

Review Article

Positive Impacts of the COVID-19 Pandemic and Public Health Measures on Healthcare

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Abstract: In the midst of the COVID-19 pandemic, several unexpected positive outcomes have surfaced. The WHO public health measures have positively transformed people's behaviour and lifestyles. The pandemic has prompted more focus on self-care and health awareness. Hand hygiene practice has been greatly emphasised. The acceptance rate for the use of personal protective equipment, such as face masks, has been remarkable. People with co-morbid conditions are paying more attention to their primary illnesses by improving diets and exercise methods. People are more willing to accept and act on public health messages. The pandemic lockdowns have not only successfully mitigated the transmission of coronavirus, but they have also indirectly reduced the hospital admission rates for endemic community respiratory infections and trauma-related emergencies like motor vehicle accidents. Fetomaternal health and wellness have significantly improved during the pandemic. The abrupt emergence of COVID-19 has also led to a massive societal shift on tobacco smoking cessation. Smokers are compelled to reflect on the harmful effects of cigarette smoking in relation to COVID-19. Issues of mental, relational and sexual health are put in the spotlight during the pandemic. People are investing more time in themselves, family and relationships. The world has seen an unprecedented global race in healthcare innovation and technology development in tackling the same global issue. Artificial intelligence, including robots and drones, have been rapidly developed and employed for healthcare as well as food and delivery services in order to minimise human physical contact. This article discusses several unforeseen positive impacts on healthcare that emerged from the COVID-19 public health measures that have been implemented. The positive impacts of the COVID-19 pandemic should be highlighted in order to provide hope to our community.

Keywords: positive impacts; COVID-19 pandemic; healthcare; public health measures

1. Introduction

The coronavirus disease 2019 (COVID-19) was one of the most popular searched keywords on the internet in 2020. Issues relating to the COVID-19 pandemic are ubiquitous in our daily lives now. COVID-19 is discussed constantly from social media to local news. This disease, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was first discovered in the Hubei Province of Wuhan, China at the end of 2019 and was declared a global pandemic by the World Health Organisation (WHO) in March 2020^[1-4]. It has affected over 195 countries^[5]. According to the WHO, nearly a total of 117 million confirmed cases, including approximately 2.6 million deaths globally up to March 2021 were recorded^[6]. The pandemic has had a disastrous impact on the lives of humans all over the world. The infectious disease mortality rate is alarming, our healthcare system is overwhelmed and medical resources are compromised. Global economic development has taken a critical hit too, as many countries experienced a severe contraction of their gross domestic product^[7].

Coronavirus is spread from person to person via respiratory droplets, mainly through coughing or sneezing. Other transmission routes of COVID-19 include contact with contaminated fomites and inhalation of aerosols^[8]. With a lack of knowledge regarding the long-term efficacy and safety of vaccines as well as the unavailability of absolute antiviral treatment for coronavirus, the prevention and control methods are currently the best approaches to control the pandemic^[9]. The WHO introduced several public health measures, including hand hygiene, social distancing, self-isolation or quarantine, respiratory etiquette and avoiding touching eyes, nose and mouth^[5]. Many nations in the world also implemented nationwide lockdowns to minimise interpersonal contact among their citizens in order to reduce the virus transmission. Schools were shut down, traffic was severely restricted, non-essential economic activities were suspended which could lead to loss of jobs, mass gatherings or events were cancelled and social distancing became the new norm^[10, 11]. It imposes great challenges on the economic and social lives of people everywhere who faced difficulties and inconveniences on a daily basis^[12].

COVID-19 public health measures have become mandatory in our daily lives now. The lockdown or movement restriction that has been implemented in many places proved to be effective in bringing down the number of COVID-19 cases^[13-16]. Numerous studies demonstrated that the pandemic also positively affected our lives. Environmental quality was significantly improved due to large emission reductions of greenhouse gases^[17-19]. The pandemic itself and the related measures taken by governments and individuals also resulted in some unprecedented health benefits to our society^[10,20,21]. Since healthcare is a major concern in the 21st century, the positive impacts of the COVID-19 pandemic on health should be highlighted in the hope that we may retain some of the beneficial changes. We should explore every advantage brought by the pandemic in preparation for the next public health concern. This review presents the positive aspects during the COVID-19 pandemic, such as the positive changes in behaviours and lifestyles of many people during the pandemic, the lower hospital admission rates for various kinds of illness and disease,

the large number of people who ended their tobacco smoking habit, the improvements that were experienced in mental, relational and sexual health, and the advances that were made in healthcare innovation.

