# Information networks for COVID-19 according to race/ethnicity

Seungil Yum[1] 

## Abstract

This study highlights information networks for COVID-19 according to race/ethnicity by employing social network analysis for Twitter. First, this study finds that racial/ethnic groups are differently dependent on racial/ethnic key players. Whites and Asians show the highest number of racial/ethnic key players, Hispanics have a racial/ethnic key player, and blacks have no racial/ethnic key player in the top 20. Second, racial/ethnic groups show different characteristics of information resources for COVID-19. Whites have the highest key player group in news media, politicians, and researchers, and blacks show the highest key player group in news media. Asians demonstrate the highest key player group in news media, and Hispanics exhibit institutes as the highest key player group. Lastly, there are some differences in group communications across the race/ethnicity. Whites and blacks show open communication systems, whereas Asians and Hispanics reveal closed communication systems. Therefore, governments should understand the characteristics of communications for COVID-19 according to the race/ethnicity.

**Keywords** Coronavirus · COVID-19 · Twitter · Race · Ethnicity

## 1 Introduction

Coronavirus (COVID-19) is one of the worst pandemic diseases in human history. As of May 26, 2020, 5,459,528 cases of COVID-19 have been reported, including 345,994 deaths [14]. COVID-19 widely spreads to the world, and more than 227 countries have COVID-19 patients (see Fig. 1).

Countries and governments try their best to develop COVID-19 policies to minimize the disease outbreak and save their citizens' life (see COVID & Team, 2020; [15, 22, 26, 31, 33, 40]). For instance, the US government employs National Syndromic Surveillance Program (NSSP), which is a collaboration among the Centers for Disease Control and Prevention (CDC), federal partners, local and state health departments and academic and private sector partners, to collect, analyze and share COVID-19 information.

Many organizations and policymakers have developed COVID-19 strategies to reduce COVID-19 damages for human life (see [6, 8, 10, 19, 43]). For example, WHO declared the Chinese outbreak of COVID-19 to be a public

health emergency of international concern posing a high risk to countries with vulnerable health systems on January 30, 2020 and develop many COVID-19 policies to minimize the economic damage of the virus and to remove rumor in the world [39].

On the other hand, scholars report that COVID-19 exerts a different impact on people according to the race/ethnicity (see [2, 3, 23, 32],Raifman et al., 2020). For instance, the APM Research Lab [1] reports that the latest overall COVID-19 mortality rate for black people is 2.4 times as high as the rate for white people and 2.2 times as high as the rate for Asian and Hispanic people in the US (see Fig. 2).

However, while many researchers have highlighted how COVID-19 plays a different role in the infection according to race/ethnicity, they have not explored how each racial/ethnic group (whites, blacks, Asians, and Hispanics) differently communicates with each other to cope with COVID-19. Therefore, this study aims to highlight how people communicate with others to reduce damages from the COVID-19 outbreak by exploring the communications of Twitter, which is one of the best Social Network Systems (SNS) worldwide. This study especially explores how much each racial/ethnic group relies on its racial/ethnic group since racial/ethnic communities play an essential role in the hubs of racial/ethnic groups. To the best of my knowledge, this study is

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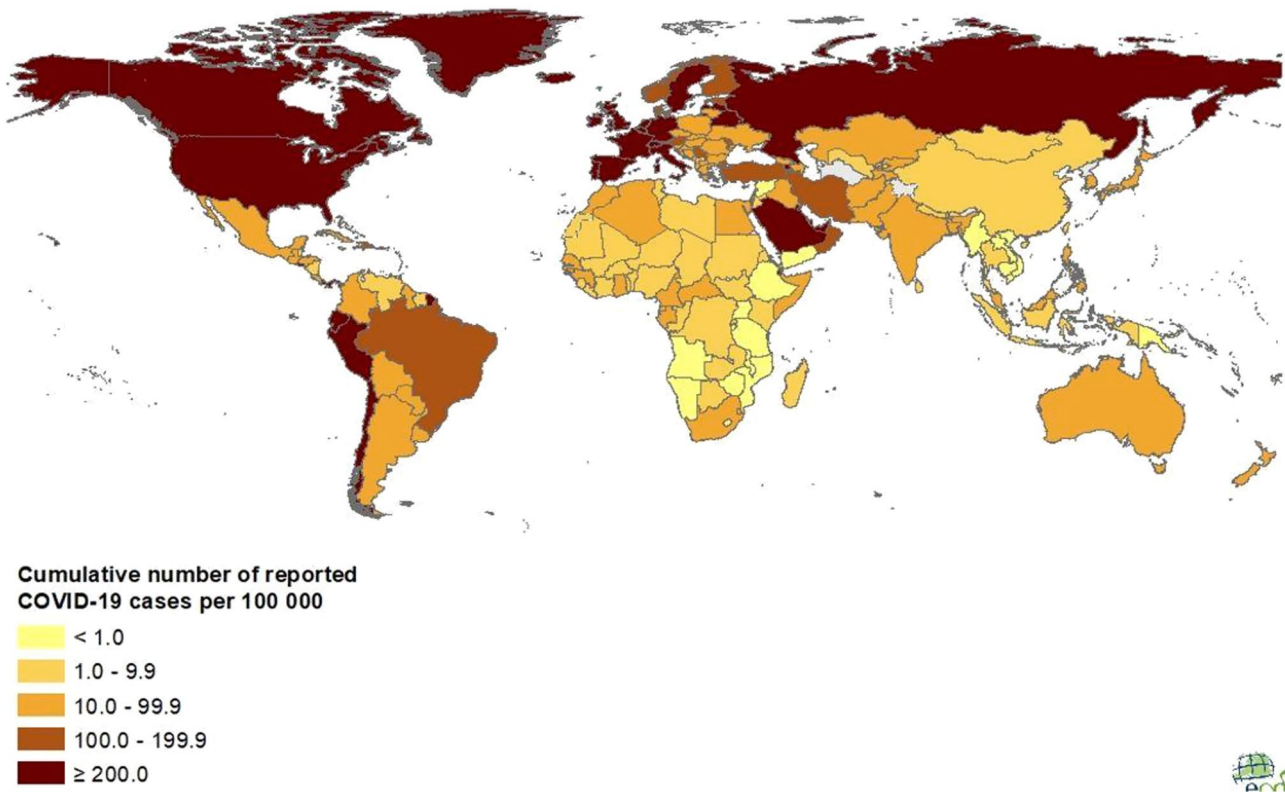
**Fig. 1** Geographic distribution of cumulative number of reported COVID-19 cases per 100 000 population (as of May 27, 2020). Source: https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases



