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FULL PAPER

Chest CT findings in patients with COVID-19 infection: a systematic review and meta-analysis

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In this work, we evaluated computed tomography (CT) results of the chest in patients with COVID-19 pneumonia. Preliminary articles were searched in the scientific databases PubMed, MEDLINE, Embase, EBSCO between 2019 to 2021. Fixed-effect model for meta-analysis using the inverse-variance method calculates effect size with 95% confidence interval (CI). Data analysis was performed using STATA software version 16. Overall effect size of Ground glass opacities (GGO) in patients with coronavirus disease 2019 (COVID-19) was 2.30 (ES, 95% CI 1.56, 3.3). Ground-glass opacity was a typical finding in COVID-19 pneumonia on CT; its incidence was about 80%. Abnormal CT in patients with COVID-19 was 2.69 (ES, 95% CI 2.52, 2.87). Ground-glass opacity is the foremost typical CT scan result in coronavirus disease 2019, and lung involvement is more common in bilateral and lower lung areas.

KEYWORDS

COVID-19; ground-glass opacity; chest CT; CT manifestations; consolidation.

Introduction

The new coronavirus, also known as COVID-19, is a single-stranded RNA virus from the coronavirus [1,2]. The World Health Organization declared Covid-19 an epidemic for the first time in March 2020 and implemented protection protocols worldwide [3]. Different risk variables have been detailed for Covid-19, including males, age over 65, smoking, comorbidities, and underlying diseases, including hypertension, diabetes, cardiovascular disease, and respiratory disease [4]. Apparent symptoms of the disease include fever, chills, dry cough, and difficulty breathing. Diarrhea, fatigue, muscle aches, sputum, and bloody sputum may also be seen in patients [5,6]. Lung involvement and respiratory symptoms are among the main symptoms in these patients. A CT scan is used to assess the extent of lung involvement [7]. Numerous studies have examined the radiological findings of Covid-19 patients, in which 69 to 89% of these patients had changes in CT scan [8,9]. According to recent studies, between 70 and 80% of CT findings are characterized by clinical manifestations. Therefore, CT (Figure 1) has been reported as an essential and practical tool for diagnosing and progressing Covid-19 disease [10]. Among these, the most common finding is ground-glass opacity, reported in different percentages in different studies [11,12]. However, RT-PCR is a diagnostic test for this patient. In addition, a CT scan is helpful in both diagnosis and choice of treatment for patients

[13]. Therefore, the present study aimed to assess the CT findings of the chest in patients with COVID-19 infection.

