Outdoor Transmission – List of Abstracts

Date: 30 April 2020

Reviewers: Ruth McQuillan, Marshall Dozier, Lara Goodwin, Evropi Theodoratou.

Search details: We searched PubMed and MedRxiv on 30 April 2020 (MD) for articles added since 1 April.

Pubmed 20200430
238 results

("Betacoronavirus"[Mesh] OR "Coronavirus Infections"[MH] OR "Spike Glycoprotein, COVID-19 Virus"[NM] OR "COVID-19"[NM] OR "Coronavirus"[MH] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[NM] OR 2019nCoV[ALL] OR Betacoronavirus*[ALL] OR Corona Virus*[ALL] OR Coronavirus*[ALL] OR Coronovirus*[ALL] OR CoV[ALL] OR CoV2[ALL] OR COVID[ALL] OR COVID19[ALL] OR COVID-19[ALL] OR HCoV-19[ALL] OR nCoV[ALL] OR "SARS CoV 2"[ALL] OR SARS2[ALL] OR SARSCoV[ALL] OR SARS-CoV[ALL] OR SARS-CoV-2[ALL] OR Severe Acute Respiratory Syndrome CoV*[ALL]) AND ((2020/04/01[EDAT] : 3000[EDAT]) OR (2020/04/01[PDAT] : 3000[PDAT]))
AND
outside[tw] OR outdoor*[tw] OR external[tw] OR parks[tw] OR “public space*”[tw] OR “social distanc*[tw]” OR “physical distanc*[tw]” OR “population mixing[tw]” OR “social mixing”[tw] OR exercis*[tw] OR jogging[tw] OR walking[tw] OR cycling[tw] OR running[tw] OR surface*[tw] OR metal[tw] OR plastic[tw] OR wood[tw] OR fence*[tw] OR gate*[tw] OR "outdoor gym*"[tw] OR stone*[tw] OR fomites[tw]

medRxiv via medRxivr 20200430
covid+outdoor+exercise terms – 216 results
covid+surfaces terms = 151 additional results

covid set combined with OR
COVID-19
[Cc]oronavirus
SARS-CoV-2
2019-nCoV

Outdoor / exercise set combined with OR, then with the covid set using AND
outside
outdoor
external
parks
public space
social distanc
physical distanc
population mixing
social mixing
exercis
jogging
walking
cycling
running

surfaces set combined with OR with outdoor set, then with the covid set using AND
surface
metal
plastic
wood
fence
gate
outdoor gym
stone
fomite

Screening criteria:

Include papers that report data on:

- Outdoor transmission

- Airborne transmission

- Surface transmission

- Laboratory-based studies that are relevant (e.g. about different surfaces, different temperatures, humidity)

Exclude

- Indoor transmission

- commentaries, editorials, opinion pieces

Search results:

We retrieved a total of 605 articles before deduplication

T&A screening was conducted by one reviewer (RM). Rejections were reviewed by a second reviewer (LG). A third reviewer checked all abstracts for relevance (ET).

27 potentially relevant articles were identified and are listed here.

Full texts have not yet been looked at – this is simply a list of potentially relevant abstracts. A link to the full text article is provided for each. Most of the articles are pre-prints and have not been peer reviewed – this is indicated.

A full update will be conducted next week.

List of abstracts

Z. Zhang; L. Zhang; Y. Wang (2020) – peer reviewed

COVID-19 indirect contact transmission through the oral mucosa must not be ignored

BACKGROUND: Coronavirus (CoV) is the single stranded sense RNA virus that has been known so far with the largest genomic capacity and plenty of natural hosts. In the past dozens of years, SARS-CoV under the branch of the new evolutionary tree has threatens greatly global public health and the severe acute respiratory syndrome new coronavirus (COVID-19) reported in China could cause fatal pathological lesions. Especially in areas with poor medical care, neglect of indirect transmission can cause more serious consequences. METHODS: First of all, with reference to SARS-CoV and other relevant studies, the possibility of virus residues on the **surface of multiple media is discussed**. Further, it is found that the surface residue of this substance may be an important factor in iatrogenic infection. RESULTS: This correspondence could point out the direction to study the pathomechanism of COVID-19 infecting human beings. CONCLUSIONS: Mucosa exposure and inappropriate treatment of medical and non-medical articles used by the patients all could increase the risks of COVID-19 transmission.

P. Shi; Y. Dong; H. Yan; C. Zhao; X. Li; W. Liu; M. He; S. Tang; S. Xi (2020) – peer reviewed

Impact of temperature on the dynamics of the COVID-19 outbreak in China

A COVID-19 outbreak emerged in Wuhan, China at the end of 2019 and developed into a global pandemic during March 2020. The effects of temperature on the dynamics of the COVID-19 epidemic in China are unknown. Data on COVID-19 daily confirmed cases and daily mean temperatures were collected from 31 provincial-level regions in mainland China between Jan. 20 and Feb. 29, 2020. Locally weighted regression and smoothing scatterplot (LOESS), distributed lag nonlinear models (DLNMs), and random-effects meta-analysis were used to examine the relationship between daily confirmed cases rate of COVID-19 and temperature conditions. The daily number of new cases peaked on Feb. 12, and then decreased. The daily confirmed cases rate of COVID-19 had a biphasic relationship with temperature (with a peak at 10 degrees C), and the daily incidence of COVID-19 decreased at values below and above these values. The overall epidemic intensity of COVID-19 reduced slightly following days with higher temperatures with a relative risk (RR) was 0.96 (95% CI: 0.93, 0.99). **A random-effect meta-analysis including 28 provinces in mainland China, we confirmed the statistically significant association between temperature and RR during the study period (Coefficient = -0.0100, 95% CI: -0.0125, -0.0074)**. The DLNMs in Hubei Province (outside of Wuhan) and Wuhan showed similar patterns of temperature. Additionally, a modified susceptible-exposed-infectious-recovered (M-SEIR) model, with adjustment for climatic factors, was used to provide a complete characterization of the impact of climate on the dynamics of the COVID-19 epidemic.

