Jurnal Berkala Epidemiologi
Volume 11 No 1. January 2023. 9 – 16
p-ISSN: 2301-7171; e-ISSN: 2541-092X
DOI: 10.20473/jbe.v11i12023.9–16
https://e-journal.unair.ac.id/JBE/
Email: jbe@fkm.unair.ac.id / jbepid@gmail.com

Jurnal Berkala
EPIDEMIOLOGI
PERIODIC EPIDEMIOLOGY JOURNAL

*ORIGINAL ARTICLE*

# TRACING OF COVID-19 TRANSMISSION BASED ON CLOSE CONTACT POPULATION: CASES IN SOUTH SUMATRA

***Penelusuran penularan COVID-19 dari Populasi Kontak Erat: Kasus di Sumatera Selatan***

**Rico Januar Sitorus[1], Hariadi Wibisono[2], Hibsah Ridwan[3], Nyoman Yudi Antara[4], Merry Natalia Panjaitan[5], Reymart V. Sangalang[6]**

[1]Department of Epidemiology, Faculty of Public Health, Sriwijaya University, 30862, Indonesia, rico_januar@fkm.unsri.ac.id
[2]Indonesia Epidemiological Association, 30151, Indonesia, wiekhw@yahoo.com
[3]Indonesia Epidemiological Association, 30151, Indonesia, hibsah@gmail.com
[4]Faculty of Health, Kader Bangsa University, Palembang, 30129, Indonesia, yudiantaranyoman@gmail.com
[5]Port Health Office, Ministry of Health of Indonesia, 30761, Indonesia, white_phanter_pjtn@hotmail.com
[6]De La Salle University, Manila, 0922, Philippines, reymart_sangalang@dlsu.edu.ph
Correspondence Author: Rico Januar Sitorus, rico_januar@fkm.unsri.ac.id, Department of Epidemiology, Faculty of Public Health, Sriwijaya University, South Sumatra, 30862, Indonesia

**ARTICLE INFO**

*Article History:*
Received March, 4th, 2022
Revised form April, 1st, 2022
Accepted December, 9th, 2022
Published online January, 29th, 2023

**Keywords:**
Close contact;
COVID-19;
Transmission;
Travel history

***Kata Kunci:***
*Kontak erat;*
*COVID-19;*
*Penularan;*
*Riwayat Perjalanan*

**ABSTRACT**

**Background:** COVID-19 causes a high death toll, illness, and economic losses. Transmission of the virus occurs from human to human and has spread to more than 200 countries. This research aims to determine the relationship between close contact and the COVID-19 incident in South Sumatra, Indonesia. **Methods:** This research used an observational analysis with a cross-sectional design. The population in this study were all COVID-19 patients and those who had close contact with COVID-19 patients in South Sumatra. The data were analyzed using univariate, bivariate, and multivariate tests. The bivariate analysis uses the chi-square test, while the multivariate analysis uses the logistic regression test. **Results:** The results show that close contact was related to the incidence of COVID-19 with a P value of 0.00 and an odds ratio adjusted (ORAdj) of 3.59 (95% CI: 2.93–4.39) after the variables of record of visiting local transmission areas, the record of visiting health facilities, the record of contact with suspected cases, and record of contact with confirmed cases were controlled. **Conclusion**: The transmission of close contact within families, such as households, was very high. A transmission could occur between a husband and wife and people who lived in the same house and shared plates while eating. To prevent a broader transmission, people who had close contact with COVID-19 needed to be quarantined. Based on these results, we could carry out public health interventions globally to fight against the pandemic.

**How to Cite:** Sitorus, R., J., Wibisono, H., Ridwan, H., Antara, N., Y., Panjaitan, M. & Sangalang, R., V. (2023). Tracing of COVID-19 transmission based on close contact population: cases in South Sumatra. *Jurnal Berkala Epidemiologi, 11(*1), 9-16.
https://dx.doi.org/10.20473/jbe.11i12023.9–16

