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Assessment of Coronavirus disease, the nose pollution filter, fermented spicy Kimchee, and peppery hot soup consumed in Korea

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Abstract

Recent statistics of Coronavirus diseases in Korea are studied with respect to many other countries. It is found that as of 8 February 2021, Korea has recorded 15.8 patients per 10,000 people, and this is used to calculate ratio to compare with other countries. On average, the number of Coronavirus patients in the world is 136.2 that is 8.6 times more than in Korea. The number of Covid-19 patients recorded in Korea is relatively smaller than other countries. There was no clear evidence on the atmospheric transport of Coronaviruses over 1 km to cause infection to other people. The infection of Coronaviruses appeared to occur mainly by close contact with an infected person or by airborne droplets in confined indoor environments, as noted earlier (Lancet, Respir Med 8(12):1159, 2020). To reduce the transmission of Coronavirus and related infections, the wearing of a pollution filter (mask) covering the nose and mouth is mandatory for Coronavirus patients. For the general public, however, we have invented a filter which covers only the nose. When there is no need for conversation and deep breathing, the nose band would be sufficient to filter out Coronavirus and air pollutants. Meanwhile, air and sea port activities including ground transport continued and strict policy on people mingle was not tightly enforced, and control measures to reduce infection were not so effective. However, it is believed that consuming fermented Korean spicy Kimchee and hot peppery soup plus warm rice tea helps in washing Coronaviruses around the throat deep down to the stomach. We find that cleansing the mouth and throat deeply including pathway is better than doing shallow gargling. A possible mechanism for cleansing the mouth and throat of Coronaviruses is here explored. This could have contributed to the relatively small number of Coronavirus patients observed in Korea.

Keywords Air quality · Assessment of Coronavirus disease · Transmission of coronaviruses and UV rays · A new filter on the nose · Fermented Kimchee and spicy soup · Pandemic of Covid-19 and Covid-20V · Exposure assessment

Introduction

The outbreak of Coronavirus disease occurred in Wuhan, China, in December 2019. Soon, the very contagious disease transferred rapidly from person to person and via vehicles, ferries, and aircrafts to 221 countries. The Coronavirus pandemic has brought in a social and economic crisis to the world. During this crisis, the number of Coronavirus patients in Korea, a near neighbor of China, is relatively small in comparison with other countries (Chung and Kim 2021), and this suggests further studies on the transmission pathways of the virus and various mechanisms to control its spread.

The WHO (2020) pointed out that according to current evidence, the Covid-19 virus is "primarily transmitted between people through respiratory droplets and contact routes." The infection of Coronaviruses appears to occur mainly by close contact with an infected person or by airborne droplets in confined indoor environments that contain the virus. Lancet (2020) has summarized that "respiratory viruses are transmitted in three main ways. First, contact transmission, someone comes into direct contact with an infected person or touches a surface that has been contaminated. Second, through droplet transmission of both large and small respiratory droplets that contain the virus, which occur when near an infected person. Third, through airborne transmission of smaller droplets and particles that are suspended in the air over longer distances and time than droplet transmission." In general, it is important to study the atmospheric transmission of Coronaviruses and their contagion potentials in all scales, short 1~10 km, medium 10~100 km, and long range in 100~1000 km.

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In indoor environments such as restaurants and hospitals (Nissen et al. 2020; WHO 2020), air sampling at near central ventilation ducts were conducted and the Covid-19 virus was detected. Kwon et al. (2020) examined a confirmed Covid-19 case in Jeonju, Korea. This case was considered to be "long-distance transmission by droplets at 6.5 m away" from the infector and 5 min exposure in a restaurant with air conditioning. However, transmission and infection of Covid-19 from 1 to 10 km is not yet reported in Korea. It has long been known that bacteria, aerosols, insects, etc. can be transported over long distances out to a few hundred kilometers (Chung and Kim 2008). The possibility of atmospheric transmission of contagious Coronaviruses with air pollutants in medium and long distances was studied, and no evidence on the atmospheric transport of Coronaviruses from China to Korea was found (Chung and Kim 2021).

