Section: Respiratory Medicine

Original Research Article

CORRELATION OF CLINICO-LABORATORY PROFILE AND HRCT THORAX SEVERITY SCORING AT ADMISSION WITH TREATMENT OUTCOMES AMONG MODERATE AND SEVERE COVID-19 CASES – A RECORD-BASED CROSS-SECTIONAL STUDY

Navaneethan M[1], Vimal Raj R[2], Muhamed Kamaludeen MM[3], Prabhu CS[4]

[1]Post Graduate Resident, Department of Respiratory Medicine, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (a Deemed-to-be University), Pondicherry, Puducherry, India
[2]Associate Professor, Department of Respiratory Medicine, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (a Deemed-to-be University), Pondicherry, Puducherry, India
[3]Assistant Professor, Department of Respiratory Medicine, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (a Deemed-to-be University), Pondicherry, Puducherry, India
[4]Professor and Head, Department of Radiodiagnosis, Aarupadai Veedu Medical College and Hospital, Pondicherry, Puducherry, India; Formerly Professor, Department of Radiodiagnosis, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (a Deemed-to-be University), Pondicherry, Puducherry, India

Received : 17/06/2024
Received in revised form : 12/08/2024
Accepted : 28/08/2024

Keywords:
COVID-19, RT-PCR, HRCT, severity score, inflammatory markers.

Corresponding Author:
Dr. Vimal Raj R,
Email: iniyaulagam@ymail.com

DOI: 10.47009/jamp.2024.6.4.183

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (4); 937-941

Abstract

Background: Coronavirus disease 2019 (COVID-19) is a highly contagious respiratory infection that can impact a person's physical and mental health. 80% of those affected had mild to moderate disease, while 5% of those with severe disease went on to develop critical illness. This study aims to quantify the High-Resolution Computed Tomography (HRCT) severity score in confirmed COVID-19 disease to assess the severity of COVID-19 pneumonia and connect the HRCT severity score with clinical and laboratory data. The aim and objective are to correlate the clinico-laboratory profile and HRCT thorax severity scoring at admission with treatment outcomes among moderate and severe COVID-19 cases. **Materials and Methods:** A record-based cross-sectional study was conducted among 106 patients diagnosed with COVID-19 and admitted as inpatients between October 2020 and June 2022. Patients above 18 years of age diagnosed with moderate and severe COVID-19, as confirmed by RT-PCR, were included in the study. The study tools include HRCT Thorax severity scoring, clinico-laboratory profile i.e., CRP, D-dimer, LDH, neutrophil-lymphocyte ratio, ferritin levels, and treatment outcomes. **Result:** Based on the HRCT scoring system, nearly 60% of study subjects were classified as moderate, and 35% as severe. Blood profile parameters such as CRP, D-dimer, LDH, and NLR were significantly elevated among the deceased patients in comparison to those who had recovered. **Conclusion:** HRCT severity score positively correlated with inflammatory lab markers, length of hospital stays, and oxygen requirement among patients with COVID-19 infection, which has proven very useful in the management protocols.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a highly contagious respiratory infection. 80% of those affected had mild to moderate disease, while five percent with severe disease went on to develop critical illness.[1,2] High-Resolution Computed Tomography (HRCT) can be used to determine the severity and prognosis of the condition. There is currently a lack of information linking the characteristics of HRCT with systemic inflammatory markers in COVID-19 patients. This study aims to quantify the HRCT severity score in COVID-19 pneumonia disease to assess the severity of COVID-19 pneumonia and to connect the HRCT severity score with clinical and laboratory data.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

MATERIALS AND METHODS

This was a record-based cross-sectional study conducted at our institute on patients diagnosed with COVID-19 and admitted as inpatients in COVID-19 care spots. The study was conducted between October 2020 and June 2022. The sample size of the study was 106. The sampling technique used was convenience sampling. Patients above 18 years of age and diagnosed with moderate and severe COVID-19 confirmed by Real Time-Polymerase Chain Reaction (RT-PCR) were included in the study and records with incomplete data entry were excluded from the study. The study tools include HRCT Thorax severity scoring, clinico-laboratory profile i.e., clinical severity (fever, cough, coryza, anosmia, ageusia, myalgia, difficulty in breathing), CRP, D-dimer, LDH, neutrophil-lymphocyte ratio (NLR), ferritin levels, and treatment outcomes (Number of days hospital stay, the requirement of oxygen support, a complication such as pulmonary embolism, death, and recovery). Data entry was done using MS Excel 2016 and data analysis was done using SPSS version 23.0. Descriptive statistics were interpreted in frequency and percentage, mean and standard deviation, chi-square test, and Fisher exact test was used to find out the strength of association between the variables. A p-value of < 0.05 was considered statistically significant.

