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COVID-19 and digital inequalities: Reciprocal impacts and mitigation strategies

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ABSTRACT

With more than three billion people in isolation, the status of digital spaces is switching from an amenity to a necessity, as they become not only the main way to access information and services, but also one of the only remaining vectors for economic, educational, and leisure activities as well as for social interactions to take place. However, not all are equals in terms of access to networks or connected devices, or when it comes to the skills required to navigate computerized spaces optimally. Digital inequalities were already existing, yet the COVID-19 crisis is exacerbating them dramatically. On the one hand, the crisis will worsen digital inequalities within the population. On the other hand, digital inequalities represent a major risk factor of vulnerability for exposure to the virus itself, and for the non-sanitary consequences of the crisis. Therefore, this paper aims at exploring the reciprocal impacts of the COVID-19 crisis and digital inequalities, and to propose operative solutions to help fight the nefarious consequences of the crisis. We first describe how digital inequalities are a determinant of health. We then investigate how COVID-19 can potentiate digital inequalities, and how digital inequalities potentiate vulnerability to COVID-19. Finally, in order to contribute to the mitigation of this crisis, we propose a set of multi-layered strategies focusing on actionability that can be implemented at multiple structural levels, ranging from governmental to corporate and community levels.

1. Introduction

From the Great Plague to the Spanish flu, mankind has already witnessed pandemics in the course of its History (Taubenberger, Kash, & Morens, 2019; Hays, 2005). Yet, the COVID-19 pandemic is unprecedented for at least two reasons. First, with more than three billion people in confinement at the date of writing this paper, its magnitude and impacts are unparalleled. Second, there is a fundamental difference between the period of forced isolation we are collectively living and historical quarantines: the overwhelming presence of technology (Guitton, 2020). Online technologies became the privileged channel for governments and supra-national entities such as the World Health Organization to convey their messages and recommendations. From online shopping and telework to distance learning, online technologies are also becoming the main tool in trying to deal with the economic consequences of the crisis. More importantly, technology is becoming central to maintain active social interactions. Therefore, the COVID-19

pandemic crisis exacerbates the importance of a hidden form of social inequality, digital inequalities. Indeed, differences exist between individuals and social groups in terms of access to technologies but also in terms of their capacity to obtain benefices from their use of technology (Büchi; Festic; Latzer, 2018; DiMaggio & Hargittai, 2001; Hargittai, 2010). Although multiples definitions coexist, digital inequalities can be conceptualized as emerging from the differences in actual access to technology, as well as differences in digital literacy – the degree to which individuals have the capacity, knowledge, motivation, and competence to access, process, engage and understand the information needed to obtains benefits from the use of digital technologies, such as computers, Internet, mobiles devices and applications. These differences in access and digital literacy are deeply embedded in social, economical, cultural and global contexts. Digital inequalities are putting socially and economically disadvantaged people at more risk to the virus and the numerous socio-economical consequences of the pandemic. Yet, and despite the major impact they are having on the spread of the epidemic,

dealing with digital inequalities is currently not receiving enough attention from decision leaders.

Independently of the impacts of political decisions on the crisis management, underlying inequalities differentially modulate the risks for different segments of the population. Therefore, this paper aims to analyze the interplay between digital inequalities and COVID-19. We will argue that this unique context of the COVID-19 pandemic presents a significant risk of increasing digital inequalities, which in turns plays a role in (re)producing health and social inequalities. After describing how digital inequalities are a determinant of health, we will describe how COVID-19 can potentiate digital inequalities. Then, we will address how digital inequalities potentiate vulnerability to COVID-19 virus itself and the repercussions of the crisis. Finally, we will propose strategies to help mitigate the impacts of digital inequalities in this unique and devastating sanitary and social crisis.

2. Digital inequalities as a determinant of health

Digital inequalities can be theorized in multiple ways. Although the question of access to technical equipment and Internet connection is essential, they are not the two sides of a dichotomous digital divide in which some would have and some would not (DiMaggio & Hargittai, 2001). Four proximal factors are impacting to the degree of ability to use technologies efficiently and effectively (Hargittai, 2003): 1) technical means (the quality of the equipment that one can access, both in terms of hardware and software as well as the power and reliability of Internet connection), 2) autonomy of use (the location where technology is accessed, and perceived freedom to use it as wanted), 3) social support networks (assistance from other experimented users), and 4) experience (time dimension enabling people to be familiar enough with the technology for retaining benefits from its use).

Technology use, prompted by physical access and digital literacy, constitute a determinant of health having multiple impacts on physical, mental and social health. Digital inequalities have repercussions on the competence individuals can mobilize to maintain their health and well-being (Baum, Newman & Biedzycki, 2014; Golder, Newman, Biedzycki & Baum, 2010; McAuley, 2014). Digital inequalities are a form of social inequalities deeply embedded in the socioeconomic context (Robinson et al., 2015). Indeed, digital inequalities do not simply mimic the dichotomic division often described between digital immigrants and digital natives. They do not only touch older adults but also socially and economically disadvantaged individuals (Robinson et al., 2015; Yates, Kirby, & Lockley, 2015). Rather, digital inequalities exist alongside a multi-dimensional continuum, reflecting existing social inequalities in, for example, socio-economical status (Hargittai, 2010; Yates et al., 2015; Haight, Quan-Haase, & Corbett, 2014), age (Hall, Bernhardt, Dodd, & Vollrath, 2015; Yates et al., 2015), level of education (Cruz-Jesus, Vicente, Bacao, & Oliveira, 2016; Zhang, 2015), immigration status (Haight et al., 2014) social support network quality (Courtois & Verdegem, 2016; Helpser & van Deursen, 2017) and health literacy (Bailey et al., 2015; Baum, Newman, & Biedrzycki, 2014).