The above studies are consistent with the findings of the WHO. Strategies to control the infection would best be focused on removing contact with an infection source up to 10 m and on disinfecting contaminated air ducts in indoor environments, and less emphasis on long-range contaminants. Korea implemented restrictions on its sea and airports and land border control early in the outbreak, but unlike countries such as Taiwan and New Zealand which exercised complete closure, Korean ports and borders remained open. As of February 2021, about 30 travelers entering Korea from various countries per day are still tested positive with the virus. Express KTX trains and buses are operating almost regularly. Many meetings including churches, labor unions, and schools are still continued, even with partial closing. As of 25 February 2021, world-wide vaccination is taking place in over 100 countries; however, Korea has yet to implement the vaccination en masse. In all, the control measures for reducing infection of Coronavirus were not enough and were almost the same as other countries. Yet, it is observed that the number of patients during one whole year is generally smaller than the number of other countries (Tables 1 and 2).

Data of Coronavirus patients in Korea were obtained from local counties and provincial governments. Also, we have used the world-wide data available (WorldOMeters 2021) for the present research. Regretfully, patient data of the Disease Control and Prevention Agency, which is ca. 10 away from this Research Centre, were not obtainable.

With the lack of evidence in aerial transmission of Coronaviruses, there are still large discrepancies in the disease statistics among 228 administrative counties in the Republic of Korea. This leads to further studies on the occurrences of Coronavirus disease and on possible mechanisms and methods to prevent the spread of this contagious virus.

To this aim, we will discuss the application of a new noseband pollution filter and a pathway to cleanse the Coronavirus in the mouth and throat by the consumption of Korean Kimchee (Kimchi) and hot peppery soup. In the 2002–2004 SARS outbreak, it was said intuitively that Kimchee played a role in reducing the wide-spreading in Korea (Fauzia 2020).

Recently, variants (V) of Coronavirus disease-19 have occurred in over 86 countries since December 2020 (Chosun Ilbo 2021), and vaccination to prevent Covid-19 and Covid-20V is starting in many countries. In turn, multi-disciplinary scientific research should continue to discover potential new ways to prevent and overcome the pandemic for our global community.

Table 1 Covid-19 Coronavirus pandemic in 20 countries, as of 8 February 2021; from WorldOMeters (2021)

#	Country	Total cases	Total deaths	Population
	World	106,749,293	2,328,722	7,836,058,14
1	USA	27,611,403	474,933	332,177,397
2	India	10,838,843	155,114	1,388,197,453
3	Brazil	9,524,640	231,561	213,473,262
4	Russia	3,983,197	77,068	145,972,446
5	UK	3,945,680	112,465	68,101,913
6	France	3,337,048	78,965	65,361,102
7	Spain	2,971,914	61,386	46,765,771
8	Italy	2,636,738	91,273	60,407,806
9	Turkey	2,531,456	26,797	84,886,799
10	Germany	2,291,441	62,128	83,946,321
15	S Africa	1,476,135	46,290	59,759,506
17	Ukraine	1,246,990	23,644	43,573,750
21	Netherlands	1,005,760	14,403	17,157,864
22	Canada	804,260	20,767	37,942,107
23	Portugal	765,414	14,158	10,178,631
83	China	89,706	4636	1,439,323,776
86	Korea	81,185	1474	51,295,962
110	Australia	28,857	909	25,678,363
169	N Zealand	2320	25	5,002,100
184	Taiwan	928	9	23,842,922

Discussion

Outbreak of Coronavirus disease

The study of Covid-19 disease data recorded from 19 January 2020 to 19 January 2021 in Korea was carried out (Chung and Kim 2021) by using the national and the world data. Table 1 shows a part of the world statistics on Coronavirus disease reported by the WHO (WorldOMeters 2021). The USA has the largest number of patients with 27.6 M, and India holds the second largest with about 10.8 M. In late February 2020, Korea had the second largest number of Coronavirus disease patients, after China. By 8 February 2021, China dropped to 83rd in the world with 89,706 patients.

