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Research Article

Do the Co-Morbid Conditions are Risk Factors for COVID-19 Patients? A View in a Tertiary Care Center

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Abstract

Aims: This study aimed to characterize the COVID-19 patient's demographic details, Symptoms, and to identify whether co-morbid conditions aggravated the COVID-19 symptoms and their vitality in the COVID-19 patients. The other aims were to identify HINI, whether, age, lab-investigations, and CT grading have changed between only COVID-19 patients and COVID-19 patients with Co-morbid conditions.

Methods: In an isolation ward of the tertiary care unit, 509, COVID-19 patients were admitted. The patient's throat swab was collected and performed Real-Time- Polymerase Chain Reaction (RTPCR), and recorded the confirmed cases for further investigations, diagnosis, and treatment. Patient's demographic details, Co-morbid conditions, biological markers, Computed Tomography (CT) scanning, and symptoms were observed and recorded. Standard care management was provided. Statistical significance was found using SPSS version 20.0. Median (Min, Max), Frequencies with percentages, and Chi-square test were done. A p-value of <0.05 was considered statistically significant.

Results: Out of 509 COVID-19 patients, 309 were male patients and 200 were female patients indicating male patients were vulnerable to COVID-19 infection. No H1N1 was identified. The median age was 42 for males and females 44. Fever is the symptom found in both genders in a high percentage followed by a cough. Males were found with a higher percentage of co-morbid conditions compared to females indicating again, that male patients are vulnerable to co-morbid conditions also. Among the COVID-19 patients with co-morbid conditions, Mylagia (p-value-0.031) and chills (p-value-0.030) were the symptoms found higher with statistical significance. Among the biochemical markers, CRP was elevated in a higher percentage in COVID-19 patients with co-morbid conditions than the patients with only COVID-19. Statistical significance was found in the CT-grade-0 between only COVID-19 patients and COVID-19 with co-morbidities patients. Grade IV was found in COVID-19 with co-morbidities patients. Among the COVID-19 patients with co-morbidities, 50-59 age groups were higher indicating the age vulnerability for COVID-19 with co-morbidities.

Conclusions: Male patients with co-morbidities were more vulnerable to COVID-19 infection. Among the co-morbid condition, hypertension is the leading vulnerable co-morbid issue in males. Myalgia and chills (p-value<0.05) were the symptoms found higher in COVID-19 patients with co-morbidities. CRP (p-value<0.05) is the bio-chemical marker that gets elevated in COVID-19 patients with co-morbidities, and age groups of 50-59 years of COVID-19 with co-morbidities patients were at higher risk. Co-morbidities, gender, and age were the very vital markers of any disease, hence clinicians and health care workers must record and follow a separate protocol for COVID-19 with co-morbidities that will support reducing the morbidity and mortality in COVID-19 with co-morbidities. No H1N1 was identified.

Keywords: COVID-19; Co-morbid; Myalgia; Diabetes Mellitus; Hypertension; Bronchial Asthma; Long COVID