**Fig. 2** Deaths per 100,000 people as of May 19, 2020. Source: APM RESEARCH LAB
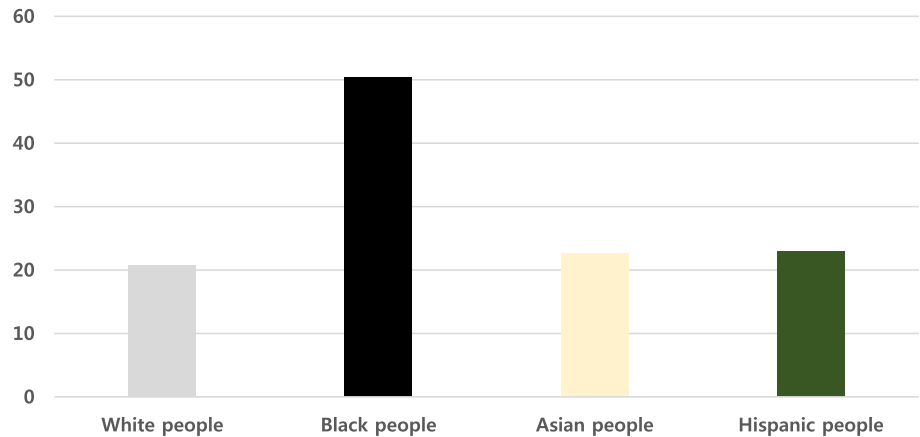
the first article exploring how people respond differently to COVID-19 according to their race/ethnicity based on Social Network Analysis (SNA) of Twitter.

## 2 Literature review

COVID-19 is a novel coronavirus that was first identified amid an outbreak of respiratory illness cases in Wuhan City, Hubei Province, China. COVID-19 brings symptoms,

such as fever, cough, fatigue, shortness of breath, and loss of smell and taste and rapidly spreads via small droplets produced by coughing, sneezing, and talking.

Many countries and departments report that COVID-19 differently affects people according to their race/ethnicity. For example, the Centers for Disease Control and Prevention (CDC) (2020) officially reports that 45% of people for whom race or ethnicity data is available are whites, compared to 59% of people in the surrounding community. However, 33% of hospitalized patients are blacks compared to 18% in

the community, and 8% are Hispanics, compared to 14% in the community. These data suggest an overrepresentation of blacks among hospitalized patients. The New York City [30] reports that death rates among blacks (92.3 deaths per 100,000 population) and Hispanics (74.3) are significantly higher than those of whites (45.2) or Asians (34.5).

The National Public Radio [29] shows that black deaths from COVID-19 are nearly two times higher than would be expected based on their share of the population. In four states, the rate is three or more times higher. In 42 states plus Washington D.C., Hispanics show a greater share of confirmed cases than their share of the population. In eight states, it's more than four times greater. White deaths from COVID-19 are lower than their share of the population in 37 states and the District of Columbia.

The COVID Tracking Project [11] shows that COVID-19 is affecting people of color the most. Black people account for 13% of the US population, whereas 25% of deaths where race is known, meaning that blacks are dying at a rate nearly two times higher than their population share. The California Department of Public Health [5] demonstrates that Hispanics have quite higher percent cases of COVID-19 (54.6), followed by whites (20.6), Asians (9.4), and blacks (5.3), compared with the percent California population (Hispanics: 38.9, whites: 36.6, Asians 15.4, and blacks 6.0) as of May 28, 2020.

