

Age-stratified analysis of SARS-CoV-2 infection and case fatality rate in China, Italy, and South Korea

J.-O. LIU¹, J.-W. XU², C.-Y. SUN³, J.-N. WANG⁴, X.-T. WANG⁵,
X. CHEN⁶, S.L. GAO⁷

¹Department of Radiotherapy, The First Affiliated Hospital of Zhengzhou University, Zhengzhou, P.R. China

²Department of Nephrology, Tongji Hospital of Tongji Medical College, Huazhong University of Science and Technology, Wuhan, P.R. China

³Department of Internal Medicine, AMITA Health Saint Joseph Hospital Chicago, Chicago, USA

⁴Institute for Social Medicine, Epidemiology, and Health Economics, Charité - Universitätsmedizin Berlin, Berlin, Germany

⁵Institute for Medical Information Processing, Biometrics and Epidemiology, Ludwig-Maximilians Universität München, Munich, Germany

⁶Department of Urology, The Second Affiliated Hospital of Anhui Medical University, Hefei, P.R. China

⁷Center of Experimental Orthopaedics, Saarland University Medical Center, Homburg/Saar, Germany

Junqi Liu and Jianwei Xu are first authors

Abstract. – OBJECTIVE: We aimed to compare the characteristics of coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in China, Italy, and South Korea.

MATERIALS AND METHODS: Detailed national epidemiological information of COVID-19 was retracted from the latest statistics reports from China, Italy, and South Korea. Population-based analysis of the age distribution among confirmed cases was conducted and their crude case fatality ratio in each c

RESULTS: The age distributions among COVID-19 cases were relatively similar between China and Italy with primarily elderly populations infected, which were considerably different from that in South Korea with primarily younger individuals infected. Most deaths occurred among elderly individuals who were older than 60 years in both Italy (98.0%) and South Korea (87.9%), consistent with the previous data from China (81.0%).

CONCLUSIONS: Most deaths occurred among elderly individuals who were over 60 in China, Italy, and South Korea. South Korea's data suggest that younger individuals might be more susceptible to SARS-CoV-2 infection, which might be fully under detected in China and Italy.

Key Words:

Coronavirus, COVID-19, Pandemic, Age, Case fatality rate, China, Italy, South Korea.

Introduction

The evolving 2019 novel coronavirus disease (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has already spread to more than 200 countries. Advanced age is associated with in-hospital deaths among adult patients with COVID-19 patients¹; however, inter-country comparisons of age-stratified infection cases and the crude case fatality rate (CFR), which are beneficial for the current global fight against COVID-19, have not yet been conducted.

Materials and Methods

We analyzed the latest statistics reports from the Chinese Center for Disease Control and Prevention (44,672 cases and 1,023 deaths until February 11, 2020)², Korea Centers for Disease

Control and Prevention (KCDC; 7,869 cases and 66 deaths until March 12, 2020)³, and Italian National Institute of Health (13,882 cases and 803 deaths until March 12, 2020)⁴. The data showed that most patients in China (53.6%) and Italy (77.4%) were aged older than 50 years; however, 59.2% of patients in South Korea were younger than 50 years, with most patients (28.7%) in their 20s. The highest crude CFR was observed in patients aged 70-79 years in both China (14.8%) and Italy (21.4%) and patients aged older than 80 years in South Korea (8.2%).

Results

The age distributions of individuals with COVID-19 were relatively similar between China and Italy with primarily elderly individuals infected, which were considerably different than that in South Korea with primarily younger individuals infected (Figure 1; Table I). Most deaths occurred among individuals who were older than 60 years in both Italy (98.0%) and South Korea (87.9%), consistent with previous data from China (81.0%)⁵. Moreover, South Korea's data