Table 2 Number of Covid-19 patients per 10,000 people recorded in 18 countries, as compared with the same number (ratio) observed in Korea, as of 8 February 2021 (data from WorldOMeters 2021). Rank# is as given by WHO

Rank#	Country	Per 10 K	Ratio (per Korea)
+	World	136.2	8.6
1	USA	831.2	52.5
2	India	78.1	4.9
3	Brazil	446.2	28.2
4	Russia	272.9	17.2
5	UK	579.4	36.6
6	France	510.6	32.3
7	Spain	635.5	40.1
8	Italy	436.5	27.6
9	Turkey	298.2	18.8
10	Germany	273.0	17.2
-	-	-	-
17	Ukraine	286.2	18.1
22	Canada	212.0	13.4
23	Portugal	752.0	47.5
37	Japan	32.0	2.0
86	**Korea**	**15.8**	**1.0**
110	Australia	11.2	0.7
169	New Zealand	4.6	0.3
184	Taiwan	0.4	0.02

Korea is situated in the downwind side of China across the Yellow Sea (Fig. 1). After maintaining a relatively small number of patients in the summer, rapid increase in many counties and cities in Korea were occurring from late November 2020 to February 2021 (Chung and Kim 2021). Air pollutants including viruses and bacteria circulate in all scale airflows of the biosphere (Chung and Kim 2008; Maki et al. 2008). By 18 February 2021, 6809 out of 85,567 coronavirus patients in Korea came from other countries. Albeit, our investigation has shown that atmospheric transmission of Coronaviruses over medium and long range from China for 350~800 km distances was not occurring in islands and western shore counties in Korea. Importantly, scientists have shown that Coronaviruses are atmospheric UV ray sensitive, and they decay within a short distance in 30~120 min while they are loaded in the boundary atmosphere (Herman et al. 2021; Hessling et al. 2020; Ratnesar-Shumate et al. 2020; Van Doremalen et al. 2020; Chung and Kim 2021). Laboratory experiments have shown that 90% of Coronavirus inactivate with UVB in about 7 min (e.g., Ratnesar-Shumate et al. 2020). In particular, there was a "zero" patient of Coronavirus disease in 23 small islands of Ongjin county; 21,227 residents living on those islands were facing China and subject to infection by highly contagious Coronaviruses contained in the general westerlies during the entire 1 year. With general westerlies, air parcels and air pollutants take 1~2 days to cross the Yellow Sea to reach the Korean Peninsula. There are two more counties of zero patient of Coronavirus diseases in Mooju and Chang-heung counties, and the geographical locations of those three counties are shown in Fig. 1. They are situated at least 5~30 km from cities which include many patients of Coronavirus disease. A former study (Chung and Kim 2021) has concluded that atmospheric transmission of Coronaviruses from about 1 km to several hundred kilometers is not occurring under UV rays especially in the daytime.

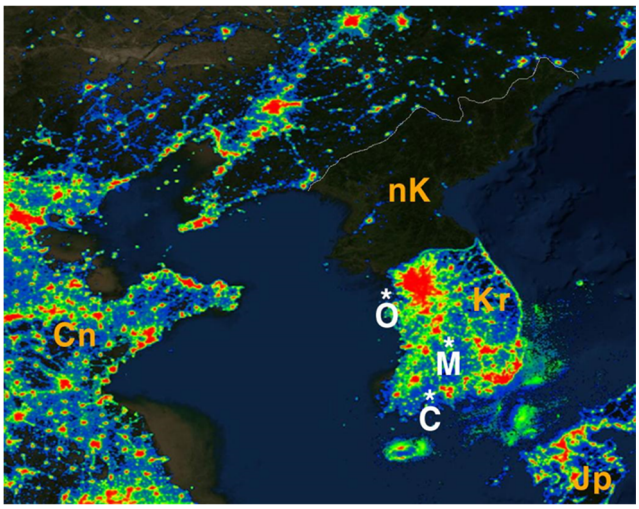

Fig. 1 A satellite image of NASA showing nighttime lights that shows relevance of emission sources in East Asia (Courtesy of H Le). Three counties of Ongjin (O), Moojoo (M), and Chang-heung (C) in Korea (Kr) are indicated, and North Korea (nK), China (Cn), and Japan (Jp) are also shown. Lights on seas are mostly from fishing fleets

