ORIGINAL ARTICLE

Epidemiological features of COVID-19 in Iran

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Background: The first confirmed case of COVID-19 in Iran was reported in February 2019. The current study aimed to investigate the epidemiological aspects of COVID-19 disease in Isfahan province and evaluate the chances of infection and death in the population. **Materials and Methods:** In this cross-sectional study, 21,203 confirmed cases of COVID-19, based on the polymerase chain reaction test, referred to outpatient facilities from February 2019 to July 2020 in Isfahan province are studied. Disease incidence, mortality, and case fatality rate, as well as odds ratio (OR) of infection and death, were calculated and analyzed using SPSS version 20. **Results:** The highest incidence of the disease was within the age group of 30–39 years 4911 (23.9%) and males 11,561 (54.5%). Mortality in people over 80 years (207 [32.9%]), men (370 cases [58.7%]), diabetics (182 cases [28.9%]), and people with cardiovascular disease (165 people [26.2%]) was more. In multivariate analysis, patients with a cancer diagnosis had the highest OR of death (OR = 4.03 confidence interval [CI]: 2.56–6.35) ($P < 0.001$), followed by those with immune deficiency disease (OR = 2.46 CI: 1.07–5.63) ($P = 0.03$). As the number of comorbidities increased, the risk of death increased in the total population, so that in patients with more than 4 underlying diseases, compared to the group without disease, the chance of death increased 6.33 times. **Conclusion:** This study showed that people with cancer and chronic respiratory disease had a higher chance of COVID-19 infection. People over the age of 60, people with cancer, and immunodeficiency also had a higher chance of COVID-19 mortalityW.

Keywords: Coronavirus, COVID-9, disease incidence, epidemiology, mortality

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INTRODUCTION

As a part of the worldwide pandemic of COVID-19, the first confirmed case of the disease in Iran was reported in February 2019 in the city of Qom. According to the Ministry of Health and Medical Education, provinces with high population density and attractive destinations for tourists (e.g., Mazandaran, Guilan, and Isfahan provinces) are more affected by the pandemic. As a newly identified pathogen with no previous immunity, coronavirus has affected many countries, including Iran. Based on the epidemiological profile of the disease, as published by China, no one is safe against COVID-19 and a series of risk factors increase the likelihood of the infection.[1] From its inception until May 7, 2020, COVID-19 has claimed 260,000 lives and infected nearly 3.5 million people worldwide. In Iran, 101,650 confirmed cases of COVID-19 are registered and more than 6418 Iranians are died.[2] COVID-19 may be asymptomatic; however, it has a wide spectrum of symptoms, including fever, dry cough, fatigue, sputum production, breathlessness, sore throat, headache, myalgia or arthralgia, chills, nausea or vomiting, nasal congestion, diarrhea, hemoptysis, and conjunctival congestion.[3]

Elderly and chronically-ill patients suffering from hypertension, diabetes, cardiovascular disease, chronic respiratory disease, and cancer are at increased risk for severe COVID-19 infection.[4] It is reported that children are less sensitive to COVID-19 infection.[5]

The current study has investigated epidemiological aspects of COVID-19 disease in Isfahan province

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and examines the chances of infection and death in the population.

MATERIALS AND METHODS

This descriptive, cross-sectional, multicenter study is conducted in Isfahan province (Iran) from February 29, 2020, to July 21, 2020. All patients with confirmed COVID-19, based on the real-time polymerase chain reaction (PCR), in the Isfahan province during the study period were included. Outpatients were selected from comprehensive health care centers, while inpatients were selected from hospitals. The current study is approved by the Ethics Committee of the Isfahan University of Medical Sciences. Besides, patients were ensured about the confidentiality of information. Patients were identified by their national code. Date of hospitalization (when the patient was admitted to the hospital for the first time), date of discharge (when the patient was discharged from the hospital for the first time), sampling date and the date of diagnosis (results of the PCR test), date of death, age, sex, place of residence (city/village), comorbid condition (cancer, diabetes, hypertension, chronic respiratory disease, cardiovascular disease, immune deficiency disease, severe obesity, and pregnancy), and final outcome (recovery/death) were extracted using patients' electronic medical files and hospital information archives. A member of the research team randomly checked the demographic factors and background conditions and the outcome of the disease by telephone calls.