Digital technologies have become a prominent vector of communication, interactions, and participation between citizens and societal entities in many countries (Baum et al., 2014). Limited access to digital technologies generally implies limited access to services, resources, and information – and their potential benefits – and an altered pattern of access to the other determinants of heath (Golder, Newman, Biedrzycki, & Baum, 2010). Indeed, digital literacy is often needed to access services, support and information provided by governments, corporations, or higher education institutions (Hardill & O'Sullivan, 2018; Cruz-Jesus et al., 2016). Digital technologies are increasingly important to create and maintain social contacts. For instance, communication apps use is associated with an increase in social capital (Mesch, Mano, & Tsamir, 2012) and a decrease in social isolation (Cho, 2015). Digital inequalities also have to be understood both within a macrosocial and technosocial context. Indeed, public decisions regarding network covering politics

(DiMaggio & Hargittai, 2001; Warf, 2011) and macroeconomic constraints result in the fact that some countries have less Internet penetration than others (Poushter, 2016) and in disparities within regions of a country (Cruz-Jesus et al., 2016; Haight et al., 2014). The type of technology used can also play a role in the process of inequalities, with inequalities in access and use of a certain device (e.g. smartphone) being more affected by age and socioeconomic status (Bert, Giacometti, Gualano; Siliquini, 2014; Ernsting et al., 2017). As an emerging form of social exclusion, digital exclusion contributes to worsen material and social deprivation. Being digitally excluded has consequences on health determinants such as education, work, and social networks, which impacts contribute in return to maintain limited access and use of technologies, a phenomenon referred to as the "digital vicious cycle" (Baum et al., 2014). Therefore, upstream factors influence individual access and skills with technologies, consequently contributing to increasing digital inequalities and their negative outcomes on health.

3. How COVID-19 potentiates digital inequalities

From a technological perspective, the COVID-19 pandemic has provoked massive, immediate, and unprecedented changes in population use of digital technologies and media (Guitton, 2020). Pre-COVID-19 Internet access and use was not necessarily a priority – if even a possibility – for all, as some people were able to function normally in most aspects of social life without it, either because of the help of someone or simply because their social context did not require it (Lupac, 2018). However, with what is now a global lockdown that severs the interpersonal ties so essential to maintain our fundamental social structures, the status of virtual digital spaces have switched from an amenity to a necessity. In the context of the COVID-19-related quarantines, alternatives to the use of technologies to deal with even the most mundane tasks are scarce. With the stress imposed on the structures themselves on the one hand, and the increased dependency toward technology, on the other hand, COVID-19 is bound to deepen existing digital inequalities on the four factors presented above (Fig. 1).

Low-income households, presumably less well equipped in terms of technological devices both in numbers and in quality, suffer from the immediate and long-term economic consequences of the COVID-19 crisis more severely (Fernandes, 2020; Van Lancker; Parolin, 2020; Wang & Tang, 2020). Therefore, updating technological equipment will unlikely rank high in the budget of these families. However, using outdated equipment generates longer delays in accessing online resources, if accessible at all, which can create a less satisfying experience, resulting in fewer opportunities to use Internet technologies and consequently fewer opportunities to develop digital literacy skills. In contrast, more economically favored households will have a high incentive to upgrade their equipment – whether for telework, learning or entertainment. This will result in a worsening of pre-existing equipment-based digital inequalities. COVID-19-triggered home confinement creates an unprecedented Internet traffic load, which results in slower connections for multiple Internet users (Bergman & Iyengar, 2020). However, this will not affect everyone in the same way, depending notably on the local cost of Internet subscription. Households with low incomes might not be able to afford the best connection both in terms of speed and data usage, without sacrificing essential spendings. In opposition, those with the greatest Internet packages subscription will likely not experience the slower connections at the same scale. Furthermore, households with more members will have to share Internet devices, downloading data and entertainment modules (such as Netflix accounts or television decoder).