2. Positive Impacts of the COVID-19 Pandemic and Public Health Measures on Healthcare

Figure 1 is a graphical abstract to illustrate the main findings of this review.

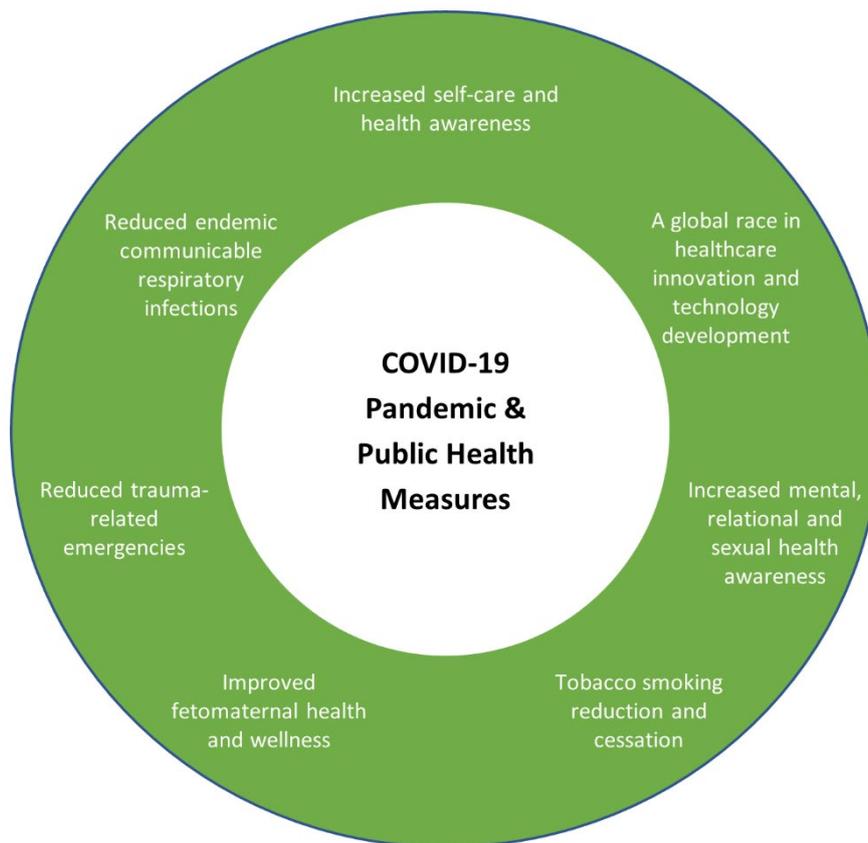


Figure 1. Summary of the review (the positive impacts of the COVID-19 pandemic and public health measures on healthcare).

2.1. Positive Changes in People’s Behaviour and Lifestyle

The COVID-19 pandemic is one of the greatest global health crises in human history. The lifestyles of many were fundamentally transformed — from wearing a face mask to physical distancing and practising hand sanitisation in public areas. Although these novel practices might have seemed bizarre to our ancestors who never heard of the word ‘pandemic’, the majority of the population in this era perceived the pandemic as a serious threat and have accepted the new way of living as normal. Self-hygiene and self-care awareness have largely spread across the globe, just like the virus itself.

For example, Muto *et al.* showed that more than three-quarters of Japanese people (75% out of 11,342 respondents) imposed preventive measures on themselves since the beginning of the pandemic^[22]. There were sporadic COVID-19 cases scattered in various regions of Japan since February 2020. Interestingly, most Japanese (80% out of 2,400 participants from Machida *et al.*) understood the deleterious effects of this infectious disease. They practised hand hygiene, self-isolation and cough etiquette, even before the WHO declared a pandemic emergency^[23]. The practice of public health measures by Japanese people highlighted their awareness of global health issues, perception of infectious disease risks and insight into self-care since the first SARS crisis. The current pandemic prompted many to focus on self-care, particularly personal hygiene. Indeed, hand hygiene is one of the important measures to curb virus or bacterial transmission^[24,25]. In the early phase of the pandemic, prior to any recommendation about hand hygiene by the WHO, Japanese people were washing their hands on average at least five times daily^[23]. Meanwhile, in hospitals, the average hand hygiene compliance rate dramatically increased up to approximately 90% among healthcare workers within the first quarter of the year^[26,27]. Hand hygiene has never received this level of attention as it was not taken as seriously as it should have been before the pandemic^[28]. The public's fear of and anxiety about coronavirus may have reinforced compliance with good hygiene practices^[29].