The case fatality rate (CFR) was calculated using the total number of deaths (numerator) and the total number of cases (denominator). The mean (standard deviation) was used to describe quantitative variables and the frequency (percentage) was used for qualitative variables. The Chi-square test and univariate and multivariate logistic regression analysis were used to analyze the data. Statistical analyses were conducted using SPSS Statistics for Windows, version 20.0 (SPSS Inc., Chicago, Ill., USA) Statistical significance was considered when $P < 0.05$.

RESULTS

In this study, a sample of 21,203 confirmed cases of COVID-19, based on the PCR test, was analyzed. The mean age of patients was 46.19 ± 19.12 years, who 11,561 (54.5%) of them were male and 9642 (45.5%) were female. The highest incidence of the disease was within the age group of 30–39 years 4911 (23.2%), males 11,561 (54.5%), diabetics 2727 (12.9%), hypertensive 2706 (12.8%), and those with cardiovascular diseases 2503 (11.8%). Out of 21,203 participants, 11,650 (68.1%) were living in urban areas with more than 20,000 population.

The highest chance of getting the COVID-19 disease is observed in the age group over 70 years 4.49 (4.31–4.68). Men had a higher chance 1.19 (1.15–1.22) of getting it than women. Patients with a cancer diagnosis had the highest 29.59 (25.57–34.23), followed by those with chronic respiratory diseases 20.43 (19.05–21.91) [Table 1].

The mortality rate, proportionate mortality, and CFR are illustrated in Table 2.

As shown in Table 3, those with cancer diagnosis had the highest odds ratio (OR) 4.03 (2.56–6.35) of dying due to COVID-19, followed by immune deficiency disease 2.46 (1.07–5.63) and hypertension 2.04 (1.63–2.55).

The OR of mortality due to COVID-19 based on gender, age, and number of underlying diseases is given in Table 4.

DISCUSSION

This study aimed to evaluate the risk factors for incidence and death in patients with a definitive diagnosis of COVID-19 in Isfahan province, Iran. In the early stages of the COVID-19 pandemic, severely-ill hospitalized patients were only selected, so the diagnosis of patients with mild symptoms in Iran was relatively low. Then, patients' identification was gradually expanded to patients with mild symptoms; hence, the incidence rate becomes closer to reality. However, it is still uncertain whether all cases of infection and death due to COVID-19 have been diagnosed and reported in

Table 1: Odds ratio of coronavirus disease 2019 infection separated by age, sex, and underlying diseases

Variable	Infection (OR)	95% CI for OR
Age		
<10	0.10	0.09-0.11
10-19	0.25	0.24-0.27
20-29	0.83	0.80-0.87
30-39	1.82	1.76-1.88
40-49	1.14	1.10-1.18
50-59	1.54	1.49-1.60
60-69	2.01	1.92-2.09
70-79	4.49	4.31-4.68
>80	3.25	3.12-3.53
Sex		
Male/female	1.19	1.15-1.22
Underlying disease	0.05	0.05
Diabetes	4.7	4.49-4.87
Hypertention	2.55	2.45-2.65
Cardiovascular disease	7.6	7.28-7.93
Chronic respiratory disease	20.43	19.05-21.91
Cancer	29.59	25.57-34.23
Severe obesity	1	1.001-1.002

OR=Odds ratio; CI=Confidence interval

Table 2: Incidence, mortality, proportionate mortality, and case fatality rate of patients with coronavirus disease 2019 (*n*=21,203)