RESULTS

In our study, 73.6% belonged to male gender and 26.4% were females. The chief complaints of the patients were breathlessness, cough, fever, chest pain & myalgia and majority of the participants had fever. The majority of the subjects had diabetes (42.5%) and hypertension (30.2%). 3.8% had hypothyroidism, 3% had CAD and 36.8% of subjects did not have any co-morbidities. With respect to complications, the majority of the participants developed moderate ARDS and the rest of the patients had severe ARDS, pulmonary embolism, atrial fibrillation, cardiogenic shock, and sudden cardiac arrest. Depending upon the grades of ARDS, 66% of the patients had developed moderate ARDS and 34% had developed severe ARDS. Based on the HRCT scoring system, nearly 60% of study subjects were classified as moderate category, and 35 % were classified as severe category. Inflammatory markers such as CRP, D-dimer, and ferritin showed that most of the participants had elevated levels of these markers [Table 1]. Whereas concerning NLR it was decreased. 36% of the patients were deceased and 66% had recovered from COVID-19 infection. Among the deceased population, 88.9% were males, and among the patients who have survived 65.7% were males. This trend was statistically significant with an odds ratio of 0.24. This explains why females have a 76% lower risk of developing mortality than males in our study population. Patients with intermediate grading were 93% less likely to die than those with severe grades and this was statistically highly significant as the p-value was 0.001. Blood profile parameters such as CRP, D-dimer, LDH, and NLR were elevated among the deceased in comparison to those who have recovered and independent t-test showed statistical significance except ferritin (p – 0.164) and NLR (p – 0.07) [Table 2]. Along with the blood profile, duration of oxygen requirement and hospital stays were increased among the deceased patient in comparison to those who have recovered and independent t test showed statistically significant.

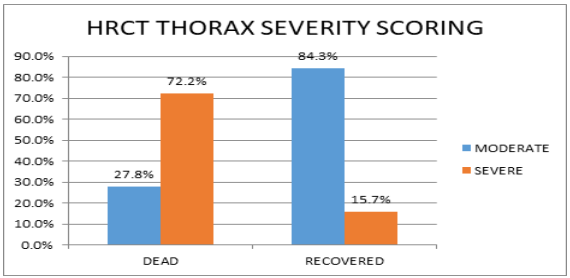

Figure 1: Association between HRCT thorax severity scoring and patient outcomes in COVID patients

Table 1: Comparison of various inflammatory markers in COVID-19 patients.

Variables	Death	Recovery	p-value (Chi-square test)
Elevated CRP	100%	72.9%	0.001
Elevated D-dimer	100%	85.7%	0.017
Elevated ferritin	100%	92.9%	0.164
Elevated LDH	94.4%	55.7%	0.001
Elevated NLR	8.3%	1.4%	0.07

Table 2: Comparison of various parameters with the outcomes of the patients

Outcome	Patient group		p-value *
	Recovery Mean ± S.D (N=70)	Death Mean ± S.D (N=36)	
Age	50.55 ± 15.00	65.52 ± 13.65	0.001
CRP mg/dl	17.04 ±15.46	25.23 ± 9.21	0.004
D- dimer mg/dl	357.1(294 – 448)	551(400 – 960)	0.001
LDH	302.41 ± 110.40	401.22± 111.70	0.001
NLR	1.91 ± 0.82	2.38 ± 0.96	0.011
Duration of Oxygen requirement (in days)	4.87 ± 3.67	11.47 ± 6.7	0.001
Duration of Hospital stays (in days)	8.25 ± 3.8	11.52 ± 6.69	0.002