Introduction

The pandemic of 2019 has made a significant impact on the quality of life of many patients who suffered from COVID-19. As of the year 2021 month of August, globally, a confirmed case of COVID-19 was 213,752,662, and deaths recorded were 4,459,381 patients[1]. Older patients with underlying conditions such as co-morbid issues like hypertension, and diabetes had made a worse prognosis than only COVID-19 patients[2]. Age is also one of the risk factors for COVID-19 disease prognosis. The reasons for age-related issues in the COVID-19 geriatric population may be changes in the anatomy of the lungs that results in physiologic function changes, reducing the lung reserve, airway clearance, and reduction in the immune system[3]. Co-morbidities can aggravate COVID-19 and cause disease severity leading to hospitalization in the Intensive Care Unit and even leading to potential death, especially in an elderly COVID-19 with co-morbidities [4]. Co-morbidities are directly associated with COVID-19 severity leading to ICU hospitalization and even leading to death. Wang, B et al reported that patients with co-morbidities were highly linked to more severe disease outcomes when infected with COVID-19, compared to patients with no underlying co-morbidities [5]. Hoang, T.et al also reported that despite the COVID-19 global vaccination recurrence of COVID-19 has also been reported worldwide[6]. Koyyada, R, et al reported the single co-morbidity and multiple co-morbidities, but not reported gender-wise co-morbidities that create a risk of COVID-19 disease severity[7]. Malik, J. A, et al reports that daily COVID-19 instances increased after the discovery of Omicron, reaching 0.6 million cases, and thousands of deaths [8]. Underlying diseases, such as diabetes, hypertension, COPD, CVD, asthma, and malignancy can be the risk factors[9]. Ejaz, H, et al describes that co-morbid conditions in COVID-19 patients can lead them to the life-threatening stage or lead to death[10]. Huang, C, et al data reflect that half of the COVID-19 patients admitted in his study were with underlying conditions[11]. Chen, N et al study also shows that 40% of the COVID-19 patients had chronic medical illness[12]. Liu, K, et al described in the article that underlying co-morbid diseases lead to a poor prognosis[13]. Mauvais-Jarvis, F et al reported that 80% of morbidity and high mortality in the elderly people in Asia, the US, and Europe were due to severe poor outcomes in the older individuals aged >65 years [14]. Omicron, the newly dominant variant, is highly characterized by increased immunity evasion, thus causing the reinfection or recurrence a challenging task to eradicate the COVID-19[15]. Altarawneh, H. N, et al published article describes that relative protection for a prior infection that is against reinfection by Omicron is 56% when compared to 92% with the Delta variant[16]. Jiang, D. H, et al refer to the term "Long COVID" that can affect at most every organ as a new-onset infection or chronic diseases like heart disease, kidney disease, neurologic issues, diabetes, mental health issues, and hematologic disorders[17]. As per the World Health Organization, COVID-19 would have caused 15 million deaths around the world and is still and on and on ravaging the globe. There is a prediction of 100 million more people to get infected in the United States because of the potential emergence of the highly transmissible, infectious, and immune-escaping Omicron variants[18]. As COVID-19, and Long COVID are new diseases, understudied, limited available data, unknown biological characteristics, and recurrence after vaccination has made us conduct this present study to get some preventive strategies to fight a battle against the COVID-19 and Long COVID, hence this study is mainly aimed at quality observational data to study whether underlying conditions such as age, co-morbidities, and gender plays a vital role in COVID-19 diseases prognosis.

Ethical clearance: The study was informed to the Institutional Ethical Committee board and received the ethical clearance document to conduct the study.

Inclusion criteria: The patients were admitted to the Isolation ward for 3 months December 2021 to February 2022 after the confirmed diagnosis of COVID-19.

Exclusion criteria: Pregnant patients, children below 1 year, moribund patients, and patients whose RTPCR results are unavailable.

Materials and Methods

Methodology

Study Subjects

An observational study of 509 (Male: Female 309:200) confirmed COVID-19 patients were admitted to the Government Hospital, HINI-Guindy, Chennai, Tamil Nādu between December 2021 to February-2022 with confirmed COVID-19 infection.

Clinical Details and sample collection

All the 509 patients were first diagnosed with COVID-19 with RTPCR test and hospitalized in the Isolation ward for further observation, diagnosis, and treatment. COVID-19 patient's demographic details such as age, gender, and address, were recorded. During the hospitalization, samples were collected for multiple investigations. Computed Tomography (CT) scanning was also done for radiological confirmation of the COVID-19 [19]. Underlying conditions such as co-morbidity were recorded. Some of the patients had single co-morbidity and some had multiple co-morbidities. The common co-morbidity recorded were hypertension, diabetes mellitus, CAD, tuberculosis, bronchial asthma, hypothyroidism, and dyslipidemia. All the symptoms

were observed and recorded. The presences of symptoms are fever, cough, myalgia, cold, loss of appetite, loss of taste, abdominal pain, vomiting, diarrhea, and loss of smell. Standard care management was followed to treat the COVID-19 patients during their admission.