Yancy [44] highlights that minorities are more susceptible to COVID-19. For instance, black and Hispanic people account for 28% and 34% of deaths, while they have 22% and 29% of the population representation. Laurencin and McClinton [25] exhibit that racial and ethnic minorities are in a vulnerable position for COVID-19. For instance, blacks have quite a higher percentage of the COVID-19 case (17.2%) than that of the population in Connecticut (12.0%), compared with other racial/ethnic groups (whites: 60.8% and 66.5%, Asians: 2.9 and 4.9%, and Hispanics: 15.9% and 16.5%). Hooper et al. [20] show that mortality rates of black people (73 per 100,000) are significantly higher than other racial/ethnic groups, such as Hispanic people (36 per 100,000) and white people (22 per 100,000) in Chicago. Therefore, this study highlights the different characteristics of each racial/ethnic group for the information networks for COVID-19 by employing SNA for Twitter in the next section.

## 3 Research methodology

This study employs SNA to explore the communication differences of people for COVID-19 according to their race/ethnicity. SNA is widely utilized for calculating and exploring the structural properties of networks of each individual relationship for social science [27]. Many scholars have employed SNA in their study to demonstrate the information networks among people (see [4, 12, 16, 21, 36]). This study utilizes Twitter data to explore information networks of people for COVID-19 across the race/ethnicity. Twitter has been widely employed for big data analyses in the academic field (see [13, 17, 24, 37, 38].

This study employs NodeXL for exploring information networks of COVID-19 across four groups. NodeXL is a visualization software program, which supports social networks and content analysis. NodeXL has been widely utilized as a social network methodology in a variety of fields (see Yep & Shulman, 2014). This study employs the NodeXL program on May 11 and May 12, 2020 and explores Twitter data since December, 2019. This study selects key players in the following categories: doctors, institutes, news media, organizations, politicians, and researchers.

This study employs the in-degree centrality to capture the key players for Twitter users. In-degree centrality measures the number of connections that others have initiated with a Twitter user. For instance, if a Twitter user is mentioned 10 times by users in a Twitter topic-network, the Twitter user's in-degree centrality metric would be 10. In-degree centrality has significant implications for exploring the importance of Twitter users in COVID-19 networks. Twitter users with high in-degree centrality gain attention to their tweets among the networks of Twitter users who participate in the conversation about the COVID-19 topic. Twitter users' in-degree centrality, therefore, shows the community's engagement with them. Those with high in-degree centrality scores can be regarded as conversational hubs because other people have mentioned, replied to, or retweeted their COVID-19 posts. In-degree centrality, thus, is an index of the cascades of information flow initiated by a user [18]. This study chooses the top 20 key players among all Twitter users based on the magnitude of their in-degree centrality (see Table 1 for descriptive statistics).

## 4 Results

Tables 2, 3, 4, 5 show the top 20 key players according to the race/ethnicity. White people have the highest racial/ethnic key players (3) among four racial/ethnic groups. For example, the Hatewatch, which is the blog that monitors and exposes the activities of the American radical right, places fourth. The Runnymede Trust, which is the race equality think tank, takes fifth. Zubaida Haque who is the deputy director of the Runnymede Trust places sixth. In contrast, black people do not have racial/ethnic key players in the top 20 players. This is an unexpected result since other racial/ethnic minority groups, such as Asian and Hispanic people, have the racial/ethnic key player, and minority racial/ethnic groups tend to rely on their racial/ethnic communities.

**Table 1** Descriptive statistics

| Graph Metric | Whites | Blacks | Asians | Hispanics |
|---|---|---|---|---|
| Graph Type | Directed | Directed | Directed | Directed |
| Vertices | 9185 | 12,691 | 1192 | 661 |
| Unique Edges | 9938 | 15,268 | 1420 | 775 |
| Edges with Duplicates | 203 | 1327 | 58 | 44 |
| Total Edges | 10,141 | 16,595 | 1478 | 819 |
| Self-Loops | 663 | 1033 | 112 | 109 |
| Reciprocated Vertex Pair Ratio | 0.002 | 0.005 | 0.006 | 0.018 |
| Reciprocated Edge Ratio | 0.004 | 0.009 | 0.012 | 0.034 |
| Connected Components | 767 | 988 | 163 | 165 |
| Single-Vertex Connected Components | 373 | 427 | 65 | 63 |
| Maximum Vertices in a Connected Component | 6796 | 9613 | 248 | 75 |
| Maximum Edges in a Connected Component | 7537 | 12,973 | 358 | 96 |
| Maximum Geodesic Distance (Diameter) | 19 | 20 | 4 | 6 |
| Average Geodesic Distance | 4.478 | 5.603 | 1.989 | 2.013 |
| Graph Density | 0.000 | 0.000 | 0.001 | 0.002 |
| Modularity | 0.802 | 0.857 | 0.842 | 0.872 |
| Minimum In-Degree | 0 | 0 | 0 | 0 |
| Maximum In-Degree | 3707 | 2660 | 245 | 64 |
| Average In-Degree | 1.092 | 1.240 | 1.216 | 1.206 |
| Median In-Degree | 0 | 0 | 0 | 0 |