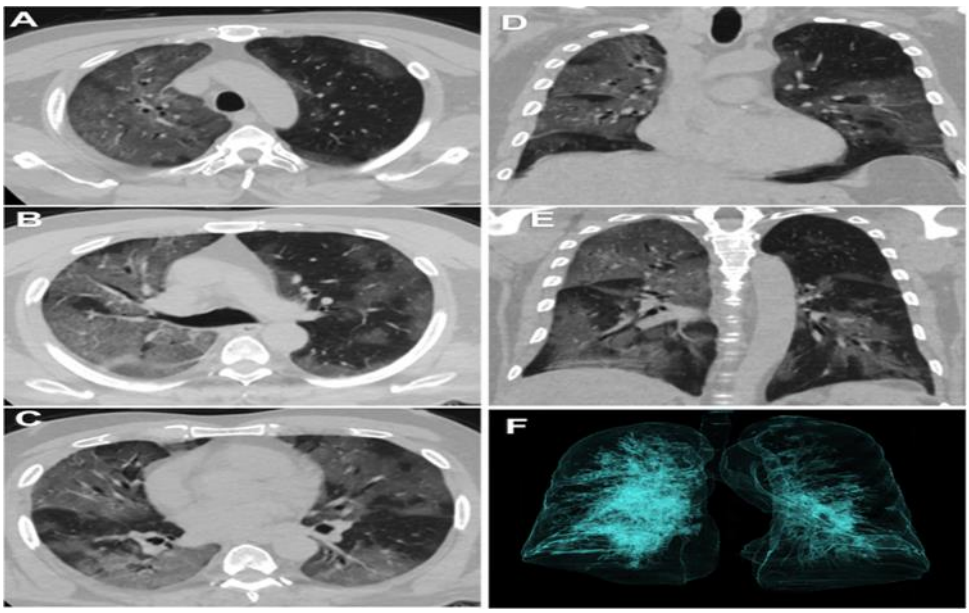

FIGURE 1 CT findings with clinical manifestations

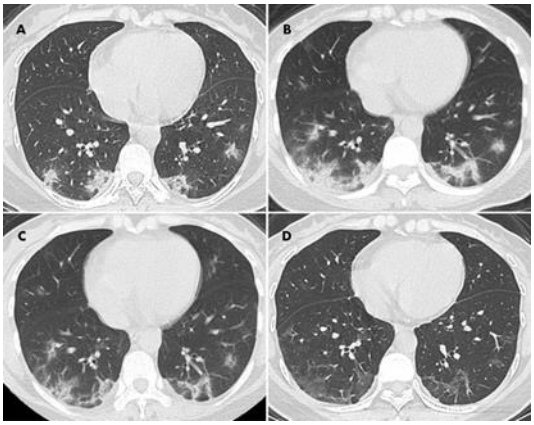

FIGURE 2 Temporal Changes of CT

Method

Preliminary articles were searched in the scientific databases PubMed, MEDLINE, Embase, and EBSCO from February 2019 to 2021. All studies were selected based on inclusion criteria. The present study is a systematic review and meta-analysis based on the PRISMA statement [14]. Reported CT Manifestations, abnormal CT results, chest CT findings in patients with COVID-19, randomized clinical trial studies, RCT studies. Prospective and retrospective studies in humans. Exclusion criteria included: animal, in-vitro, case reports, and reviews studies.

Data extraction and analysis method

Study/ year, age, sex, patients, thin-section CT images, and abnormal CT scan.

Two blind browsers extracted the data independently from the full text of the selected studies, and the third browser then examined the data. Before the screening, kappa statistics were performed to confirm the level of agreement between the reviewers. Kappa values were 0.80, estimated that this value is

appropriate and high. A fixed-effect meta-analysis using the inverse-variance method calculates the effect size with a 95% confidence interval (CI). Random effects were also examined to address potential heterogeneity, with a coefficient of I^2 indicating heterogeneity. A coefficient above 25% < I^2 <75% suggests moderate heterogeneity, and I^2>75% suggests high heterogeneity. Meta-analysis was performed using the latest version of STATA version 16, which is the fastest meta-analysis method.

Results

First, the search was performed using primary keywords, and 77 studies were found in the database. After removing the duplicate studies found in the databases, 72 studies were selected to review the abstract. After studying the abstract based on Word criteria and exclusion from the study, 54 articles were removed, and the full text of 18 articles was reviewed. Then 12 articles were deleted at this stage, and only six studies were selected to enter the meta-analysis (Figure 3).