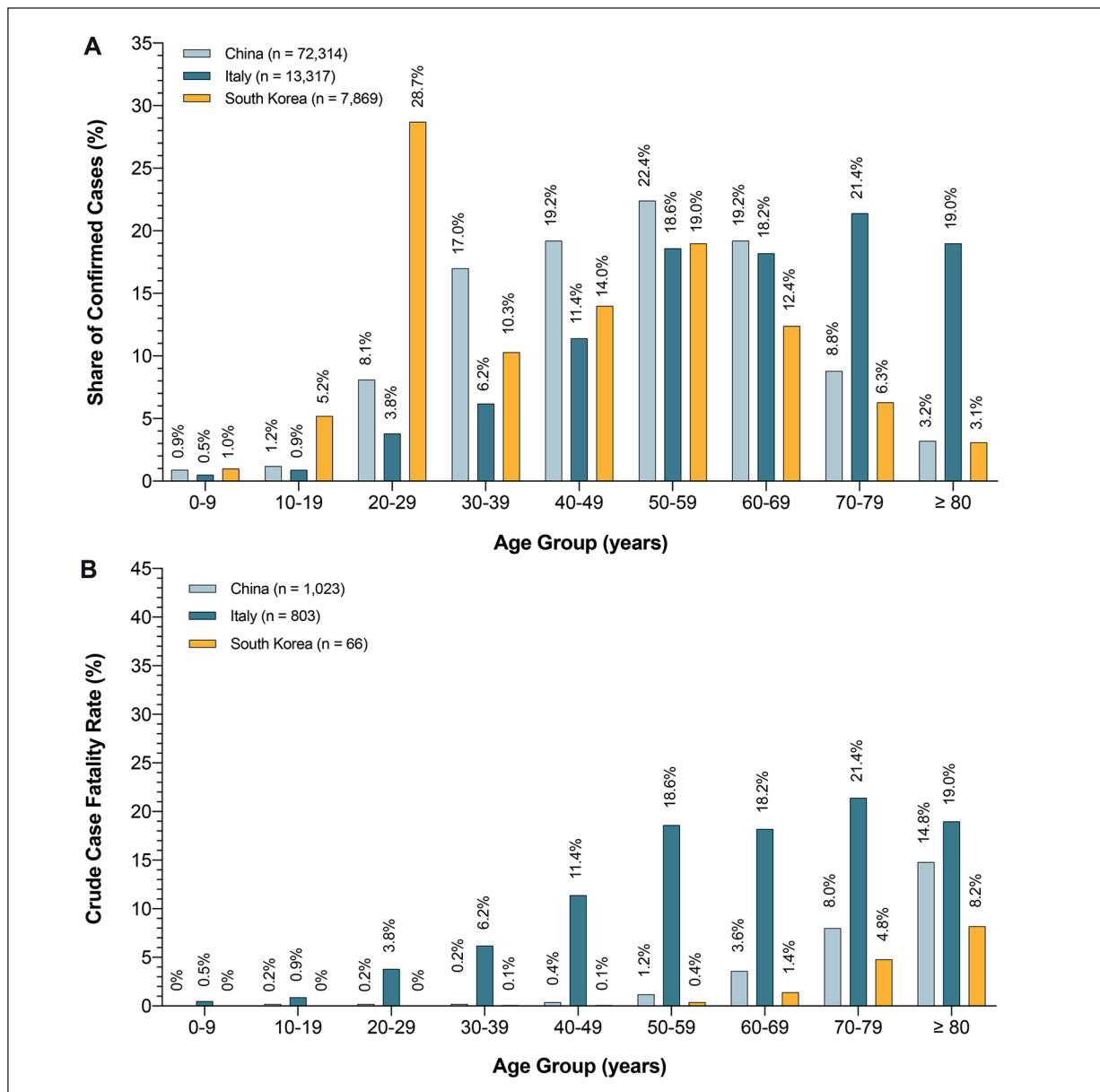


Figure 1. Age distribution of confirmed cases (A) and crude case fatality rate (B) of COVID-19 infection in China, Italy, and South Korea.

Table 1. Age-stratified calculation of confirmed cases, deaths, and crude case fatality rate of COVID-19 in China, Italy, and South Korea.

	China*			Italy†			South Korea‡		
	Cases (%)	Deaths (%)	CCFR (%)	Cases (%)	Deaths (%)	CCFR (%)	Cases (%)	Deaths (%)	CCFR (%)
Overall	44672	1023	2.3	13882	803	5.8	7869	66	0.8
Age group, years									
0-9	416 (0.9)	0 (0)	0	63 (0.5)	0 (0)	0.5	76 (1.0)	0 (0)	0
10-19	549 (1.2)	1 (0.1)	0.2	118 (0.9)	0 (0)	0.9	412 (5.2)	0 (0)	0
20-29	3619 (8.1)	7 (0.7)	0.2	511 (3.8)	0 (0)	3.8	2261 (28.7)	0 (0)	0
30-39	7600 (17.0)	18 (1.8)	0.2	819 (6.2)	1 (0.1)	6.2	812 (10.3)	1 (1.5)	0.1
40-49	8571 (19.2)	38 (3.7)	0.4	1523 (11.4)	1 (0.1)	11.4	1101 (14.0)	1 (1.5)	0.1
50-59	10008 (22.4)	130 (12.7)	1.2	2480 (18.6)	14 (1.8)	18.6	1495 (19.0)	6 (9.1)	0.4
60-69	8583 (19.2)	309 (30.2)	3.6	2421 (18.2)	65 (8.3)	18.2	972 (12.4)	14 (21.2)	1.4
70-79	3918 (8.8)	312 (30.5)	8.0	2849 (21.4)	274 (34.9)	21.4	497 (6.3)	24 (36.4)	4.8
Over 80	1408 (3.2)	208 (20.3)	14.8	2533 (19.0)	430 (54.8)	19.0	243 (3.1)	20 (30.3)	8.2

Crude case fatality rate (CGFR) is deaths divided by cases for each age group. *Data reported from Chinese Center for Disease Control and Prevention (February 11, 2020). †Data obtained from Korea Centers for Disease Control and Prevention (March 12, 2020). ‡Data obtained from Italian National Institute of Health (March 12, 2020).

suggested that younger individuals (28.3% of patients aged 20-29 years) might be more susceptible to SARS-CoV-2 infection, which might not be under detected in either China or Italy ([Supplementary Figure 1](#)).