N. van Doremalen; T. Bushmaker; D. H. Morris; M. G. Holbrook; A. Gamble; B. N. Williamson; A. Tamin; J. L. Harcourt; N. J. Thornburg; S. I. Gerber; J. O. Lloyd-Smith; E. de Wit; V. J. Munster (2020) – letter to the editor

Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1

M. P. G. Mol; S. Caldas (2020) – peer reviewed

Can the human coronavirus epidemic also spread through solid waste?

Wastes generated in healthcare facilities have been discussed and the World Health Organization has proposed a guideline for controlling the spread of the virus that causes Coronavirus Disease 2019 (COVID-19). However, waste management outside the generating facility should be discussed in more detail, taking into account factors such as virus resistance, differences in waste management systems and the climatic conditions in each affected region. Patients infected by human coronavirus being treated at home are generating infected waste possibly discarded as domestic waste, which can pose risks to workers and the environment, depending on the conditions of transport and disposal. In particular, t**he spread of the coronavirus may be increased by inadequate waste management,** highlighting poor handling conditions associated with inappropriate use of personal protective equipment and other unfavourable conditions presented mainly in developing countries.

L. Setti; F. Passarini; G. De Gennaro; P. Barbieri; M. G. Perrone; M. Borelli; J. Palmisani; A. Di Gilio; P. Piscitelli; A. Miani (2020) - Editorial

Airborne Transmission Route of COVID-19: Why 2 Meters/6 Feet of Inter-Personal Distance Could Not Be Enough

The COVID-19 pandemic caused the shutdown of entire nations all over the world. In addition to mobility restrictions of people, the World Health Organization and the Governments have prescribed maintaining an inter-personal distance of 1.5 or 2 m (about 6 feet) from each other in order to minimize the risk of contagion through the droplets that we usually disseminate around us from nose and mouth. However, recently published studies support the hypothesis of virus transmission over a distance of 2 m from an infected person. Researchers have **proved the higher aerosol and surface stability of SARS-COV-2 as compared with SARS-COV-1** (with the virus remaining viable and infectious in aerosol for hours) and that airborne transmission of SARS-CoV can occur besides close-distance contacts. Indeed, there is reasonable evidence about the possibility of **SARS-COV-2 airborne transmission due to its persistence into aerosol droplets in a viable and infectious form**. Based on the available knowledge and epidemiological observations, it is plausible that small particles containing the virus may diffuse in indoor environments covering distances up to 10 m from the emission sources, thus representing a kind of aerosol transmission. **On-field studies carried out inside Wuhan Hospitals showed the presence of SARS-COV-2 RNA in air samples collected in the hospitals and also in the surroundings**, leading to the conclusion that the airborne route has to be considered an important pathway for viral diffusion. Similar findings are reported in analyses concerning air samples collected at the Nebraska University Hospital. On March 16th, we have released a Position Paper emphasizing the airborne route as a possible additional factor for interpreting the anomalous COVID-19 outbreaks in northern Italy, ranked as one of the most polluted areas in Europe and characterized by high particulate matter (PM) concentrations. The available information on the SARS-COV-2 spreading supports the hypothesis of airborne diffusion of infected droplets from person to person at a distance greater than two meters (6 feet). The inter-personal distance of 2 m can be reasonably considered as an effective protection only if everybody wears face masks in daily life activities.

L. Setti; F. Passarini; G. De Gennaro; P. Barbieri; A. Pallavicini; M. Ruscio; P. Piscitelli; A. Colao; A. Miani (2020) - Editorial

Searching for SARS-COV-2 on Particulate Matter: A Possible Early Indicator of COVID-19 Epidemic Recurrence

A number of nations were forced to declare a total shutdown due to COVID-19 infection, as extreme measure to cope with dramatic impact of the pandemic, with remarkable consequences both in terms of negative health outcomes and economic loses. However, in many countries a Phase-2" is approaching and many activities will re-open soon, although with some differences depending on the severity of the outbreak experienced and SARS-COV-2 estimated diffusion in the general population. At the present, possible relapses of the epidemic cannot be excluded until effective vaccines or immunoprophylaxis with human recombinant antibodies will be properly set up and commercialized. COVD-19-related quarantines have triggered serious social challenges, so that decision makers are concerned about the risk of wasting all the sacrifices imposed to the people in these months of quarantine. The availability of possible early predictive indicators of future epidemic relapses would be very useful for public health purposes, and could potentially prevent the suspension of entire national economic systems. On 16 March, a Position Paper launched by the Italian Society of Environmental Medicine (SIMA) hypothesized for the first time **a possible link between the dramatic impact of COVID-19 outbreak in Northern Italy and the high concentrations of particulate matter (PM10 and PM2.5) that characterize this area, along with its well-known specific climatic conditions.** Thereafter, a survey carried out in the **U.S. by the Harvard School of Public Health suggested a strong association between increases in particulate matter concentration and mortality rates due to COVID-19.** The presence of SARS-COV-2 RNA on the particulate matter of Bergamo, which is not far from Milan and represents the epicenter of the Italian epidemic, seems to confirm (at least in case of atmospheric stability and high PM concentrations, as it usually occurs in Northern Italy) that the virus can create clusters with the particles and be carried and detected on PM10. Although no assumptions can be made concerning the link between this first experimental finding and COVID-19 outbreak progression or severity, the presence of SARS-COV-2 RNA on PM10 of outdoor air samples in any city of the world could represent a potential early indicator of COVID-19 diffusion. Searching for the viral genome on particulate matter could therefore be explored among the possible strategies for adopting all the necessary preventive measures before future epidemics start."