The raised awareness about hygiene practice was not only observed in hand washing but also in the adoption of personal protective equipment, particularly face masks. With the implementation of mandatory wearing a face mask in public areas by many governments around the world, people nowadays travel with a face mask^[23]. The face mask acceptance rate is as high as 80% in Asia. It is rather impressive that the estimated number of face masks used daily across 49 Asian countries is approximately 2.23 billion, with China holding the top place (around a billion masks used daily)^[30]. Turkey is another example of a country where people generally have positive attitudes toward public health measures. A survey study done in April 2020 showed that almost all study participants (97.3%) washed their hands more than usual. About two-thirds (63.7%) of participants went out with a mask and one-third (34.3%) wore gloves. Almost all of them sanitised items brought in from outside (93%) and participants did not accept visitors to their homes (97%)^[31]. The use of sanitising solutions increased during the pandemic, with almost 90% (out of 124 participants) declaring that they use it quite often^[32].

In particular, many people with chronic diseases have faced great challenges during the pandemic lockdown. Due to the inaccessibility of certain healthcare services during the pandemic, some patients have engaged in self-care or self-management strategies to deal with cardiometabolic diseases, including diabetes mellitus, hypertension, cardiovascular diseases and chronic kidney disease^[33]. Self-care programmes may improve a patient's awareness, knowledge, attitude, self-care behaviour and efficacy of chronic disease management^[34,35]. For example, in people with diabetes mellitus, self-care management was shown to significantly improve glycosylated haemoglobin type A1c (HbA1c) status^[36]. Many individuals were able to optimise their glycaemic status during lockdown because

they had additional time to focus on diabetes self-management^[37]. Grabia *et al.*^[32] stated that 60–65% of people with diabetes in Poland had improved their diet by eating more regular, nutrient-dense meals during the pandemic. About 40% of the surveyed participants with diabetes started to monitor their disease more vigorously^[32]. In Malaysia, a local market survey showed that up to 72% of Malaysians reduced sugar intake during the period of ‘Movement Control Order’, as the lockdown was called. About 36% of them experienced weight loss during the pandemic^[38]. Meanwhile, Kaye *et al.*^[39] observed a relative increase of 14% in adherence to controller inhalers among 7578 people with bronchial asthma and chronic obstructive pulmonary disease (COPD) during the pandemic. This may be due to the increased awareness in patients themselves in response to COVID-19 guidelines that were published and their concern about controlling their primary respiratory illness with medicine^[39]. The pandemic has empowered patients with co-morbidities to assume responsibility for their own conditions through dietary precaution, medication adherence, self-monitoring of blood glucose and blood pressure, as well as stress management^[40]. With increased self-awareness of one’s own health, it is possible that the condition of non-communicable diseases may be optimised and controlled in the long run^[41]. The attitude of the public towards the new health practices imposed during the pandemic was not as unfavourable as it might have been. The number of COVID-19 cases may have risen daily, but awareness about hygiene practices and self-care were greatly stimulated by the pandemic.

Stringent measures such as ‘stay at home’ orders were implemented in countries across the globe. Citizens were asked to stay home in an effort to flatten the COVID-19 epidemic curve while lessening the burden on the healthcare system. It is a fair assumption that home confinement may have certain detrimental impacts on lifestyle, especially regarding physical activities. Home confinement imposed difficult challenges for many people in their effort to maintain fitness since outdoor sports and physical activities were restricted or prohibited^[42]. People began searching for innovative ways to stay active and healthy even while staying at home. Since the pandemic started, there has been a growing body of literature regarding the use of new technologies and strategies for home-based exercises and fitness programmes^[43]. Plenty of fitness videos were advertised by exercise practitioners on social media sites, such as Facebook, YouTube, Twitter, etc.^[44]. People with adequate internet connections were able to easily access online electronic platforms in order to engage with others in various physical activities. Besides social media channels, virtual based exercise gadgets such as the Xbox 360 gaming console, Your Shape Fitness Evolved software, Nintendo Wii Fit, Oculus Rift DK2 virtual reality (VR) headset, etc. have become popular as media for exercise performance^[45]. These VR-based gadgets offer a large variety of home-based exercise programmes, including VR yoga, Tai Chi, kayaking, gym etc. and even mental exercises where users get to stay physically active as well as mentally healthy at home^[46].