Ease of access to technologies (e.g. computer and Internet) differs between those who can access them from home and those who need to access them from public spaces such as schools, libraries or Wi-Fi hotspots at coffee shops. Inequalities in the autonomy of use are particularly concerning in the context of COVID-19, as governmental authorities are closing numerous centers that people could use to access Internet. With
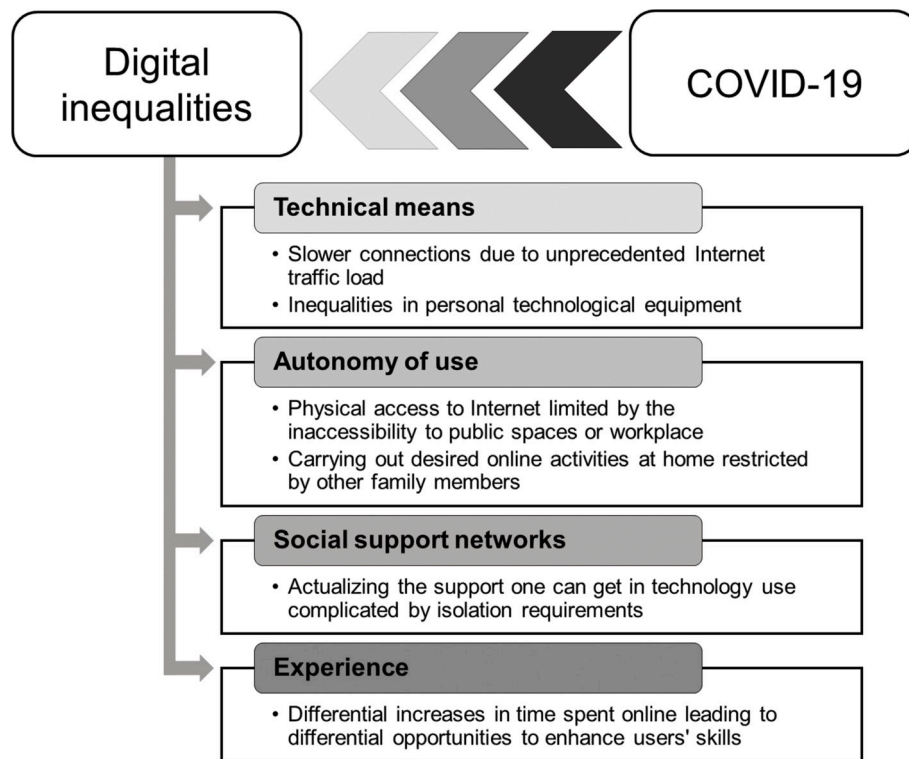
Fig. 1. Impacts of the COVID-19 crisis on digital inequalities.

companies being closed as well, people who accessed Internet at work don't have this possibility anymore either. More importantly, one of the direct economic impacts of the crisis is an increase in unemployment (Fernandes, 2020), making people with limited resources unlikely to be able to maintain a home connection to Internet provider services. Furthermore, finding another job in the pandemic context will be more challenging for those with limited digital skills. Besides issues related to physical access to Internet, the perception of freedom in technology use will also be altered by the COVID-19-induced confinement. Indeed, Internet use at home is becoming further restricted by other family members' presence such as the children or by telework imperatives, raising the challenges surrounding carrying out desired online activities.

The social support network factor contributes to digital skills in multiple ways. Having assistance in the form of recommendations or advice from more experienced Internet users when problems arise would increase knowledge (van Laar et al., 2019). The exposure to technologies in the social network also raises the likelihood to adopt new technologies. Therefore, people who learn from their social contacts will develop skills quicker. The context of COVID-19 raises new socio-technical challenges to the contribution of social support networks in developing digital literacy. Indeed, the isolation requirements make it harder to actualize the support one can give in technology use because a minimum of digital literacy is needed for the person to receive helpful support. This creates an unprecedented paradox for the population digitally disfavored: how to find helpful support in digital technology use, having mostly only digital technologies as mean for action? For instance, when facing a problem with Internet connection or amenities, support might only be offered through phone communication, leaving the person to realize the manipulations by themselves. Hence, for the more digitally disadvantaged individuals, support could be harder to obtain or to meet the needs, whereas those with higher digital skills could adapt to news means of support much easier.

The factor of experience particularly contributes to the increase in digital skills. With the COVID-19 crisis, time spent online will likely increase for those who have access, although usual exposure through settings such as school or work offering time to acquire knowledge and skills that can be applied in personal settings would be reduced. The longer one has been using Internet, the better are his skills at finding information and navigating online. With the changes that COVID-19 brings, people who have spent more time online and have more positive experiences to draw upon will likely adapt more easily to the changes in communication means. They will also probably spend more time online during the crisis and therefore continuously increasing their digital skills. However, less experienced users might misuse digital spaces, and might get more prone to being exposed to potentially addictive applications such as online games. Therefore, digital exclusion is likely to get exacerbated during and after the COVID-19 crisis, reinforcing digital vicious circles.