Variable	Total population (*n*)	Mortality rate (per 100,000)	Confirmed case, *n* (%)	Mortality, *n* (proportionate %)	Case fatality rate (%)	*P**
Age						
<10	772,650	0.5	458 (2.2)	4 (0.6)	0.9	<0.0001
10-19	661,165	0.45	915 (4.3)	3 (0.5)	0.3	<0.0001
20-29	624,021	0.96	2539 (12)	6 (1)	0.2	<0.0001
30-39	977,099	1.3	4911 (23.2)	12 (1.9)	0.2	<0.0001
40-49	683,423	5	3640 (17.3)	34 (5.4)	0.8	<0.0001
50-59	465,930	12.9	3242 (15.3)	60 (9.5)	1.8	<0.0001
60-69	297,282	36.3	2652 (12.5)	108 (17.1)	2.3	<0.0001
70-79	139,272	140.7	1683 (7.9)	196 (31.1)	11	<0.0001
>80	71,932	287.7	1086 (5.1)	207 (32.9)	17.8	<0.0001
Sex						
Male	2,236,846	16.5	11561 (54.5)	370 (58.7)	2.8	0.017
Female	2,218,294	11.72	9642 (45.5)	260 (41.3)	2.4	
Comorbid condition						
Hypertension	243,200	61.67	2706 (12.8)	150 (23.8)	15.6	<0.00001
Diabetes	138,400	131.5	2727 (12.9)	182 (28.9)	3.3	<0.00001
Cardiovascular disease	79,210	208.3	2503 (11.8)	165 (26.2)	7.6	<0.00001
Chronic respiratory disease	10,412	624.27	893 (4.2)	65 (10.3)	7.4	<0.00001
Cancer	1692	1063.8	208 (1)	18 (2.9)	14.9	<0.00001
Pregnancy	20,342		186 (0.9)	8 (1.3)	0.5	0.04
Immune deficiency disease	2366	126.8	76 (0.4)	3 (0.5)	11.5	<0.00001
Severe obesity	36,702	27.2	123 (0.6)	10 (1.6)	6.5	0.02
Location of residency						
City with population>20,000 people	2,952,604	10.09	11650 (68.1)	298 (58.7)	2.4	<0.00001
City with population<20,000 people	666,881	29.36	2147 (12.5)	95 (18.7)	2.9	
Marginalized	523,499	6.49	1697 (9.9)	34 (6.7)	2.5	
Rural	547,040	14.8	1628 (9.5)	81 (15.9)	2.5	

*Chi-square test,

Iran. In the present study, those with cancer and chronic respiratory diseases had the highest chance of infection. Diabetes, cardiovascular diseases, and hypertension were also major risk factors for COVID-19 infection. Furthermore, males were at greater risk of developing COVID-19. In a meta-analysis of 1558 patients with confirmed COVID-19, hypertension, diabetes, chronic obstructive pulmonary diseases (COPDs), and cardiovascular and cerebrovascular diseases are reported as the most fundamental risk factors for COVID-19 infection. This meta-analysis found no association between an increased risk of COVID-19 and liver disease, malignancy, or kidney diseases.[6]

In another meta-analysis conducted by Emami *et al*. on 76,993 hospitalized COVID-19 patients, the authors mentioned hypertension, cardiovascular diseases, diabetes, chronic renal disease, COPD, and malignancy as the most prevalent underlying diseases.[7] The CFR is often used to describe the burden of COVID-19 and other diseases. However, several factors contribute to accurate estimates of CFR such as virus novelty, clinical course, few information about them, capacity, and healthcare-related factors such as human resources, facilities, resources and preparedness, tracking contacting persons, and implementation of quarantine policies and isolating infected or suspected cases.[8] Out of 630 officially reported deaths, 511 (81.1%) have occurred in those older than 60 years. According to the findings, the overall CFR was 3%, which was calculated based on the total number of patients (both outpatients and inpatients). The CFRs reported by other studies range from 1.85% to 9.26%.[9,10] On March 23, the CFR in Italy, Spain, and France was 9.26%, 6.16%, and 4.21%, respectively.[11] This discrepancy can be attributed to differences in the age and genes of the populations in various countries, sampling approaches, screening protocols, and access to health infrastructure.