Biochemical Investigations and Analysis

The investigations are Total Count (TC) [20], C-reactive protein (CRP) [21] Neutrophil/Lymphocyte Ratio (NLR) [22], and Lactate dehydrogenases (LDH) [23] were done. TC (>11K), NLR (>3), CRP (>10), and LDH (>350) were considered normal levels as per assay, patient's bio-chemical levels above the normal values were considered as elevated levels of these bio-chemical markers and the values were recorded.

Quality control

The biochemical investigations were analyzed along with quality controls to ensure the quality as per standard operating protocols provided in the assay.

Statistical Analysis

The data was analyzed using SPSS version 20.0. Median (min, max) was given for continuous variables. Frequency and proportions were given for categorical variables. Mann Whitney U test and Chi-square tests were performed to test the statistical significance between the groups respectively. Frequencies with percentages are presented for categorical variables. A p-value of <0.05 was considered statistically significant. A linear trend line was drawn for the age distribution vs. presence of COVID-19 with co-morbid conditions and also R2 value was noted.

Results

A total of 509 COVID-19 patients were selected for this study after the confirmation test of RTPCR and after admission to the Isolation ward of tertiary care, the demographic details such as age, and gender were reordered. Symptoms were observed and recorded. Further investigations like biochemical markers and CT scanning were also done. No H1N1 was identified.

Variables	Male(n=309)	Female(n=200)	P value
Age (in years)*	42(2,83)	44.5(2,90)	0.646
Age Categories (in years) *			
≤ 19 years	11(3.6%)	12 (6.0%)	0.195
20-29 years	43 (13.9%)	23 (11.5%)	0.713
30-39 years	75 (24.3%)	47 (23.5%)	0.842
40-49 years	81 (26.2%)	44 (22.0%)	0.28
50-59 years	41 (13.3%)	36 (18.0%)	0.145
60-69 years	35 (11.3%)	27 (13.5%)	0.464
> 70 years	23 (7.4%)	11 (5.5%)	0.391
COVID-19 Symptoms			
Fever	237(76.7%)	159 (79.5%)	0.457
Cold	163 (52.8%)	104 (52.0%)	0.868
Cough	187 (60.5%)	135 (67.5%)	0.11
Myalgia	130 (42.1%)	87 (43.5%)	0.75
Loss of Appetite	76 (24.6%)	55 (27.5%)	0.464
Loss of Taste	86 (27.8%)	57 (28.5%)	0.869
Loss of Smell	96 (31.1%)	58 (29.0%)	0.619
Nausea	56 (18.1%)	39 (19.5%)	0.696
Vomiting	33 (10.7%)	27 (13.5%)	0.335
Abdominal Pain	28 (9.1%)	16 (8.0%)	0.677
Diarrhoea	32 (10.4%)	27 (13.5%)	0.279
Chills	31 (10.0%)	19 (9.5%)	0.843
Co-morbid conditions			

No co-morbidities	245 (79.3%)	156 (78%)	0.64
Diabetes Mellitus	17 (5.5%)	13 (6.5%)	0.49
Hypertension	20 (6.5%)	7 (3.5%)	0.143
Diabetes + Hypertension	15 (4.9%)	8 (4.0%)	0.65
CAD	2 (0.6%)	1 (0.5%)	0.832
Diabetes +Hypertension +Dyslipidaemia +CAD	7 (2.3%)	1 (0.5%)	0.177
Bronchial Asthma + Tuberculosis	0 (0)	6 (3.0%)	-
Hypothyroidism	1 (0.3%)	3 (1.5%)	0.142
Hypothyroidism + Diabetes	2 (0.6%)	5 (2.5%)	0.079

* - Median (min, max)

Table 1: Basic Characteristics of the Selected COVID-19 Patients.