The very first Covid-19 patient in Korea reported on 19 January 2020 came from Wuhan, China. The patient belonged to the "S"-church in Daegu City in SE Korea, with a population of 2.41 M. By 20 February 2020, 44 Covid-19 patients from that church were reported and the number increased explosively to 5214 by 18 February 2021 about 1 year later. During that year, only one patient in the neighborhood of the church was found (Fig. 2). The patient was believed to work for a delivery company 800 m from the S-church and was related to a member of the church group. Furthermore, about 5200 passengers per day who use a subway train station 100 m from the church were not known to be affected. These observations do not support that the Coronavirus can be easily spread by direct air transmission in outdoor environments.

In Sejong City of central Korea, there is a camping site on the Keum River bank. The city manages a Coronavirus patient center and about 20 patients infected with Coronavirus were forced to stay there in separate cabins for about 2 months. Yet, no residents living in nearby villages downwind 1~3 km away from the camping site were infected by the disease. Moreover, the very paper is written from this Research Centre located just 7 km east-northeast from the camping site, and no infection is recorded. Importantly, over several hundred

Fig. 2 A meeting of about 500 at "S"-church in Daegu City, Korea (blog.naver.com/enasca84/221819590998)

Coronavirus patients were found in church, old-age home, evening school, factory, prison, and many meeting places. Yet, residents living nearby within 1 km from those buildings have so far reported no infections from the highly contagious diseases. In Korea, clearly there was no confirmed case of infection of Coronavirus from a patient living over 1 km distance. These prove that atmospheric transmission of Coronaviruses out to ca. 300 m~10 km distance is hardly occurring with UV rays in the biosphere, and our study of distant infection can be focused on a scale of less than 1 km. Since UV rays are negligible at night, the possible transfers of the virus and impact to humans in the nighttime and early morning should also be studied further.

Presently, 2-m distancing in the outdoor environment from a Covid-19 patient is recommended to avoid droplets and airborne transmissions. Also, any confirmed infection in the outdoors beyond 2-m deserves careful review.

This Research Centre in Korea recorded air temperatures of − 20.6 °C and + 21.1 °C on 8 January and 21 February 2021, respectively. This wide swing of 41.7 °C from cold to warm air temperatures had no apparent effect on Coronavirus cases. Likewise, hot summer weather in Korea in 2020 with + 35 °C had negligible impact. Elsewhere, Russia has recorded only 3983 K patients in polar climate (Table 1), while in tropical humid weather, large numbers of Coronavirus disease patients were recorded in Mexico 1932 K, South Africa 1476 K, Indonesia 1266 K, Philippines 538 K, Nigeria 139 K, etc. This clearly suggests that outdoor air temperature does give negligible impact, and our effort to curb the pandemic should be focused on indoor air quality and human contacts in confined space. The spreading of contagious Coronaviruses appeared to relate mainly with confined indoor atmosphere and surfaces (Lancet 2020).

Table 2 shows Covid-19 statistics of 18 countries reported on 8 February 2021, as compared with the number of patients recorded in Korea. Relatively, Korea has a smaller number than that of other countries. Table 2 also contains the number of Coronavirus patients per 10 K people in each country. The ratio is obtained from the number of patients per 10 K in each country and then normalized to the Korean value of 15.8 patients. On average, the number of Coronavirus patients in the world is 136.2, while the USA has 831.2 patients per 10 K. The USA has 6.1 times more patients than the world average, and 52.5 times more than in Korea.