***ABSTRAK***

***Latar Belakang:*** *COVID-19 menyebabkan tingginya angka kematian, penyakit, dan kerugian ekonomi. Penularan virus terjadi dari manusia ke manusia dan telah menyebar ke lebih dari 200 negara.* ***Tujuan:*** *Penelitian ini bertujuan untuk mengetahui hubungan antara hubungan kontak dekat dengan kejadian COVID-19 di Sumatera Selatan Indonesia.* ***Metode:*** *Penelitian ini menggunakan analisis observasional dengan desain cross-sectional. Populasi dalam penelitian ini adalah seluruh pasien COVID-19 dan yang pernah kontak dekat dengan pasien COVID-19 di Sumatera Selatan. Data dianalisis secara univariat, bivariat dan multivariat. Analisis bivariat menggunakan uji chi square, sedangkan Analisis multivariat menggunakan uji regresi logistic.* ***Hasil:*** *Hasil penelitian menunjukkan bahwa kontak dekat berhubungan dengan kejadian COVID-19 dengan P 0,00 dan Odds Ratio Adjusted (ORAdj) = 3,59 (95% CI: 2,93-4,39) setelah variabel riwayat kunjungan ke daerah transmisi lokal, riwayat kunjungan fasilitas kesehatan, riwayat kontak dengan kasus suspek, dan riwayat kontak dengan kasus terkonfirmasi dikontrol.* ***Kesimpulan :*** *Penularan kontak dekat dalam keluarga seperti rumah tangga sangat tinggi. Penularan bisa terjadi antara suami istri dan orang-orang yang tinggal di rumah yang sama dan berbagi piring saat makan. Untuk mencegah penularan yang lebih luas, orang yang pernah kontak dekat dengan penderita COVID-19 perlu dikarantina. Dari hasil tersebut, kita dapat melakukan intervensi kesehatan masyarakat secara global untuk memerangi pandemik.*



## INTRODUCTION

Close contact and respiratory droplets pose a high potential risk of transmission of COVID-19 through the air if aerosols are present (1). Close contact is defined as being within 6 feet of a person with confirmed or suspected COVID-19 or being in their presence for a cumulative total of 15 minutes or longer throughout 24 hours (2). When the first case of COVID-19 was detected in Wuhan, China, in December 2019, COVID-19 became a severe threat and was confirmed as a pandemic (3). On October 6, 2020, the total number of positive COVID-19 cases was 35,347,404, with a death toll of 1,039,046 cases. Cases are increasing and affect over 200 countries (4).

The COVID-19 infection related to the seafood market at Huanan presumably came from illegally sold wild animals (3). The first case in Indonesia was reported on March 2, 2020, then spread and increased daily. The total number of cases in Indonesia on October 6, 2020, was 315,714, with a total mortality of 240,291 cases (5). The spread of COVID-19 can happen to people with symptoms or those who are asymptomatic (6). In the early stage, COVID-19 is identified by fever, cough, fatigue, shortness of breath, pneumonia, and other respiratory disorder symptoms (7).

The morbidity and mortality rate for COVID-19 is relatively high. A prone patient is often someone with low immunity which is 60 years old, male, retired, obese, and has comorbidities (8–10). COVID-19 has been confirmed as a human-to-human transmission by multiple means: droplets, aerosols, and fomites. It can occur within families who make close contact with an infected person (11,12). Concerns about the spread of COVID-19 infection in the community prompted the government to enact policies restricting community activities outside the home. It is necessary to conduct close contact tracing with the case to control the transmission. The closer the contact is with COVID-19 patients, the higher the risk of infection.

Close contact is defined as those who live in the same household, share food, travel, or interact socially with a confirmed case two days before the onset of symptoms of COVID-19 (13). The population movement, such as people going to the office by public transportation and traveling to infected areas, can increase the risk of transmission when returning home with their families (14). The wide spread of cases necessitates sensitive and specific detection methods and knowledge of potential transmission

through close contact. Respiratory droplet transmission can occur when a person is in close contact (within 1 meter) with an infected person who has respiratory symptoms (e.g., coughing or sneezing) or who speaks or sings. Under these circumstances, respiratory droplets containing the virus can reach a susceptible person's mouth, nose, or eyes and cause infection (15). Studies based on laboratory experiments have shown that SARS-CoV-2 can maintain the infectivity and integrity of virions in aerosols for about 16 hours (16). Restrictions on activities in the community are expected to reduce the transmission of contagion. This study aims to determine the link between close contact transmission and COVID-19 infection.

## METHODS

The health research ethics committee, Faculty of Public Health Sriwijaya University's description of ethical approval "ethical approval" no: 127/un9.1.10/kke/2020 approved study materials such as research protocols, data collection, and questionnaire. Informed consent was given to participants before their data were collected. This study used an observational analytic method with a cross-sectional study design. The population in this study was all COVID-19 patients and 2203 people who had close contact with patients. The research was conducted in South Sumatra. Data were collected in June–September 2020. Epidemiological investigation instruments developed by the Indonesia Epidemiological Association in collaboration with the CDC Foundation (Kobo.humanitarianresponse) were used as the data collection tool. The data were collected using the total sample data collection technique. The number of samples entered at Kobo.humanitarianresponse was 2,203. The data was cleaned before inputting into the samples for analysis, including 2,137 respondents. Incomplete filling question form data were excluded from this study. The criteria of respondents in this study were people who were declared infected with COVID-19.