4. How digital inequities potentiate vulnerability to COVID-19

Evidence regarding COVID-19 impacts on social health inequalities are already pilling up, with women, older adults, homeless populations and low-income households being already more affected by the crisis (Tsai & Wilson, 2020; Wang & Tang, 2020; Wenham, Smith, & Morgan, 2020; Zhou et al., 2020). Indeed, socially and economically disadvantaged people are also among those more at risk of suffering from chronic health conditions and faces barriers to access health systems (McNamara et al., 2017). Digital factors are likely contributing to this unequal distribution of vulnerability. As the use of technology massively increases during the COVID-19 crisis, so do the impacts of digital inequalities. Given the dependency toward technology in all the spheres of life, digital inequalities put the most digitally disadvantaged more at risk, both to get the virus itself and to suffer from negative outcomes related to the crisis overall (Fig. 2). Therefore, we will first discuss how digital inequalities increase vulnerability to the virus itself, and consequently the efficacy of the public health measures taken. Then, we will explore how digital inequalities will contribute to further increase vulnerability to the repercussions of the crisis.
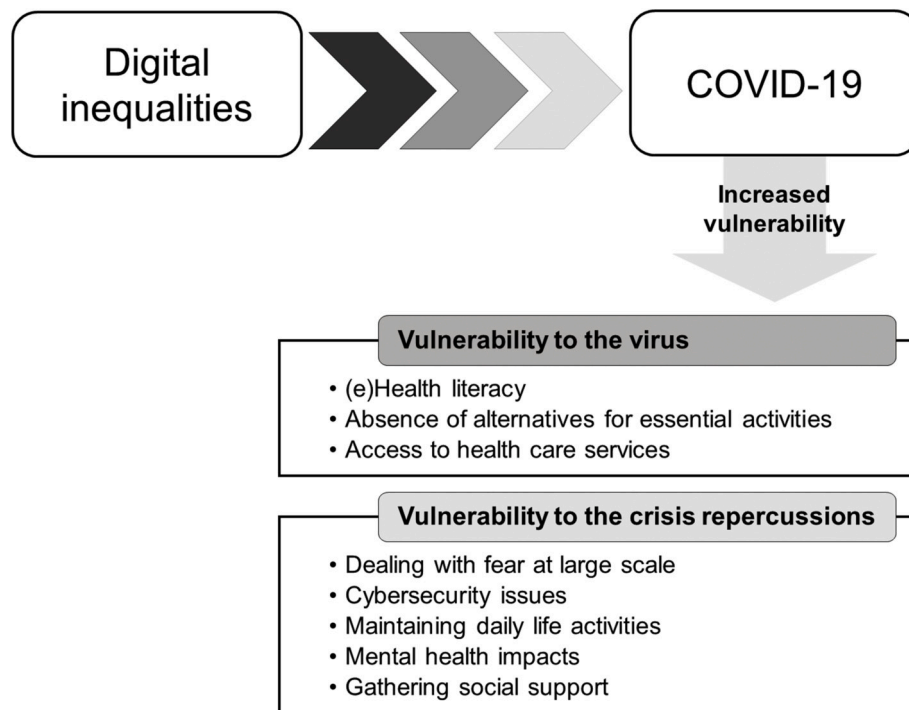
Fig. 2. Impacts of digital inequalities on COVID-19 vulnerability.

4.1. Vulnerability to the virus itself

The question of accessing and understanding online information and following recommendations is central in the capacity of individuals to take protective actions. Since the beginning of the COVID-19 crisis, digital spaces have been the main tool government and official agencies, such as the World Health Organization, have used to disseminate information about the measures that people have to take both to avoid getting contaminated and contaminate others. However, some of the most vulnerable social groups, including the aged, the homeless, recent immigrants, or rural residents are those who are the most difficult to reach if digital media serve as the main route of communication (Lee, Rogers, & Braunack-Mayer, 2008). In this context, health literacy inequalities get exacerbated as they merge with digital literacy inequalities. These two factors result in differences in eHealth literacy – people's literacy, knowledge, motivation, and competence to access, understand, and appraised health information from electronics sources and to apply it to make decisions in everyday life to address healthcare, disease prevention, and health promotion to maintain or improve quality of life (Norman & Skinner, 2006; Sørensen et al., 2012). People presenting lower levels of eHealth literacy are more vulnerable to COVID-19 contamination or propagation because they have a harder time accessing, understanding and applying protective measures. The context of COVID-19 brings up supplementary elements adding to the complexity in processing and implementing health-related information. Indeed, each decision implies abstract notions that directly affect everyday life, as one needs to think about the risks and probabilities of certain formerly mundane behavior adoption.

Given that the requirements of home confinement are understood, other factors might impair the possibility to actualize recommended behaviors. These difficulties are linked to the level of digital skills, social networks composition, and financial constraints. With the impossibility to realize some everyday life essential errands or activities, people need to find suitable alternatives, such as online grocery shopping or having someone to get groceries for them. This is especially true for the population who are most at risk of mortality if they contracted the virus, such as the elderly and people suffering from chronic health conditions (Zhou et al., 2020). Access to virtual alternatives is limited by a restrained set of digital skills and economical constraints related to delivery fees. As mentioned above, one of the ways digital inequalities get actualized during the COVID-19 crisis is related to Internet access – or for that matter, the lack of proper access. People having to get in public places to get access to Internet are at increased risk of exposure. Also, inaccessibility to support while using technologies (see part 3 of this paper) could lead to breaking isolation restrictions to obtain this help (for instance, adults going at their elderly parents' place to repair or install technological equipment, such as television or computer). Finally, in a context where medical workforce and resources are getting scarce due both to the overwhelming situation in health care units and to the fact that more and more health care professionals are getting infected as well, we are witnessing the premises of attempts to telemedicine interventions, particularly for telediagnosis (Greenhalgh, Koh, & Car, 2020). While this provides new avenues, it might also compromise the chances for the most digitally vulnerable to get access to the health care system in comparison with the rest of the population. This is especially true in countries with no universal care coverage, where low-income households won't have enough money to pay for those services and might have to resort to face to face emergency services, where they will be more at risk to contract the virus or to spread it.