Table 1 describes the basic characteristics of the selected COVID-19 Patients. Total male patients were 309 and females were 200. The male median age was 42(2, 83) and the female median age was 44.5(2, 90). The age of the patients was further categorized and analyzed for the study. Among the male patients, 40-49 years of patients were higher in percentage (26.2%) than other age groups. Among the females, 30-39 years were higher in percentage (23.5%). The least percentage observed in both gender was <19 years. Table 1 explains the symptoms present in COVID-19 patients during hospital admission. Symptoms like fever, cold, cough, and Myalgia were in higher percentage in both males and females. Fever was the predominant symptom with 76.7% in males and 79.5% in females. The second predominant symptom was cough with 60.5% in males and 67.5% in females. The lest symptom identified in both gender was abdominal pain. Even though the female patients were lesser (n=200) in number compared to male (n=309) patients, female patients were observed to present with a higher percentage of symptoms than male patients. Out of 12 symptoms observed, 8 symptoms such as fever, cough, Myalgia, loss of appetite, loss of taste, nausea, vomiting, and Diarrhoea were higher in females than in males. Table1 also shows the co-morbid conditions of the COVID-19 patients. No co-morbid conditions were found in 245 (79.3%) of male patients whereas, in females, no co-morbid conditions were found in 156 (78%). A total of 64 male COVID-19 patients had co-morbid conditions whereas 44 female COVID-19 patients had co-morbid conditions. Hypertension (6.5%) was higher followed by Diabetes mellitus (5.5%) in males COVID-19 patients. In female COVID-19 patients, Diabetes mellitus was 6.5%, followed by Diabetes along with Hypertension at 4.0%. CAD and multi-co-morbid conditions including Diabetes, Hypertension, Dyslipidaemia, and CAD were higher percentages in male COVID-19 patients compared to female COVID-19 patients. Hypothyroidism and Hypothyroidism along with Diabetes were found in a higher percentage in female COVID-19 patients compared to male COVID-19 patients. Bronchial Asthma along with Tuberculosis was found only in female COVID-19 patients. As we have identified that male COVID-19 patients had higher co-morbid conditions compared to female COVID-19, we further analyzed, categorizing the COVID-19 patients into 2 main groups and described the details in Table 2. The first group was patients with only COVID-19 and the second group was COVID-19 patients with co-morbid conditions. Only COVID-19 patients were 401 (78.8%) and COVID-19 patients with co-morbid conditions were 108 (21.2%). The age of the only COVID-19 patients (39(2,83)) and COVID-19 patients with co-morbid conditions (56.5(30,90)) were compared and found Statistically Significant with a p-value of <0.0001.

Variables	Patients with only COVID-19 (n = 401) (78.8%)	COVID-19 patients with co-morbid conditions (n = 108) (21.2%)	P value
Age	39(2,83)	56.5(30,90)	<0.0001*
Gender			
Male ≤ 19 years	11 (2.7%)	-	-
Female ≤ 19 years	12 (3.0%)	-	-
Male ≥ 20 years	234 (58.4%)	64 (59.3%)	0.948
Female ≥ 20 years	144 (35.9%)	44 (40.7%)	0.204
Presence of COVID-19 Symptoms			
Fever	297 (78.6%)	80 (74.1%)	0.998
Cold	198 (52.4%)	57 (47.2%)	0.53
Cough	232 (61.4%)	70 (64.8%)	0.191
Myalgia	151 (39.9%)	53 (49.1%)	0.031*
Loss of Appetite	96 (52.4%)	28 (25.9%)	0.669
Loss of Taste	106 (28%)	26 (24.1%)	0.619
Loss of Smell	112 (29.6%)	31 (28.7%)	0.873
Nausea &Vomiting	46 (12.2%)	13 (12%)	0.87
Abdominal Pain	34 (9.0%)	7 (6.5%)	0.498
Diarrhoea	42 (11.1%)	13 (12%)	0.642
Chills	32 (8.5%)	16 (14.8%)	0.030*

* Statistical Significant

Table 2: Comparison of patients with Only COVID-19 Vs. COVID-19 patients with co-morbid conditions.

