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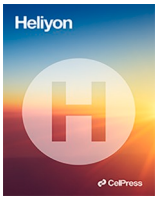

Research article

Space and social distancing in managing and preventing COVID-19 community spread: An overview

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ABSTRACT

The spread of COVID-19 at a large scale and at a rapid pace indicates the lack of social distancing measures at multiple levels. The individuals are not to be blamed, nor should we assume the early measures were ineffective or not implemented. It is all down to the multiplicity of transmission factors that made the situation more complicated than initially anticipated. Therefore, in facing the COVID-19 pandemic, this overview paper discusses the importance of space in social distancing measures. The methods used to investigate this study are literature review and case study. Many scholarly works have already provided us with evidence-based models that suggest the influential role of social distancing measures in preventing COVID-19 community spread. To further elaborate on this important topic, the aim here is to look at the role of space not only at the individual level but at larger scales of communities, cities, regions, etc. The analysis helps better management of cities during the pandemics such as COVID-19. By reflecting on some of the ongoing research on social distancing, the study concludes with the role of space at multiple scales and how it is central to the practice of social distancing. We need to be more reflective and responsive to achieve earlier control and containment of the disease and the outbreak at the macro level.

1. Introduction

Like other viruses such as SARS and MERS, although each infectious disease has new characteristics, prevention, and control

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involve three main factors the pathogen, transmission route, and susceptible population [1]. To cut off the transmission pathways, maintaining a 1.5 m distance between people is regarded as one of the most effective ways to minimise the spread of most respiratory infectious diseases transmitted by air droplets and/or aerosols transmissive [1]. As part of the earlier recommendations, the World Health Organization (WHO) [2] provided a set of six 'Basic protective measures against the new coronavirus'; and one of which was to maintain social distancing.

The wording (itself) indicates three factors of keeping the act of social distancing, understanding the social activities or matters that need to be considered, and the importance of space in distancing. This was previously added in other action plans against airborne diseases (e.g., Singapore's Ministry of Health, 2018) and, as such, is a common practice that is suggested to reduce disease transmission between index cases (i.e., human to human). Also, according to the Network for Public Health Law [3], there is a variety of social distancing defined by Public health officials and as part of their decision-making on the development of critical legal and policy decisions during public health emergencies. The definitions of social distancing vary from context to context, but the universal explanation is the one by the Centers for Disease Control and Prevention (CDC) [4] that suggests "limiting face-to-face contact with others is the best way to reduce the spread of coronavirus disease 2019 (COVID-19)". The explanation also refers to the compatible terminology of 'physical distancing', which is also debated by other scholars who argue for the importance of social connection [5], mental health wellbeing [6,7] Wasserman et al., 2020), concerns for minimising risks for certain groups [8], as well as social connectedness [9], etc. These arguments also refer to earlier scholarly research and discussions on emotional distance [10], distance constancy [11], or more recent work associated with public health [12,13] and wellbeing [14] that are offered by socialising attributes. In all cases, the intention is to minimise "unnecessary physical meetings, events, and gatherings" [15], and those social activities that happen physically and outside our households [16]. There are, of course, polarised opinions on social distancing, as highlighted by Allcott et al. [17], even though evidence proves that social distancing and public health interventions were major drivers of reducing the disease transmissions [1,18–20]. However, over these recent few months, we see differences in different contexts in how social distancing is introduced, standardised, practiced, and regulated. Therefore, the question is on the role of space in social distancing at multiple scales. This is a primary aspect that is little studied almost 12 months after the first COVID-19 cases were reported in December 2020.

2. Case study

Ningbo is a populated mid-to-large city of approximately 6.5 million inhabitants, and an average population density of 792.39 inhabitants/km^2 in the urban areas [21]. The city managed to control and contain the outbreak in only a few weeks, which was also appraised by the provincial and national governments. At its peak, the highest number of recorded infected cases was 157 (until March 2020), and the city had no new cases from March 2020 to May 2021. So far, the city has experienced one or two minor outbreak cases in the summer 2021, which were quickly managed within days. Since the early days, Ningbo has developed a range of high-level restrictions, contingency plans, and response plans.