4.2. Vulnerability to the repercussions of the crisis

Pandemics can cause a lot of harm – both in terms of human losses and of economical consequences. In the connected modern age, epidemic outbreaks can also elicit massive responses from the population. In an age of 'fake news' and distrust toward official messages, these responses, powered by social media and nurtured by misleading popular culture representations, can trigger large-scale panic that can be highly deleterious – in fact, potentially considerably worse than the outbreak itself. While diffusing information, governments and public health agencies need to find a balance between sufficient sensibilization and unnecessary fear. Internet plays a crucial role in the rapid and diffuse growth of fake news or other information from unrecognized sources that might go against governments and public health recommendations.

People not able to decipher the degree of veracity of information (typically due to low level of critical digital or health literacy) might follow various advice regarding COVID-19 that could not only be detrimental for their health but also be harmful for the population.

In the context of COVID-19, digital spaces are getting essential to maintain daily life activities, education, work, services, or entertainment, emphasizing the importance of digital inequalities as one of the main determinants of well-being. The context of COVID-19 also raises cybersecurity issues. Indeed, the multiplication of the time spent online, as well as the increased dependency on technological tools make people more vulnerable to cybercriminality (Guitton, 2019). Of note, multiple fraudulent scams preying on fear and lack of eHealth literacy have already been reported (Saltzman, 2020; World Health Organization, 2020).

Mental health issues will arise during and after the COVID-19 crisis. The pandemic increases psychological distress for the population (Qiu et al., 2020), especially for people already suffering from mental health issues (Brooks et al., 2020; Yao, Chen, & Xu, 2020) and health professionals (Greenberg, Docherty, Gnanapragasam & Wassely, 2020). Furthermore, the occurrence of domestic violence might also increase during the confinement period (Cluver et al., 2020). Of note, mental health burden resulting both from the crisis and from the interruption of what was deemed "non-essential" services will likely bring about economical challenges to answer mental health needs. With health systems already experiencing difficulties to adequately answer the burden of mental health disorders ((World Health Organization, 2013)), social distancing measures increase the weight of technology to pursue psychological therapeutic services (either by phone communication or telepsychotherapy), reinforcing the negative impact of digital inequalities. Therefore, a new psychological distress burden could add pressure to already fragile mental health systems.

As the primary strategy that governments worldwide have taken to face the COVID-19 pandemic is to impose various degrees of social distancing measures, virtual spaces offer means of communication that can be used to maintain social bonds between family members, friends, coworkers or community members and strengthen durable social bonds (Sunderland, Beekhuyzen, Kendall, & Wolski, 2013). Maintaining social interactions through virtual spaces is critical to receive social support necessary to cope with uncertainties, fears, and anxiety that come with the consequences of the pandemic (Brooks et al., 2020; Qiu et al., 2020). Furthermore, the importance of virtual communities such as online groups or even tools like forums will increase both for social support and information seeking purposes (of note, Reddit, one of the major online forum platform, is already supporting at least three community rooms about COVID-19). In a context of imposed social isolation, resorting to virtual communities will give a major edge to those able to navigate digital spaces optimally.

Implied in the above, the COVID-19 pandemic will bring a rather high amount of loss for many people, whether it is job loss, loss of social bonds, loss of "normality" or loss of a loved one. Indeed, the COVID-19 crisis has already made a high number of victims around the world. In addition to the patients dying as a result of contracting the virus, shadow victims are less mentioned. With hospital visits being limited in most countries, dying patients in long-term care facilities receiving palliative care are spending the last days of their life alone without the support of family members and friends. With the pandemic, traditional mourning rituals offered by funeral homes are disturbed – whether loved ones died from the COVID-19 or from another cause. The burden of not having been there for the last moments of a loved one and the absence of funeral rituals could have multiple impacts of mental health and grief processes that are yet to be qualified. While digital technology could offer means to mitigate these impacts, from online memorials and virtual funerals (Arnold, Gibbs, Kohn, Meese, & Nansen, 2018) to online peer support groups (Robinson and Pond, 2019), the benefits people can retain from these tools differ according to their digital skills levels. For instance, the lack of experience with online memorials features both on grief specific

and unspecific websites (e.g. Facebook memorialization option) could become barriers in their use. Similarly, slower Internet connection could limit access to virtual funerals.

5. Strategies of mitigation

In light of the challenges complexity that digital inequalities represent for the resilience of the population to COVID-19, mitigation strategies need to be implemented. These strategies will aim at mitigating both the impacts of the COVID-19 crisis on digital inequalities and the digital inequalities impacts on COVID-19 vulnerability. These strategies will necessarily be multi-layered and need to take into account several levels of decision: governmental, organizational, community, and individual, in partnership with research and higher education structures. In the specific context of the COVID-19 pandemic, all strategies should keep an overall goal of actionability – making sure that things implemented translate into possibilities of action for the population – and equity. Following a Saussurian definition of human communication (de Saussure, 1916), while all strategies should ultimately be aimed at people, some are specifically targeting individuals' technologies access and use, while others are focusing on the message itself (Fig. 3).