H. Fathizadeh; P. Maroufi; M. Momen-Heravi; S. Dao; S. Kose; K. Ganbarov; P. Pagliano; S. Esposito; H. S. Kafil (2020) – peer reviewed

Protection and disinfection policies against SARS-CoV-2 (COVID-19)

In late December 2019, reports from China of the incidence of pneumonia with unknown etiology were sent to the World Health Organization (WHO). Shortly afterwards, the cause of this disease was identified as the novel beta-coronavirus, SARS-CoV-2, and its genetic sequence was published on January 12, 2020. Human-to-human transmission via respiratory droplets and contact with aerosol infected surfaces are the major ways of transmitting this virus. **Here we attempted to collect**

information on virus stability in the air and on surfaces and ways of preventing of SARS-CoV-2 spreading.

G. Pascarella; A. Strumia; C. Piliego; F. Bruno; R. Del Buono; F. Costa; S. Scarlata; F. E. Agro (2020) – peer reviewed

COVID-19 diagnosis and management: a comprehensive review

Severe acute respiratory syndrome coronavirus (SARS-CoV)-2, a novel coronavirus from the same family as SARS-CoV and Middle East respiratory syndrome coronavirus, has spread worldwide leading the World Health Organization to declare a pandemic. The disease caused by SARS-CoV-2, coronavirus disease 2019 (COVID-19), presents flu-like symptoms which can become serious in high-risk individuals. Here we provide an overview of the known clinical features of and treatment options for COVID-19. We carried out a systematic literature search using the main online databases (PubMed, Google Scholar, MEDLINE, UpToDate, Embase and Web of Science) with the following keywords: 'COVID-19', '2019-nCoV', 'coronavirus' and 'SARS-CoV-2'. We included publications from 1 January 2019 to 3 April 2020 which focused on clinical features and treatments. **We found that infection is transmitted from human to human and through contact with contaminated environmental surfaces.** Hand hygiene is fundamental to prevent contamination. Wearing personal protective equipment is recommended in specific environments. The main symptoms of COVID-19 are fever, cough, fatigue, slight dyspnoea, sore throat, headache, conjunctivitis and gastrointestinal issues. Real-time PCR is used as a diagnostic tool using nasal swab, tracheal aspirate or bronchoalveolar lavage samples. Computed tomography findings are important for both diagnosis and follow-up. To date, there is no evidence of any effective treatment for COVID-19. The main therapies being used to treat the disease are antiviral drugs, chloroquine/hydroxychloroquine and respiratory therapy. In conclusion, although many therapies have been proposed, quarantine is the only intervention that appears to be effective in decreasing the contagion rate. Specifically designed randomized clinical trials are needed to determine the most appropriate evidence-based treatment modality.

G. K. Goh; A. K. Dunker; J. A. Foster; V. N. Uversky (2020) – peer reviewed

Shell disorder analysis predicts greater resilience of the SARS-CoV-2 (COVID-19) outside the body and in body fluids

The coronavirus (CoV) family consists of viruses that infects a variety of animals including humans with various levels of respiratory and fecal-oral transmission levels depending on the behavior of the viruses' natural hosts and optimal viral fitness. A model to classify and predict the levels of respective respiratory and fecal-oral transmission potentials of the various viruses was built before the outbreak of MERS-CoV using AI and empirically-based molecular tools to predict the disorder level of proteins. Using the percentages of intrinsic disorder (PID) of the nucleocapsid (N) and membrane (M) proteins of CoV, the model easily clustered the viruses into three groups with the SARS-CoV (M PID = 8%, N PID = 50%) falling into Category B, in which viruses have intermediate levels of both respiratory and fecal-oral transmission potentials. Later, MERS-CoV (M PID = 9%, N PID = 44%) was found to be in Category C, which consists of viruses with lower respiratory transmission potential but with higher fecal-oral transmission capabilities. Based on the peculiarities of disorder distribution, the SARS-CoV-2 (M PID = 6%, N PID = 48%) has to be placed in Category B. Our data

show however, that the SARS-CoV-2 is very strange with one of the hardest protective outer shell, (M PID = 6%) among coronaviruses. **This means that it might be expected to be highly resilient in saliva or other body fluids and outside the body.** An infected body is likelier to shed greater numbers of viral particles since the latter is more resistant to antimicrobial enzymes in body fluids. These particles are also likelier to remain active longer. These factors could account for the greater contagiousness of the SARS-CoV-2 and have implications for efforts to prevent its spread.

wei li, Xiaohong Chen, Chunxing Chen, Guowei Liao (2020) - pre-print: not peer reviewed

The nexus of travel restriction, air pollution and COVID-19 infection: Investigation from a megacity of the southern China

