus [57-59].

In Elhadedy's study, which was conducted on the outcome of Covid-19 in 8 kidney transplant patients, 4 of whom were women and the other 4 were men, it was reported that high blood pressure is the most important factor predicting the severity of the disease in these people. Also, the most common clinical symptoms in these patients were fever and cough [60-62]. The most common radiological method used in these patients was portable chest radiology. Other common findings in these patients include lymphopenia, high CRP, and very high ferritin levels. In general, among these 8 patients, 1 patient was treated on an outpatient basis, but the other patients required hospitalization, one of them was admitted to the ICU. All 7 patients studied in this study were discharged from the hospital and recovered [63]. One of the patients required mechanical ventilation. In addition to

these findings, this study showed that a short stay in the hospital and home quarantine after leave reduces the burden on health services and the transmission of disease to the surrounding people [64-66].

### Conclusion

Hospitalization in the intensive care unit, advanced age, high severity of covid-19, high blood sugar and underlying diseases significantly increase the risk of death due to mucormycosis following covid-19.

### References

- [1]Jiang, S., et al., Journal of Drug Delivery Science and Technology, **2022**: p. 103792. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [2]M Bonyadi, Esmaeili M, Abhari M, Lotfi A. Genetic testing and molecular biomarkers. **2009**, 13: 689–92. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [3]SM Ronagh, PANAHALI A, LOTFI A, Ahmadpour PF. Razi Journal of Medical Science. **2018**. [[Google Scholar](#)], [[Publisher](#)]
- [4]A Afshari, et al. Advances in Materials Science and Engineering. **2022**;2022:6491134. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [5]A Susanabadi, et al., Journal of Chemical Reviews, **2021**, 3 (3), 219-231, [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [6]AR Baghestani, P Shahmirzalou, S Sayad, ME Akbari, F Zayeri, Asian Pacific journal of cancer prevention: APJCP, **2018** 19 (6), 1601 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [7]R Azhough R, Azari Y, Taher S, Jalali P. Asian Journal of Endoscopic Surgery. **2021**;14(3):458-63. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [8]R Azhough, R., Jalali, P., E J Golzari, S. et al. Indian J Surg. **2020**; **82**:824–827. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [9]D Aghamohamadi., M.K. Gol., Int J Womens Health Reprod Sci, **2020**. 8(2): p. 227-31. [[Google Scholar](#)], [[Publisher](#)]
- [10] D Alvandfar., M. Alizadeh, M. Khanbabayi Gol, The Iranian Journal of Obstetrics, Gynecology and Infertility, **2019**. 22(9): p. 1-7. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [11] E Tahmasebi, M Alam, M Yazdaniyan, H Tebyanian, A Yazdaniyan, A Seifalian, et al. Journal of Materials Research and Technology. **2020**;9(5):11731-55. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [12] E Tahmasebi, M Alam, M Yazdaniyan, H Tebyanian, A Yazdaniyan, A Seifalian, et al. Journal of Materials Research and Technology. **2020**;9(5):11731-55. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [13] E Yahaghi, F Khamesipour, F Mashayekhi, F Safarpour Dehkordi, MH Sakhaei, M Masoudimanesh, MK Khameneie. BioMed Research International. **2014** 12;2014: 757941. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [14] M Eidy, Ansari M, Hosseinzadeh H, Kolahdouzan K. Pakistan Journal of Medical Sciences. **2010**; 26(4):778-781. [[Google Scholar](#)], [[Publisher](#)]
- [15] Eskandar S, Jalali P. Revista espanola de cardiologia (English ed.).**2020**; 74(8): 725–726. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [16] M Eydi, Golzari SEJ, Aghamohammadi D, Kolahdouzan K, Safari S, Ostadi Z. Anesthesiology and Pain Medicine; **2014**: 4(2),e15499 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [17] F Beiranvandi, et al., Journal of Pharmaceutical Negative Results, **2022** 4417-4425 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [18] FB SS Seyedian, A shayesteh, Elsevier, **2018** 2526-2530 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [19] Forghani N, Jalali Z, Ayramlou H, Jalali P. J Clin Images Med Case Rep. 2022;3(1):1626.
- [20] G Sharifi, A Jahanbakhshi, et al., Global spine journal, **2012** 2 (1), 051-055 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [21] G Sharifi, A Jahanbakhshi, Journal of Neurological Surgery Part A: Central European