Discussion

There are several possible explanations for the different clinical phenotypes in South Korea compared to those in China and Italy. First, according to the KCDC (March 12, 2020), 4,759 (60.5%) of South Korea's 7,869 confirmed cases of COVID-19 were linked to the Shincheonji Church of Jesus, the members of which are predominantly young³. Second, the COVID-19 testing policies among countries are greatly different. In China (320,000 individuals tested in Guangdong; 2,830 tests per million population) and Italy (60,761 individuals tested; 1,005 tests per million population), individuals exhibiting symptoms of acute respiratory infection were predominantly tested; meanwhile in South Korea with its large-scale testing program, 210,144 individuals (4,099 tests per million population)⁵ were tested, and therefore, more asymptomatic but positive COVID-19 cases were detected in South Korea than in China and Italy, particularly among young individuals⁶. Third, the potentially high mutation rate of SARS-Cov-2 might contribute to different clinical severities of the viral infection

with possibly altered host susceptibility⁷. However, more genetic and functional investigations of SARS-CoV-2 from different countries are warranted.

Conclusions

Identification of the true susceptible population is needed to ascertain the possibility of young populations as under detected virus carriers. Considering the potential mutations of SARS-CoV-2, dynamically updated treatment protocols might also be necessary to combat this evolving pandemic.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Funding Source

This study was supported by a grant (No. 81703158) from the National Natural Science Foundation of China.

Authors' Contribution

S.L.G. led the interpretation and supervised the paper. S.L.G. and J.Q.L. initiated the original concept and design of the study. C.Y.S., J.W.X., and X.C. collected the data. S.L.G. and J.Q.L. performed the statistical analysis. All authors contributed to the critical revision of the manuscript for important intellectual content.

References

- 1) ZHOU F, YU T, DU R, FAN G, LIU Y, LIU Z, XIANG J, WANG Y, SONG B, GU X, GUAN L, WEI Y, LI H, WU X, XU J, TU S, ZHANG Y, CHEN H, CAO B. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 2020; 395: 1054-1062.
- 2) NOVEL CORONAVIRUS PNEUMONIA EMERGENCY RESPONSE EPIDEMIOLOGY. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in china. *Zhonghua Liu Xing Bing Xue Za Zhi* 2020; 41: 145-151.
- 3) KOREA CENTERS FOR DISEASE CONTROL AND PREVENTION. Updates on COVID-19 in Korea (as of 12 March). https://www.cdc.go.kr/board/board.es?mid=a30402000000&bid=0030&act=view&list_no=366537.
- 4) ITALIAN NATIONAL INSTITUTE OF HEALTH. Epidemia COVID-19 Aggiornamento nazionale 12 marzo 2020 - ore 16:00. [Available from: https://www.epi-centro.iss.it/coronavirus/bollettino/Bollettino-sorveglianza-integrata-COVID-19_12-marzo-2020.pdf].
- 5) ZHUANG Z, ZHAO S, LIN Q, CAO P, LOU Y, YANG L, YANG S, HE D, XIAO L. Preliminary estimates of the reproduction number of the coronavirus disease (COVID-19) outbreak in Republic of Korea and Italy by 5 March 2020. *Int J Infect Dis* 2020; 95: 308-310.
- 6) WORDOMETERS. Coronavirus Testing: Criteria and Numbers by Country. [Available FROM: <https://www.worldometers.info/coronavirus/covid-19-testing/>].
- 7) JIN X, XU K, JIANG P, LIAN J, HAO S, YAO H, JIA H, ZHANG Y, ZHENG L, ZHENG N, CHEN D, YAO J, HU J, GAO J, WEN L, SHEN J, REN Y, YU G, WANG X, LU Y, YU X, YU L, XIANG D, WU N, LU X, CHENG L, LIU F, WU H, JIN C, YANG X, QIAN P, QIU Y, SHENG J, LIANG T, LI L, YANG Y. Virus strain from a mild COVID-19 patient in Hangzhou represents a new trend in SARS-CoV-2 evolution potentially related to Furin cleavage site. *Emerg Microbes Infect* 2020; 9: 1474-1488.