Home-based exercise is not a new idea since it existed in the pre-pandemic era^[44]. However, it is now in the spotlight as its usefulness and convenience have been helpful

during the lockdown. The pandemic provided an opportunity to explore internet resources for physical activities. People under home confinement have adequate time to explore their interests. The accessibility and availability of online fitness resources may help maintain people's wellness but can also raise awareness of self-care and health concerns even during home confinement. The 'stay at home' order may restrain one socially, but it does not stop people from being physically and emotionally healthy^[47].

2.2. Reduced Hospital Admissions

Public health measures have been successful in mitigating the transmission of coronavirus in certain countries where stringent standard operating procedures were implemented^[20]. These approaches, which were favourable in the prevention and control of COVID-19, had positive impacts on other diseases too.

The number of hospital admissions for community-related communicable diseases scaled down drastically after public health measures against COVID-19 were introduced. For instance, a study from Singapore General Hospital showed that the number of cases for the non-influenza respiratory virus in 2020 was 50% lower in comparison to preceding years^[48]. Similarly, the admission rate for influenza cases decreased up to 90% and the percentage of influenza positivity in Singapore was reduced by up to 64% in 2020 when compared with each of the years from 2017 to 2019^[49]. Meanwhile, in Finland, there was a decline in the number of paediatrics admissions caused by non-COVID-19 respiratory viral infections. Two hospitals revealed that the daily median rate of Finnish paediatric visits decreased up to 70% after the national lockdown was implemented^[50, 51]. It was not expected that the annual influenza season would end swiftly among the paediatric population. This phenomenon could be attributed to the closure of schools and nurseries which broke the transmission chain of the virus. Moreover, frequent screening for COVID-19 also proved to be beneficial for other non-COVID-19 communicable diseases, such as tuberculosis (TB). Clinicians were able to pick up an early diagnosis of pulmonary TB on suspected COVID-19 patients as both diseases present similar signs and symptoms^[52]. The COVID-19 containment strategy may contribute to achieving the goal of a TB-free world by 2030^[53,54]. COVID-19 safe practices like hand hygiene, social distancing and wearing face masks are effective not only in containing coronavirus but all the communicable diseases transmitted through coughing, sneezing and touching.

Of note, the COVID-19 lockdown seems to have had a significant positive impact on the health and wellness of pregnant women and also on preterm infants with very low birth weight (VLBW) and extremely low birth weight (ELBW). Philip *et al.* stated that there was a huge decline in the rates of VLBW infants (73% reduction) and ELBW infants (100% reduction) in the first four months of the pandemic year in Ireland when compared to the preceding 20 years^[55]. Denmark also reported a reduction of 90% in live births of premature infants after the nationwide lockdown as compared with the preceding five years^[56]. Similar findings were reported in the Netherlands in relation to the reduction of preterm births^[57]. These positive impacts on overall fetomaternal well-being could be

explained by the improvement of socio-environmental and behavioural modifiers induced by the lockdown. At home, mothers received family and partner support, adequate rest hours and exercise, reduced chances of infection and accidents, optimum nutrition as well as financial aid from governments. The lockdown also effectively reduced road traffic which eased access to maternity services during emergencies^[55].

The COVID-19 public health measures had a positive impact on trauma-related emergency cases too, particularly motor-vehicle accidents (MVA). One of the main reasons for MVA is driving under the influence of alcohol or illicit drugs^[53]. With the COVID-19 lockdown, a series of measures were introduced, including restriction of non-essential travel, prohibition of alcohol sales, closure of non-essential services and places, and bans on social gatherings. The number of MVA cases was successfully brought down by the implementation of restriction measures. Morris *et al.* reported that there was a reduction by almost half in trauma cases that presented to emergency departments at hospitals in South Africa during the lockdown in comparison to two previous years. The majority of the cases were MVA and pedestrian-vehicle accidents^[58]. Manyoni *et al.* observed that the most significant decline (around 90%) in trauma, particularly MVA-related soft tissue injuries, happened in April 2020 after the South African government implemented a nationwide lockdown^[59]. By eliminating the risk of driving under the influence of alcohol or illicit drugs and with fewer cars on the roads, there was a reduction in the number of MVA cases that presented to hospitals and that lessened the burden on the currently overwhelmed healthcare system.

