The Spill-Over Impact of the Novel Coronavirus-19 Pandemic on Medical Care and Disease Outcomes in Non-communicable Diseases: A Narrative Review

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Objectives: The coronavirus-19 (COVID-19) pandemic has claimed more than 5 million lives worldwide by November 2021. Implementation of lockdown measures, reallocation of medical resources, compounded by the reluctance to seek help, makes it exceptionally challenging for people with non-communicable diseases (NCD) to manage their diseases. This review evaluates the spill-over impact of the COVID-19 pandemic on people with NCDs including cardiovascular diseases, cancer, diabetes mellitus, chronic respiratory disease, chronic kidney disease, dementia, mental health disorders, and musculoskeletal disorders.

Methods: Literature published in English was identified from PubMed and medRxiv from January 1, 2019 to November 30, 2020. A total of 119 articles were selected from 6,546 publications found.

Results: The reduction of in-person care, screening procedures, delays in diagnosis, treatment, and social distancing policies have unanimously led to undesirable impacts on both physical and psychological health of NCD patients. This is projected to contribute to more excess deaths in the future.
INTRODUCTION

The coronavirus-2019 (COVID-19) pandemic caused by the SARS-CoV-2 virus has placed the world and the healthcare system in an unprecedented situation. Most studies to date have focused on reported infections, hospitalizations, and deaths amongst patients with COVID-19, but the true toll of the pandemic goes beyond direct deaths related to COVID-19. As of October 2020, the pandemic has caused nearly 300,000 deaths in the United States, out of which roughly 100,000 fatalities were indirectly related to COVID-19 and would not have occurred if not for the virus [1]. Estimation of excess fatalities were indirectly related to COVID-19 and would not of October 2020, the pandemic has caused nearly 300,000 deaths in the United States, out of which roughly 100,000 fatalities were indirectly related to COVID-19 and would not have occurred if not for the virus [1]. Estimation of excess mortality in the United Kingdom suggested that in about one third of the year, excess mortality amounted to 75% of the deaths anticipated in the whole of the previous year [2]. Implementation of strict infection control strategies, reallocation of resources to enhance emergency care have deflected usual care for the non-communicable diseases (NCD) management [3]. The World Health Organization (WHO) reported in May 2020 that more than 60% of countries surveyed had partial or complete disruptions to services for NCDs [3]. Only approximately 17% of high-income countries allocated additional funding from government budgets to include provision of NCDs services into the national COVID-19 plan [3].

People living with NCDs are more vulnerable to becoming severely ill or dying from COVID-19 [4]. Service disruptions due to cancellation of elective care, lockdown hindering access to health facilities, in addition to the difﬁdence of NCD patients in seeking assistance for fear of risking iatrogenic exposure altogether pose additional challenges for disease management in NCD. The impact of the COVID-19 on NCD-related deaths is likely to become more signiﬁcant in the coming months than those directly by the infection.

Globally, healthcare utilization saw a median reduction of 37% between the pre-pandemic and pandemic periods [5]. Reports from around the world unanimously observed steep declines in non-COVID-19 Emergency Department (ED) visits in hospitals [6–9]. Evidence of excess population mortality and related observations such as increases in out-of-hospital cardiac arrests (OHCA) [10] and contacts with emergency phonelines [11] makes planning for ensuring adequate care for all patients even more imperative. The “spill-over” impact is a term commonly used in health economics to describe the indirect impact on individuals who did not receive the intervention but are affected for better or worse [12]. This review aims to describe the spill-over impact of the COVID-19 pandemic on changes in healthcare utilization and speciﬁc NCD outcomes in the early phase of the pandemic. While international differences in excess mortality will likely become more apparent over time due to policy differences in lifting lockdowns, a comprehensive understanding of the extent to which NCD patients are impacted will inform policy makers, healthcare managers, and systems to optimize post-pandemic use of resources.

RESULTS: THE IMPACT OF THE COVID-19 ON SPECIFIC NCDs

Cardiovascular Diseases

Universal reduction in the admission and hospitalization for patients with cardiovascular conditions including acute coronary syndrome (ACS) [13–18], acute myocardial infarction (AMI) [19–22] and heart failure [23, 24] has been reported. More patients had a longer symptom-to-first contact time immediately after the launch of emergency response measures against COVID-19 [25, 26]. Patients with ACS may try to endure their symptoms until intolerant [27, 28], and when they arrive in hospital, treatment may be delayed due to additional time needed for infection control measures [14, 29]. For instance, reports from 147 National Health Service hospitals in England showed that ACS admissions declined by 40% from mid-February to the end of March 2020 [17]. Hospitalization rates for cardiovascular conditions decreased by 43.4% in the United States, but in-hospital mortality rates did not differ compared with 2019 [13]. ED visits for ACS fell by 54–60% in Greece during the outbreak but increased to 107–125% compared to the pre-outbreak period after lockdown measures were lifted.

