Epidemiological characteristics of all-cause mortality reviewing out-hospital death under the clouds of COVID-19

Linfeng Li¹, Weidong Yan², Yongqing Wang³, Dezhi Chen³, Yuanchang Qiao³, Min Liu¹, Bin Cong¹,⁴, Libing Yun¹

¹Department of Forensic Pathology, West China School of Basic Medical Sciences and Forensic Science, Sichuan University, Chengdu, Sichuan 610041, China; ²Department of Cardiopulmonary Bypass, Fuwai Hospital, National Center for Cardiovascular Disease, Chinese Academy of Medical Science and Peking Union Medical College, Beijing 100037, China; ³Department of Forensic Science, Criminal Science and Technology Division, Criminal Investigation Bureau, Chengdu Public Security Bureau, Chengdu, Sichuan 610031, China; ⁴Department of Forensic Medicine, Hebei Medical University, Shijiazhuang, Hebei 050017, China.

To the Editor: Coronavirus disease 2019 (COVID-19) has rapidly become a great global infection and brought about a wide range of health consequences, including a high number of deaths due to continuous spread.¹ Wu et al.² reported that the changes in mortality were heterogeneous across different countries, and this resulantly restricts the common measure of COVID-19 mortality to the particular outcome of in-hospital death and can therefore be regarded as incomplete. In China, the status of COVID-19 has varied from outbreak to proactive prevention due to comprehensive countermeasures such as maintaining social distance and wearing surgical masks. Meanwhile, investigation with community-based samples should contribute to clarifying the doubt about mortality in out-hospital deaths. Moreover, the impact of the pandemic situation on unnatural death remains unclear, particularly about suicide. This may illustrate the impact of COVID-19 on the epidemiology of people’s state of mind. A retrospective study was designed to analyze the characteristics of all deaths that occurred outside hospitals to obtain a full overview of the broader impact, as well as to lend further plausibility to the specificity of fatal associations according to the need to study all-cause mortality.

Deaths that occurred out of hospital between January 1, 2020, and April 30, 2020, were collected in Chengdu city and Tianfu new district of Sichuan, China, from the local death registration system of out-hospital death, based on the death certificates. Four groups were set according to the change of COVID-19 emergency levels in the region, which can indicate the local severity of COVID-19. The duration of each group was approximately 1 month: (1) Pre-outbreak: from January 1 to January 23, (2) Level I (period of stringent lockdown): from January 24 to February 25, (3) Level II (period of mild lockdown): from February 26 to March 24, and (4) Level III (period of epidemic surveillance without lockdown): from March 25 to April 30. The period of COVID-19 was determined to be between January 24 (which was the date of declaration of emergency) and April 30, and we aimed to compare the mortality during the same period in 2018 and 2019. The study was approved by the Ethics Committee of Sichuan University. The postmortem interval (PMI) was defined as the interval between the death occurrence and the discovery of the corpse. The manner of death was explicated in unnatural deaths. Continuous variables expressed as mean ± standard deviation were compared using one-way analysis of variance with the Student–Newman–Keuls test. Qualitative variables were compared using the chi-squared test with Bonferroni correction. In addition, the Mantel–Haenszel chi-square test and Spearman correlation coefficient were used for the correlation and trend analysis. All statistical analyses were performed in IBM SPSS Statistics 26.0 (IBM Corp., Armonk, NY, USA), and statistical significance was considered when P value < 0.05.

Eventually, 1560 out-hospital deaths occurred in the selected time range of 2020, and the characteristics are presented in Table 1. The number of out-hospital deaths significantly decreased in the depths of COVID-19 but gradually rose again as the lockdown was gradually eased [Supplementary Figure 1, http://links.lww.com/CMJ/B47]. Similarly, the average age of deaths increased in Levels I and II, with a resilient trend after the epidemic was contained. When the emergency response was declared, there was a statistically significant reduction in the deaths...
occurring in indoor public places (shopping malls, for instance) with poor ventilation, which is a high-risk factor for spreading the COVID-19 infection. There was no statistically significant difference in PMI at every stage of COVID-19. The proportion of deaths induced by serious illnesses (except COVID-19, because all patients with COVID-19 must be hospitalized no matter how mild the patient’s condition) or chronic disease increased during the lockdown. Unsurprisingly, it showed a downward trend as the COVID-19 control measures were enforced.