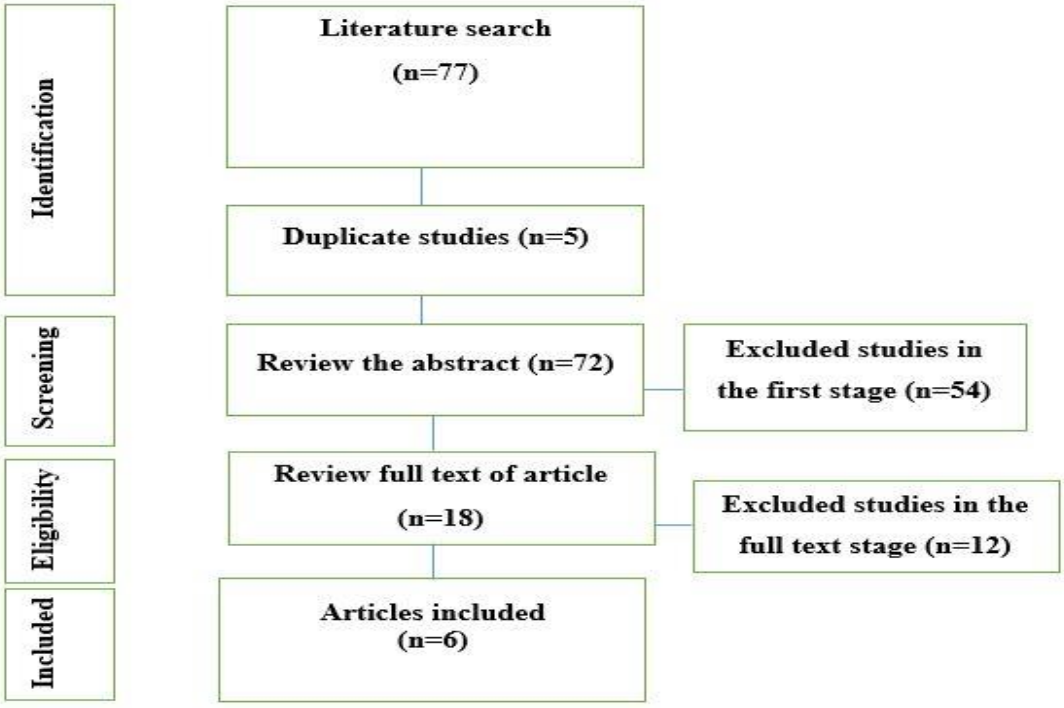

FIGURE 3 PRISMA flowcharts

Characteristics

The number of patients was 452 (male: 231; female: 221) with a mean age of 46.73±7.1 years (Table 1).

TABLE 1 Characteristics of selected studies

Study. Years	Number of patients		Mean of age	thin-section	abnormal CT scan
	male	female			
Zhang *et al.*, 2020 [15]	5	4	35.30	yes	seven
Song *et al.*, 2020 [16]	25	26	49.60	yes	Fifty one
Bernheim *et al.*, 2020 [17]	61	60	45.10	yes	Ninety four
Shi *et al.*, 2020 [18]	42	39	50.00	yes	Eighty one
Xu *et al.*, 2020 [19]	29	21	43.00	yes	Forty one
Zhang *et al.*, 2002 [20]	69	71	57.40	NR	134

Abnormal CT result

Overall effect size of Abnormal chest Computed Tomography in adult patients with coronavirus disease 2019 was 2.69 (ES, 95% CI 2.52, 2.87) with moderate heterogeneity (I^2 = 71.38%; P =0.00) (Figure 4). Based on findings, 90.26% of patients with COVID-19 had Abnormal CT.

CT findings

In patients with COVID-19 pneumonia overall effect size of chest CT findings was 1.80 (ES, 95% CI 1.46, 2.15) with low heterogeneity (I^2 = 0%; P =0.91) (Figure 5).

Subgroup meta-analysis

Ground-glass opacity

Overall effect size of Ground-glass opacity of COVID-19 pneumonia was 2.30 (ES, 95% CI 1.56, 3.3) with low heterogeneity (I^2 = 0%; P =0.75) (Figure 5). This result showed Ground-glass opacity was typical findings in COVID-19 pneumonia on CT; its incidence was about 80%.

Consolidation

Overall effect size of Consolidation in patients with COVID-19 was 1.50 (ES, 95% CI 0.73, 2.28) with low heterogeneity (I^2 = 0%; P =0.95) (Figure5); its incidence was about 43%.

Ground-glass opacity with mixed consolidation

Overall effect size of Ground-glass opacity of COVID-19 pneumonia was 1.72 (ES, 95% CI 1.26, 2.18) with low heterogeneity (I^2 = 0%; P =0.95) (Figure 5); its incidence was about 59%.

Patterns of the lesion

According to the studies. Incidence rate of Air bronchogram, Diffuse interlobular septal thickening (DIST), crazy-paving pattern, Bronchiectasis, Diffuse pleural thickening, Pleural effusion, Pericardial effusion, swelling of lymph nodes was 45%, 48%, 15%, 6%, 53% 53%, 6%, 5%, 4%, respectively.