Table 2 also shows the age and gender categorization, both genders of <19 years were without co-morbid conditions, whereas >20 years of age groups in both genders had co-morbid conditions. Males 64 (59.3%) were higher with co-morbid conditions compared with females 44 (40.7%). We also analyzed the presence of symptoms between only COVID-19 patients and COVID-19 patients with co-morbid conditions. Among the only COVID-19 patients, fever, cold, loss of appetite, loss of taste, loss of smell, nausea, vomiting, and abdominal pain were higher compared to COVID-19 patients with co-morbid conditions. In COVID-19 patients with co-morbid conditions, cough and myalgia were higher compared to only COVID-19 patients with statistical significance (p-value-0.031). Diarrhea was slightly higher in COVID-19 patients with co-morbid conditions, and chills were also higher in COVID-19 patients with the co-morbid condition compared to patients with only COVID-19 showing a statistical significance of (p-value-0.030).

Variables	Male (n=309)			Female (n=200)		
	Patients with only COVID-19	COVID-19 patients with co-morbid conditions	P value	Patients with only COVID-19	COVID-19 patients with co-morbid conditions	P value
TC (>11K)	238 (77%)	71 (23%)	0.366	148(74%)	52 (26%)	0.319
NLR (>3)	252 (81.6%)	57 (18.4%)	0.513	158 (79%)	42 (21%)	0.75
CRP (>10)	78 (25.2%)	231 (74.8%)	0.706	64 (32%)	136 (68%)	0.482
LDH (>350)	188 (60.8%)	121 (39.2%)	0.257	121 (60.5%)	79 (39.5%)	0.828

Table 3: Bio-Chemical profile of Patients with Only COVID-19 vs. Patients with COVID-19 and Co-morbid conditions.

Table 3 shows the biochemical profile of Patients with Only COVID-19 vs patients with COVID-19 and Co-morbid conditions. The elevated level of TC in males only with COVID-19 was 77% and in COVID-19 patients with co-morbid conditions was 23%. In females, the elevated TC was 74% in only COVID-19 whereas COVID-19 patients with co-morbid conditions were 26%. The elevated level of NLR in males only with COVID-19 was 81.6% and in COVID-19 patients with co-morbid conditions was 18.4%. In females, the elevated NLR was 79% in only COVID-19 whereas COVID-19 patients with co-morbid conditions were 21%. The elevated level of CRP in males only with COVID-19 was 25.2% and in COVID-19 patients with co-morbid conditions was 74.8%. In females, the elevated CRP was 32% in only COVID-19 whereas COVID-19 patients with co-morbid conditions were 68%. The elevated level of LDH in males only with COVID-19 was 60.8% and in COVID-19 patients with co-morbid conditions was 39.2%. In females, the elevated TC was 60.5% in only COVID-19 whereas COVID-19 patients with co-morbid conditions were 39.5%. CRP was elevated in a higher percentage in COVID-19 patients with co-morbid conditions compared to only COVID-19 patients than other biochemical markers.

CT Grade	Patients with only COVID-19 (n = 401)	Patients with COVID-19 and other Co-morbid conditions (n = 108)	P value
Grade 0	338 (84.3%)	80 (74.1%)	0.004*
Grade I	34 (8.5%)	12 (11.1%)	0.397
Grade II	26 (6.5%)	11 (10.2%)	0.188
Grade III	3 (0.7%)	2 (1.8%)	0.301
Grade IV	0 (0)	3 (2.8%)	-

* Statistical Significant

Table 4: CT grades based on presence of Co-morbid condition.

Table 4 shows the CT grades in only COVID-19 patients and COVID-19 patients with co-morbid conditions. Grade 0 was higher in both groups with a statistical significance of (p-value-0.004). Among the CT grade in both groups, CT grade I was higher compared to other CT grades. In COVID-19 patients with co-morbid grade IV was seen in 3 patients whereas, in only COVID-19 patients, no CT grade IV was found.