To control and prevent the spread of COVID-19, generalized social distancing measures, such as traffic control and travel restriction acted in China. Previous studies indicated that the traffic conditions had significant influence on the air quality, and which was related to the respiratory diseases. This study aimed to reveal the nexus of travel restriction, air pollution and COVID-19. Shenzhen, one of the top 4 megacities in China was considered as the study area, statistical analysis methods, including linear/nonlinear regression and bivariate correlation was conducted to evaluate the relationship of the traffic and passenger population, travel intensity, NO2, PM10, PM2.5 and the number of COVID-19 confirmed cases. T**he results suggested that traffic control and travel restriction had a significant correlation with the number of COVID-19 confirmed cases, which shown negative correlation with the traffic intensity of the city, NO2, PM10 and PM2.5 show significant positive correlation with the traffic intensity, traffic control and travel restriction would slow down and prevent the spread of the viruses at the outbreak period.** Different study scale might results in different results, thus the research focused on the nexus of traffic control and travel restriction, air pollution and COVID-19 should been enhanced in future, and differentiated epidemic control and prevention measures should be considered according to the different situation of cities as well as countries.

Kumar S (2020) - pre-print: not peer reviewed

Will COVID-19 pandemic diminish by summer-monsoon in India? Lesson from the first lockdown

The novel Coronavirus (2019-nCoV) was identified in Wuhan, Hubei Province, China, in December 2019 and has created a medical emergency worldwide. It has spread rapidly to multiple countries and has been declared a pandemic by the World Health Organization. In India, it is already reported more than 18 thousand cases and more than 600 deaths due to Coronavirus disease 2019 (COVID-19) till April 20, 2020. Previous studies on various viral infections like influenza have supported an epidemiological hypothesis that the cold and dry (low absolute humidity) environments favor the survival and spread of droplet-mediated viral diseases. These viral transmissions found attenuated in warm and humid (high absolute humidity) environments. However, the role of temperature, humidity, and absolute humidity in the transmission of COVID-19 has not yet been well established. Therefore the s**tudy to investigate the meteorological condition for incidence and spread of**

COVID-19 infection, to predict the epidemiology of the infectious disease, and to provide a scientific basis for prevention and control measures against the new disease is required for India. In this work, we analyze the local weather patterns of the Indian region affected by the COVID-19 virus for March and April months, 2020. We have investigated the effect of meteorological parameters like Temperature, relative humidity, and absolute humidity on the rate of spread of COVID-19 using daily confirm cases in India. We have used daily averaged meteorological data for the last three years (2017-2019) for March and April month and the same for the year 2020 for March 1 to April 15. We found a positive association (Pearsons r=0.56) between temperature and daily COVID-19 cases over India. We found a negative association of humidity (RH and AH) with daily COVID-19 Cases (Persons r=-0.62, -0.37). We have also investigated the role of aerosol in spreading the pandemic across India because its possible airborne nature. For this, we have investigated the association of aerosols (AOD) and other pollutions (NO2) with COVID-19 cases during the study period and also during the first lockdown period (25 March-15 April) in India. We found a negative association in March when there were few cases, but in April, it shows positive association when the number of cases is more (for AOD it was r=-0.41 and r=0.28 respectively). During the lockdown period, aerosols (AOD) and other pollutants (NO2; an indicator of PM2.5) reduced sharply with a percentage drop of about 36 and 37, respectively. This reduction may have reduced the risk for COVID-19 through air transmission due to the unavailability of aerosol particles as a base. HYSPLIT forward trajectory model also shows that surface aerosols may travel up to 4 km according to wind and direction within three h of its generation. If coronavirus becomes airborne as suggested by many studies, then it may have a higher risk of transmission by aerosols particles. So relaxing in the lockdown and environmental rules in terms of pollutant emissions from power plants, factories, and other facilities would be a wrong choice and could result in more COVID-19 incidences and deaths in India. Therefore the current study, although limited, suggests that it is doubtful that the spread of COVID-19 would slow down in India due to meteorological factors, like high temperature and high humidity. Because a large number of cases have already been reported in the range of high Tem, high Relative, and high absolute humidity regions of India. **Thus our results in no way suggest that COVID-19 would not spread in warm, humid regions or during summer/monsoon.** So effective public health interventions should be implemented across India to slow down the transmission of COVID-19. If COVID-19 is indeed sensitive to environmental factors, it could be tested in the coming summer-monsoon for India. So the only summer is not going to help India until monsoon is coming. Only government mitigations strategies would be helpful, whether its lockdown, aggressive and strategic testing, medic l facilities, imposing social distancing, encouraging to use face mask or monitoring by a mobile application (Aarogya Setu).

Guerrero N et al (2020) - pre-print: not peer reviewed

COVID-19. Transport of respiratory droplets in a microclimatologic urban scenario

Although there are some recent studies which intent to address the spread of respiratory droplets through the air, these correspond to indoor conditions or outdoor situations which not take into account realistic scenario. Less attention has been paid to the spread of respiratory droplets in outdoor environments under microclimatologic turbulent wind and which is of growing importance given the current COVID19 epidemic. **We implement a computational model describing a sneezing person in an urban scenario under a medium intensity climatological wind. Turbulence was described with a wall-modeled Large Eddy Simulation model and the spread of respiratory droplets by using a lagrangian approach.** Results show the spread of respiratory droplets is characterized by the dynamics of two groups of droplets of different sizes: larger droplets (400 - 900

m) are spread between 2-5 m during 2.3 s while smaller (100 - 200 m) droplets are transported a larger range between 8-11 m by the action of the turbulent wind in 14.1 s average. Given the uncertainty of potential contagion over this way and with this reach, these efforts are an intent to contribute to shine a light on the possibility of adopting stricter self-care and distancing measures.