Under the shadow of potential new waves of the outbreak, the city has maintained prevention and safety measures. The early measures were implemented through strategies at the national and provincial levels [22]. The immediate lockdowns of residential communities, starting on the 29th of January 2020, were the initial signs of social distancing on a large scale [15]. The ins and outs of public premises were either not permitted or minimised. Restrictions included canceling all types of gatherings, closing all unessential businesses, and limiting the number of times per week an individual could leave the perimeters of the residential complex. The measures also were coupled with restricted social distancing measures to avoid gatherings, populated environments, and direct contacts in communities. The aim was to reduce community transmission through spatial management, which was partly successful due to the most common urban configuration of Chinese residential blocks and community structures (such as urban fabric and urban form), but largely due to rapid response and policy measures that limited mobility, community gatherings, outdoor activities and events, etc. [15]. For months after reaching the containment stage successfully, prevention and safety measures were continuously in place to minimise travel, social gatherings, secondary public services use, and uncontrolled access to certain parts of cities. The use of smart technologies to register people's travel movement on their smartphones helped to reopen businesses gradually. This approach enabled a faster track and trace method, evaluating and monitoring people's mobility within the city and in and out of the city. It is claimed that the acceptance rate of contact tracing applications (CTA) in China is much higher than in Germany and the US, where 60% strong acceptance of CTA is found in China versus about 40% in the other two countries [23]. One of the underlying reasons may be that using CTA for pandemic control and prevention is obligatory in China, while it is voluntary in Germany and the US [24]. Also, the government's public credibility plays a critical role in CTA adoption and acceptance. Meanwhile, the expenditure/cost of other public health measures for containing and stopping COVID-19 like vaccines, tests, isolation, and medical treatment, are either free or very low in China owing to the government's policy, making people more willing to comply with regulations and protocols for pandemic control and prevention. This also builds people's confidence and trust to win this battle against the virus and increases their motivation to follow related public health strategies and policies. Plus, the convenience provided by the easy accessibility of the COVID-19 test sites on the street and the high efficiency of releasing the result report (usually within 12 h) also boosts people's willingness to follow containment measures and policies. For instance, the Zhejiang province has announced that Hangzhou, the capital of Zhejiang, is planning to set up more sampling sites for massive COVID-19 nucleic acid testing [25] to make sure that all residents are within a 15-min walking distance from the nearest site.

Furthermore, the urban management aspect has undoubtedly played a major part in spatial considerations in containing the outbreak at the city level. To keep the vulnerable groups safe, the city has imposed larger scale distancing measures to prevent outsiders from entering the communities, including a higher population of elderly groups, such as villages and elderly care centers. The

important aspect is to control the overflow of people in any location. This is maintained through a set of guidelines that are followed as temporary – but highly effective – regulations (see Fig. 2). For instance, using facial masks, travel movement health code checks, and temperature checks remained compulsory to enter public premises for months. The measures are still kept to date, particularly for public buildings/premises and travel. While these measures were gradually reduced to ensure community safety is reached and maintained, they were brought back as part of a response plan to smaller outbreak events during the summer of 2021. As of September 2021, the measures are in plans to enhance community safety. This is done through on-site monitoring and checks, as well as continuous use of health codes, temperature checks, and entry/exit records.