For those older than 80 years, males, cancer patients, obese people, and those living in rural areas and cities with a population of <20,000 the CFR and mortality rate per 100,000 inhabitants were higher. Risk factors such as excessive obesity, diabetes, cardiovascular diseases, chronic respiratory disease, and cancer, increase the likelihood of death due to COVID-19 by more than 2.5 times. Possibly, the higher mortality rate in cities with a population of <20,000 and rural areas is due to limited access to advanced medical

Table 3: Univariate and multivariate analysis of dying due to coronavirus disease 2019 separated by age groups, sex, city and underlying diseases

Variable	Univariate analysis		Multivariate analysis	
	OR (95% CI for OR)	*P**	OR (95% CI for OR)	*P**
Age (years)				
Children (<5)	0.7 (0.31-1.57)	0.38	0.75 (0.28-2.04)	0.58
Adolescents (6-19)	0.07 (0.02-0.24)	<0.0001	7.38 (2.36-23.04)	0.001
Young (19-29)	0.06 (0.03-0.13)	<0.0001	0.10 (0.04-0.24)	<0.0001
Middle-aged (30-59)	0.15 (0.12-0.18)	<0.0001	0.19 (0.15-0.24)	<0.0001
Elderly (>60)	14.19 (11.73-17.18)	<0.0001	10.18 (8.22-12.62)	<0.0001
Sex				
Male/female	1.16 (1-1.35)	0.05	1.25 (1.05-1.48)	0.01
City				
Isfahan/other	2.55 (1.99-3.26)	<0.0001	0.81 (0.61-1.06)	0.13
City/rural	1.03 (0.78-1.37)	0.8	1.22 (0.89-1.66)	0.2
Comorbid condition[++]				
Diabetes	1.36 (2.79-4.02)	<0.0001	1.49 (1.22-1.83)	<0.0001
Hypertention	7.48 (6.12-9.15)	<0.0001	2.04 (1.63-2.55)	<0.0001
Cardiovascular disease	3.27 (2.73-3.93)	<0.0001	0.98 (0.8-1.21)	0.91
Chronic respiratory disease	2.79 (2.12-3.66)	<0.0001	1.44 (1.07-1.95)	0.01
Cancer	5.90 (3.97-8.76)	<0.0001	4.03 (2.56-6.35)	<0.0001
Immune deficiency disease	4.28 (2.13-8.62)	<0.0001	2.46 (1.07-5.63)	0.03
Pregnancy	0.17 (0.02-1.24)	0.08	0.73 (0.08-6.83)	0.78
Sever obesity	2.25 (1.09-4.64)	0.02	1.25 (0.55-2.84)	0.19
Other disease	0.92 (0.76-1.11)	0.40	1.80 (1.39-2.33)	<0.0001

[++]Yes/no. OR=Odds ratio; CI=Confidence interval

facilities and hospitals or delayed referrals to healthcare centers. Ji *et al*. pointed to the potential association between access to healthcare services and COVID-19 mortality.[12] Peng *et al*. argued that the timely management of cases has a crucial role in reducing COVID-19 mortality.[13]

However, Lai *et al*. showed that the incidence of COVID-19 has a positive correlation with access to and quality of healthcare services, while mortality per 1,000,000 inhabitants was not associated with the level of provided services.[14] These findings might be explained by the fact that many countries did not provide accurate information on deaths at the time of the study. Mehra *et al*. argued that being older than 65 years, coronary artery disease, heart failure, cardiac arrhythmia, and COPD are associated with an increased risk of in-hospital death from COVID-19.[15] Du *et al*. also discovered that being older than 65 years, preexisting concurrent cardiovascular or cerebrovascular diseases were associated with higher death due to COVID-19 pneumonia.[16] The results of recent studies on the role of obesity as a risk factor for coronavirus mortality in Italy are conflicting.[17] In the present study, the CFR in those with excessive obesity was 8.1%, but its role as a risk factor in the incidence of COVID-19 infection was not confirmed (OR = 1). Jin *et al*. examined the association between gender and the incidence and mortality among COVID-19 patients and found no difference between both sex concerning the disease incidence, but men demonstrated a greater risk for adverse complications and higher mortality rates.[18] In our study, the mortality rate of males was higher than females. Therefore, there is a gender difference concerning COVID-19-related deaths. The observed difference between these two studies could be attributed to the different sexual behaviors and lifestyles of the two communities under investigation.