Portugal has the second largest number of Covid-19 patients at 752.0 per 10 K with 47.5 times larger than in Korea. Spain has 635.5 patients per 10 K and 40.1 times higher than in Korea, the UK 579.4 patients per 10 K and 36.6 times, France 510.6 patients per 10 K and 32.3 times, Brazil 446.2 patients per 10 K and 28.2 times, and Italy has 436.5 patients per 10 K and with 27.6 times higher than the Korean ratio 1.0. And particularly to note here is Ukraine 286.2 patients per 10 K with ratio 18.1 and Germany 273.0 patients per 10 K with ratio 17.2.

At the outbreak of the pandemic, China had the largest number of Coronavirus patients. Korea is nearest China across the Yellow Sea and its air and sea ports were restricted early but remained open for travelers during this crisis. To this day, Korea still receives 20~30 Coronavirus patients daily from other countries. Control measures were not strictly enforced, and vaccination en masse has yet to materialize as of 25 February 2021, behind over 100 countries. Yet, Korea's number of Coronavirus patients is relatively small.

Both Russia and Canada have a huge land area with sparse density of population, and we believe this is the reason they have had relatively a smaller number of Covid-19 patients, in comparison with Spain and France, etc. On the other hand, Australia, New Zealand, and Taiwan are all surrounded by water away from densely populated countries, and they were able to maintain a small number of contagious disease patients comparatively with complete closure of their ports.

Attenuation of Coronavirus with Korean Kimchee and spicy soup

While one could always argue for improvements on which control measures to adopt, their schedulling and execution, we switch our attention to virus defense based on improving personal hygiene. Tsai and Wu (2020) recommend gargling as an effective means to clear virus from the throat. "Within the first week after infection, the viruses in the oropharynx and throat were the ones that most actively replicated…. Therefore, SARS-CoV-2 is suggested to exhibit tropism for the tissues of the throat." If the virus enters the body via the nose or mouth, it has the tendency to stay in the throat and inner part for days, before proceeding to infect other organs. Any mechanism that cleanses the throat would attenuate the virus's damaging potentials. Early in the pandemic, people

were abusing various substances to fight against the Coronavirus. It was falsely believed that drinking sanitizer, bleach, and disinfectant (e.g., Crolox) could destroy Coronavirus. However, the strong detergent is too hazardous to swallow and can be fatal. Indeed, some deaths from their misuse have been reported.

Tsai and Wu (2020) posit two mechanisms to explain the effectiveness of throat gargling: the (physical) shedding of the virus and infected cells causes the chemical inactivation of the virus.

Bousquet et al. (2020) have found that reported Covid-19 deaths in Germany are relatively low as compared to many European countries, and among other factors that may be significant are the dietary habits. Germans and Ukrainians consume pickled sauerkraut from time to time, along with regular consumption of alcoholic beer. Coincidently, India, Turkey, and Japan which consume a variety of spicy food also have relatively small numbers of Coronavirus patients.

In Korea, consuming pickled cabbage in the form of Kimchee (Fauzia 2020) has been a tradition for over 2000 years. It has been the primary source of vegetables and vitamin C to prevent scurvy, especially during the cold winter months. Kimchee is now made from a variety of ingredients including garlic, green onion, ginger, and anchovies. Fermented Kimchee has a strong odour.

Traditionally, Koreans consume fermented sour Kimchee plus peppery hot soup (200~300 mL) in every meal. After each meal, Koreans also drink warm tea made from scorched brownish rice to wash the mouth.

The anatomy of the mouth and throat is shown (Wikipedia 2021) in Fig. 3, and Coronaviruses landed in the nasal cavity should flow down to the pharynx. The pharynx is connected with the entrance of the larynx, a pass way to the lungs. Consuming spicy-sour Kimchee could "wash-down" a part of Coronaviruses from around the throat including pharynx/epiglottis/entrance of larynx to the stomach, and strong acid in the stomach could disintegrate the Coronavirus protein. The cleansing mechanism of pharynx and epiglottis is the new scheme to introduce here. The above cleansing role is more effective than the mouth gargling of Tsai and Wu (2020) suggested.