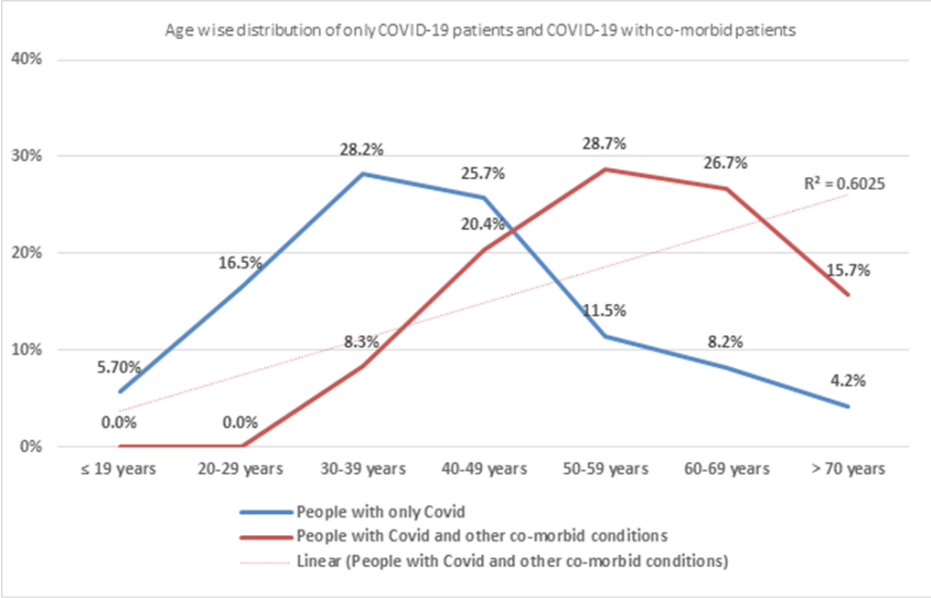

Figure 1: Age wise distribution of only COVID-19 patients and COVID-19 with co-morbid patients.

Figure 1 describes the age-wise distribution of only COVID-19 patients and COVID-19 with co-morbid patients. Patients with only COVID-19 were in higher percentage (28.2%) in the age group of 30-39 years compared to other age groups, whereas COVID-19 with co-morbid patients was higher in percentage (28.7%) in the 50-59 years of age group compared to other age groups.

Discussion

A study published by Zhang, J et al showed that older patients > 60 years exhibited a more and high graded severity form of COVID-19 disease [24]. In our study also, COVID-19 with co-morbid patients was higher in percentage in the 50-59 years of age group compared to other age groups. Yang, X et al reported the onset of this COVID-19 breakdown symptom was fever and cough, this present study also found that fever and cough were in a higher percentage of COVID-19 patients [25]. Zhou, F et al published an article that described that hypertension and cardiovascular conditions were the predominant co-morbidities found in their study, but they have not given co-morbidities based on gender. Our study explains that in male COVID-19 patients hypertension is the higher found co-morbidity and in females, diabetes is the higher found co-morbidity [26]. Data published by Sanyaolu, et al showed that 15.80% of COVID-19 patients had hypertension, but not given a gender-wise distribution, but our present study reported that hypertension is the leading co-morbidities in male COVID-19 patients, and in females, hypertension is the second largest predominant underlying disease, whereas diabetes being the first predominant co-morbidities in females [27]. As per the CDC's weekly report of morbidity and mortality by Garg, S et al, 34.6% of patients who are aged 18 to 49 years with an underlying chronic condition of lung disease, like asthma, but not provided a gender-wise distribution of underlying co-morbidities. In our study, we reported that only female patients had asthma and not male patients [28]. Wu, C, et al reported in CDC weekly report that as the age increased the rate of mortality also increased, our present study also reported that the age of 50-59 years was in a high percentage of COVID-19 with co-morbidities patients and these category patients with increased age with COVID-19 and co-morbidities requires immediate and intensive management care to reduce the further mortality of these elderly COVID-19 patients with co-morbidities [29]. A cohort study published by Zhu, L, et al explained that type 2 diabetes COVID-19 patients required increased interventions than non-diabetic; poorer blood glucose control substantially increased the risks of complications and mortality [30]. Risks of mortality are higher (1.3) for patients with complicated diabetes, and other related disorders compared with patients without underlying conditions, but not reported the gender

and reported that limited information is available for hypertension [31]. But, in our present study, we reported the presentence of gender-wise co-morbidities and diabetes was an increased percentage in females than in males, and hypertension was high in males than in females. Aiyegbusi, O. L, et al data explained that symptoms of long COVID-19 include myalgia, fatigue, and cough. Our present data reports that in COVID-19 patients with co-morbid conditions cough and Mylagia were higher compared to only COVID-19 patients with the statistical significance (p-value-0.031) [32]. Ranzani, O. T, et al and Menni, C, et al reported older patients (>65 years) with underlying conditions are at greater risk, which may be due to the vaccine effectiveness or potency wanes more rapidly in these age groups [33,34].