Lesion distribution

According to the studies, the incidence rate of bilateral lung, Peripheral was 79% and 77%, respectively.

Lobes involved

According to the studies, the incidence rate of 1, 2, 3, 4, and 5 of Lobes involved was 16%, 14%, 10%, 21%, and 36%, respectively.

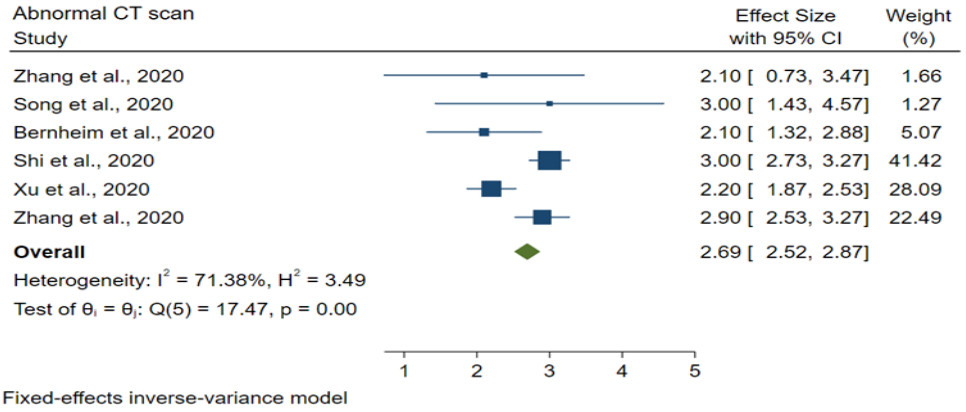

FIGURE 4 The forest plot, showing abnormal CT results in patients with COVID-19

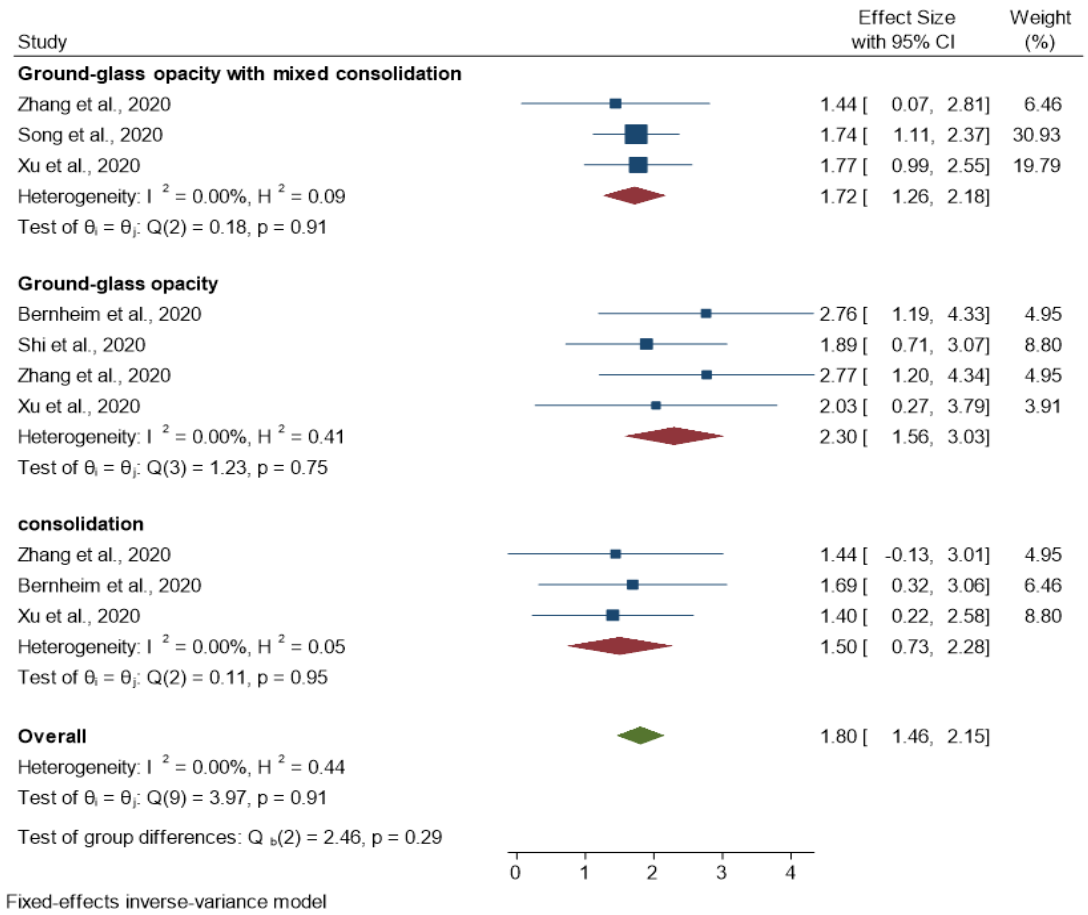

FIGURE 5 Forest plot showed CT manifestations

Discussion

This study aimed to systematically evaluate the chest's computed tomography results in 452 patients with COVID-19 pneumonia and meta-analysis. Based on the present study's findings, 90.26% of the patient's Abnormal CT results and Ground-glass opacity and consolidation are widespread. So the prevalence of Ground-glass opacity with positive findings were 80% and 43%, respectively. The frequency of Ground-glass opacity in patients with abnormal CT scan findings in the study of Ai *et al*., 2020 [21-23] was 46%. Yuan *et al*., 2020 reported an incidence rate of 67% of Ground-glass opacity [24-26]. Present meta-analysis study and other studies showed that in patients with COVID-19 pneumonia, Ground-glass opacity is the most common CT scan result [27-29]. This has different values in different studies, which may have different values due to different strains, which may be due to different strains [30-32]. The disease and the distinction within the pattern of association in different communities and the time of CT scan, because Ground glass is more common in the early stages of lung involvement. The most common finding in patients was pleural effusion and lobular centric nodule [33-35].

Conclusion