*p < 0.05 – statistically significant; p < 0.001 – statistically highly significant

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 3: Association between HRCT thorax severity scoring and patient outcomes in COVID patients

HRCT thorax severity scoring	Outcome		p-value *
	Death	Recovery	
Moderate	10	59	0.001
	27.8%	84.3%	
Severe	26	11	
	72.2%	15.7%	
Total	36	70	
	100.0%	100.0%	
Odds ratio	0.071 (0.027-0.189)		

*p<0.001 – statistically highly significant

DISCUSSION

COVID-19 is a global health issue. Early identification of critical patients has various advantages, including appropriate critical care and reduction of mortality rate.

In our study, among the study population, 73.6% belonged to the male gender and 26.4% were females. A study done by Sharma et al, found that majority of cases were aged between 41 and 60 years. The mean age of the study group was 54.46 (±16.71) years. Among previous studies, Bhandari S et al, reported that the mean age of the patients was 50.40 years, which is very similar to our study.[3,4] A study done by Ghufran et al. revealed male predilection and severe disease were mostly seen in males (93.4%). Studies suggest that such distribution can be attributed to the possible protective effect of estrogen.[5] The most severe disease and the highest mortality rates were found in the 50- to 59-year age group.

A study done by Hafez et al. showed that the common clinical symptoms of patients with COVID-19 were fever, cough, dyspnoea, and fatigue.[6,7] In this study, fever and lower respiratory symptoms are the common presenting symptoms in 69.5% and 66% of the patients, respectively.

In a study done by Sharma et al., found that of all patients, 55.2% patients had some or other underlying comorbid disease like diabetes mellitus, hypertension, Chronic Obstructive Pulmonary Disease (COPD), and others.[3] Although in our study, there was a higher proportion of cases with comorbidity in mild grade of disease, the difference was not statistically significant. This is similar to a previous study done by Saeed et al.[8] Likewise, a study done by Aziz-Ahari et al., found that individuals with these comorbidities were at increased risk of suffering a severe form of COVID-19 and have a higher mortality rate that it is consistent with similar studies.[9,10] Guan et al., in their study, stated that the presence of risk factors, particularly hypertension, diabetes, lung, and coronary artery diseases carried a poor prognosis, with even worse outcomes when multiple risk factors are present.[11]

In our study, among the study population based on the HRCT scoring system, nearly 60% of study subjects were classified as moderate category, and 35 % were classified as severe category. Whereas a study done by Sharma et al., observed that more than half of the cases had a severe grading, more than a quarter of the cases were labeled as moderately severe, while 22 cases had mild severity on CT score.[3] This observation could be due to the sample being taken from tertiary care hospital which caters to comparatively sick patients.

All studies have indicated that COVID-19 has typical peripheral and subpleural distributions, and in most patients, COVID-19 involved multiple lobes, particularly the lower lobes. In this study by Hafez et al, 93.5% of all patients had bilateral involvement, whereas 89.5% had peripheral involvement. Higher severity scores for the lower lobe were observed in 55.5% of the patients.[6] These results conform to the study by Salehi et al., who reported bilateral involvement and peripheral distribution in 87.5% and 76.0% of their patients, respectively.[12] However, many studies such as that by Zhou et al., have reported that 77.4% of the patients had predominantly peripheral distribution of lesions; the mean CT-SS for the upper zone was significantly lower than that for the middle and lower zones, and no significant difference in the mean CT-SS was observed between the middle and lower zones.[13,14] In a study by Aziz-Ahari et al., the authors found that right lung involvement was slightly predominant over left lung involvement, which is not consistent with other studies.[7,9] Also, the presence of pleural effusion was significantly higher in cases with severe form of the disease. The HRCT severity score was higher in the severe/critical patients [Figure 1]. A statistically significant (p = 0.001) difference in HRCT severity scoring was found among the recovered patients than those who died [Table 3]. These findings are consistent with the Homayounieh et al study.[15] The CT severity score was higher in patients who died after adjustment of parameters in both groups in the Abbasi et al, study and it is consistent with our results. Also, the CT severity score could be an acceptable prognostic factor for mortality and severity (area under the curve of 0.72).[16] In another study done by Hafez et al., they found that the death rate in their study population was significantly increased among patients with severe CT findings, as noted in other studies.[6] Patients with intermediate grading were 93% less likely to die than those with severe grades. This was statistically significant as the p-value was 0.001 but in contrast to our finding, Sharma et al, found that patient survival was significantly decreased among patients with severe CT findings. In contrast, the proportion of cases who survived was comparable among all grades