**Table 2** Top 20 public key players for whites

| | RE | ID | Name | Description |
|---|---|---|---|---|
| 1 | | 111 | Donald J. Trump | The US president |
| 2 | | 83 | AJ+ | Online news by Al Jazeera Media Network |
| 3 | | 80 | Ebony Jade Hilton | Medical Director |
| 4 | W1 | 53 | Hatewatch | Blog that monitors and exposes the activities of the American radical right |
| 5 | W2 | 44 | Runnymede Trust | Race equality think tank |
| 6 | W3 | 43 | Zubaida Haque | Deputy Director of The Runnymede Trust |
| 7 | | 42 | Lori Lightfoot | Mayor of Chicago |
| 8 | | 42 | Sara Goldrick-Rab | Professor at Temple University |
| 9 | | 38 | HuffPost Politics | American news aggregator |
| 10 | | 32 | CNN | American news-based pay television channel |
| 11 | | 26 | Phil McGraw | Psychologist who is the host of the television show Dr. Phil |
| 12 | | 26 | Mehmet Oz | Columbia University professor |
| 13 | | 24 | Eric Swalwell | U.S. Representative for California |
| 14 | | 24 | Greg Abbott | Governor of Texas |
| 15 | | 19 | Sanjay Gupta | Professor at the Emory University School of Medicine |
| 16 | | 15 | President Trump | The US president |
| 17 | | 11 | MSNBC | American cable television channel |
| 18 | | 11 | Williams Institute | Public policy research institute based at the UCLA |
| 19 | | 10 | NCDC | Nigeria Centre for Disease Control |
| 20 | | 10 | The Wall Street | American newspaper |

*RE* racial/ethnic key players, *ID* In-degree, *W* racial/ethnic key players in whites, *B* racial/ethnic key players in blacks, *A* racial/ethnic key players in Asians, *H* racial/ethnic key players in Hispanics

**Table 3** Top 20 public key players for blacks

| RE | ID | Name | Description |
|---|---|---|---|
| 1 | 2660 | CDC | Centers for Disease Control and Prevention |
| 2 | 315 | AJ+ | Online news by Al Jazeera Media Network |
| 3 | 283 | John Talmadge | Medical specialist in Dallas, Texas |
| 4 | 213 | SkyNews | British news channel |
| 5 | 161 | richard horton | Editor-in-chief of The Lancet |
| 6 | 160 | Financial Times | International daily newspaper |
| 7 | 135 | Breitbart News | American far-right syndicated news |
| 8 | 111 | UNN.TV | Uighur National Network |
| 9 | 111 | Nina Turner | American politician |
| 10 | 111 | UKLabour | Centre-left political party in the UK |
| 11 | 103 | Khaled Beydoun | Professor at the University of Arkansas |
| 12 | 97 | Donald J. Trump | The US president |
| 13 | 84 | Trevon D Logan | Professor at The Ohio State University |
| 14 | 63 | Yolande Bouka | Professor at Queen's University |
| 15 | 61 | CNN | American news-based pay television channel |
| 16 | 57 | The Democrats | Political parties in the United States |
| 17 | 55 | Allen West | American political commentator |
| 18 | 40 | Kaiser Family Foundation | American non-profit organization |
| 19 | 38 | Melina Abdullah | Chair of Pan-African Studies at UCLA |
| 20 | 32 | The New York Times | American newspaper |

**Table 4** Top 20 public key players for Asians

| | RE | ID | Name | Description |
|---|---|---|---|---|
| 1 | | 245 | SkyNews | British free-to-air television news channel |
| 2 | | 57 | China Xinhua News | Official state-run press agency of China |
| 3 | A1 | 36 | British Asian Trust | International development organization |
| 4 | | 11 | BBC News | British news channel |
| 5 | | 11 | Kevin J. Boyle | Member of the Pennsylvania House |
| 6 | | 7 | Toronto Star | Canadian broadsheet daily newspaper |
| 7 | A2 | 5 | Racial Health Equity | Center for the Study of Racism at UCLA |
| 8 | | 4 | ABC The Drum | Australian nightly television |
| 9 | | 4 | BahaiTeachings.org | Organization for the oneness of humanity |
| 10 | A3 | 4 | COVID19 in Asia | News aggregator focused on #COVID19 in Asia |
| 11 | | 3 | Human Rights Watch | International non-governmental organization |
| 12 | | 3 | The Spectator Index | News on politics, economics, science and sports |
| 13 | | 3 | Public Health England | Department of Health and Social Care in the UK |
| 14 | | 3 | Aksyon | Filipino news program |
| 15 | | 3 | AJ+ | Online news by Al Jazeera Media Network |
| 16 | | 3 | Equality Federation | Social justice building organization |
| 17 | | 2 | World Bank | International financial institution |
| 18 | | 2 | RN Breakfast | News program in Australia |
| 19 | | 2 | Penny Wong | Australian Senator |
| 20 | | 2 | The New York Times | American newspaper |

Instead, black people are likely to use all information sources for COVID-19. Black people are the only racial/ethnic group, which has their top 20 players in all categories.