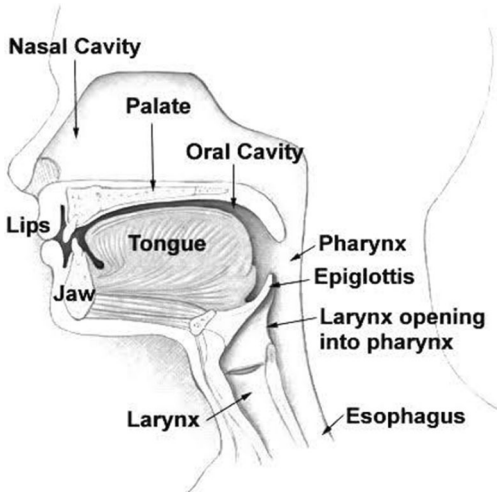

Fig. 3 Pharynx: the part of a throat behind the mouth and nasal cavity (Wikipedia 2021)

An operating mechanism to demonstrate the benefits of certain food against Coronavirus has yet to be fully discussed in the literature. Albeit, it is observed that fermented cabbage, Korean sauerkraut, sour "Kimchee," and spicy hot soup are good for washing potential Coronavirus attached in our throat and inner pathway.

Also, warm and peppery hot soup and stew would be very helpful with a similar cleansing role for washing down fat and oily remains in the mouth and throat plus epiglottis, etc. Sizzling/deep-boiled spicy soup includes meat, fish, reddish, bean sprouts, bean curd, fermented bean paste, spinach, chard, Kimchee, brown seaweed, and garlic.

Nutritional and biochemical composition of typical Kimchee is shown in Wikipedia (2021). There are actually over 20 varieties of Kimchee and they contain microorganisms, probiotics, and acid bacteria known to play a valuable role against other viruses in the intestine and colon. It is plausible that fermented spicy-sour Kimchee and peppery hot soup plus warm rice tea could wash Coronaviruses settled/attached to the inner throat and pharynx and epiglottis down to our stomach, and this could well play a preventive and decay role of Coronavirus in our body. Laboratory studies should be conducted to determine the effectiveness of each product with respect to their ability to shed infected cells from the throat and to chemically deactivate the virus.

Air pollution filter on nose

The purpose and role of a "pollution filter" (mask) on the nose and mouth were discussed (Chung et al. 2019), and with the world-wide pandemic, we are urged to wear it in many countries. "Pollution filter" rather than "mask" is a more appropriate term. The role and function of a pollution filter band are not for hiding and covering the face, but it is to reduce air pollution including viruses and bacteria from entering our respiratory system. To prevent further spreading of Coronaviruses to other people, Coronavirus patients indoor must wear the pollution filter c in Fig. 4.

We breathe to bring air and oxygen into and out of the lungs. Breathing can be performed completely via the nose without engaging the mouth. In other words, if we do not need conversation and deep breathing, wearing a "filter" band on the nose without covering the mouth (b in Fig. 4) is sufficient. In the outdoor environment, however, wearing the nose filter is not needed if we are not within 3 m from any person/patient and if there is no potential of Coronavirus loadings in the air.