Travaglio M et al (2020) - pre-print: not peer reviewed

Links between air pollution and COVID-19 in England

In December 2019 a novel disease [coronavirus disease 19 (COVID-19) emerged in the Wuhan province of the People's Republic of China. COVID-19 is caused by a novel coronavirus (SARS-CoV-2) thought to have jumped species, from another mammal to humans. A pandemic caused by this virus is running rampant throughout the world. Thousands of cases of COVID-19 are reported in England and over 10,000 patients have died. Whilst there has been progress in managing this disease, it is not clear which factors, besides age, affect the severity and mortality of COVID-19. A recent analysis of COVID-19 in Italy identified links between air pollution and death rates. Here, we explored the correlation between three major air pollutants linked to fossil fuels and SARS-CoV-2 lethality in England. W**e compare up-to-date, real-time SARS-CoV-2 cases and death measurements from public databases to air pollution data monitored across over 120 sites in different regions. We found that the levels of some markers of poor air quality, nitrogen oxides and ozone, are associated with COVID-19 lethality in different English regions**. We conclude that the levels of some air pollutants are linked to COVID-19 cases and morbidity. We suggest that our study provides a useful framework to guide health policy in countries affected by this pandemic.

Ray D et al (2020) - pre-print: not peer reviewed

Predictions, role of interventions and effects of a historic national lockdown in India's response to the COVID-19 pandemic: data science call to arms

Importance: India has taken strong and early public health measures for arresting the spread of the COVID-19 epidemic. With only 536 COVID-19 cases and 11 fatalities, India - a democracy of 1.34 billion people - took the historic decision of a 21-day national lockdown on March 25. The lockdown was further extended to May 3, soon after the analysis of this paper was completed. Objective: To study the short- and long-term impact of an initial 21-day lockdown on the total number of COVID-19 cases in India compared to other less severe non-pharmaceutical interventions using epidemiological forecasting models and Bayesian estimation algorithms; to compare effects of hypothetical durations of lockdown from an epidemiological perspective; to study alternative explanations for slower growth rate of the virus outbreak in India, including exploring the association of the number of cases and average monthly temperature; and finally, to outline the pivotal role of reliable and transparent data, reproducible data science methods, tools and products as we reopen the country and prepare for a post lock-down phase of the pandemic. Design, Setting, and Participants: We use the daily data on the number of COVID-19 cases, of recovered and of deaths from March 1 until April 7, 2020 from the 2019 Novel Coronavirus Visual Dashboard operated by the Johns Hopkins University Center for Systems Science and Engineering (JHU CSSE). Additionally, we use COVID-19 incidence counts data from Kaggle and the monthly average temperature of major cities across the world from Wikipedia. Main Outcome and Measures: The current time-series data on daily proportions of cases and removed (recovered and death combined) from India are analyzed

using an extended version of the standard SIR (susceptible, infected, and removed) model. The eSIR model incorporates time-varying transmission rates that help us predict the effect of lockdown compared to other hypothetical interventions on the number of cases at future time points. A Markov Chain Monte Carlo implementation of this model provided predicted proportions of the cases at future time points along with credible intervals (CI). Results: Our predicted cumulative number of COVID-19 cases in India on April 30 assuming a 1-week delay in people's adherence to a 21-day lockdown (March 25 - April 14) and a gradual, moderate resumption of daily activities after April 14 is 9,181 with upper 95% CI of 72,245. In comparison, the predicted cumulative number of cases under no intervention" and "social distancing and travel bans without lockdown" are 358 thousand and 46 thousand (upper 95% CI of nearly 2.3 million and 0.3 million) respectively. An effective lockdown can prevent roughly 343 thousand (upper 95% CI 1.8 million) and 2.4 million (upper 95% CI 38.4 million) COVID-19 cases nationwide compared to social distancing alone by May 15 and June 15, respectively. When comparing a 21-day lockdown with a hypothetical lockdown of longer duration, we find that 28-, 42-, and 56-day lockdowns can approximately prevent 238 thousand (upper 95% CI 2.3 million), 622 thousand (upper 95% CI 4.3 million), 781 thousand (upper 95% CI 4.6 million) cases by June 15, respectively. **We find some suggestive evidence that the COVID-19 incidence rates worldwide are negatively associated with temperature i**n a crude unadjusted analysis with Pearson correlation estimates [95% confidence interval] between average monthly temperature and total monthly incidence around the world being -0.185 [-0.548, 0.236] for January, -0.110 [-0.362, 0.157] for February, and -0.173 [-0.314, -0.026] for March. Conclusions and Relevance: The lockdown, if implemented correctly in the end, has a high chance of reducing the total number of COVID-19 cases in the short term, and buy India invaluable time to prepare its healthcare and disease monitoring system. Our analysis shows we need to have some measures of suppression in place after the lockdown for the best outcome. We cannot heavily rely on the hypothetical prevention governed by meteorological factors such as t mperature based on current evidence. From an epidemiological perspective, a longer lockdown between 42-56 days is preferable. However, the lockdown comes at a tremendous price to social and economic health through a contagion process not dissimilar to that of the coronavirus itself. Data can play a defining role as we design post-lockdown testing, reopening and resource allocation strategies. Software: Our contribution to data science includes an interactive and dynamic app (covind19.org) with short- and long-term projections updated daily that can help inform policy and practice related to COVID-19 in India. Anyone can visualize the observed data for India and create predictions under hypothetical scenarios with quantification of uncertainties. We make our prediction codes freely available (https://github.com/umich-cphds/cov-ind-19) for reproducible science and for other COVID-19 affected countries to use them for their prediction and data visualization work."