The decline in the number of hospital admissions of non-COVID-19 community respiratory diseases, preterm births and MVA cases during the pandemic is a reflection of multiple contributing factors. Raised awareness about hygiene practices, self-care and improvements in traffic situations are the primary reasons behind the reduction in the number of cases. Additionally, this could be partially explained by patients balancing the urgency of an immediate healthcare need with concerns regarding the risk of contracting coronavirus infection in an emergency department or a hospital. The COVID-19 public health measures that produced unintended positive effects may serve as a model for future public health concerns.

2.3. Tobacco Smoking Reduction and Cessation

The continued popularity of tobacco smoking has been one of the major public health concerns since the pre-pandemic era. It is widely known that smoking has noxious health effects on our bodies, particularly with regard to its strong association with lung cancer^[60]. Smoking also suppresses immunity, increases risks of respiratory diseases (asthma and COPD) and cardiovascular diseases such as myocardial infarction^[61]. During the pandemic, the public was concerned about the link between smoking and susceptibility to COVID-19 infection as well as the severity of the illness if contracted by a smoker. Several meta-analyses reported that the percentage of severe COVID-19 cases was higher in smokers (21.2%; 65/305) compared to non-smokers (10.7%; 978/9067). There has been a

clear association between severe COVID-19 cases and those patients who are smokers or who have a past history of smoking^[62,63]. Many believe that smoking increases the risk of getting coronavirus infection and the severity of the disease^[64]. Fear and anxiety about the deadly virus may cause smokers to think twice before smoking another cigarette.

Numerous research papers identified a relationship between the COVID-19 pandemic and the lower use of tobacco. Elling *et al.* indicated that one-third of smokers in the Netherlands found the motivation to quit smoking since the beginning of the pandemic. About one-fifth of them reduced the number of daily cigarettes since they perceived that coronavirus could cause severe illness^[65]. More than half of American smokers were motivated to quit smoking during the pandemic. Some even found that pandemic-related restrictions like the ‘stay-at-home’ order made it easier to quit smoking due to less accessibility to cigarettes^[66]. Kowitt *et al.* reported that more than 70% of smokers in the United States (US) had intentions to quit tobacco and almost half of them attempted to quit in the first six months of the pandemic^[67]. The COVID-19-induced lockdown also affected the US collegiate smokers and vapers. About 30% of US college students paused tobacco use after campuses were closed^[68]. Bommele *et al.* showed that the COVID-19 lockdown in the United Kingdom had positive impacts on the number of smokers who attempted to quit smoking (39.6% after VS 29.1% before the lockdown) and who were successful in quit smoking (21.3% after VS 13.9% before the lockdown)^[69]. Last but not least, a Dutch online survey found that there are more current smokers (16.1% after VS 12.1% before the lockdown) who are motivated to quit smoking since the pandemic began^[70].

It is probable that tobacco users with higher-level COVID-19 risk perceptions are more likely to attempt to quit smoking and are more likely to be successful in quitting smoking^[67]. The pandemic has the potential to impact multiple individual psychosocial factors particularly relevant to tobacco use, including daily behavioural patterns, living contexts, social contexts, mental health and perceived health risks. This is an opportunity for smokers to reflect on smoking and for public health regulators to revise tobacco control policies and tobacco cessation services.

2.4. Mental, Relational and Sexual Health

Regrettably, little attention has been devoted to the importance of maintaining mental health and relational health before the pandemic despite the fact that they are considered important parts of one’s overall health and quality of life. There is a boom in interesting research articles about the impact of the COVID-19 pandemic on our mental health since the beginning of the pandemic. Although the evidence regarding positive impacts from the pandemic on mental health is very limited, we can still note some positive trends^[71].

Children and adolescents in the twenty-first century face tremendous stress and pressure from scholastic performance. The pressure may result in mental health problems such as depression, anxiety, panic disorder, etc.^[72]. Since the implementation of national lockdowns, many schools closed temporarily and were forced to postpone examinations.