- Neurosurgery, **2013** 74, e145-e148 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [22] R Gheisari, Doroodizadeh T, Estakhri F, Tadbir A, Soufdoost R, Mosaddad S. Journal of Stomatology. **2019**;72(6):269-73. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [23] R Gheisari, Resalati F, Mahmoudi S, Golkari A, Journal of Oral and Maxillofacial Surgery. **2018**;76(8):1652.e1-e7.[[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [24] R Gheisari, Resalati F, Mahmoudi S, Golkari A, Mosaddad SA. Journal of Oral and Maxillofacial Surgery. **2018**;76(8):1652.e1-e7.[[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [25] Golfeshan F, Ajami S, Khalvandi Y, Mosaddad SA, Nematollahi H. Journal of Biological Research - Bollettino della Società Italiana di Biologia Sperimentale. **2020**;93(1). [[Google Scholar](#)], [[Publisher](#)]
- [26] F Golfeshan, Mosaddad SA, Babavalian H, Tebyanian H, Mehrjuyan E, Shakeri F. India Section B: Biological Sciences. **2022**;92(1):5-10. [[Google Scholar](#)], [[Publisher](#)]
- [27] F Golfeshan, Mosaddad SA, Ghaderi F., Medicine. **2021**;2021:3304543. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [28] H Ansari lari, et al. Advances in Materials Science and Engineering. **2022**;2022:8621666. [[Google Scholar](#)], [[Publisher](#)]
- [29] H Danesh, et al., Journal of Medicinal and Chemical Sciences, **2022**, 561-570, [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [30] M Haghdoost, Mousavi S, Gol MK, Montazer M. International Journal of Women's Health and Reproduction Sciences. **2019**; 7(4): 526-30. [[Google Scholar](#)], [[Publisher](#)]
- [31] M Haghdoost, Mousavi S, Gol MK, Montazer M. International Journal of Women's Health and Reproduction Sciences. **2019**; 7(4): 526-30. [[Google Scholar](#)], [[Publisher](#)]
- [32] M Irajian, Beheshtirooy A. International Journal of Current Microbiology and Applied Sciences. **2016**;5(1): 818-825.[[Google Scholar](#)], [[Publisher](#)]
- [33] Irajian M, Faridaalae G. Iranian Journal of Emergency Medicine. **2016**;3(3): 115-118. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [34] K Hashemzadeh., M. Dehdilani, and M.K. Gol, Crescent Journal of Medical & Biological Sciences, **2019**. 6(4). [[Google Scholar](#)], [[Publisher](#)]
- [35] Kheradjoo H, et al., Molecular Biology Reports, **2023**, 50, 4217-4224, [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [36] M Eidi, et al., Iranian Journal of Medical Sciences. **2012**; 37(3):166-172. [[Google Scholar](#)], [[Publisher](#)]
- [37] M Jalessi, A Jahanbakhshi, et al., Interdisciplinary Neurosurgery, **2015** 2 (2), 86-89 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [38] M Khanbabaei Gol., et al., The Iranian Journal of Obstetrics, Gynecology and Infertility, **2019**. 22(5): p. 52-60. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [39] M Khanbabayi Gol., F. Jabarzade, V. Zamanzadeh, Nurs Midwifery J, **2017**. 15(8): p. 612-9. [[Google Scholar](#)], [[Publisher](#)]
- [40] M Milanifard, Weakness and Irritability, GMJ Medicine, **2021** 5 (1), 391-395 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [41] M Montazer., et al., Gynecology and Infertility, **2019**. 22(8): p. 10-18. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [42] M Najafi, A Jahanbakhshi, et al., Current Oncology, **2022** 29 (5), 2995-3012 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [43] M Yazdani, A Rahmani, E Tahmasebi, H Tebyanian, A Yazdani, SA Mosaddad. in Medicinal Chemistry. **2021**;21(7):899-918. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [44] M.K Gol., A. Dorosti, and M. Montazer, Journal of education and health promotion, **2019**. 8. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [45] Mahdavi F, Osquee HO.2020; 23(3): 34-39. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [46] Mahmoudi H, et al., Nanomedicine Research Journal, **2022**, 7(3), 288-293, [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]