He Z et al (2020) - pre-print: not peer reviewed

Meteorological factors and domestic new cases of coronavirus disease (COVID-19) in nine Asian cities: A time-series analysis

AIM To investigate the associations of meteorological factors and the daily new cases of coronavirus disease (COVID-19) in nine Asian cities. METHOD Pearson correlation and generalized additive modeling were performed to assess the relationships between daily new COVID-19 cases and meteorological factors (daily average temperature and relative humidity) with the most updated data currently available. RESULTS The Pearson correlation showed that daily new confirmed cases of COVID-19 were more correlated with the average temperature than with relative humidity. Daily new confirmed cases were negatively correlated with the average temperature in Beijing (r=-0.565,

P<0.01), Shanghai (r=-0.471, P<0.01), and Guangzhou (r=-0.530, P<0.01) , yet in contrast, positively correlated with that in Japan (r=0.441, P<0.01). In most of the cities (Shanghai, Guangzhou, Hong Kong, Seoul, Tokyo, and Kuala Lumpur), generalized additive modeling analysis showed the number of daily new confirmed cases was positively associated with both average temperature and relative humidity, especially in lagged 3d model, where a positive influence of temperature on the daily new confirmed cases was discerned in 5 cities except in Beijing, Wuhan, Korea, and Malaysia. Nevertheless, the results were inconsistent across cities and lagged time, suggesting meteorological factors were unlikely to greatly influence the COVID-19 epidemic. CONCLUSION The associations between meteorological factors and the number of COVID-19 daily cases are inconsistent across cities and lagged time. Large-scale public health measures and expanded regional research are still required until a vaccine becomes available and herd immunity is established.

Setti L et al (2020) - pre-print: not peer reviewed

SARS-Cov-2 RNA Found on Particulate Matter of Bergamo in Northern Italy: First Preliminary Evidence

In previous communications, we have hypothesized the possibility that SARS-CoV-2 virus could be present on particulate matter (PM) during the spreading of the infection, consistently with evidence already available for other viruses. Here, we present the first results of the analyses that we have performed on 34 PM10 samples of outdoor/airborne PM10 from an industrial site of Bergamo Province, collected with two different air samplers over a continuous 3-weeks period, from February 21st to March 13th. **We can confirm to have reasonably demonstrated the presence of SARS-CoV-2 viral RNA by detecting highly specific RtDR gene on 8 filters in two parallel PCR analyses. This is the first preliminary evidence that SARS-CoV-2 RNA can be present on outdoor particulate matter, thus suggesting that, in conditions of atmospheric stability and high concentrations of PM, SARS-CoV-2 could create clusters with outdoor PM and, by reducing their diffusion coefficient, enhance the persistence of the virus in the atmosphere**. Further confirmations of this preliminary evidence are ongoing, and should include real-time assessment about the vitality of the SARS-CoV-2 as well as its virulence when adsorbed on particulate matter. At the present, no assumptions can be made concerning the correlation between the presence of the virus on PM and COVID-19 outbreak progression. Other issues to be specifically addressed are the average concentrations of PM eventually required for a potential boost effect of the contagion (in case it is confirmed that PM might act as a carrier for the viral droplet nuclei), or even the theoretic possibility of immunization consequent to minimal dose exposures at lower thresholds of PM.

Rader B et al (2020) - pre-print: not peer reviewed

Crowding and the epidemic intensity of COVID-19 transmission

The COVID-19 pandemic is straining public health systems worldwide and major non-pharmaceutical interventions have been implemented to slow its spread. During the initial phase of the outbreak the spread was primarily determined by human mobility. Yet empirical evidence on the effect of key geographic factors on local epidemic spread is lacking. We analyse highly-resolved spatial variables for cities in China together with case count data in order to investigate the role of climate, urbanization, and variation in interventions across China. Here we show that the epidemic intensity of COVID-19 is strongly shaped by crowding, such that epidemics in dense cities are more spread out

through time, and denser cities have larger total incidence. Observed differences in epidemic intensity are well captured by a metapopulation model of COVID-19 that explicitly accounts for spatial hierarchies. Densely-populated cities worldwide may experience more prolonged epidemics. Whilst stringent interventions can shorten the time length of these local epidemics, although these may be difficult to implement in many affected settings.

Rodrigues W et al (2020) - pre-print: not peer reviewed

REGIONAL DETERMINANTS OF THE EXPANSION OF COVID-19 IN BRAZIL

Objective: This study investigates the regional differences in the occurrence of COVID-19 in Brazil and its relationship with climatic and demographic factors by use data from February 26 to April 04, 2020. Methods: A Polynomial Regression Model with cubic adjustments of the number of days of contagion, demographic density, city population and climatic factors was designed and used to explain the spread of COVID-19 in Brazil. Main results: It was evidenced that temperature variation maintains a relationship with the reduction in the number of cases of COVID-19. A variation -3.4% in the number of COVID-19 cases was found for each increase of 1 C. Conclusion: There are evidences that the temperature, has a relative effect in the variation in the number of COVID-19's researched cases. For the reason, it recommends this relationship deserves to be investigated in other tests with more extended time series, wide and with especially non-linear data adjustments.