ISSN (O): 2687-5365; ISSN (P): 2753-6556

of severity on CT scans. This difference between the two groups was statistically significant. The mean CT severity score among patients who died was significantly higher than patients who survived.[3]

Inflammatory markers such as CRP, D- dimer, and ferritin showed most of the participants had elevated levels of these markers. Whereas with respect to NLR, it was decreased. In our study population, there were only 4 study participants (3.8%) with elevated NLR and 102 subjects showed reduced NLR during admission. In our study, among the deceased population, all the subjects had elevated CRP whereas among those who have recovered 72.9% showed elevated CRP levels in blood. This difference in trend was statistically significant as the p-value was 0.001 and all the subjects had elevated D-dimer whereas among those who have recovered 85.7 % showed elevated D-dimer levels in the blood. This difference in trend was statistically significant as the p-value was 0.017. Also, all the subjects had elevated serum ferritin levels whereas among those who have recovered 92.9% showed elevated levels of serum ferritin. This difference in trend was not statistically significant as the p-value was 0.10. We also found that among the deceased population, 94.4% showed elevated LDH levels, and 55.7% of those who survived did as well. Given that the p-value was 0.001, this trend was statistically significant. It also explains why patients with normal LDH levels had a 93% survival rate. Blood profile parameters such as CRP, D-dimer, LDH, and NLR ratio were elevated among deceased patients, in comparison to those who have recovered and independent t-test showed statistically significant except for D-dimer. 8.3% of participants had increased NLR levels, but only 1.4% of them was recovered patients. Given that the p-value was 0.077, this trend difference was not statistically significant.

Many previous studies have suggested alterations of laboratory parameters in COVID-19 patients with greater frequency such as lymphocyte count, CRP, D-dimer, and serum ferritin.[17] In a study by Sharma et al., more than three-fourths of the cases had a raised CRP level (CRP>0.1 mg/dL), while more than two-thirds of the cases had a raised ESR level (ESR>30). In contrast, an almost comparable proportion of cases had raised and normal absolute leukocyte count and serum ferritin. D-dimer levels were raised in the majority (62.0%) of the cases. Lymphocyte count was decreased in more than half (52%) of the cases.[3] Severe disease was associated with a significantly lower lymphocyte count compared to mild disease. In contrast, CRP, D-dimer, and serum ferritin were significantly higher in severe cases compared to mild cases. The strong correlation between lymphopenia and disease severity can be related to the inflammatory cytokine storm in COVID-19 patients.[8] This study showed a statistically significant correlation between raised CRP levels and increasing CT severity. Previous studies have also suggested that CRP can be used as a predictive marker for the likelihood of disease progression and can guide clinicians in early treatment at the early disease stage. Similarly, serum ferritin acts as a vital mediator of immune dysregulation as shown in this study where serum ferritin level was closely correlated with severity of disease. Likewise, higher D-dimer levels were seen in severe disease and can be used as a prognostic indicator. A similar study done by Aziz-Ahari et al. found that serum LDH and CRP levels were elevated in COVID-19 as well as other inflammatory diseases.[9] According to our results, individuals with elevated CRP and LDH serum levels had a higher mortality rate. Other studies also reported high CRP and LDH as strong predictors for severity, and higher CRP levels were positively correlated with lung involvement in CT imaging.[18] Albumin as a negative acute inflammatory factor was decreased in the deceased group in this study which is consistent with the other studies.