Children obtained a temporary 'break' from their unavoidable stressors^[73]. Online classes also save time and energy for children since they did not have to travel. Many children experienced more leisure time to explore their own interests. With school closures, peer bullying issues may have temporarily declined since children at home are more likely to be under parental supervision^[73]. Hawke *et al.* reported that the mental and relational health of almost half (47.3%) of the young people in Canada benefited in a positive way from the COVID-19 lockdown. Some expressed that they had improved social relationships at home, better sleeping quality and rest, more personal time for hobbies and exercises and greater self-reflection and self-care^[74].

This pandemic is also an opportunity for family bonding time. Family relationships were strengthened during the lockdown as household members invested more time together doing household chores or exploring their creativity in culinary pursuits. In terms of culture, younger people were spending more time with their parents which inevitably connects them to their cultural roots^[75,76]. Moreover, the COVID-19 pandemic forced some non-essential services employees to work from home (WFH). It is believed that WFH increases some aspects of productivity and efficiency. WFH helps people to avoid the stress of travelling. They get to work at a familiar place, dress comfortably and avoid direct contact with their employers or colleagues which may be one of their work stressors^[19].

Other than mental and relational health, sexual health, which is still a taboo subject in much of the world, also received public attention during the pandemic. Safe sex practices were observed more often between cohabiting monogamous partners during the lockdown^[77]. Some reduction of the incidence of sexually transmitted diseases (STD) and diagnoses of the human immunodeficiency virus (HIV) were reported after the travel restriction was imposed worldwide^[78]. Physical distancing, one of the recommended COVID-19 precautions, minimises the amount of close contact with other people who do not live in the same household and therefore reduced sexual and physical intimacy generally. Hammoud *et al.* reported that there was a relative reduction of approximately 85% in random sex with casual partners among Australian gay and bisexual men in April 2020 shortly after the pandemic began. The reduction in sexual behaviour that was observed may be attributed to a higher perceived risk of contracting COVID-19 along with the pressure of physical distancing, both of which diminished sexual desire overall^[79]. An Israeli study demonstrated that the COVID-19 pandemic altered sexual behaviour among men who have sex with men by showing a significant decrease in the number of sexual partners and a more limited sexual repertoire (by avoiding kissing their partners) in comparison to their pre-social distancing sexual behaviour^[80]. The Dutch public health measures in response to the pandemic effectively changed risky behaviour, indirectly driving STD and HIV transmission downward in a short period of time, with an 8% positivity rate of bacterial STDs during COVID-19 restrictions versus 19% before the pandemic. There were also no HIV infections diagnosed between March and June 2020 in Amsterdam^[81].

Certainly, the ultimate impact of the pandemic on mental, relational and sexual health is yet to be determined. Perhaps the biggest benefit we experienced was the opportunity to

spend more time together with our loved ones compared to the pre-pandemic time when many people were more focused on individual pursuits.

2.5. Healthcare Innovation and Technology Development

The pace of healthcare innovation and technology development was rapid in the past year because of the pandemic. Many people from around the world came together to fight COVID-19. Innumerable public health experts, clinicians, researchers, data analysts, pharmacists, medical device companies, engineers, designers, entrepreneurs, etc., collaborated as cross-functional teams to find solutions for real-world problems. The pandemic started a global race in healthcare innovation.

One extraordinary example is the development of remote-controlled robots for COVID-19 screening by scientists from Tsinghua University, China. The robots are able to perform a throat swab and disinfect themselves after performing their duties^[82]. Similar 3D-printed robotic arms were invented in Denmark to perform COVID-19 screening on people who arrived at drive-thru facilities in their cars^[83]. A Taiwanese physician invented an “Aerosol box” that covers a patient’s head but has arm holes for doctors so that they may perform intubation while being protected from infection^[84]. The Guangdong Provincial People’s Hospital in Guangzhou, China used robots for autonomous transportation of drugs. The robots were loaded with medicines, given instructions to travel to particular hospitals, and were able to open and close doors and take lifts without human assistance^[85, 86]. Harvard medical school in the US used intelligent robots to measure the vital signs of patients. The Americans have also developed a robot equipped with a camera, a microphone and a stethoscope that performed a consultation with a COVID-19 patient who was held in an isolated room originally designed during the Ebola crisis^[87]. These technologies greatly minimise the risk of exposure of healthcare providers. The world of healthcare innovation is borderless, as anyone can innovate, regardless of age. A 13-year-old boy scout invented a pair of 3D-printed ear guards to help healthcare workers relieve pain caused by prolonged wearing of face masks^[88]. The pandemic opened many minds and brought new perspectives, allowing innovation to blossom even during the most difficult time.