CONCLUSION

The spill-over impact of COVID-19 on patients with NCD is just beginning to unravel, extra efforts must be taken for planning the resumption of NCD healthcare services post-pandemic.

Keywords: health services, public health, COVID-19, non-communicable diseases, chronic diseases
In Israel, the trend in admissions for AMI inversely correlated with the incidences of newly-diagnosed COVID-19 cases, with a 12–18% decrease at the first 6 weeks of the outbreak, followed by a subsequent increase in admissions by up to 26% [22].

Cardiac procedures including percutaneous coronary interventions (PCI) and ST-elevation myocardial infarction (STEMI) activations observed significant delays, and patients had reduced treatment options relative to prior to the pandemic [15, 19, 25, 27, 30, 31]. PCI and coronary artery bypass graft (CABG) surgery reduced by 21–37% and 80% respectively in ACS patients, along with a decrease in the length of stay [17]. In England, patients admitted after the lockdown tended to be younger, and less likely to have diabetes, hypertension, or previous MI, PCI or CABG.

### TABLE 1 | Search terms or keywords used in the literature search. (Spill-over impact of COVID-19, Hong Kong 2021).

| Search Term | Search Term |
|-------------|-------------|
| COVID-19 OR | SARS-CoV-2 OR |
| 2019-nCoV OR | coronavirus disease 2019 OR |

**AND**

| 2.1 | Cardiovascular disease |
|-----|------------------------|
| Cardiovascular disease OR | Coronary artery disease OR |
| Coronary heart disease OR | Heart disease OR |
| Ischemic heart disease OR | Myocardial infarction OR |
| Cerebrovascular disease OR | Stroke OR |
| Ischemic stroke OR | Ischemic attack OR |
| Hemorrhagic stroke |

| 2.2 | Diabetes Mellitus |
|-----|-------------------|
| Diabetes mellitus OR | Diabetic |

| 2.3 | Cancer |
|-----|--------|
| Cancer OR | Malignancy OR |
| Neoplasm |

| 2.4 | Chronic kidney disease |
|-----|------------------------|
| Chronic kidney disease OR | Chronic renal disease OR |
| Dialysis OR | Renal failure OR |
| End-stage renal disease |

| 2.5 | Chronic Respiratory disease |
|-----|-----------------------------|
| Chronic respiratory disease OR | Chronic obstructive pulmonary disease OR |
| Chronic obstructive lung disease OR | Asthma OR |
| Respiratory tract disease |

| 2.6 | Musculoskeletal disorders |
|-----|--------------------------|
| Osteoporosis OR | Fracture OR |
| Major osteoporotic fracture OR | Osteoarthritis OR |
| Arthritis |

| 2.7 | Mental health disorders |
|-----|-------------------------|
| Mental health disorder OR | Mental health illness OR |
| Mood disorder OR | Depression OR |
| Anxiety |

| 2.8 | Dementia |
|-----|----------|
| Dementia OR | Alzheimer’s disease OR |
| Cognitive disorder OR | Cognitive impairment |

**Filters applied in PubMed**

| Publication date | January 1, 2019 to November 30, 2020 |
| Age | Adults (19+) |
| Language | English |
| Species | Humans |
compared to before the lockdown [32]. Despite a comparable case volume compared to pre-pandemic levels, there was a four-fold increase in symptom-to-door-time in ACS patients requiring PCI in a tertiary hospital in Australia [33]. An increased rate of in-hospital complicated course or worse outcomes such as more in-hospital deaths or cardiogenic shock was observed [25]. Rate of all-cause mortality among STEMI patients also increased by 4-fold during the pandemic [30].

A nationwide analysis of all adult deaths in the United Kingdom showed that the cause of acute cardiovascular death differed by place of death, with stroke being the most common cause in care homes and hospices, compared with ACS at home, or cardiogenic shocks in hospitals [34]. The incidence of out-of-hospital cardiac arrests (OHCA) increased by up to 5-fold in various countries including the United States [35, 36], the United Kingdom [37], Italy [38], and Spain [39]; all with less favorable outcomes upon discharge, and almost doubling of pronounced deaths on the scene [36]. The increase in OHCA was strongly associated ($r = 0.87$) with the cumulative incidence of COVID-19 [40]. While no differences in out-of-hospital deaths were reported in Australia, initiation of resuscitation by Emergency Medical Services, and initial shocks by public access defibrillation also reduced [41].