Lung involvement in the present study was mostly bilateral, 79% bilateral, and subclinical. Incidence rate of 1, 2, 3, 4, and 5 of Lobes involved were 16%, 14%, 10%, 21%, and 36%, respectively. There were also more men with lung involvement than women. The qualities of the present study are the high number of tests, the description of morphological discoveries, and the distribution of changes within the lungs concurring to the lobes included, and one of

the shortcomings of the study is the lack of onset of side effects within the PACS system. Also, one of the general limitations of such studies is the limitation of molecular testing at the beginning of the epidemic. Chest CT imaging findings are used in patients with high-intensity COVID-19. In patients with COVID-19 pneumonia, the most common result in chest CT is Ground-glass opacity. Lung involvement is more common in bilateral and lower lung areas.

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References

[1] S. Bilgin, O. Kurtkulagi, G.B. Kahveci, T.T. Duman, B.M.A. Tel, *Exp. Biomed. Res.*, **2020**, *3*, 117-125. [Crossref], [Google Scholar], [Publisher]

[2] Y. Furuse, Y.K. Ko, M. Saito, Y. Shobugawa, K. Jindai, T. Saito, H. Nishiura, T. Sunagawa, M. Suzuki, *JJID*, **2020**, *73*, 391-393. [Crossref], [Google Scholar], [Publisher]

[3] Z. Zheng, F. Peng, B. Xu, J. Zhao, H. Liu, J. Peng, Q. Li, C. Jiang, Y. Zhou, S. Liu, C. Ye, *J. Infect.*, **2020**, *81*, e16-e25. [Crossref], [Google Scholar], [Publisher]

[4] National Health Commission & National Administration of Traditional Chinese Medicine, *Chin. Med. J.*, **2020**, *133*, 1087-1095. [Crossref], [Google Scholar], [Publisher]

[5] Y.H. Jin, L. Cai, Z.S. Cheng, H. Cheng, T. Deng, Y.P. Fan, C. Fang, D. Huang, L.Q. Huang, Q. Huang, Y. Han, *Military Med. Res.*, **2020**, *7*, 1-23. [Crossref], [Google Scholar], [Publisher]