5.1. Strategies targeting individuals' technology use

- **Increasing physical access to connected devices and Internet:** Making sure that the population has optimal access to technology – both in terms of equipment and network connectivity – is central to reduce the impacts of digital inequalities in the COVID-19 context. The first step to do so is to map the disparities of access to technology by identifying the most vulnerable populations and areas. In other words, to spot the "digital deserts", through proxies such as mobile network coverage, smartphone penetration, or socioeconomic status. Joint efforts by governments and telecommunication companies shall be made to increase the coverage of Internet networks, as well as its capabilities – both in terms of speed and downloading capacities – to support more connections by more people, particularly in disadvantaged neighborhoods. Alternative transitory solutions can be offered using mobile Internet relay, for instance via broadcasting trucks. Authorities should consider keeping places allowing public access to Internet opened, but ensuring that a limited number of people can use these facilities at a given time and under appropriate hygiene conditions. Public fundings can be used to assist low-income households in getting connected devices. Community solidarity can also take place through donations of used devices to charities, that would redistribute them to people digitally excluded.
- **Increasing digital literacy:** Several strategies can be implemented on a short-term basis to increase the digital literacy of people, and therefore their behavioral capability to interact efficiently with new technology. The first set of strategies will be to reinforce household and family (typically intergenerational) and community peer-support to promote the acquisition of digital skills. While this can be done on a short-term basis through the help of volunteers interacting though phone with digitally disadvantaged people, it will require on a long-term basis the development of digital alphabetization units through community organisms – eventually with specific hygiene measures if the virus is still present. Such strategies might have to be implemented at large in low-income countries to accelerate the digital switch of endangered economies, as well as to promote the well-being of disadvantaged populations. For those already having some – even if limited – digital access and skills, the promotion of the acquisition of digital skills can be done through online video, tutorials, or courses. Governments, corporations, and higher education institutions can cooperate to develop efficiently such material – and optimally to make its access free. The last set of strategies aims at increasing the presence of digital skills acquisition in school curriculums. The present crisis demonstrates the
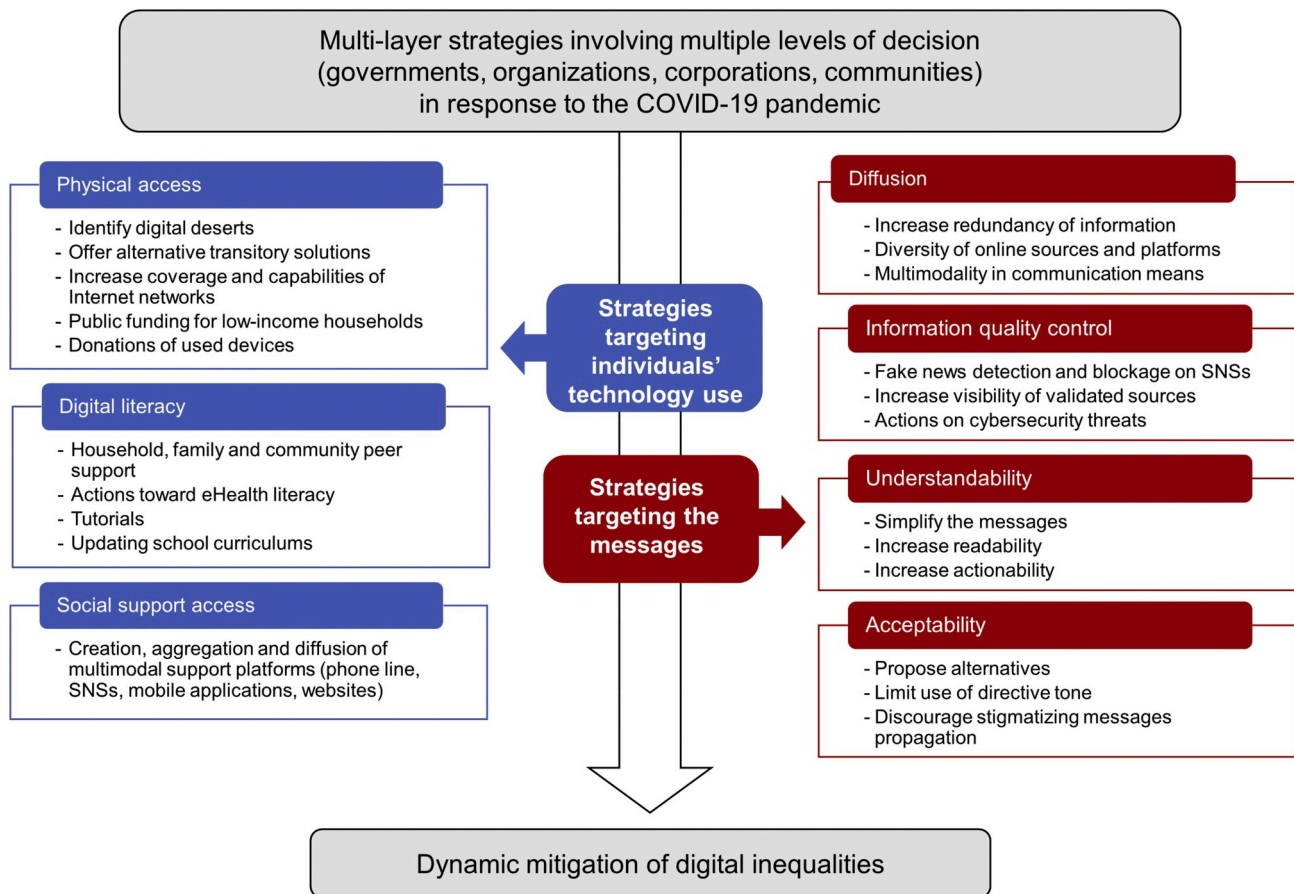
Fig. 3. Mitigation strategies to limit the impacts of digital inequalities during the COVID-19 crisis.