Asian people also show the highest racial/ethnic key players (3) among the groups. For instance, the British Asian Trust, which is the diaspora-led international development organization, ranks third. The Racial Health Equity, which is the center for the study of racism, social justice & health at the fielding school of public health at UCLA, places seventh. The COVID19 in Asia, which is the news aggregator focused on

**Table 5** Top 20 public key players for Hispanics

| | RE | ID | Name | Description |
|---|---|---|---|---|
| 1 | | 23 | Utibe R. Essien, MD MPH | Professor of Medicine |
| 2 | | 14 | Jorge A Rodriguez MD | Brigham and Women's Hospital |
| 3 | | 14 | Pete Ricketts | Governor of Nebraska |
| 4 | | 12 | High Country News | Independent non-profit news media |
| 5 | | 12 | ABC7 News | Breaking news in the Bay Area |
| 6 | | 12 | University of Nebraska Medical Center | Public center of health sciences research |
| 7 | | 11 | Nebraska Medicine | The most esteemed academic medical center in the region |
| 8 | | 11 | Armando De Alba | Nebraska Medical Center |
| 9 | | 9 | The Center for Public Integrity | American nonprofit investigative journalism organization |
| 10 | | 8 | Economic Policy Institute | American think tank |
| 11 | H1 | 8 | Know Your Rights Camp | Black and Brown communities |
| 12 | | 8 | UCSF Global Health | Institute for global health sciences |
| 13 | | 7 | Pew Research Center | American think tank |
| 14 | | 7 | CSPI | Center for Science in the Public Interest |
| 15 | | 7 | IWPR | Institute for War and Peace Reporting |
| 16 | | 7 | Tatiana Prowell | Johns Hopkins medicine |
| 17 | | 5 | KTVU | Fox owned-and-operated television station |
| 18 | | 4 | City of Boston | The City of Boston's official Twitter account |
| 19 | | 4 | Donald J. Trump | The US president |
| 20 | | 4 | IDPH | The Illinois Department of Public Health |

on COVID19 in Asia, ranks tenth. Hispanic people have only one racial/ethnic key player. The Know Your Rights Camp, which is the black and brown communities, ranks eleventh.

Next, this study highlights the ranks of key players across racial/ethnic groups. In the whites' networks, Donald Trump who is the US president ranks first. Donald Trump is the only key player who has in-degree centrality more than 100 (111). The next key player is AJ+, which is online news by Al Jazeera Media Network (83). Ebony Jade Hilton who is the Medical Director at UVA Health ranks third (80). The racial/ethnic key players (Hatewatch, Runnymede Trust, and Zubaida Haque) place fourth, fifth, and sixth (53, 44, and 43), respectively.

In the blacks' networks, the Centers for Disease Control and Prevention (CDC) takes first. The CDC has 2,660 in-degree centrality, which is about 8.5 times higher than that of the second-highest key player (AJ+: 315). This is the biggest gap between the top player and second key player among racial/ethnic groups. John Talmadge who is the medical specialist practicing psychiatry and addiction medicine in Dallas, Texas ranks third (283). SkyNews, which is British free-to-air television news channel, places fourth (213). Richard Horton who is the editor-in-chief of The Lancet (a weekly peer-reviewed general medical journal) ranks fifth (161).

In the Asians' networks, SkyNews places first (245). China Xinhua News, which is official state-run press agency of the People's Republic of China, ranks second (57). This

is the second-highest gap between the first key player and second key player. British Asian Trust, which is the diaspora-led international development organization and racial/ethnic key player, takes third (36). BBC news, which is the diaspora-led international development organization, places fourth (11). Kevin Boyle who is the Member of the Pennsylvania House of Representatives ranks fifth (11).

In the Hispanics' networks, Utibe Essien who is the Doctor of Medicine at University of Pittsburgh ranks first (23). Jorge A Rodriguez who is the Doctor of Medicine at Brigham and Women's Hospital places second (14). Pete Ricketts who is the governor of Nebraska takes third (14). High Country News, which is the independent non-profit news media, ranks fourth (12). ABC7 News, which is the for breaking news, weather, and sports in the San Francisco Bay Area, places fifth (12).