[6] J.G. Goldin, D.A. Lynch, D.C. Strollo, R.D. Suh, D.E. Schraufnagel, P.J. Clements, R.M. Elashoff, D.E. Furst, S. Vasunilashorn, M.F. McNitt-Gray, M.S. Brown, *Chest*, **2008**, *134*, 358-367. [Crossref], [Google Scholar], [Publisher]

[7] F. Homayounieh, E.W. Zhang, R. Babaei, H. Karimi Mobin, M. Sharifian, I. Mohseni, A. Kuo, C. Arru, M.K. Kalra, S.R. Digumarthy, *Plos one*, **2020**, *15*, e0239519. [Crossref], [Google Scholar], [Publisher]

[8] Z. Zheng, Z. Yao, K. Wu, J. Zheng, *J. Clin. Virol.*, **2020**, *128*, 104396. [Crossref], [Google Scholar], [Publisher]

[9] K. Ghajarzadeh, M. Milani Fard, M.R. Alebouyeh, H.A. Otaghvar, A. Dabbagh, M. Mohseni, S.S. Kashani, A.M. Milani Fard, S.H. Faiz, *Ann. Rom. Soc. Cell Biol.*, **2021**, *25*, 2466-2484. [Google Scholar], [Publisher]

[10] Y. Wang, C. Dong, Y. Hu, C. Li, Q. Ren, X. Zhang, H. Shi, M. Zhou, *Radiology*, **2020**, *296*, E55-E64. [Crossref], [Google Scholar], [Publisher]

[11] T.J. Kim, J.M. Goo, K.W. Lee, C.M. Park, H.J. Lee, *Lung Cancer*, **2009**, *64*, 171-178. [Crossref], [Google Scholar], [Publisher]

[12] X. Mei, H.C. Lee, K.Y. Diao, M. Huang, B. Lin, C. Liu, Z. Xie, Y. Ma, P.M. Robson, M. Chung, A. Bernheim, *Nat. Med.*, **2020**, *26*, 1224-1228. [Crossref], [Google Scholar], [Publisher]

[13] D. Moher, A. Liberati, J. Tetzlaff, D.G. Altman, D. Altman, G. Antes, D. Atkins, V. Barbour, N. Barrowman, J.A. Berlin, J. Clark, *J. Chin. Integr. Med.*, **2009**, *7*, 889-896. [Crossref], [Google Scholar], [Publisher]

[14] M.Q. Zhang, X.H. Wang, Y.L. Chen, K.L. Zhao, Y.Q. Cai, C.L. An, M.G. Lin, X.D. Mu, *Chinese Journal of Tuberculosis and Respiratory Diseases*, **2020**, *43*, E013. [Crossref], [Google Scholar], [Publisher]

[15] F. Song, N. Shi, F. Shan, Z. Zhang, J. Shen, H. Lu, Y. Ling, Y. Jiang, Y. Shi, *Radiology*, **2020**, *295*, 60523-2251. [Crossref], [Google Scholar], [Publisher]

[16] A. Bernheim, X. Mei, M. Huang, Y. Yang, Z.A. Fayad, N. Zhang, K. Diao, B. Lin, X. Zhu, K. Li, S. Li, *Radiology*, **2020**, *295*, 200463. [Crossref], [Google Scholar], [Publisher]

[17] J. Zhang, X. Dong, Y.Y. Cao, Y.D.Yuan, Y.B. Yang, Y.Q. Yan, C.A. Akdis, Y.D. Gao, *Allergy*, **2020**, *75*, 1730-1741. [Crossref], [Google Scholar], [Publisher]

[18] T. Ai, Z. Yang, H. Hou, C. Zhan, C. Chen, W. Lv, Q. Tao, Z. Sun, L. Xia, *Radiology*, **2020**, *296*,