From a ubiquitous preventive guideline [2,4], social distancing is practiced as a primary measure at multiple scales, which is aimed at containing and control community transmissions. Notably, we can see the effects that led to social closeness and spatial distancing [26], which suggest being sufficient in control of infection rate through isolation procedures [27]. In this regard, we can see continuous control of city-level and intra-city level boundaries. This is then taken into consideration of district-level guidelines that follow the city-level measures on prevention and safety measures. The local government then provides regular updates on temporary guidelines and strategies that are continuously developed as measures against any potential waves of the outbreak. At the community level, the spatial use was limited for better monitoring and control, including the closure of secondary routes and access points [22]. On a small scale, essential public and service buildings, such as banks or supermarkets, implemented marked lines on the floor to control the distance between clients. This approach is mainly maintained in formal indoor and outdoor environments, while the informal spaces need more application of such measure. Nonetheless, for the informal environments, other control measures were implemented to avoid larger gatherings and high density of group and individual contacts in a clustered environment.

The consideration of space was not merely considered at the individual level, but at the community level, too. The isolation of individuals under specific circumstances of having symptoms and/or arriving from infected regions or other countries was then in place at the community level. For the first time, we noticed the importance of community-level implementation strategies that enabled us to contain the disease at the early stages. At the micro-level of individuals, social distancing was practiced mainly through the spatial dimension, or better to say, the socio-spatial dimension. The control and isolation were implemented temporarily to ensure all cases were found and necessary actions were taken before opening the businesses. Hence, social distancing could not succeed at the individual level, which is wrongly advocated elsewhere. It is beyond just the role of a person but also embedded in the use and control of space, communities, and larger-scale physical environments.

3. Methodology

The study is an overview study done through three steps. First, we provide an overview of space and social distancing. This is studied as a dependent variable on its own. While there are other containment measures, such as test, trace, and isolate, closure of work environments and entertainment venues, and travel restrictions, social distancing has been a central variable to all of them.

According to Yao [28], an aerosol is defined as “a mixture of particles of less than 100 μm in a gaseous medium” in aerosol science. The primary purpose of social distancing is to prevent aerosol transmission, which could dominate the spread rapidly when a pandemic appears, contributing to most outbreaks of large-scale transmissive disease [28]. Meanwhile, the increasing climate change impacts also intensify the frequency of those infectious disease outbreaks. For the SARS-CoV-2 virus, its transmission pathways are found to have multiple means, including direct ways via the air, wastewater, and surfaces (e.g., sneezing, coughing, etc.); and indirect transmission through re-aerosolising such as flushing toilets [28]. Concerning this, it is commonly agreed that improving the indoor ventilation and engineering control system will prevent indirect indoor environment infections [28]. Although the COVID-19 disease is mainly transmitted to humans via air, its emission pattern remains unknown [28]. Thus, reducing contact with others as much as possible to minimise the likelihood of getting infected by social distancing with other precautionary and proactive strategies are the optimal options for pandemic control and prevention.

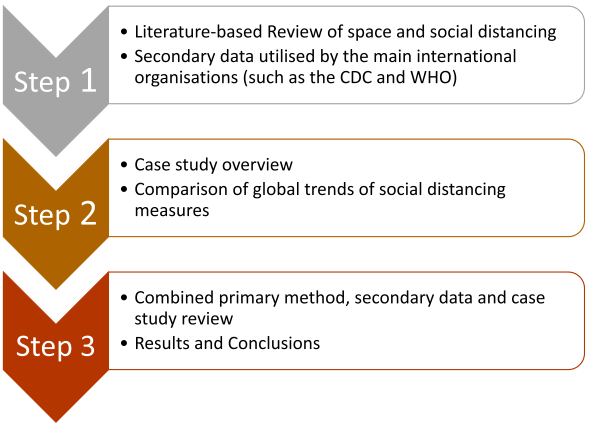

Fig. 1. Summary of methodological process of the study.