importance of implementing such strategies in our education systems. Although this appear as a long-term goal, some actions can be undertaken right away though the initiative of schools and teachers, for instance, reaching out to those most in need.

- **Increasing access to social support:** Measures aiming at increasing social support access should focus on the creation, aggregation, and diffusion of information about multimodal platforms including communication features. For the digitally excluded, phone support line with volunteers should be put in place and they should be open for all the population and not just the elderly. Other measures can be added that focus on users having poor digital skills. For instance, health professionals and community leaders could promote user-friendly apps such as SNSs to maintain social contacts with friends, family members, and coworkers. Diffuse information for digital literate persons to be aware of the difficulties that might be encountered by fellow Internet users and advice to use the apps they are most confident with (Braun, 2013; Beaunoyer and Guitton 2017). Any professional aiming at creating an online community should consider the fact that they most often emerge spontaneously in cyberspace (Eysenbach, Powell, Englesakis, Rizo et Stern, 2004). Yet, there is a need for mutual exchange of personal information and the mention of personal problems instead of off-topic conversations to promote engagement (Pfeil, Zaphiris, & Wilson, 2010). Finally, diffuse information about "unconventional" spaces to receive social support such as websites or applications for playing online board games or tabletop role-playing games. Those platforms serve both for entertainment purposes and social support either with strangers, acquaintances or with closed ones and therefore contribute to maintaining existing social bonds.

5.2. Strategies targeting the messages

- **Increasing the diffusion of the messages:** The first mean to increase the diffusion of the messages is to increase the redundancy of information. Indeed, repetitive exposition to information enhances the likelihood of this information to be perceived as relevant by the targeted population (Beaunoyer & Guitton, 2017). Increasing the redundancy of information has been demonstrated to increase the efficacy of the propagation of important information in virtual communities with low density (Guitton, 2015). Furthermore, the interconnectivity of the different social media provides a substratum to support information redundancy within communities having an online presence. The use of social media interfaces' communication tools (e.g., hashtags) can be optimized to promote the dialogue with the citizens, and their engagement within the community and with the message (Chen et al., 2020). Of note, redundancy should come from trusted channels – which does not necessarily mean official ones, as individuals ranging from celebrities to community leaders might have as much weight than governments when it comes to mobilizing people. Messages that aim at stimulating storytelling and conversation should draw and retain more public attention (Meng et al., 2018). Alongside redundancy of the information, increasing the diversity of online sources and platforms is key to optimize the reach of messages. Digitalized spaces can be accessed through very diverse connected devices, and optimal strategies should include most – if not all – of them, from computers to mobile phones. Efforts should be made to ensure to target platforms with which a majority of users are already comfortable. Although all efforts shall be made to increase access to online spaces, a proportion of the population will remain out of the digital reach. Since the digitally excluded are also among those most at risk, it is critical to focus the use of offline

sources to reach these populations – from printed flyers to using personalized phone calls. Community expertise will be central to implement such strategies.

- **Increasing the control over the quality of the messages:** In a pandemic context, erroneous messages such as fake news, powered by social media and nurtured by distrust toward official messages, can have large-scale impacts that can be extremely deleterious. Strategies to detect and block erroneous information and fake news have to be implemented systematically. While an equilibrium has to be made between freedom of speech and level of control, using legal ways to avoid the propagation of potentially harmful information might be required at some point. One of the most powerful ways to fight against fake news is to increase the visibility of validated sources. Work can be done with the giants of Internet to ensure that news or information coming from the governments or other validated public health organizations are systematically ranked first in the various search engines. Active information diffusion by government officials, employees, and citizens on social networks can strongly contribute to the propagation of important elements. Official websites and webpages can be made more visible online and more user-friendly. Furthermore, people with limited digital literacy having no other choice than to massively use Internet are putting themselves at higher risk of frauds and other cybersecurity threats. Indeed, the main determinant of cybersecurity is not technology, but users' behavior (Guitton, 2019). Campaigns aiming at increasing cybercriminality awareness are important to be implemented, particularly in disadvantaged neighborhoods. All services offered through phone or online communication should take into consideration the highest risk of fraud during the crisis when dealing with vulnerable populations. From a virtual community building perspective, focusing on the usefulness and the relative safety of an application is one of the keys to engage older adults to use online interfaces (Braun, 2013). Highlighting the security-related characteristics alongside the features dealing with usefulness is thus a good strategy to retain the participation of such populations in online communities (Beaunoyer & Guitton, 2017).