Figure 3 shows information networks based on the in-degree centrality according to the race/ethnicity. In the whites' networks, many individuals are clustered in the main circle in the center, and W1 (Hatewatch), W2 (Runnymede Trust), and W3 (Zubaida Haque), are located in the second large circle (W3 is right behind W2 in the graph). In the blacks' networks, people show a big circle and are highly concentrated in the inner part. Nodes are also heavily clustered in the core of the circle. In the Asians' networks, people demonstrate four large circles, and A1 (British Asian Trust), A2 (Racial Health Equity), and A3 (COVID19 in Asia) have some distance from each other. In the Hispanics'

**Fig. 3** In-degree centrality



[White people]

[Black people]

[Asian people]

[Hispanic people]
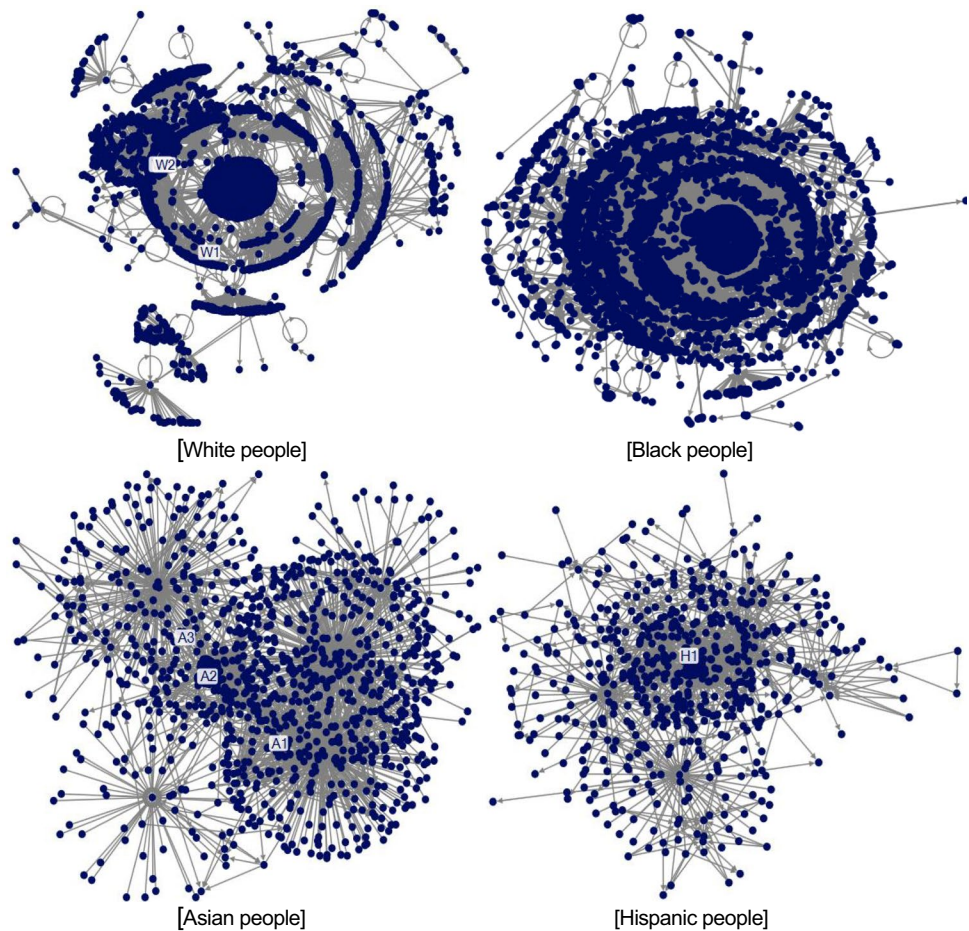
networks, they show the most dispersed pattern, compared with other racial/ethnic groups. H1 (Know Your Rights Camp) is located in the central area of the upper circle.

Figure 4 highlights the key players according to six categories. In the whites' networks, the top key players are evenly distributed more than other racial/ethnic networks. People have the highest top key player group in news media, politicians, and researchers (5, respectively). Interestingly, they have no top key player in organizations. In the blacks' networks, they have the highest key player group in news

**Fig. 4** The distribution of key players
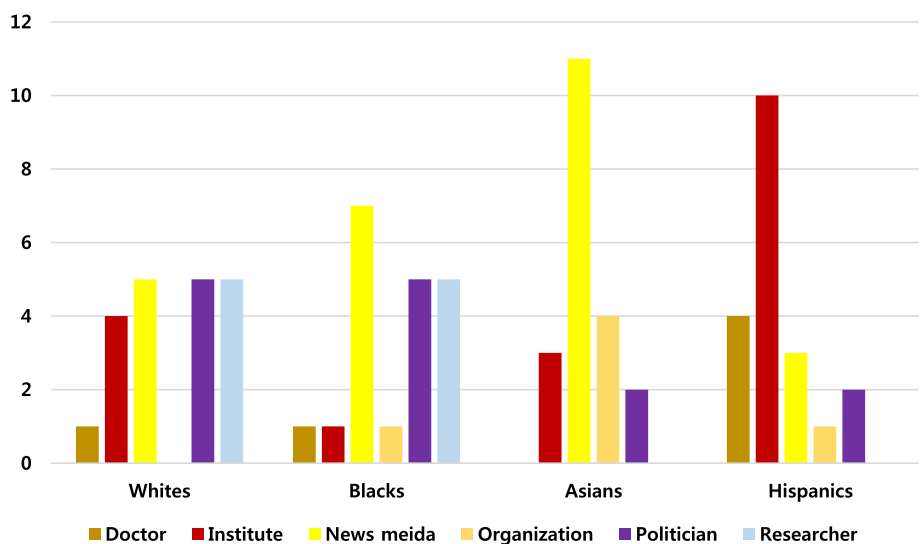
media (7). One of the important findings is that the blacks have the key player in all categories, inconsistent with other racial/ethnic groups. In the Asians' networks, news media play the most significant role in the information networks. They have 11 out of the 20 key players. One noticeable finding is that they do not have key players in doctors and researchers. Also, Asians are the only group that does not have Donald Trump as the top key player. In the Hispanics' networks, institutes exert the most powerful impact on the information networks. They have 10 key players in the group, which is one-half of the top 20 key players. One remarkable finding is that researchers are not in the key player lists.