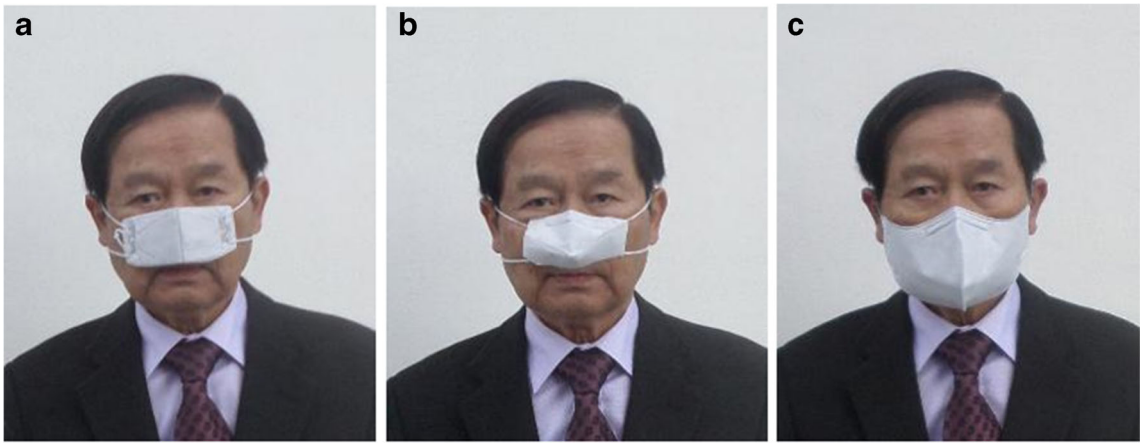

Fig. 4 Filter: nose filter (**a**); Chung's filter band on the nose (**b**); filter on the nose and mouth (**c**) band every 30 min in highly polluted air potentially loaded with Coronavirus. The new design and development of a nose "filter" band are invented for world-wide use and is shown in Fig. 4b. For easy and comfortable breathing, a large and big-nose shape filter is recommended. The 3-layer with KF80~94 filter type, or better quality, should be used

Because of wetting and self-contamination of air pollution in the breathing system, it is important to change frequently the nose filter.

Summary and conclusions

Recent statistics of Coronavirus diseases in Korea is discussed with respect to many other countries. Our previous study (Chung and Kim 2021) has shown that there was no evidence on long-range transports of Coronaviruses to Korea from Chinese continent. In addition, there was no clear evidence on the atmospheric transport of Coronaviruses over 1 km to cause infection to other people. It is observed Korea has reported 15.8 patients per 10,000 people, and this is used to calculate ratio to compare with other countries. Among the countries with a large number of Coronavirus disease patients, the USA has 831.2 patients per 10 K people and it has 52.5 times more patients than Korea. Spain, the UK, France, Brazil, and Italy have patients from 436.5 to 635.5 which are 27.6~40.1 times higher than the standing value of Korea. In comparison, Germany has 273.0 patients which is 17.2 times more than Korea, while Ukraine observes 286.2 patients and has 18.1 times higher than the value of Korea.

Korea has been maintaining its air and sea ports open mostly during the Coronavirus pandemic, even with partial disruption. However, the number of patients is relatively small compared with the aforementioned countries. Control measures were not adequate and enough. Yet, we believe that the traditional food daily consumed in Korea, especially fermented spicy Kimchee and peppery hot soup, contribute partially to lowering the number of Coronavirus cases. Similarly, Germans and Ukrainians also eat fermented sour sauerkraut and this may have given some effect to defend and decay Coronaviruses. An operating mechanism on cleansing viruses in the throat including pharynx and epiglottis by spicy food was shown. Meanwhile, Taiwan, New Zealand, and Australia should receive credit and compliments on their effective management of the pandemic by strict controls of their sea and airports.

In outdoor environments, natural UV rays can effectively deactivate Coronavirus. In indoor environments, the transfer of Coronaviruses appears to occur mainly from people to people. A half-face "pollution filter" on the nose and mouth (mask) should be worn by Coronavirus disease patients and people who need to communicate by speech (c in Fig. 4). When there is no need for conversation and deep breathing, we suggest that a "filter" band on the nose (b in Fig. 4) may be used for the general public, especially in the morning and evening hours when UV rays are at their minimum. Because of wetting and self-contamination from breathing, the filter band should be changed every half an hour to bring in the fresh air.

The infection of Coronaviruses occurred mainly in indoor environments including church, theater, dancing hall, school, prison, and large meeting places. The Coronaviruses in its multiple variants (Covid-20V) present difficult challenges to our global community. The race to develop vaccines that keep pace with new mutations and controlling its spread in the meantime is a battle that requires efforts from many disciplines of science and public administrations worldwide. We suggest that a variety of research on this topic should be continued with the aim to bring potential answers to this pandemic crisis to an earlier end.

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Data availability Data and materials used are all included in the text.

Declarations

Conflict of interest The author declares no competing interests.

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