E32-E40. [Crossref], [Google Scholar], [Publisher]
[19] M. Yuan, W. Yin, Z. Tao, W. Tan, Y. Hu,. *PloS one*, **2020**, *15*, e0230548. [Crossref], [Google Scholar], [Publisher]
[20] A. Ghodsi, M. Bijari, S.A. Alamdaran, A. Saberi, E. Mahmoudabadi, M.R. Balali, S. Ghahremani, *World J. Pediatr.*, **2021**, *17*, 234-241. [Crossref], [Google Scholar], [Publisher]
[21] A. Firoozfar, M. Dousti, *Mag. Civ. Eng.*, **2019**, *90*, 119-129. [Crossref], [Google Scholar], [Publisher]
[22] A. Susanabadi, S. Etemadi, M.S. Sadri, B. Mahmoodiyeh, H. Taleby, M. Milani Fard, *Ann. Rom. Soc. Cell Biol.*, **2021**, *25*, 2875-2887. [Crossref], [Google Scholar], [Publisher]
[23] A.M. Milani Fard, M. Milani Fard, *Eurasian J. Sci. Technol.*, **2022**, *2*, 14-31. [Crossref], [Google Scholar], [Publisher]
[24] F. Zabihi, M.A. Abbasi, R. Alimoradzadeh, *Ann. Rom. Soc. Cell Biol.*, **2019**, *25*, 2573-2579. [Pdf], [Google Scholar], [Publisher]
[25] F.E. Sadr, Z. Abadi, N.E. Sadr, M. Milani Fard, *Ann. Rom. Soc. Cell Biol.*, **2021**, *25*, 6839-6852. [Crossref], [Google Scholar], [Publisher]
[26] K. Ghajarzadeh, M. Milani Fard, H. Alizadeh Otaghvar, S.H.R. Faiz, A. Dabbagh, M. Mohseni, S.S. Kashani, A.M. Milani Fard, M.R. Alebouyeh, *Ann. Rom Soc. Cell Biol.*, **2021**, *25*, 2457-2465. [Crossref], [Google Scholar], [Publisher]
[27] K. Ghajarzadeh, M. Milani Fard, H. Alizadeh Otaghvar, S.H.R. Faiz, A. Dabbagh, M. Mohseni, S.S. Kashani, A.M. Milani Fard, M.R. Alebouyeh, *Ann. Rom. Soc. Cell Biol.*, **2021** *25*, 2449-2456.. [Crossref], [Google Scholar], [Publisher]
[28] K. Ghajarzadeh, M. Milani Fard, M.R. Alebouyeh, H. Alizadeh Otaghvar, A. Dabbagh, M. Mohseni, S.S. Kashani, A.M. Milani Fard, S.H.R. Faiz, *Ann. Rom. Soc. Cell Biol.*, **2021**, *25*, 2466-2484. [Crossref], [Google Scholar], [Publisher]
[29] M. Mokhtare, R. Alimoradzadeh, S. Agah, H. Mirmiranpour, N. Khodabandehloo, *Middle East J. Dig. Dis.*, **2017**, *9*, 228-234. [Crossref], [Google Scholar], [Publisher]
[30] R. Alimoradzadeh, H. Mirmiranpour, P. Hashemi, S. Pezeshki, S.S. Salehi, *J. Neurology Neurophys.*, **2019**, *10*, 1000483. [Crossref], [Google Scholar], [Publisher]
[31] R. Alimoradzadeh, M. Mokhtare, S. Agah, *Iran. J. Age.*, **2017**, *12*, 78-89. [Crossref], [Google Scholar], [Publisher]
[32] S. Etemadi, B. Mahmoodiyeh, S. Rajabi, A. Kamali, M. Milani Fard, *Ann. Rom. Soc. Cell Biol.*, **2021**, *25*, 2417-2426. [Google Scholar], [Publisher]
[33] S. Ghorbanizadeh, Y. Raziani, M. Amraei, M. Heydarian, **2021**, *12*, 54-58. [Crossref], [Google Scholar], [Publisher]
[34] Y. Raziani, B.S. Othman, S. Raziani, *Ann. Med. Surg.*, **2021**, *69*, 102739. [Crossref], [Google Scholar], [Publisher]
[35] Y. Raziani, B.S. Othman, *Veins and Lymphatics*, **2021**, *10*, 5-10. [Google Scholar], [Publisher]

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