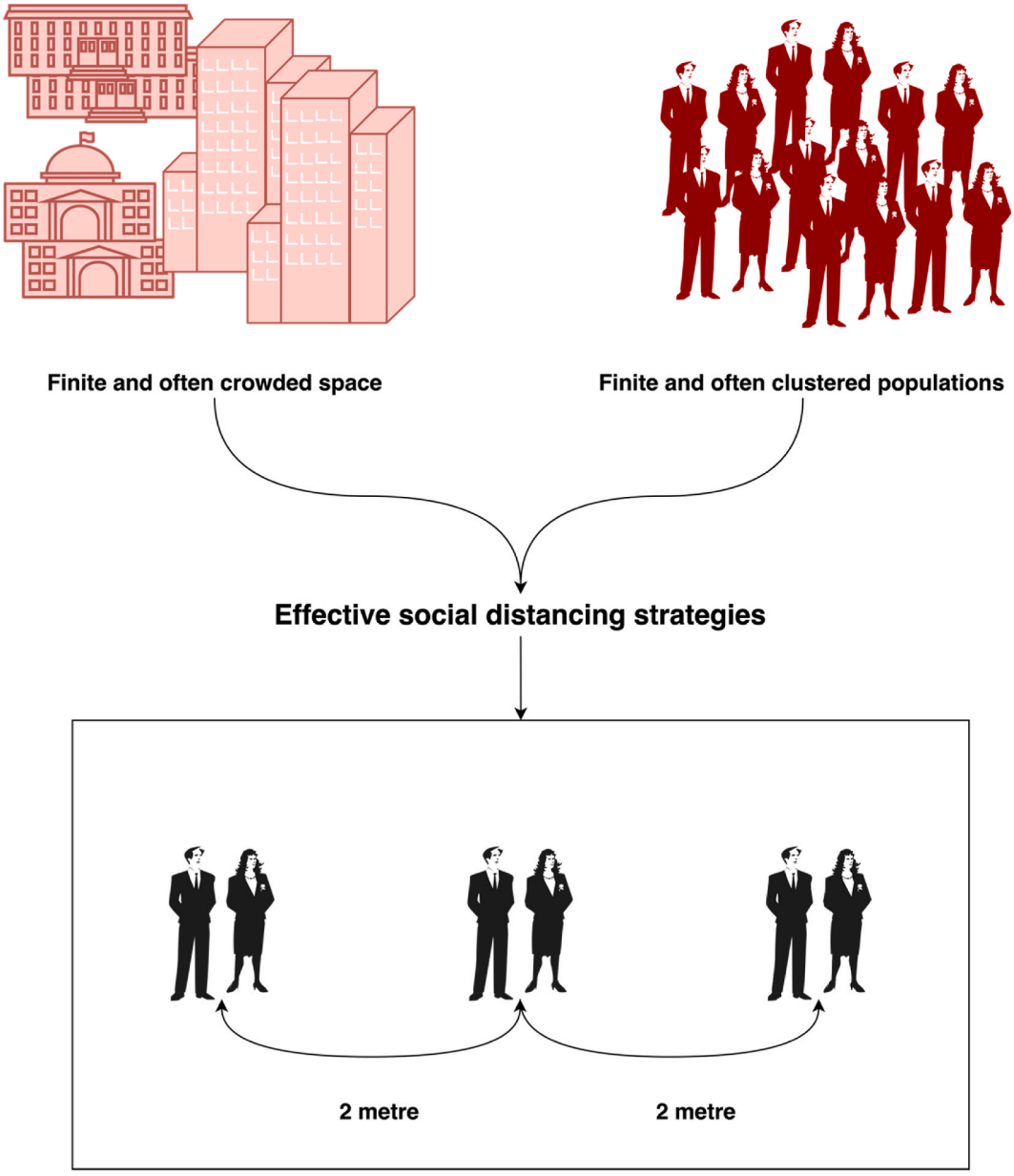

Fig. 2. A schematic representation of the interplay between space, populations, and social distancing strategies.

This step is a literature-based review and benefits from the primary literature and secondary data utilised by organisations such as the CDC and WHO. In the second step, the study provides an overview of the case study and compares global trends of social distancing measures in containing the COVID-19 pandemic in their specific local contexts. We note the limitations of the study base validity of the case study approach, which ensures this review study could help future research on social distancing measures and their impact on other variables or measures. The third step is developed from the earlier two steps using a primary method, secondary data, and case study review to draw results and conclusions. As an overview study, this paper offers new discourse to an ongoing debate on social distancing measures during the ongoing COVID-19 pandemic. The findings feed into similar discussions about the importance of social distancing and other measures in managing and containing the outbreaks. Fig. 1 below summarises the methodological process of the paper.