The statistical analysis used was the chi-square test, with simple and multiple logistics. The population in this study was all COVID-19 patients and 2203 people who had close contact with patients. The dependent variable was divided into two categories based on the examination results: confirmed and non-confirmed. Positive confirmation was given to respondents that had been examined through a laboratory test, while non-confirmed respondents were cases that had not been checked. The last cases comprised probable cases and suspected cases. A chi-square test was used to compare the differences between patients who had COVID-19 infection and those who did not. A significance level of p 0.05 was chosen. Continuous and categorical variables were presented as means and absolute numbers (percentages). After being controlled by confounding, multiple logistic regression analysis with a risk factor model was conducted to determine the relationship between close contact and the incidence of COVID-19 cases. Potentials Confounding factors in this study were gender, occupation, the record of traveling, the record of visiting the hospital (health centers), the record of contact with suspects, and the record of contact with people who received positive confirmation.

## RESULTS

From a total of 2,137 respondents, the majority (51.99%) were male. The mean age of the respondents was 38.19 years. Most respondents worked as entrepreneurs (12.68%) (Table 1). Table 2 shows that close contact, the record of visiting abroad (P 0.01), the record of visiting local transmission areas (P 0.00), the record of visiting health facilities (0.00), the record of contact with suspected COVID-19 patients (P 0.00), and the record of contact with COVID-19 patients (P 0.00) were significantly associated with the incidence of COVID-19. Nevertheless, gender and occupation were not related to COVID-19.

Table 3 shows that close contact was associated with the incidence of COVID-19 with a p-value < 0.00 with an Odds Ratio Adjusted (OR) value = 3.59 (95% CI: 2.93–4.39) after the variables of record of visiting local transmission areas, the record of visiting health facilities, contact history with the suspected cases, and contact history with the confirmed cases were controlled. People with close contact with people infected with COVID-19 were 3.59 times more likely to become infected than those without close contact. These results indicated that the attributable risk was 35.52%, while the population's attributable risk was 19.76%. It could be interpreted that among COVID-19 cases, 35.52% could be prevented by controlling close contact with those infected, while 19.67% could be prevented by controlling close contact. Therefore, tracing people in close contact with cases was

necessary to control this disease's transmission. Respondents infected with COVID-19 (45.6%) had previous close contact with a COVID-19 patient. Close contact was defined as a person having close contact (within 1 m) with a confirmed or suspected patient two days before the onset of symptoms in suspected or confirmed patients or two days before samples of asymptomatic infection were taken (17).

**Table 1**
Distribution of Socio-demographic Characteristics

| Socio-demographic characteristics | Finding N | % |
|---|---|---|
| **Age (years)** (Mean + Standard deviation) | 38.19 + 17.32 | |
| **Gender** | | |
| Male | 1,111 | 51.99 |
| Female | 1,026 | 48.01 |
| **Job** | | |
| Day laborer | 89 | 4.16 |
| Pharmacist | 8 | 0.37 |
| Accounting | 36 | 1.68 |
| Medical worker | 182 | 8.52 |
| Artist | 1 | 0.05 |
| Factory worker | 42 | 1.97 |
| Traders | 72 | 3.37 |
| Public service | 111 | 5.20 |
| Institution | 90 | 4.21 |
| Businessman | 19 | 0.89 |
| Fishery | 4 | 0.19 |
| Forestry | 3 | 0.14 |
| Mining | 24 | 1.12 |
| Farmer | 79 | 3.70 |
| Government employees | 199 | 9.31 |
| Information technology | 3 | 0.14 |
| Merchants | 1 | 0.05 |
| Army | 58 | 2.71 |
| Transportation | 28 | 1.31 |
| Entrepreneur | 271 | 12.68 |
| Unemployed | 817 | 38.23 |

## DISCUSSION

The main risk of COVID-19 transmission through close contact is that it occurs at home by 25% and increases to 94% in health services and places where people congregate (18). Transmission of SARS-CoV-2 can occur through direct, indirect, or close contact with an infected person through infected secretions such as saliva and respiratory secretions or their respiratory droplets, which are released when an infected person coughs, sneezes, talks, or sings (19). People who were in close contact with people with COVID-19 needed quarantine to prevent widespread transmission. Based on the clinical examination, the incubation period for this virus was generally 1–14 days and mostly 3–7 days. Those who had made close contact were quarantined for 14 days according to the incubation period of COVID-19, but some others were quarantined for 21 days (20). Close contact with a person infected with COVID-19 may occur within the family, among close friends, or coworkers.