The feature of unnatural deaths that occurred during COVID-19 was similar to all-cause mortality in demographic characteristics, pointing out that more unnatural deaths occurred at home or outdoors and in older people. Conversely, the rate of accidental deaths such as disasters or man-made accidents dropped during the COVID-19 pandemic compared with the situation before the outbreak. However, there was no statistical difference in the mortality of homicides [Table 1].

Although occupying a great percentage of unnatural deaths, the incidence of suicide per day did not significantly change during the outbreak of COVID-19 [Supplementary Table 1, http://links.lww.com/CM9/B47]. Notably, the number of suicide cases increased in the period of Levels II and III. Concerning sex, the suicide rate was much higher in women during the worst phase of the pandemic. Falling and hanging were the most common methods of suicide, accounting for >90% of the suicidal population who chose to end their life during COVID-19 instead of drowning and poisoning, which were more common during the lockdown.

From January 24 to April 30 in 2019 and 2018, the average number of deaths was 1253. There was no significant difference in the number of daily cases and the proportion of unnatural deaths. However, the daily suicide incidence increased (5.36 ± 2.16 vs. 4.62 ± 1.26, P = 0.037) with a reduction in the number of homicides and fatal accidents.

In the current study, no increase was observed for the out-of-hospital mortality for severe COVID-19, even in the period of outbreak and lockdown. Conversely, the number of deaths decreased in the most serious stage. More specifically, there were fewer unnatural out-of-hospital deaths during the lockdown. This is attributed to the fact that most people took protective measures, including avoiding excessively contacting strangers and staying at home, to enormously decrease the incidence of accidents or conflicts. When the epidemic was controlled, the number of daily out-hospital deaths returned to the previous level, probably because people resumed work and normal life.

Although most deaths happening at home were because people maintained self-quarantine to avoid infection, the deaths that happened outdoors were not rare during COVID-19. To a large extent, it can be inferred that many ways were chosen to be active outdoors and ensure access to an open and ventilated environment. During the height of the COVID-19 pandemic, no increase in homicides could imply the stability of public and social order. However, notably, there were a high proportion of suicides and suicidal events during the pandemic. It is possibly related to psychological problems such as distress, anxiety, fear of contagion, and depression.

### Table 1: The characteristics of out-hospital deaths in different period of COVID-19.

| Parameters                        | Pre-outbreak | Level I (Serious) | Level II (Mild) | Level III (Controlled) | P value |
|----------------------------------|--------------|-------------------|-----------------|------------------------|---------|
| Deaths (per day)†                | 13.1 ± 3.6   | 10.9 ± 3.3        | 13.9 ± 3.7      | 13.8 ± 3.1             | 0.002   |
| Age (years)‡                     | 51.7 ± 20.5  | 56.3 ± 19.6       | 56.0 ± 21.1     | 51.9 ± 21.1            | 0.001   |
| Gender                           |              |                   |                 |                        | 0.306   |
| Male                             | 212 (70.4)   | 235 (65.3)        | 278 (71.3)      | 348 (68.4)             |         |
| Female                           | 89 (29.6)    | 125 (34.7)        | 112 (28.7)      | 161 (31.6)             |         |
| PMI (days)‡                      |              |                   |                 |                        | 0.541   |
| ≤1                               | 246 (81.7)   | 287 (79.7)        | 316 (81.0)      | 425 (83.5)             |         |
| >1                               | 55 (18.3)    | 73 (20.3)         | 74 (19.0)       | 84 (16.5)              |         |
| Location of death                |              |                   |                 |                        | 0.002   |
| Home                             | 185 (61.5)   | 248 (68.9)        | 260 (66.6)      | 320 (62.9)             |         |
| Indoor public places             | 64 (21.2)    | 35 (9.7)          | 49 (12.6)       | 70 (13.8)              |         |
| Outdoors                         | 52 (17.3)    | 77 (21.4)         | 81 (20.8)       | 119 (23.3)             |         |
| Cause of death                   |              |                   |                 |                        | <0.001  |
| Diseases†                        | 112 (37.2)   | 179 (49.7)        | 161 (41.3)      | 185 (36.3)             |         |
| Unnatural causes†                | 189 (62.8)   | 181 (50.3)        | 229 (58.7)      | 324 (63.7)             |         |
| Manner of unnatural death        |              |                   |                 |                        | 0.026   |
| Suicides                         | 112 (59.2)   | 133 (73.5)        | 172 (75.1)      | 227 (70.1)             |         |
| Homicides                        | 9 (4.8)      | 6 (3.3)           | 6 (2.6)         | 12 (3.7)               |         |
| Accidents                         | 68 (36.0)    | 42 (23.2)         | 51 (22.3)       | 85 (26.2)              |         |