4. Results & discussion

4.1. Space and social distancing: an overview

The concept of space could be construed both objectively and subjectively. As well-understood in everyday life, the phrase “give me

Table 1
Example social distancing criteria adopted by countries with greatest numbers of COVID-19 cases.

Country	Definition of "safe" social distance	COVID-19 Cases (As of January 9th, 2020)	Source	Other contaminant measures	% of population (data from June 13th, 2022) (O: at least one dose; F: full vaccinated) (Source: https://ourworldindata.org/covid-vaccinations?country=OWID_WRL~GBR~USA~BRA~RUS~CHN~IND)
WHO	1 m	Worldwide total: 88.9 million	https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public#:~:text=If%20COVID%2D19%20is%20spreading,a%20bent%20elbow%20or%20tissue	• Get vaccinated • Wear a mask properly • Avoid the 3C spaces (closed, crowded, or involve close contact) • Meet people outside • Increase natural ventilation when indoors • Keep good hygiene (e.g., regularly, and thoroughly clean your hands, clean and disinfect surfaces frequently)	• F: 60.67% • O: 66.36%
U·S.	2 m	22 million	https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html	• Get vaccinated • Wear a mask properly (ages 2 year and older) (e.g. in indoor areas of public transportation and transportation hubs; in areas with high COVID-19 Community Level) • Wash hands often • Clean and disinfect • Monitor your health daily	• F: 66.80% • O: 77.88%
India	1 m	10.4 million	https://www.mohfw.gov.in/pdf/socialdistancingEnglish.pdf https://www.mohfw.gov.in/pdf/Poster_Corona_ad_Eng.pdf	• Wear a mask/cloth to cover your mouth and nose while visiting doctor • Wash hands often • Clean and disinfect • Avoid participating in large gatherings • Throw used tissues into closed bins immediately after use • Cover your nose and mouth with handkerchief/tissue while sneezing and coughing	• F: 64.66% • O: 72.76%
Brazil	2 m	8.01 million	https://www.unasus.gov.br/especial/covid19/pdf/23	• Wear a mask properly • Wash hands often • Clean and disinfect	• F: 78.56% • O: 86.13%
Russia	1.5 m	3.32 million	https://www.sobyanin.ru/ https://www.sobyanin.ru/covid-19	• Waived the requirements to wear protective masks since March 15, 2022	• F: 50.72% • O: 55.59%

(*continued on next page*)

Table 1 (*continued*)

Country	Definition of "safe" social distance	COVID-19 Cases (As of January 9th, 2020)	Source	Other contaminant measures	% of population (data from June 13th, 2022) (O: at least one dose; F: full vaccinated) (Source: https://ourworldindata.org/covid-vaccinations?country=OWID_WRL~GBR~USA~BRA~RUS~CHN~IND)
U·K.	2 m	2.96 million	https://www.gov.uk/coronavirus	• Get vaccinated • Meet people outside • Increase natural ventilation when indoors • Consider wearing a face covering in crowed, enclosed spaces	• F: 73.34% • O: 78.44%
China	1-2 m	0.887 million	https://www.chinacdc.cn/en/COVID19/	• Get vaccinated • Wear a mask properly • Avoid the 3C spaces (closed, crowded, or involve close contact) • Meet people outside • Increase natural ventilation when indoors • Keep good hygiene (e.g., regularly, and thoroughly clean your hands, clean and disinfect surfaces frequently)	• F: 87.05% • O: 89.38%

Note. WHO: World Health Organization; U.S.: United States; U.K.: United Kingdom.