Shi *et al*. and Huang *et al*. argued that diabetes is associated with both increased mortality and worse prognosis in COVID-19 patients.[19,20] In the present study, also, diabetes was associated with an increased risk of death due to COVID-19 infection by 2.75-folds. Diabetic patients are at a greater risk of experiencing respiratory infections due to immune response dysregulations, especially innate immunity.[21] Cardiovascular diseases are also correlated with an increased risk for poor outcomes in COVID-19 patients.[22] Based on the evidence, it seems that COVID-19 causes heart diseases or exacerbates the existing cardiovascular diseases.[23] Furthermore, cancer was also a major risk factor for severe respiratory disease and pneumonia due to malignancy or immunosuppressive medications. COVID-19-infected cancer patients presented unsatisfactory outcomes with a high occurrence of clinically severe consequences and death rates as well.[24] In the current study, the mortality rate of cancer patients infected with COVID-19 was higher by 2.96-folds.

The current study has some limitations, including not investigating the association between disease severity,

Table 4: Logestic regression analysis of mortality due to coronavirus disease 2019

Variable	OR (95% CI for OR)							
	Total population[a]	Gender[b]		Age groups[c] (years)				
		Male	Female	<5	5-19	20-29	3-59	>60
Comorbidity (contin)	1.45 (1.34-1.57)	1.39 (1.25-1.55)	1.54 (1.37-1.73)	N.C	6.25 (0.96-40.63)	3.61 (0.95-13.72)	2.34 (1.95-2.80)	1.42 (1.31-1.55)
Comorbidity								
No	1	1	1	1	1			
Yes	1.54 (1.30-1.82)	1.46 (1.18-1.81)	1.68 (1.28-2.19)	1.75 (0.31-9.9)	1.87 (0.16-20.75)	1.25 (0.22-6.83)	2.36 (1.64-3.41)	1.46 (1.22-1.76)
Comorbidity number								
No	1	1	1	1	1	1	1	1
1	1.64 (1.34-2.01)	1.75 (1.35-2.26)	1.51 (1.08-2.09)	N.C	N.C	6.12 (1.09-34.41)	3.08 (1.95-4.85)	1.45 (1.16-1.81)
2	2.03 (1.60-2.57)	1.91 (1.39-2.64)	2.17 (1.52-3.12)	N.C	14.23 (1.25-161.5)	N.C	7.98 (4.49-14.11)	1.80 (1.40-2.32)
3	2.94 (2.09-4.13)	1.89 (1.13-3.15)	4.46 (2.78-7.13)	N.C	N.C	N.C	16.66 (6.9-40.21)	2.82 (1.98-4.02)
≥4	6.33 (1.34-2.01)	8.01 (3.75-17.08)	5.3 (2.52-11.13)	N.C	N.C	N.C	32.84 (9.31-115.82)	5.77 (3.34-9.96)

[a]Adjusted for age and gender, [b]Adjusted for age, [c]Adjusted for gender. OR=Odds ratio; CI=Confidence interval

hospitalization in the intensive care unit, and the need for mechanical ventilation. We also tried to shed light on the influence of underlying diseases on the incidence and mortality of COVID-19 using electronic health records of patients; however, other diseases were not evaluated. Furthermore, as mentioned previously, initially only patients with severe conditions were recording and the registration system was gradually developed to other patients. Moreover, the criterion of PCR testing was changed which may have affected the number of infected patients and the total mortality.

CONCLUSION

This study demonstrated that chronic respiratory disease and cancer were major factors that increased COVID-19 infection. Being older than 60 years, cancer, diabetes, and cardiovascular diseases also profoundly increase the chance of death from COVID-19. Through raising awareness about these factors, categorization of those who are at increased risk of developing COVID-19 infection can be improved; hence, better preventive interventions can be designed and implemented.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Karimi J. Epidemiological review of the coronavirus disease 2019 (COVID-19) pandemic up to 15 March 2020. J Isfahan Med Sch 2020;38:14-23.
2. World Health Organization. Coronavirus disease 2019 (COVID-19): situation report,3. 2020.
3. Wang C, Horby PW, Hayden FG, Gao GF. A novel coronavirus outbreak of global health concern. Lancet 2020;395:470-3.
4. Lippi G, Wong J, Henry BM. Hypertension and its severity or mortality in Coronavirus Disease 2019 (COVID-19): a pooled analysis. Pol Arch Intern Med. 2020 Mar 31;130(4):304-9.
5. Wu F, Zhao S, Yu B, Chen YM, Wang W, Song ZG, *et al*. A new coronavirus associated with human respiratory disease in China. Nature 2020;579:265-9.
6. Wang B, Li R, Lu Z, Huang Y. Does comorbidity increase the risk of patients with COVID-19: Evidence from meta-analysis. Aging (Albany NY) 2020;12:6049-57.
7. Emami A, Javanmardi F, Pirbonyeh N, Akbari A. Prevalence of underlying diseases in hospitalized patients with COVID-19:

A systematic review and meta-analysis. Arch Acad Emerg Med 2020;8:e35.
8. Rajgor DD, Lee MH, Archuleta S, Bagdasarian N, Quek SC. The many estimates of the COVID-19 case fatality rate. Lancet Infect Dis 2020;20:776-7.
9. Fu L, Wang B, Yuan T, Chen X, Ao Y, Fitzpatrick T, *et al.* Clinical characteristics of coronavirus disease 2019 (COVID-19) in China: A systematic review and meta-analysis. J Infect 2020;80:656-65.
10. 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;323:1239-42.
11. Khafaie MA, Rahim F. Cross-country comparison of case fatality rates of COVID-19/SARS-COV-2. Osong Public Health Res Perspect 2020;11:74-80.
12. Ji Y, Ma Z, Peppelenbosch MP, Pan Q. Potential association between COVID-19 mortality and health-care resource availability. Lancet Glob Health 2020;8:e480.
13. Peng Y, Xu B, Sun B, Han G, Zhou YH. Importance of timely management of patients in reducing fatality rate of coronavirus disease 2019. J Infect Public Health 2020;13:890-2.
14. Lai CC, Wang CY, Wang YH, Hsueh SC, Ko WC, Hsueh PR. Global epidemiology of coronavirus disease 2019 (COVID-19): Disease incidence, daily cumulative index, mortality, and their association with country healthcare resources and economic status. Int J Antimicrob Agents 2020;55:105946.
15. Mehra MR, Desai SS, Kuy S, Henry TD, Patel AN. Cardiovascular disease, drug therapy, and mortality in Covid-19. New England Journal of Medicine. 2020 Jun 18;382(25):e102.
16. Du RH, Liang LR, Yang CQ, Wang W, Cao TZ, Li M, Guo GY, Du J, Zheng CL, Zhu Q, Hu M. Predictors of mortality for patients with COVID-19 pneumonia caused by SARS-CoV-2: a prospective cohort study. European Respiratory Journal. 2020 May 1;55(5).
17. Onder G, Rezza G, Brusaferro S. Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy. JAMA 2020;323:1775-6.
18. Jin JM, Bai P, He W, Wu F, Liu XF, Han DM, *et al.* Gender differences in patients with COVID-19: Focus on severity and mortality. Front Public Health 2020;8:152.
19. Shi Q, Zhang X, Jiang F, Zhang X, Hu N, Bimu C, *et al.* Clinical characteristics and risk factors for mortality of COVID-19 patients with diabetes in Wuhan, China: A two-center, retrospective study. Diabetes Care 2020;43:1382-91.
20. Huang I, Lim MA, Pranata R. Diabetes mellitus is associated with increased mortality and severity of disease in COVID-19 pneumonia – A systematic review, meta-analysis, and meta-regression. Diabetes Metab Syndr 2020;14:395-403.
21. Ma RCW, Holt RIG. COVID-19 and diabetes. Diabet Med. 2020;37(5):723-5.
22. Pranata R, Huang I, Lim MA, Wahjoepramono EJ, July J. Impact of cerebrovascular and cardiovascular diseases on mortality and severity of COVID-19–systematic review, meta-analysis, and meta-regression. Journal of Stroke and Cerebrovascular Diseases. 2020 Aug 1;29(8):104949.
23. Madjid M, Safavi-Naeini P, Solomon SD, Vardeny O. Potential effects of coronaviruses on the cardiovascular system: A review. JAMA Cardiol 2020;5:831-40.
24. Zhang L, Zhu F, Xie L, Wang C, Wang J, Chen R, *et al.* Clinical characteristics of COVID-19-infected cancer patients: A retrospective case study in three hospitals within Wuhan, China. Ann Oncol 2020;31:894-901.