Likewise, a study done by Hafez et al., studies have also suggested that prompt treatment at an early disease stage can be considered using CRP as a predictive marker for the likelihood of disease progression. Similarly, serum ferritin is a vital mediator of immune dysregulation, and its level was closely linked to the severity of the disease. D-dimer likewise can be used as a prognostic indicator, where higher levels are seen in more critical conditions. However, there is a lack of evidence regarding the causal effect. It is not yet clear whether this increase is related to the direct effect of the virus or the systemic inflammatory response.[6]

In our study, the mean duration of oxygen requirement was 4.87± 3.67 days for the recovered group and 11.47 ± 6.7 days for the death group. Similarly, a study done by Saeed et al., found only two patients (3.3%) with severe CT scores did not require oxygen support, 8 (13.1%) required a nasal cannula, 8 (13.1%) required a face mask, 5 (8.2%) required nonrebreather mask, 4 (6.6%) required BiPAP/HFNC, and 34/61 (55.7%) required intubation. Oxygen requirement and CT severity scores were found to have a statistically highly significant correlation ($p < 0.0001$, r - 0.529). As expected, and found in our data, oxygen requirements increase with the increasing CT severity. Progressive increase in oxygen requirement can be due to the direct damage of the lung by the virus causing inflammatory changes in the alveolar wall that limit oxygen exchange, leading to acute respiratory distress, pulmonary fibrosis, and eventually death.[8]

In our study, the mean duration of hospital stay was 8.25 ± 3.8 days for the recovered group and 11.52 ± 6.69 days for the deceased. In a similar study, Saeed et al. found that 21.1% with negative scans, 30.6% with mild CT severity scoring, 17.7% patients with moderate, and 5 patients (0.6%) with severe CT thorax findings were either discharged on the same day or required hospital admission for <5 days.[8] Concerning the length of hospital stay for patients with COVID-19 disease, a systematic review done by Rees et al., has suggested that length of stay varies

ISSN (O): 2687-5365; ISSN (P): 2753-6556

depending on multiple factors such as admission and discharge criteria, bed demand and availability, and different timing within the pandemic.[19] Death rate in our cohort was significantly increased among patients with severe CT findings, as noted in other similar studies.[20]

Limitations

- Since it is a cross-sectional record-based study, the measure of association is a crude ratio.
- The use of convenient sampling in this study is one of the limitations.

CONCLUSION

In patients with COVID-19 pneumonia, multi-slice CT plays a vital role in early identification of the disease with the ground-glass densities and peripheral adhesions being the most typical findings. Thus, radiologists should be familiar with other possible findings. Chest CT severity score of patients with COVID-19 and inflammatory laboratory markers can work as an indicator of disease severity and outcome. CT chest imaging can play a vital role in the management plan of COVID-19 pneumonia and should be used for a comprehensive evaluation, combined with the results of nucleic acid tests and epidemiological data. CT severity score is positively correlated with inflammatory lab markers, length of hospital stays, and oxygen requirement in patients with COVID-19 infection. This is our tertiary care teaching centre's experience during the COVID-19 pandemic. With the emergence of new COVID-19 variants happening regularly (omicron, XBB.1.16, and the recent identification of a subvariant of omicron – Eris), the learning points need to be revisited frequently to keep ourselves prepared well in advance for any life-threatening future outbreaks. Since the world is considered a global village, we all should be alert irrespective of the proximity of an outbreak and be better prepared and, our experience during COVID-19 waves serves as a reminder in the right direction.