some space" often decries the message sender's demand for freedom, peace, or even serenity, instead of an additional 2 by 2 area in square metres. The notion of personal space also varies from culture to culture, gender, or age. For instance, South Americans generally require less personal space than Asians [29]. The notion of social distance between people in normal circumstances is a social construct, affected by restrictive measures. Another example of subjective space is the concept of social space, which could be understood as "*an intersubjective matrix of psychological distances based on physical and social reality that provides a framework constraining how people are influenced by each other*" [30]. In the context of this study, however, space is examined from an objective perspective, where it is defined as the geographical matrix within which people physically interact with one another. In this sense, space can be measured, and subsequently, physically distanced to protect personal and public health amid pandemics like COVID-19. Social distancing can be understood as "physical distancing," which means, "*keeping a safe space between yourself and other people who are not from your household*" [4]. While different administrations have adopted varying criteria, the recommended distance to maintain safe social interaction is usually between 1 m and 2 m [4]. A list of criteria adopted by different countries can be found in Table 1.

4.2. The limitations of the overview

A thorough examination of different countries' social distancing criteria and their corresponding COVID-19 case numbers could lead to the conclusion that a more spacious social distancing recommendation does not lead to a lower COVID-19 infection caseload. As a matter of fact, available evidence suggests that countries' performance in COVID-19 control is not only contingent on space, such as population density [31,32] —factors ranging from effective crisis communication efforts to coherent and consistent public health policy all play an important role in shaping pandemic control efforts. For instance, though China has a high population density, it has performed far better than low-population-density countries such as the U.S., based on the generated 2021 COVID-19 Global Map [33]. However, what is important to understand is that though factors such as effective health communication efforts are critical to stemming COVID-19, the role of space in shaping sustainable pandemic control efforts is equally, if not more, instrumental.

For starters, mounting evidence shows that population density is a facilitating factor in the virus spread amid the COVID-19 pandemic [34–36]. Furthermore, different from other contextual factors, such as public health officials' coherence in communicating COVID-19 safety measures or the public's compliance with these measures, space is more fundamental and less modifiable—without space, social distancing cannot be achieved; and when space is limited, even if citizens wish to comply with social distancing mandates meticulously, they lack the ability to secure or compete for a 2-m distance that is not there. Therefore, the role of space in shaping social distancing policies should not be outlooked. In the following sections, we discuss the interplay between space

and social distancing in greater detail in shaping pandemic control and containment.

Among all the pandemic control and prevention strategies, social distancing is considered the fundamental approach to prevent people from directly contacting the potential source of pathogens and remains the most effective one not only for the SARS-CoV-2 virus but also all other aerobic transmissive diseases (e.g., normally cold, SARS, H1N1 [swine flu] or MERS). It is the simplest, the most cost-effective, and works the fastest to obtain expected outcomes from the history of combating aerobic transmissive diseases in epidemiology experiences. Without social distancing, the effectiveness of other strategies may get a massive cut.

Since the virus can transmit via aerosols, solely relying on social distancing is not enough in real-life scenarios, especially in indoor environments with poor ventilation and high population density as people are moving randomly, which increases the likelihood of getting infected except for the situation of home isolation. Accordingly, the optimal strategy to deal with those circumstances would be combining social distancing with other extra precautionary and proactive approaches such as wearing facial masks, regular sterilising, increasing ventilation, getting people vaccinated, etc.

4.3. Social distancing: from strategy to prevention and safety measure

Indications of spatial adaptive measures [22] suggest simple but effective public health interventions that could help minimise and prevent the COVID-19 community spread. There are also relevant policy responses to specific impacts [37,38], specific response models or frameworks to contextual requirements [39–41], and examples of measures that suggest the role of space or spatial considerations in control and containment procedures [42]. There are also successful examples of spatial-temporal analysis [43–45] that suggest the role of space in the control and containment of outbreaks in cities or larger scales.