- [47] MH Abdollahi, et al. Nigerian medical journal: journal of the Nigeria Medical Association. **2014**; 55(5): 379. [[Google Scholar](#)], [[Publisher](#)]
- [48] MN Darestani, et al., Photobiomodulation, Photomedicine, and Laser Surgery. **2023**. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [49] Mobaraki-Asl N, Ghavami Z, Gol MK. Journal of education and health promotion. **2019**;8:179.
- [50] Moharrami M, Nazari B, Anvari HM. Trauma Monthly. **2021**; 26(4):228-234. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [51] Mokhtari Ardekani AB, et al., BioMed Research International, **2022**, Article ID 5744008, [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [52] Namanloo RA, Ommani M, Abbasi K, Alam M, Badkoobeh A, Rahbar M, et al. Advances in Materials Science and Engineering. **2022** :2489399. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [53] Nazari B, Amani L, Ghaderi L, Gol MK. Trauma Monthly. **2020**; 25(6): 262-268. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [54] Owaysee HO, Pourjafar H, Taghizadeh S, Haghdoost M, Ansari F. Journal of Infection. **2017**; 74(4): 418-420. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [55] R Dargahi, et al., International Journal of Women's Health and Reproduction Sciences. **2021**; 9(4):268-273. [[Google Scholar](#)], [[Publisher](#)]
- [56] Rostami F, Osquee HO, Mahdavi F, Dousti S. International Journal of Women's Health and Reproduction Sciences. **2020**; 8(3): 297-302. [[Google Scholar](#)], [[Publisher](#)]
- [57] S Cozzi, M Najafi, et al., Current Oncology, **2022** 29 (2), 881-891 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [58] S Torkan, MH Shahreza. VacA, CagA, IceA and Oip. Tropical Journal of Pharmaceutical Research. **2016** 4;15(2):377-84. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [59] SAY Ahmadi, S Sayad, et al., Current Pharmacogenomics and Personalized Medicine, **2020** 17(3) 197-205 [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [60] SE Ahmadi, et al., Romanian Journal of Military Medicine, **2022**,356-365, [[Google Scholar](#)], [[Publisher](#)]
- [61] Shahidi N, Mahdavi F, Gol MK. Journal of Education and Health Promotion. **2020**;9: 153. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [62] Shamsavarinia K, Gharekhani A, Mousavi Z, Aminzadeh S, Jalali P. J Clin Images Med Case Rep. 2022;3(2):1634. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [63] Shirvani M, et al., BioMed Research International, **2022**, Article ID 5744008, [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [64] SS Aghili, et al., Open Access Maced J Med Sci. **2022** Nov 04; 10(F):763-772. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [65] SS Beladi Mousavi, et al., Jundishapur Scientific Medical Journal (JSMJ), **2014** 13 (1), 11-20 [[Google Scholar](#)], [[Publisher](#)]
- [66] Susanabadi A, et al., Annals of the Romanian Society for Cell Biology, **2021**, 25 (6), 2703-2716, [[Google Scholar](#)], [[Publisher](#)]

---

This journal is a double-blind peer-reviewed journal covering all areas in Chemistry, Medicinal and Petroleum. EJCMPR is published quarterly (6 issues per year) online and in print. Copyright © 2022 by ASC ([Amir Samimi Company](#)) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.