Similarly, a study by Margarita et al (21) revealed that 42% of COVID-19 transmissions occurred due to close contact. Close contact with family members increased the risk of infection. The risk of infection could occur from activities such as eating together, sharing transportation, making social visits, serving medical care, and taking care of individuals with COVID-19 infection (3,22–24). COVID-19 has a higher pathogenicity and transmission rate than SARS-CoV and MERS-CoV (25).

Meeting up with a confirmed patient, staying close for 15 or 50 seconds, and not wearing a mask were all factors in the infection route. The higher the frequency of contact, the greater the risk of infection; therefore, isolation measures must be taken to prevent a wider transmission (26). COVID-19 causes cluster transmission, especially within a family. Transmission among MERS-infected family members occurred in approximately 13%-21% of cases and 22%-39% of SARS infection cases (27). It has been proven that infected family members treated at home could infect other people. COVID-19 transmission could also occur through feces, and the viruses could live for 1-2 days (28,29). Transmission of this disease has also occurred through local transmission. Local transmission clusters should be identified to improve deployment control through preparedness and response actions.

**Table 2**
Bivariable Analysis of Factors Associated with COVID-19

| Variable | Category | COVID-19 cases | | | | p-value |
|---|---|---|---|---|---|---|
| | | Confirmed | | Unconfirmed (probable +suspect) | | |
| | | n | % | n | % | |
| Gender | Male | 681 | 61.29 | 430 | 38.71 | 0.92 |
| | Female | 632 | 61.60 | 394 | 38.40 | |
| Job | Employee | 815 | 61.74 | 505 | 38.36 | 0.75 |
| | unemployed | 498 | 61 | 319 | 39 | |
| Abroad travel history | Yes | 7 | 58.33 | 5 | 41.67 | 0.02 |
| | Unknown | 17 | 94.44 | 1 | 5.56 | |
| | No | 1289 | 61.18 | 818 | 38.82 | |
| Local transmission history | Yes | 96 | 50.79 | 93 | 49.21 | 0.00 |
| | Unknown | 60 | 92.31 | 5 | 7.69 | |
| | No | 1,157 | 61.44 | 726 | 38.56 | |
| Medical facility visitation history | Yes | 195 | 77.38 | 57 | 22.62 | 0.00 |
| | Unknown | 73 | 92.41 | 6 | 7.59 | |
| | No | 1,045 | 57.86 | 761 | 42.14 | |
| Contact history with suspect | Yes | 138 | 63.30 | 80 | 36.70 | 0.00 |
| | Unknown | 235 | 81.60 | 53 | 18.40 | |
| | No | 940 | 57.63 | 691 | 42.37 | |
| Contact history with confirmed case | Yes | 456 | 72.84 | 170 | 27.16 | 0.00 |
| | Unknown | 189 | 76.21 | 59 | 23.79 | |
| | No | 940 | 74,43 | 323 | 25.57 | |
| Close contact | Yes | 742 | 76.18 | 232 | 23.79 | 0.00 |
| | No | 571 | 49.10 | 592 | 50.90 | |

**Table 3**
Multivariate Analysis with Multiple Logistic Regression Risk Factor Model

| Risk Factors | Category | β | p-value | OR (95% CI) |
|---|---|---|---|---|
| History of the local transmission area | No | | | Reff |
| | Unknown | 1.95 | 0.00 | 0.14 (0.05 – 0.41) |
| | Yes | 0.81 | 0.12 | 0.44 (0.16 – 1.24) |
| Medical facility visitation history | No | | | Reff |
| | Unknown | 0.76 | 0.12 | 0.47 (0.18 – 1.22) |
| | Yes | 1.47 | 0.00 | 0.23 (0.09 – 0.58) |
| Contact history with suspect | No | | | Reff |
| | Unknown | 0.83 | 0.00 | 0.44 (0.24 - 0.79) |
| | Yes | 1.02 | 0.00 | 0.36 (0.21 – 0.63) |
| Contact history with a confirmed case | No | | | Reff |
| | Unknown | 0.08 | 0.78 | 1.08 (0.62 – 1.88) |
| | Yes | 0.87 | 0.00 | 2.39 (1.36 – 4.18) |
| Close contact | No | | | Reff |
| | Yes | 1.278 | 0.000 | 3.59 (2.93 – 4.39) |

Controlling the spread of COVID-19 also requires precise information on human mobility, epidemiological, and genetic data at the local, regional and global levels. This information will ensure success in disseminating resources in mitigating COVID-19 transmission. The results also show that human mobility in the residential environment makes a major contribution to influencing the increase in daily transmission of COVID-19 transmission (16,30). Before quarantine, the population had a high risk of confirmed transmission. Close contact with previously infected people contributes to the transmission of new cases by as much as 80% (18).