In cities and regions with no infected cases, we see shreds of evidence from earlier closures and high-level prevention and safety measures [46]. The same applies to those that managed to flatten the curve at the smaller scale of the city or region. This paper explored the city of Ningbo in East China as a case study to comprehend how social distancing in high-dense cities is a key factor on the control of spreading. The case study review provides a good ground for discussion and comparison with other social distancing measures elsewhere couples.

4.4. Space and social distancing in maintaining public health

Social distancing measures followed in order to control the spread of contagious illnesses include the followings: 'Self-isolation', 'Self quarantine', 'School closure', 'Workplace closure', 'Cordon sanitaire', and 'Cancellation of mass gatherings at events, pubs, discos, theaters, clubs, religious places, musical concerts etc.'. There are some tangible benefits of social distancing. For instance, increasing the doubling time, shortening the length of epidemics, and lowering the incidence and related mortality at the individual and community levels are all benefits of social distancing strategies that are obtained by cutting back on interactions. Measures of mandatory social isolation applied for a more extended period of time and at the beginning of the pandemic were quite successful. However, due to financial considerations, this approach cannot be used for an extended time. According to recent studies such as Girum [47], imposing travel restrictions and a lockdown for an extended length of time lowers individual income and wages and poses problems for the world economy.

A study on the effects of rapid antigen tests, vaccination, and social distance on the Omicron outbreak during significant temperature swings in Hong Kong reveals that tightening social distance measures did not succeed in containing the outbreak until later with the use of rapid antigen tests (RAT) and higher vaccination rates. More specifically, social isolation decreased the cumulative incidence (CI) from 58.2% to 44.5% on average with the adoption of the vaccination. Utilizing RAT further lowered the CI to 39.0%. Without further vaccinations during two months of isolation, the CI rose to 49.1% [48]. As part of retrospective research, it was determined that the daily growth rate of the confirmed COVID-19 cases was decreased by 5.4% after 1–5 days, 6.8% after 6–10 days, 8.2% after 11–15 days, and 9.1% after 16–20 days [47] when the government applied social distancing measures.

The role of space, regardless of primary and secondary uses, is evident in how social distancing can be practiced or maintained [49]. The connection between humans and space is for long been studied to be interlinked, and in the case of social distancing, we cannot simply detach them from each other. Hence, how spaces are managed and controlled subsequently impacts how social distancing is maintained and adequately practiced. We cannot simply blame the individuals for their improper social distancing practices. At the same time, it is evidenced that the multi-scalar approach to spatial management is effective in better control and containment of community transmission. The possible air travel distance of droplets from a person coughing varies between 20 cm using commercial masks to 1.12 m using a bandana [50]. Therefore, wearing masks is a very useful way to prevent the disease spread, but it is not so effective if only a few use them in crowded places or if minimum distances are not considered. The rationale behind spatial management indicates the effects that space could have on maintaining public health, not only at the individual level but the larger scales of communities, cities, and regions. This goes back to the CDC's description of social distancing [4] for different conditions that suggest the variability of space in recommending tailor-made considerations for various living and working environments. There is, of course, no set of by-default recommendations but it is evident that space is the main part of practicing social distancing. Regardless of how social distancing may change our social norms, hopefully just temporarily, we must take into consideration the other variables [51,52] that could influence the use of space, the conditions of space, and the management of space. We must also consider unintended consequences [53–55] and eventual paradigm shifts [15,17] that could have tangible impacts on human well-being and public health.

To date, the mechanism of how the SARS-CoV-2 virus can stay viable on the surface or in the air is still unknown. Also, the precise inhalation dose of airborne SARS-CoV-2 necessary for developing an infection [28] is still unknown. Such unknown factors make the prevention and control measures of the COVID-19 pandemic in indoor environments more complex, adding more risks and

complications to indoor environment control measures. Therefore, there are major challenges due to reduced ventilation, growing uncertainty, and increased risks. Concerning the rapidly mutating variants of the SARS-CoV-2 virus, a better understanding of its aerobic transmission mechanisms is needed. Currently, existing research and social distancing practices are inadequate to deal with the unknown uncertainty of future mutant viruses. The research progress on the transmission mechanisms cannot match the speed of evolving mutations. In fact, there has been much research on the extent of aerobic transmission of particles in different environments, and this has been linked to the analysis of existing mutations, such as buses in large cities [56]; live theatre events [57]; work/-indoor/outdoor environments [58]; cricket games [59], etc.