Innovation in healthcare ranges from artificial intelligence (AI) to medical services. When social distancing was implemented, physicians came up with an innovative yet effective solution to replace traditional consultations. Telemedicine, also termed ‘telehealth’ or ‘teleconsultation’ is defined as the delivery of health care service by telecommunication irrespective of location via the means of electronic, digital, internet-based, or telephone-based systems or any sort of information technology^[89]. The use of telemedicine by healthcare providers during the pre-pandemic time was scarce. Implementing it was difficult due to a lack of demand for it, logistical issues, concerns about healthcare provider reimbursement, laws and regulations and a lack of universal access. However, the COVID-19 crisis resulted in a surge of telemedicine due to an increased demand for virtual medical visits and a temporary lift on medicolegal barriers that had limited telehealth

expansion before the pandemic^[90]. Telemedicine services became very important during the pandemic. Telesurgery, which is conducted by general surgeons onsite under the supervision of sub-specialised surgeons who may interact remotely via a virtual interface, has also been used during the COVID-19 pandemic^[87, 91].

Advanced technology is not only seen in connection with the delivery of healthcare but also exists in our daily lives. Implementation of physical distancing has been instrumental in mitigating the transmission of the virus. Deliveries of food and other packages of all kinds were replaced in some instances by delivery robots and drones. A drone, also known as an 'Unmanned Aerial Vehicle' (UAV) is a flying device controlled remotely by a person or a computer. The Chinese e-commerce company JD.com launched a group of drones to carry out numerous food distribution tasks. The drones could, for example, replace an hour of ground delivery with a 10-minute flight^[92]. The use of robots was increased by fast-food chains, including McDonald's, and by warehouses, such as Amazon, FedEx, DHL and Walmart^[93,94]. Singapore was also testing a four-legged robot named Spot to enforce physical distancing in a public park^[95]. Using AI services during this pandemic such as robots and drones, not only saved manpower and time but also helped to reduce the spread of the virus^[96].

Under normal circumstances, innovation is a time-consuming process that can take months or even years. A primary example is the timeline for a new pharmaceutical drug which could take 12 years to develop from bench to market^[97]. The COVID-19 global health crisis greatly accelerated the pace of research and development. Innovation is a learning progress. Applying all these new innovations to healthcare services generally, even after the pandemic has waned, may provide many clinical benefits beyond simply reducing the infection risks of COVID-19.

3. Conclusions

The COVID-19 pandemic is certainly a tragedy of apocalyptic measure as the world has suffered serious, negative impacts ranging from socio-economic problems to the death of millions. The harm cannot be undone, but we can take some solace in the positive impacts that the pandemic had on our healthcare and other aspects of life: beneficial environmental effects on the planet; people have become more health-conscious; the number of hospital admissions for various kinds of illness and disease was drastically reduced; more people quit smoking; mental health, sexual health and family relationship issues were positively impacted in some ways; and there was a global movement toward healthcare innovation and technology development.

Highlighting the positive aspects of the current situation is not to downplay the harmful effects or the tragic losses, but this is to provide some hope and optimism during a challenging time. The abovementioned positive impacts may contribute to lessen public fear and give a different perspective to those who have undergone hardships during the pandemic. Our daily activities in the future may incorporate some of the hard-learned lessons from the

pandemic. Perhaps people will have a greater appreciation for our former ways of living in the time before the pandemic and will realise the great value of healthcare systems worldwide. Nothing is more valuable than our own health and the pandemic may inspire people to give a greater priority to good health practices. Public health policymakers such as the WHO may also emphasise the silver linings of the COVID-19 pandemic and seek to promote greater use of some of the public health measures in order to prevent, or at least lessen the impact of, the next global health concern. Global solidarity would ensure the survival of humanity even during the darkest time. As the COVID-19 pandemic runs from a sprint to a marathon, we must consider how we can keep some of the positive impacts on a long-term basis to help us build a better future.

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