Data are presented as means ± standard deviations, or as n (%). † There was a positive correlation between the severity of the epidemic (serious to controlled) and the characteristic. ‡ There was a negative correlation between the severity of the epidemic (serious to controlled) and the characteristic. The statistical difference was ascertained through a comparison with the pre-outbreak situation, based on multiple comparison analysis. COVID-19: Coronavirus disease 2019; PMI: Postmortem interval.
associated with the COVID-19 pandemic, particularly after the start of the outbreak.\textsuperscript{1,4,5} Furthermore, most individuals committed suicide by jumping from a height or hanging themselves, perhaps because they did not need to have a specific condition and could do it immediately. Conversely, this may show that most suicides occurred during the COVID-19 pandemic on the spur of the moment. It is imperative to promote mental health with psychological interventions and mental therapy for psychiatric disorders in vulnerable populations to reduce suicides during the COVID-19 crisis.

In conclusion, based on our comparison of the epidemic period vs. the normal period data, we have ascertained that COVID-19 significantly affected the characteristics of all-cause out-of-hospital mortality, including daily mortality, age, locations, and causes. Among unnatural deaths, the variation in the manners of death and the increasing trend of suicides deserve the greatest attention. Differing from previous assumptions, this study provides new evidence about suicide, reflecting individuals’ susceptibility to mood swings during an epidemic. In particular, the valuable information suggested by our research contributes to a comprehensive analysis of future mortality for not only public health and healthcare professionals but also forensic practitioners, enabling them to handle criminal casework better. Further follow-up of management of deaths associated with out-of-hospital mortality as well as future mortality data by keeping track of nationwide cases will help delineate the long-term sequelae of COVID-19.

\section*{Funding}
This study was supported by a grant from the Opening Project of Key Laboratory of Forensic Pathology, Ministry of Public Security (No. GAFYBL201802).

\section*{Conflicts of interest}
None.

\section*{References}
1. El-Zoghby SM, Soltan EM, Salama HM. Impact of the COVID-19 pandemic on mental health and social support among adult Egyptians. J Community Health 2020;45:689–695. doi: 10.1007/s10900-020-00853-5.
2. Wu J, Mafham M, Mamas MA, Rashid M, Kontopantelis E, Deanfield JE, \textit{et al.} Place and underlying cause of death during the COVID-19 pandemic: retrospective cohort study of 3.5 million deaths in England and wales, 2014 to 2020. Mayo Clin Proc 2021;96:952–963. doi: 10.1016/j.mayocp.2021.02.007.
3. Melikov AK, Ai ZT, Markov DG. Intermittent occupancy combined with ventilation: an efficient strategy for the reduction of airborne transmission indoors. Sci Total Environ 2020;744:140908. doi: 10.1016/j.scitotenv.2020.140908.
4. Li W, Yang Y, Liu ZH, Zhao YJ, Zhang Q, Zhang L, \textit{et al.} Progression of mental health services during the COVID-19 outbreak in China. Int J Biol Sci 2020;16:1732–1738. doi: 10.7150/ijbs.45120.
5. Sher L. The impact of the COVID-19 pandemic on suicide rates. QJM 2020;113:707–712. doi: 10.1093/qjmed/hcaa202.

\textbf{How to cite this article:} Li L, Yan W, Wang Y, Chen D, Qiao Y, Liu M, Cong B, Yun L. Epidemiological characteristics of all-cause mortality reviewing out-hospital death under the clouds of COVID-19. Chin Med J 2022;135:2113–2115. doi: 10.1097/CM9.0000000000002146