Next, this study employs cluster analysis by utilizing the Clauset–Newman–Moore cluster algorithm. Cluster analysis is a methodology for the task of assigning a set of objects into groups so that the objects in the same cluster are more similar to each other than those in other clusters. The Clauset-Newman-Moore cluster algorithm is one of the best methods for big data analysis [41]. Figures 5 and 6 show information networks among racial/ethnic groups based on the Clauset–Newman–Moore cluster algorithm for the typical case and groups. The group networks show remarkable characteristics according to racial/ethnic groups (see Fig. 6).
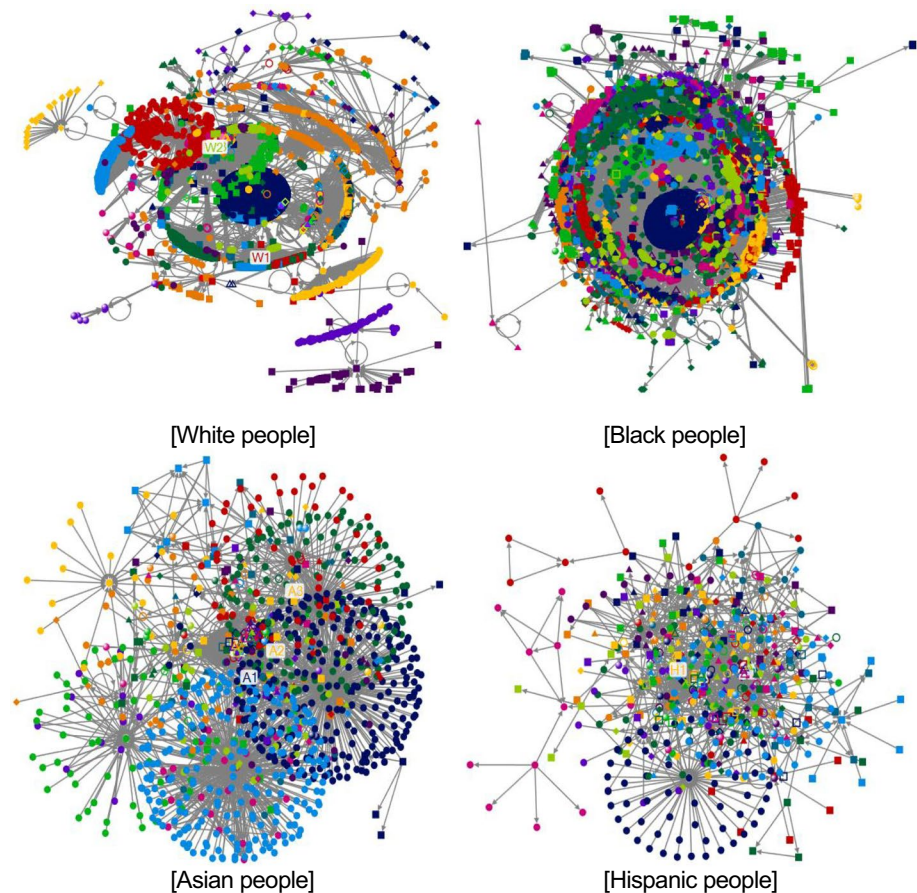
First, white and black people show open networks, whereas Asian people and Hispanic people exhibit closed networks among groups. To be specific, white people are mainly clustered in the largest group (group 1), and the group positively communicates with other groups. Many groups in black people actively interact with each other. In contrast, Asian people tend to have their communications in their group. Hispanic people also show the similar characteristics with Asian people.