Buonanno G et al (2020) - pre-print: not peer reviewed

Estimation of airborne viral emission: quanta emission rate of SARS-CoV-2 for infection risk assessment

Airborne transmission is a pathway of contagion that is still not sufficiently investigated despite the evidence in the scientific literature of the role it can play in the context of an epidemic. While the medical research area dedicates efforts to find cures and remedies to counteract the effects of a virus, the engineering area is involved in providing risk assessments in indoor environments by simulating the airborne transmission of the virus during an epidemic. To this end, virus air emission data are needed. Unfortunately, this information is usually available only after the outbreak, based on specific reverse engineering cases. **In this work, a novel approach to estimate the viral load emitted by a contagious subject on the basis of the viral load in the mouth, the type of respiratory activity (e.g. breathing, speaking), respiratory physiological parameters (e.g. inhalation rate), and activity level (e.g. resting, standing, light exercise) is proposed.** The estimates of the proposed approach are in good agreement with values of viral loads of well-known diseases from the literature. The quanta emission rates of an asymptomatic SARS-CoV-2 infected subject, with a viral load in the mouth of 108 copies mL-1, were 10.5 quanta h-1 and 320 quanta h-1 for breathing and speaking respiratory activities, respectively, at rest. In the case of light activity, the values would increase to 33.9 quanta h-1 and 1.03x103 quanta h-1, respectively. The findings in terms of quanta emission rates were then adopted in infection risk models to demonstrate its application by evaluating the number of people infected by an asymptomatic SARS-CoV-2 subject in Italian indoor microenvironments before and after the introduction of virus containment measures. The results obtained from the simulations clearly highlight that a key role is played by proper ventilation in containment of the virus in indoor environments.

Katsumi Chiyomaru, Kazuhiro Takemoto (2020) - pre-print: not peer reviewed

Global COVID-19 transmission rate is influenced by precipitation seasonality and the speed of climate temperature warming

The novel coronavirus disease 2019 (COVID-19) became a rapidly spreading worldwide epidemic; thus, it is a global priority to reduce the speed of the epidemic spreading. Several studies predicted that high temperature and humidity could reduce COVID-19 transmission. However, exceptions exist to this observation, further thorough examinations are thus needed for their confirmation. In this study, therefore, we used a global dataset of COVID-19 cases and global climate databases and comprehensively investigated how climate parameters could contribute to the growth rate of COVID-19 cases while statistically controlling for potential confounding effects using spatial analysis. We also confirmed that the growth rate decreased with the temperature; however, the growth rate was affected by precipitation seasonality and warming velocity rather than temperature. In particular, a lower growth rate was observed for a higher precipitation seasonality and lower warming velocity. These effects were independent of population density, human life quality, and travel restrictions. The results indicate that the temperature effect is less important compared to these intrinsic climate characteristics, which might thus be useful for explaining the exceptions. However, the contributions of the climate parameters to the growth rate were moderate; rather, the contribution of travel restrictions in each country was more significant. Although our findings are preliminary owing to data-analysis limitations, they may be helpful when predicting COVID-19 transmission.

Pirouz B et al (2020) - pre-print: not peer reviewed

Relationship between Average Daily Temperature and Average Cumulative Daily Rate of Confirmed Cases of COVID-19

The rapid outbreak of the new Coronavirus (COVID-19) pandemic and the spread of the virus worldwide, especially in the Northern Hemisphere, have prompted various investigations about the impact of environmental factors on the rate of development of this epidemic. Different studies have called the attention to various parameters that may have influenced the spread of the virus, and in particular, the impact of climatic parameters has been emphasized. The main purpose of this study is to investigate the correlation between the average daily temperature and the rate of coronavirus epidemic growth in the infected regions. The main hypothesis object of our research is that between regions exhibiting a significant difference in the mean daily temperature, a significant difference is also observed in the average cumulative daily rate of confirmed cases, and that this does not happen if there is no significant difference in mean daily temperature. To test this research hypothesis, we carried on the case study of three regions in each of five countries and analyzed the correlation through F-test, and Independent-Samples T-Test. In all five selected countries, we found that when there is a significant difference in the daily mean temperature between two regions of a country, a significant difference exists also in the average cumulative daily rate of confirmed cases. Conversely, if there are no significant differences in the mean daily temperature of two regions in the same country, no significant difference is observed in the average cumulative daily rate of confirmed cases for these regions.

Sun Z et al (2020) - pre-print: not peer reviewed

Stability of the COVID-19 virus under wet, dry and acidic conditions

COVID-19 has become a pandemic and is spreading fast worldwide. The COVID-19 virus is transmitted mainly through respiratory droplets and close contact. However, the fecal-oral transmission of the virus has not been ruled out and it is important to ascertain how acidic condition in the stomach affects the infectivity of the virus. Besides, it is unclear how stable the COVID-19 virus is under dry and wet conditions. In the present study, we have shown that the COVID-19 virus is extremely infectious as manifested by the infection of Vero-E6 cells by one PFU (Plaque Forming Unit) of the virus. We then investigated the stability of the COVID-19 virus in wet, dry and acidic (pH2.2) environments at room temperature. Results showed that the COVID-19 virus could survive for three days in wet and dry environments, but the dry condition is less favorable for the survival of the virus. Our study also demonstrated that the COVID-19 virus at a relative high titer (1.2 x 103 PFU) exhibits a certain degree of tolerance to acidic environment at least for 60 minutes. When the virus titer was ≤1.0 x 103 PFU, acid treatment (pH2.2) for 30 or 60 minute resulted in virus inactivation. It suggests that the virus at a high concentration may survive in the acidic environment of the stomach. The finding of the present study will contribute to the control of the spread of the COVID-19 virus.