The main strategy for deciding the transmission of COVID-19 can be done through social distancing. This strategy has been shown to reduce the increase in cases in the community significantly. The activities to support social distancing are closing schools and houses of worship, limiting the number of people entering the office, and limiting the number of people who go out to the mall on a date. Another strategy the government has taken to fight the severity caused by COVID-19 is vaccination. The COVID-19 vaccine effectively reduces the risk of contracting COVID-19 and helps to prevent serious illness and death (2).

## CONCLUSION

After controlling for the four variables: the record of visiting local transmission areas, the record of visiting health facilities, the record of contact with suspected cases, and the record of contact with confirmed cases, the results show that close contact was associated with the incidence of COVID-19 with a p-value of 0.00 and the odds ratio adjusted (OR) value = 3.59 (95% CI: 2.93-4.39). The transmission of COVID-19 needs to be prevented, starting with yourself, your family, and society. Self-prevention could be done by wearing a mask when you leave your house, maintaining at least 1 m of distance (social distancing), practicing personal hygiene, such as routinely washing your hands, and avoiding crowds. If we had close contact with the patient, we could prevent the family by maintaining sanitation, reducing gathering activities with other family members, and instituting quarantine or independent isolation. Meanwhile, regarding prevention in the community, we could avoid activities that had the potential to cause crowds and keep wearing masks when doing outdoor activities.

## CONFLICT OF INTEREST

None declared.

## AUTHOR CONTRIBUTIONS

RJS: Conceptualization, Methodology, and Writing: Original Draft Preparation HW: Data curation, writing—original draft preparation. HR: Data curation: NYA, MNP: Writing - Proofreading and editing: RVS: proofreading.

## ACKNOWLEDGMENTS

The Indonesia Epidemiological Association, the CDC Foundation, the Health Office of South Sumatra, and all district and city health offices in South Sumatra support all authors.

## REFERENCES

1. Chan JF-W, Yuan S, Kok K-H, To KK-W, Chu H, Yang J, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. Lancet. 2020;395(10223):514–23.
2. Centes for Disease Control and prevention. Benefits of getting a COVID-19 vaccine [Internet]. 2022. Available from: https://www.cdc.gov/coronavirus/2019-ncov/vaccines/vaccine-benefits.html
3. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020;395(10223):507–13.
4. WHO. WHO Coronavirus (COVID-19) dashboard [Internet]. 2019. Available from: https://covid19.who.int/
5. Satuan Tugas Penanganan COVID-19. Kesembuhan kumulatif mencapai 240.291 kasus [Internet]. 2020. Available from: https://covid19.go.id/artikel/2020/10/07/kesembuhan-kumulatif-mencapai-240291-kasus
6. Rothe C, Schunk M, Sothmann P, Bretzel G, Froeschl G, Wallrauch C, et al. Transmission of 2019-NCOV infection from an asymptomatic contact in Germany. N Engl J Med. 2020;382(10):970–1.
7. Yang Y, Lu Q, Liu M, Wang Y, Zhang A, Jalali N, et al. Epidemiological and clinical features of the 2019 novel coronavirus outbreak in China. MedRxiv. 2020;
8. Guan W, Ni Z, Hu Y, Liang W, Ou C, He J, et al. Clinical characteristics of 2019 novel coronavirus infection in China. MedRxiv. 2020;
9. Wang XF, Shi GC, Wan HY, Hang SG, Chen H, Chen W, et al. Clinical features of three avian influenza H7N 9 virus-infected patients in S hanghai. Clin Respir J. 2014;8(4):410–6.
10. Zhao J, Li X, Huang W, Zheng J. Potential risk factors for case fatality rate of novel coronavirus (COVID-19) in China: A pooled analysis of individual patient data. Am J Emerg Med. 2020;
11. Jayaweera M, Perera H, Gunawardana B, Manatunge J. Transmission of COVID-19 virus by droplets and aerosols: A critical review on the unresolved dichotomy. Environ Res. 2020;188:109819.
12. Ramanathan K, Antognini D, Combes A, Paden M, Zakhary B, Ogino M, et al. Planning and provision of ECMO services for severe ARDS during the COVID-19 pandemic and other outbreaks of emerging infectious diseases. Lancet Respir Med [Internet]. 2020;8(5):518–26.
13. Bi Q, Wu Y, Mei S, Ye C, Zou X, Zhang Z, et al. Epidemiology and transmission of COVID-19 in 391 cases and 1286 of their close contacts in Shenzhen, China: a retrospective cohort study. Lancet Infect Dis. 2020;
14. Zhang C, Chen C, Shen W, Tang F, Lei H, Xie Y, et al. Impact of population movement on the spread of 2019-nCoV in China. Emerg Microbes Infect. 2020;9(1):988–90.
15. Masriadi, Mahmud NU, Javid N, Sarwin M, Lukman, Megantari SH, et al. Determinants of transmission COVID-19 in South Sulawesi. J Berk Epidemiol [Internet]. 2022;10(3):237–45. Available from: https://e-journal.unair.ac.id/JBE/article/view/37724/22504
16. Tang L, Liu M, Ren B, Chen J, Liu X, Wu X, et al. Transmission in home environment associated with the second wave of COVID-19 pandemic in India. Environ Res. 2022;204:111910.