- **Increasing the understandability of the messages:** As understanding the public health messages is critical in decreasing the toll of the pandemic, major efforts should be made to increase this aspect. Specifically, attention should be put in simplifying the messages, increasing their readability, and increasing their actionability (Beaunoyer, Arsenault, Lomanowska, & Guitton, 2017). Messages should be simplified in terms of the language and terminology used. Non-essential information should be used with parsimony to make sure that the focus is on the essential. This is particularly important for communication made by health care system representatives when they are addressing patients individually and the population globally. Increasing the readability of the messages can be done notably by using visual implementations, such as charts of figures (Beaunoyer et al., 2017). Finally, all messages should be developed and considered with actionability in mind.

- **Increasing the acceptability of the messages:** At last but not least, it is critical to ensure information and recommendations acceptability. Strategies in this category will vary depending upon the sociocultural and geographical contexts and should all be tailored upon individuals needs. To increase the societal acceptability of the measures, it might be needed to reduce the directive tone of the messages to avoid both paternalism or the use of over-authoritative stances (that can sometimes border military language). Also, it will be important to ensure that people have access to information on the alternatives to access services that are closed or restricted, or to tasks that people used to perform strictly offline. Finally, as economical and interindividual tensions will increase as the crisis becomes longer, it will be critical to prevent the propagation of stigmatizing messages – through SNSs or other means –, both regarding specific populations (such as people of Asian descents as it was observed

during the early stages of the outbreak), or population speaking against some measures.

6. Conclusion

Preparedness is central in the crisis management discourses of a lot of countries. However, the COVID-19 pandemic is clearly showing the world populations that we are still not fully prepared to deal with the societal impacts of pandemics at a global level. From earlier epidemics, we know that socially and economically disadvantaged people are at higher risk when it comes to catching the disease. A series of political and community interventions aiming to solidify the social safety net is needed to support the most socially vulnerable population and prevent increasing both their vulnerability to the pandemic, and the social health inequalities. Indeed, although vulnerabilities and social inequalities existed long before the COVID-19 crisis, there are getting exacerbated in the current context. This crisis is unmasking an emerging form of technology-related social inequalities that were rampant since some times already, but did not receive the full attention it deserved.

The current work offers a starting point in analyzing the reciprocal impacts of COVID-19 and digital inequalities. However, more research will be needed to get a deeper understanding of these bi-directional interactions, as well as to document the feasibility and efficiency of potential mitigation strategies – particularly in regards to resource availability and constraints, social acceptability and political context, and timeline of implementation. Considering that important variations exist in political and economical systems across countries, mitigation strategies implementation will need to be anchored in a specific sociocultural context. Future research will have to navigate between large-scale investigations of how online behavior impacted and was impacted by the COVID-19 crisis, and smaller scale studies aiming at document possible interventions. Beside purely quantitative large-scale investigations, there is a critical need to consider and document individuals' experiences of the crisis. This will be particularly important in the context of progressive end of the quarantine that has been initiated in many countries. However, equilibrium will have to be reached between the need to quickly document the phenomenon as the crisis unfolds in the one hand, and the need for scientific robustness in the other hand. In this context, mixed methods studies combining quantitative analyses with strong qualitative observations may be an interesting solution. In this view, qualitative designs will have to consider generating large enough dataset so that quantitative analyses could be performed on them. Reciprocally and complementarily, typical quantitative studies might benefit from integrating qualitative data to help contextualize the results, in order to insure operationability of data necessarily obtained during a limited, and unique period.

The COVID-19 pandemic represents the first large-scale event for which digital inequalities become a major factor of vulnerability – both to the health-related impacts of the exposition and the spreading of the coronavirus, and the socio-economical consequences of the pandemic. As isolation becomes more and more drastic, virtual spaces, digital media, and mass media take an unprecedented place not just as means of information diffusion, but also potentially as the only remaining vector for social interactions to take place. Taken together the challenges that digital inequalities pose for population health and well-being should be addressed in priority. This crisis will be a turning point in the way we manage public and global health for numerous reasons, one of them being that from now on, public health policies can not anymore oversee the impact of digital inequalities. Although the mitigation strategies proposed in this article specifically aimed at reducing the reciprocal effects of digital inequalities and the COVID- 19 crisis, they will also contribute to win the war against this invisible enemy.

Declaration of competing interest

There is no conflict of interest with this paper.

CRediT authorship contribution statement

Elisabeth Beaunoyer: Conceptualization, Writing - original draft, Visualization. **Sophie Dupéré:** Writing - original draft. **Matthieu J. Guitton:** Conceptualization, Writing - original draft, Visualization, Supervision.

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