A study by the University College London (UCL) Department of Civil, Environmental, and Geomatic Engineering (CEGE) found that buses in big cities can be high-risk indoor environments for pathogen contamination. Their analysis was mainly based on the condition of poor ventilation and high population density, posing a greater risk of getting infected to drivers as they have the most prolonged exposure duration [56]. On the other hand, Adzic et al. [57] found that suitable ventilation strategies effectively prevent long-range transmission of COVID-19 or other airborne diseases for relative occupancies. It is also suggested that ventilation should be used with other precautionary methods like isolation of infected people, good hygiene practices, vaccination, social distancing, and so on [57,60,61]. Another study reveals that social distancing, combined with general COVID-19 awareness, can significantly reduce exposures with proximity <1 m by 98% [59]. In short, it would be hard to connect known patterns of the spread of particles to hypothetical infectivity of future mutants, which has further been adding more uncertainties and challenges to the present "New Era of Pandemic", not the "Post-Pandemic Era".

5. Conclusions

This is an overview article and hence, limited in terms of empirical and scientific data. Nonetheless, the explorations here highlight that space and social distancing measures differ depending on contextual factors. Some measures, such as lockdowns and travel bans only were implemented in certain contexts, but measures such as social distancing became more common even if different. Despite the commonalities, we see a divergence in the use of space and social distancing measures for managing and preventing COVID-19 community spread.

The findings from this overview study highlight that social distancing is no longer just a universal recommendation from strategies to prevention and safety measures. The provided evidence shows how social distancing has become more effective in reducing and preventing community transmissions in various contexts. This has been advocated since the inception of this novel disease and will continue to be part of preventive measures until this pandemic is over. We hope that the recommendations are not taken only at the individual level but also at larger scales of communities and above. In doing so, the practice of social distancing would no longer be the source of added anxiety. However, it would be seen as an effective intervention towards containment and control of this pandemic. The spread of COVID-19 and other diseases is likely to continue, and possibly through forthcoming waves and outbreak incidents. Therefore, we have to be fully prepared and develop a holistic understanding of space, or spatial dimension, in social distancing measures. We state the importance of coupling social distancing with other measures; however, as a dependent variable, social distancing remains central to other containment and safety measures. This study provides a new discourse that social distancing should be considered from the spatial dimension and coupled with other measures. Although the scope of the study was only to study social distancing as a dependent variable, we intend to inform future research of such important measures and their relationship with other measures practiced during the COVID-19 pandemic. As the study's title entails, social distancing must be studied from the spatial dimension or perspective.

Summary box

"What is already known on this subject?"

To date, social distancing has been studied as a policy or regulatory measure. The existing literature highlights the effective role of social distancing measures in preventing the disease spread, especially during the COVID-19 pandemic outbreak. While useful insights are available in epidemiological studies, public health views, and medical studies, the correlation between social distancing and space is not yet studied.

"What does this study add?"

This study reflects ongoing research on the critical topic of social distancing in preventing COVID-19 community spread. The study adds to the existing literature by evaluating the role of space at multiple scales and how it is central to the practice of social distancing. The study addresses the fact that space should not only be considered at the individual level but at larger scales of communities, cities, regions, etc.

This item belongs to the item group IG000006.

Author contribution statement

Ali Cheshmehzangi: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Zhaohui Su: Conceived and designed the experiments; Wrote the paper.

Ruoyu Jin; Ayotunde Dawodu; Maycon Sedrez; Saeid Pourroostaei Ardakani: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Tong Zou: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

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Data availability statement

No data was used for the research described in the article.

Declaration of interest's statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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