REFERENCES

1. Wu Z, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention. JAMA. 2020 Apr 7;323(13):1239–42.
2. Levin AT, Owusu-Boaitey N, Pugh S, Fosdick BK, Zwi AB, Malani A, et al. Assessing the burden of COVID-19 in developing countries: systematic review, meta-analysis and public policy implications. BMJ Glob Health. 2022 May;7(5):e008477.
3. Sharma S, Aggarwal A, Sharma RK, Patras E, Singhal A. Correlation of chest CT severity score with clinical parameters in COVID-19 pulmonary disease in a tertiary care hospital in Delhi during the pandemic period. Egypt J Radiol Nucl Med. 2022 Dec;53(1):166.
4. Bhandari S, Rankawat G, Bagarhatta M, Singh A, Singh A, Gupta V, et al. Clinico-Radiological Evaluation and Correlation of CT Chest Images with Progress of Disease in COVID-19 Patients. J Assoc Physicians India. 2020 Jul;68(7):34–42.
5. Dangis A, De Brucker N, Heremans A, Gillis M, Frans J, Demeyere A, et al. Impact of gender on extent of lung injury in COVID-19. Clin Radiol. 2020 Jul;75(7):554–6.
6. Hafez MAF. The mean severity score and its correlation with common computed tomography chest manifestations in Egyptian patients with COVID-2019 pneumonia. Egypt J Radiol Nucl Med. 2020 Dec;51(1):254.
7. Yang R, Li X, Liu H, Zhen Y, Zhang X, Xiong Q, et al. Chest CT Severity Score: An Imaging Tool for Assessing Severe COVID-19. Radiol Cardiothorac Imaging. 2020 Apr;2(2):e200047.
8. Saeed GA, Gaba W, Shah A, Al Helali AA, Raidullah E, Al Ali AB, et al. Correlation between Chest CT Severity Scores and the Clinical Parameters of Adult Patients with COVID-19 Pneumonia. Radiol Res Pract. 2021;2021:6697677.
9. Aziz-Ahari A, Keyhanian M, Mamishi S, Mahmoudi S, Bastani EE, Asadi F, et al. Chest CT severity score: assessment of COVID-19 severity and short-term prognosis in hospitalized Iranian patients. Wien Med Wochenschr 1946. 2022 Mar;172(3–4):77–83.
10. Zhang J, Meng G, Li W, Shi B, Dong H, Su Z, et al. Relationship of chest CT score with clinical characteristics of 108 patients hospitalized with COVID-19 in Wuhan, China. Respir Res. 2020 Jul 14;21(1):180.
11. Guan WJ, Liang WH, Zhao Y, Liang HR, Chen ZS, Li YM, et al. Comorbidity and its impact on 1590 patients with COVID-19 in China: a nationwide analysis. Eur Respir J. 2020 May;55(5):2000547.
12. Salehi S, Abedi A, Balakrishnan S, Gholamrezanezhad A. Coronavirus Disease 2019 (COVID-19): A Systematic Review of Imaging Findings in 919 Patients. AJR Am J Roentgenol. 2020 Jul;215(1):87–93.
13. Zhou S, Wang Y, Zhu T, Xia L. CT Features of Coronavirus Disease 2019 (COVID-19) Pneumonia in 62 Patients in Wuhan, China. AJR Am J Roentgenol. 2020 Jun;214(6):1287–94.
14. Francone M, Iafrate F, Masci GM, Coco S, Cilia F, Manganaro L, et al. Chest CT score in COVID-19 patients: correlation with disease severity and short-term prognosis. Eur Radiol. 2020 Dec;30(12):6808–17.
15. Homayounieh F, Zhang EW, Babaei R, Karimi Mobin H, Sharifian M, Mohseni I, et al. Clinical and imaging features predict mortality in COVID-19 infection in Iran. PloS One. 2020;15(9):e0239519.
16. Abbasi B, Akhavan R, Ghamari Khameneh A, Zandi B, Farrokh D, Pezeshki Rad M, et al. Evaluation of the relationship between inpatient COVID-19 mortality and chest CT severity score. Am J Emerg Med. 2021 Jul;45:458–63.
17. Orlacchio A, Gasparrini F, Roma S, Ravà MS, Salvatori E, Morosetti D, et al. Correlations between chest-CT and laboratory parameters in SARS-CoV-2 pneumonia: A single-center study from Italy. Medicine (Baltimore). 2021 Apr 9;100(14):e25310.
18. Booth AL, Abels E, McCaffrey P. Development of a prognostic model for mortality in COVID-19 infection using machine learning. Mod Pathol Off J U S Can Acad Pathol Inc. 2021 Mar;34(3):522–31.
19. Rees EM, Nightingale ES, Jafari Y, Waterlow NR, Clifford S, B Pearson CA, et al. COVID-19 length of hospital stay: a systematic review and data synthesis. BMC Med. 2020 Sep 3;18(1):270.
20. Li Y, Yang Z, Ai T, Wu S, Xia L. Association of "initial CT" findings with mortality in older patients with coronavirus disease 2019 (COVID-19). Eur Radiol. 2020 Nov;30(11):6186–93.

ISSN (O): 2687-5365; ISSN (P): 2753-6556