In conclusion, through this present study, we have a better understanding of the association of co-morbidities, age, and gender with COVID-19 diseases prognosis and these vital markers play an important role in Covid-19 diseases, hence clinicians and health care workers must surely record all the co-morbid conditions of the patients during their admission for COVID-19 and, follow a separate protocol of standard management care for patients with COVID-19 with co-morbidities to reduce the morbidity and mortality caused by COVID-19, still several qualitative and quantities studies on COVID-19 complete profile and vaccine efficacy will bring enlightening insights to reduce and eradicate COVID-19 and Long COVID from our world.

References

1. World Health Organization, “WHO Coronavirus (COVID19).
2. Singh AK, Gupta R, Ghosh A, Misra A (2020) Diabetes in COVID-19: Prevalence, pathophysiology, prognosis and practical considerations. Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 14: 303-310.
3. Liu K, Chen Y, Lin R, Han K (2020) Clinical features of COVID-19 in elderly patients: a comparison with young and middle-aged patients. J InfSecur. 15: 1-5.
4. Covid CDC, Team R, COVID C, Bialek S, et al (2020) Severe outcomes among patients with coronavirus disease 2019 (COVID-19) United States, February 12–March 16, 2020. Morbidity and mortality weekly report, 69: 343.
5. Wang B, Li R, Lu Z, Huang Y (2020) Does comorbidity increase the risk of patients with COVID-19: evidence from meta-analysis. Aging (albany NY), 12: 6049.
6. Hoang T (2021) Characteristics of COVID-19 recurrence: a systematic review and meta-analysis. Annals of Global Health, 87.
7. Koyyada R, Nagalla B, Tummala A, Singh AD, Patnam S, et al (2022) Prevalence and Impact of Preexisting Comorbidities on Overall Clinical Outcomes of Hospitalized COVID-19 Patients. BioMed research international, 2022: 1-12.
8. Malik JA, Mulla AH, Farooqi T, Pottoo FH, Anwar S, et al (2021) Targets and strategies for vaccine development against SARS-CoV-2. Biomedicine & Pharmacotherapy, 137: 111254.
9. Wang T, Du Z, Zhu F, Cao Z, An Y, et al (2020) Comorbidities and multi-organ injuries in the treatment of COVID-19. The Lancet, 395: e52.
10. Ejaz H, Alsrhani, A, Zafar, A, Javed, H, Junaid, K, et al, (2020). COVID-19 and comorbidities: Deleterious impact on infected patients. Journal of infection and public health, 13(12), 1833-1839.
11. Huang, C, Wang, Y, Li, X, Ren, L, Zhao, J, et al, (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The lancet, 395(10223), 497-506.
12. Chen N, Zhou M, Dong X, Qu J, Gong F, et al (2020) Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. The lancet, 395: 507-513.
13. Liu K, Fang YY, Deng Y, Liu W, Wang MF, et al, (2020) Clinical characteristics of novel coronavirus cases in tertiary hospitals in Hubei Province. Chinese medical journal, 133: 1025-1031.
14. Mauvais-Jarvis F (2020) Aging, male sex, obesity, and metabolic inflammation create the perfect storm for COVID-19. Diabetes, 69: 1857-1863.
15. Eggink D, Andeweg SP, Vennema H, van Maarseveen N, Vermaas K, et al, (2022) Increased risk of infection with SARS-CoV-2 Omicron BA. 1 compared with Delta in vaccinated and previously infected individuals, the Netherlands, 22 November 2021 to 19 January 2022. Eurosurveillance, 27: 2101196.
16. Altarawneh HN, Chemaitelly H, Hasan MR, Ayoub HH, Qassim, S, et al (2022) Protection against the omicron variant from previous SARS-CoV-2 infection. New England Journal of Medicine, 386: 1288-1290.
17. Jiang DH, Roy DJ, Gu BJ, Hassett LC, McCoy RG (2021) Post-acute sequelae of severe acute respiratory syndrome coronavirus 2 infection: a state-of-the-art review. Basic to Translational Science, 6: 796-811.
18. Zhu J, Jain S, Sha J, Batra H, Ananthaswamy N, et al (2022) A Bacteriophage-Based, Highly Efficacious, Needle-and Adjuvant-Free, Mucosal COVID-19 Vaccine. mBio, e01822-22.
19. Richmond C (2004) “Obituary-Sir Godfrey Hounsfield”. BMJ. 2004: 329: 687.
20. Teferi R, Hanson CA, Inwards DJ (2005) How to interpret and pursue an abnormal complete blood cell count in adults, concise review for Clinicians. In Mayo Clinic Proceedings 80: 923-936.
21. Tillett WS, Francis Jr T (1930) Serological reactions in pneumonia with a non-protein somatic fraction of pneumococcus. The Journal of experimental medicine. 52: 561.
22. Zahorec R (2001) Ratio of neutrophil to lymphocyte counts-rapid and simple parameter of systemic inflammation and stress in critically ill. Bratislavskelekarskelisty, 102: 5-14.
23. Bhagavan NV (2002) CHAPTER 27-Nucleotide metabolism. Medical Biochemistry (Fourth Edition), NV Bhagavan, Editor. 2002: 615-44.
24. Zhang J, Wang X, Jia X, Li J, Hu K, et al (2020) Risk factors for disease severity, unimprovement, and mortality in COVID-19 patients in Wuhan, China. Clinical microbiology and infection, 26: 767-772.
25. Yang X, Yu Y, Xu J, Shu H, Liu H, et al (2020) Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. The Lancet Respiratory Medicine, 8: 475-481.