Hossain MA (2020) - pre-print: not peer reviewed

Is the spread of COVID-19 across countries influenced by environmental, economic and social factors?

The SARS-CoV-2 virus, emerged from Wuhan, China is spreading all over the world in an unprecedented manner, causing millions of infections and thousands of deaths. However, the spread of the disease across countries and regions are not even. Why some countries and regions are more affected than some other countries and regions? We employ simple statistical methods to investigate any linkage between the severity of the disease and the environmental, economic, and social factors of countries. The estimation results indicate that the number of confirmed cases of Coronavirus infection is higher in countries with lower yearly average temperatures, higher economic openness, and stronger political democracy. However, findings of this analysis should be interpreted carefully keeping in mind the fact that statistical relations do not necessarily imply causation. Only clinical experiments with medical expertise can confirm how the virus behaves in the environment.

Chang M et al (2020) - pre-print: not peer reviewed

Modeling the impact of human mobility and travel restrictions on the potential spread of SARS-CoV-2 in Taiwan

Background: As COVID-19 continues to spread around the world, understanding how patterns of human mobility and connectivity affect outbreak dynamics, especially before outbreaks establish locally, is critical for informing response efforts. Methods: Here, in collaboration with Facebook Data for Good, we built metapopulation models that incorporate human movement data with the goals of identifying the high risk areas of disease spread and assessing the potential effects of local travel restrictions in Taiwan. We compared the impact of intracity vs. intercity travel restrictions on both the total number of infections and the speed of outbreak spread and developed an interactive application that allows users to vary inputs and assumptions. Findings: We found that intracity travel

reductions have a higher impact on overall infection numbers than intercity travel reductions, while intercity travel reductions can narrow the scope of the outbreak and help target resources. We also identified the most highly connected areas that may serve as sources of importation during an outbreak. The timing, duration, and level of travel reduction together determine the impact of travel reductions on the number of infections, and multiple combinations of these can result in similar impact. Interpretation: In Taiwan, most cases to date were imported or linked to imported cases. To prepare for the potential spread within Taiwan, we utilized Facebook's aggregated and anonymized movement and colocation data to identify cities with higher risk of infection and regional importation. Both intracity and intercity movement affect outbreak dynamics, with the former having more of an impact on the total numbers of cases and the latter impacting geographic scope. These findings have important implications for guiding future policies for travel restrictions during outbreaks in Taiwan.

Riccardo Pansini, Davide Fornacca (2020) - pre-print: not peer reviewed

Initial evidence of higher morbidity and mortality due to SARS-CoV-2 in regions with lower air quality

COVID-19 has spread in all continents in a span of just over three months, escalating into a pandemic that poses several humanitarian as well as scientific challenges. We here investigated the geographical expansion of the infection and correlate it with the annual indexes of air quality observed from the Sentinel-5 satellite orbiting around China, Italy and the U.S.A. Controlling for population size, we find more viral infections in those areas afflicted by Carbon Monoxide (CO) and Nitrogen Dioxide (NO2). Higher mortality was also correlated with poor air quality, namely with high PM2.5, CO and NO2 values. In Italy, the correspondence between poor air quality and SARS-CoV-2 appearance and induced mortality was the starkest. Similar to smoking, people living in polluted areas are more vulnerable to SARS-CoV-2 infections and induced mortality. This further suggests the detrimental impact climate change will have on the trajectory of future epidemics.

Qian H et al (2020) - pre-print: not peer reviewed

Indoor transmission of SARS-CoV-2

Background: By early April 2020, the COVID-19 pandemic had infected nearly one million people and had spread to nearly all countries worldwide. It is essential to understand where and how SARS-CoV-2 is transmitted. Methods: Case reports were extracted from the local Municipal Health Commissions of 320 prefectural cities (municipalities) in China, not including Hubei province, between 4 January and 11 February 2020. We identified all outbreaks involving three or more cases and reviewed the major characteristics of the enclosed spaces in which the outbreaks were reported and associated indoor environmental issues. Results: Three hundred and eighteen outbreaks with three or more cases were identified, involving 1245 confirmed cases in 120 prefectural cities. We divided the venues in which the outbreaks occurred into six categories: homes, transport, food, entertainment, shopping, and miscellaneous. Among the identified outbreaks, 53.8% involved three cases, 26.4% involved four cases, and only 1.6% involved ten or more cases. Home outbreaks were the dominant category (254 of 318 outbreaks; 79.9%), followed by transport (108; 34.0%; note that

many outbreaks involved more than one venue category). Most home outbreaks involved three to five cases. **We identified only a single outbreak in an outdoor environment, which involved two cases.** Conclusions: All identified outbreaks of three or more cases occurred in an indoor environment, which confirms that sharing indoor space is a major SARS-CoV-2 infection risk.

Nishiura H et al (2020) - pre-print: not peer reviewed

Closed environments facilitate secondary transmission of coronavirus disease 2019 (COVID-19)

Commissioned by the Minister of the Ministry of Health, Labour, and Welfare of Japan, we collected secondary transmission data with the aim of identifying high risk transmission settings. We show that closed environments contribute to secondary transmission of COVID-19 and promote superspreading events. Closed environments are consistent with large-scale COVID-19 transmission events such as that of the ski chalet-associated cluster in France and the church- and hospital-associated clusters in South Korea. Our findings are also consistent with the declining incidence of COVID-19 cases in China, as gathering in closed environments was prohibited in the wake of the rapid spread of the disease. Reduction of unnecessary close contact in closed environments may help prevent large case clusters and superspreading events.