## 5 Conclusions

COVID-19 is the most important issue across the world. Releasing valuable information to people is one of the most crucial tasks for governments and centers for disease control and prevention to minimize the COVID-19 outbreak. They should understand information networks for COVID-19 according to their race/ethnicity since they have different characteristics (see [28, 35, 42]). Therefore, we should explore how individuals interact with others for the COVID-19 information according to racial/ethnic groups.
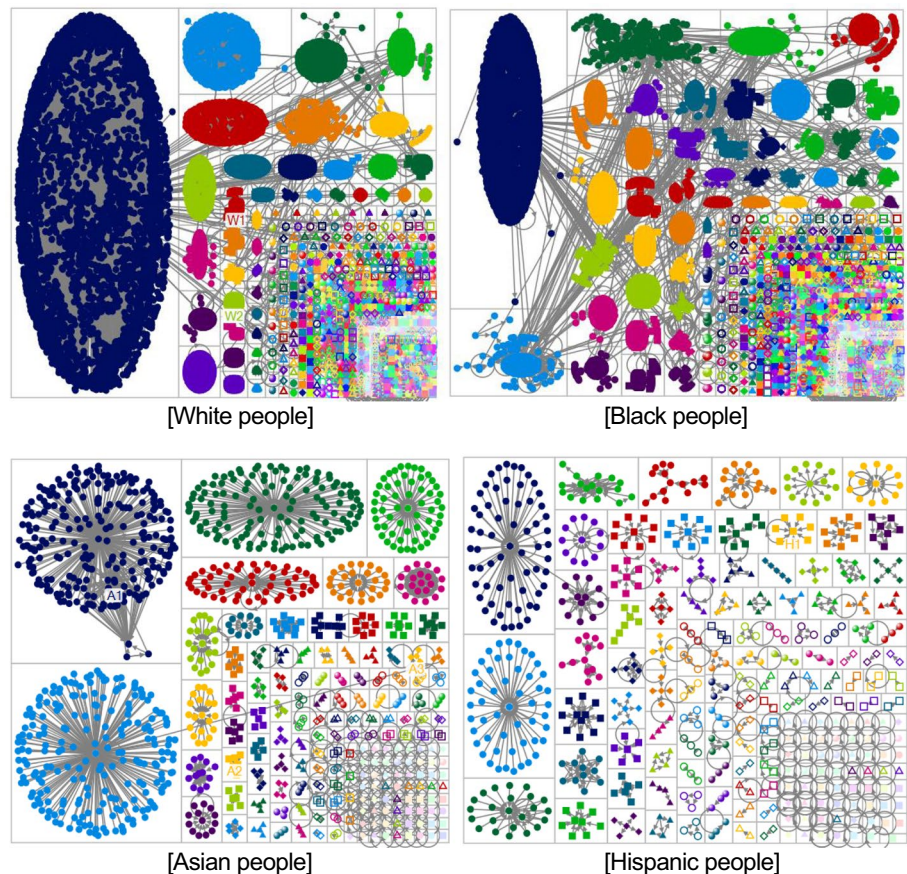
This study provides some important findings as follows: first, racial/ethnic groups are differently dependent on racial/

**Fig. 5** Social networks for the typical case



[White people]

[Black people]

[Asian people]

[Hispanic people]

**Fig. 6** Social networks for groups



[White people]

[Black people]

[Asian people]

[Hispanic people]

ethnic key players. White and Asian people show the highest reliance on the key players, Hispanic people have a key player, and black people do not rely on racial/ethnic key players. Therefore, governments should understand the role of racial/ethnic key players in their groups to release valuable information effectively.

Second, blacks show the most diverse key players, inconsistent with other racial/ethnic groups. They are the only racial/ethnic group, which has key players in all categories. In contrast, whites have no key players in organizations. Asians are not dependent on doctors and researchers. Also, Asians are the only group, which does not have Donald Trump as the top key player. In contrast, Hispanics rely heavily on institutes and are not interested in researchers.

Third, in the group networks, white and black people actively communicate with others across the groups, whereas Asian and Hispanic people tend to communicate with each other within the groups. However, they also have some different characteristics according to their race/ethnicity. For instance, the largest group of whites energetically communicates with other groups, whereas many groups of blacks have communications across the groups. Asians have some large groups and relatively similar communication ways, whereas Hispanics show many small groups and relatively diverse communication patterns.

This study suggests some important implications as follows: first, governments and policymakers should release COVID-19 information based on the characteristics of racial/ethnic groups. For example, they should utilize racial/ethnic key players for whites, Asians, and Hispanics. In contrast, it might not be an effective way to provide valuable information to racial/ethnic key players for black people. Instead, it would be a good strategy for employing news media for blacks.

Second, this study shows that minority racial/ethnic groups are more susceptible to COVID-19. This is because the economic and social environments of the minority racial/ethnic groups are worse than whites. Especially, many studies indicate that black people are more vulnerable to the coronavirus disease (see [20, 25, 44]). Therefore, governments and planners should focus more on black people not only for them but also other racial/ethnic groups since the virus spreads to all people regardless of the race/ethnicity. In this sense, the findings of this study would provide useful implications for the information networks of black people for COVID-19. For instance, they have news media as the top key player group, and providing pivotal information on COVID-19 via news media would be a good strategy for blacks.

Third, governments and decision makers should understand information networks of people according to the race/ethnicity. For instance, whites and blacks show open network systems, whereas Asians and Hispanics reveal closed network systems. Therefore, they could utilize the major large groups for whites and blacks, whereas they should deliver relevant information to the key players in each group for Asians and Hispanics.

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