26. Zhou FY u T, Du R, Fan G, Liu Y, et al (2020) Clinical course and risk factors for mortality of adult inpatients with COVID19 in Wuhan, China: a retrospective cohort study. Lancet, 395: 1054-1062.

27. Sanyaolu A, Okorie C, Marinkovic A, Patidar R, Younis K, et al, (2020). Comorbidity and its impact on patients with COVID-19. SN comprehensive clinical medicine, 2: 1069-1076.

28. Garg S, Kim L, Whitaker M, O'Halloran A, Cummings C, et al (2020) Hospitalization rates and characteristics of patients hospitalized with laboratory-confirmed coronavirus disease 2019—COVID-NET, 14 States, March 1–30, 2020. Morbidity and mortality weekly report, 69: 458.

29. Wu C, Chen X, Cai Y, Zhou X, Xu S, et al (2020) Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in Wuhan, China. JAMA internal medicine, 180(7), 934-943.

30. Zhu L, She ZG, Cheng X, Qin JJ, Zhang XJ, et al (2020) Association of blood glucose control and outcomes in patients with COVID-19 and pre-existing type 2 diabetes. Cell metabolism, 31: 1068-1077.

31. Kompaniyets L, Pennington AF, Goodman AB, Rosenblum HG, Belay B, et al (2021). Peer Reviewed: Underlying Medical Conditions and Severe Illness Among 540,667 Adults Hospitalized With COVID-19, March 2020–March 2021. Preventing chronic disease, 18.

32. Aiyegbusi OL, Hughes SE, Turner G, Rivera SC, McMullan C, et al (2021) Symptoms, complications and management of long COVID: a review. Journal of the Royal Society of Medicine, 114: 428-442.

33. Ranzani OT, Hitchings MD, Dorion M, D'Agostini TL, de Paula RC, et al (2021) Effectiveness of the CoronaVac vaccine in older adults during a gamma variant associated epidemic of covid-19 in Brazil: test negative case-control study. BMJ, 20: 374.

34. Menni C, May A, Polidori L, Louca P, Wolf J, et al (2022) COVID0-19 vaccine waning and effectiveness and side-effects of boosters: a prospective community study from the ZOE COVID Study. The Lancet Infectious Diseases, 22: 1002-1010.