17. Miao, Yang L, Chu H, Fan, MengRong X. Effect of delay in diagnosis on transmission of COVID-19. Math Biosci Eng. 2020;17(3):2725–40.
18. Phucharoen C, Sangkaew N, Stosic K. The characteristics of COVID-19 transmission from case to high-risk contact, a statistical analysis from contact tracing data. EClinicalMedicine. 2020;27:100543.
19. Guo Y-R, Cao Q-D, Hong Z-S, Tan Y-Y, Chen S-D, Jin H-J, et al. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak–an update on the status. Mil Med Res. 2020;7(1):1–10.
20. Wang S-X, Wang Y, Lu Y-B, Li J-Y, Song Y-J, Nyamgerelt M, et al. Diagnosis and treatment of novel coronavirus pneumonia based on the theory of traditional Chinese medicine. J Integr Med. 2020/04/15. 2020 Jul;18(4):275–83.
21. Martinez-Fierro ML, Ríos-Jasso J, Garza-Veloz I, Reyes-Veyna L, Cerda-Luna RM, Duque-Jara I, et al. The role of close contacts of COVID-19 patients in the SARS-CoV-2 transmission: an emphasis on the percentage of non-evaluated positivity in Mexico. Am J Infect Control. 2020;
22. Jing Q-L, Liu M-J, Zhang Z-B, Fang L-Q, Yuan J, Zhang A-R, et al. Household secondary attack rate of COVID-19 and associated determinants in Guangzhou, China: a retrospective cohort study. Lancet Infect Dis. 2020;20(10):1141–50.
23. Li W, Zhang B, Lu J, Liu S, Chang Z, Cao P, et al. The characteristics of household transmission of COVID-19. Clin Infect Dis. 2020;
24. Hui DS, Azhar EI, Kim Y-J, Memish ZA, Oh M, Zumla A. Middle East respiratory syndrome coronavirus: risk factors and determinants of primary, household, and nosocomial transmission. Lancet Infect Dis. 2018;18(8):e217–27.
25. Novel CPERE. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. Zhonghua liu xing bing xue za zhi= Zhonghua liuxingbingxue zazhi. 2020;41(2):145.
26. Feng L, Shelan LIU, Chaorong NI, Jinren PAN, Ying LIU, Enfu C, et al. Epidemiological investigation of the first reported case of coronavirus disease 2019 (COVID-19) in Zhejiang Province. J Prev Med. 2020;109–12.
27. Yin Y, Wunderink RG. MERS, SARS and other coronaviruses as causes of pneumonia. Respirology. 2018;23(2):130–7.
28. Chan K-H, Sridhar S, Zhang RR, Chu H, Fung A-F, Chan G, et al. Factors affecting stability and infectivity of SARS-CoV-2. J Hosp Infect. 2020;106(2):226–31.
29. Chen Y, Guo Y, Pan Y, Zhao ZJ. Structure analysis of the receptor binding of 2019-nCoV. Biochem Biophys Res Commun. 2020;
30. WHO. Critical preparedness, readiness and response actions for COVID-19: interim guidance, 4 November 2020. World Health Organization; 2020.