Delays in patient presentation and reduction in admission volume by up to 85% were similarly reported in stroke centers across the world [42–48], with a significantly higher proportion of patients receiving intravenous thrombolysis [45]. Suspensions of daycare and rehabilitation centers, as well as delays in providing critical rehabilitation services for stroke patients, may further aggravate disabling outcomes at discharge [49], in turn exacerbating physical exhaustion and psychological distress among family caregivers [50]. The long-term impact of COVID-19 on functional outcomes of patients with cardiovascular diseases, including those with TIA and minor strokes who did not seek medical care, in addition to missed opportunities to receive secondary treatment warrants further investigation.

**Cancer**

Delays and suspensions in cancer care ranging from disruption of medication supply, cancer screening, diagnostic interventions, specialty care, to treatments including chemotherapy, radiotherapy, immunotherapy, and surgical removal of malignancy was widely reported [51–61]. Most clinicians (89%) altered their practice because of the pandemic and were less likely to prescribe cancer-directed therapies, raising concerns for negative impacts on patient survival [62]. A recent meta-analysis of over 1 million individuals worldwide estimated that mortality risk would increase by 6–8% even with a 4-week delay in cancer treatment [63]. Alternatively, in geographical areas with a relatively low incidence of COVID-19, implementation of policies to facilitate cancer care have not resulted in significant
delays in patient care despite a decrease in patient admission or duration of therapy [64–66].

Cancer screening patterns based on insurance claims in the United States revealed an abrupt drop in screening for breast (-87%), cervical (-83%), colon (-90%), lung (-39%), and prostate (-60%) cancers [67] from March to June 2020; over 80,000 positive diagnoses for these cancers could be missed or delayed as a result of healthcare disruption [67]. Weekly incidence of newly-diagnosed cancers or referral cases dropped by up to 90% in the United States and United Kingdom during the COVID period [68, 69]. Population-based modeling in England estimated that cancer deaths during COVID-19 will increase up to 5.3% for lung cancer; 6.0% for esophageal cancer; 9.6% for breast cancer and 16.6% for colorectal cancer compared with pre-pandemic figures due to diagnostic delays over 12 months [70]. The changes in cancer services due to COVID-19 are estimated to result in 6,270 excess deaths in England, and 33,890 excess deaths in the United States after 1 year in people with cancer [69]. A 6-month delay in diagnosis of four cancers (breast, lung, colorectal, and melanoma) is predicted to result in $46 million Australian dollar excess in healthcare costs [71]. Medical costs were greater in patients that underwent CRC surgeries during the pandemic [72]. Modeling of the impact of screening delay for colorectal cancers (CRC) suggested that a delay for greater than 4–6 months would increase the chance of having advanced CRC by 3–6%, whereas mortality can increase up to 12% with 12 months delay [73]. Endoscopy procedure levels reduced to as little as 5% of pre-COVID levels in the United Kingdom [74]. Public hospitals in Hong Kong similarly reported >50% reduction in gastrointestinal endoscopy volume, while the number of patients diagnosed with gastric and CRC dropped by up to 49% [75]. The proportion of CRC patients diagnosed in the emergency setting increased during the pandemic while those by the screening program decreased [76]. Detection rates for high-risk adenomas and cancers increased in endoscopy units where CRC screening programs continued [77]. Additionally, mammography screening examinations decreased by 51–96% with the pandemic [78], along with a decrease in the number of newly diagnosed gynecological or breast cancers [79], and surgeries performed in lower tumor stages (stages T1-T2, N0) [80]. Preliminary results from population-based modeling studies suggested that excess mortality and healthcare costs due to the decrease in cancer screening are likely substantial [70, 71, 75], however, the precise increase in cancer-specific mortality because of the disruption in cancer screening programs remained to be determined from longer-term real-world data.

**Diabetes Mellitus**

Measures to prevent the spread of COVID-19 have affected the lifestyle and healthcare of patients with diabetes mellitus. Both positive and negative changes in the disease control in patients with type 1 (T1DM) and type 2 diabetes mellitus (T2DM) have been reported. Glycemic control in patients with T1DM remained largely unaffected [81, 82] or even improved both during and after the lockdown [82–88]. Interestingly, T1DM patients who stayed at home as a result of lockdown observed significant reductions in average glucose levels, whereas no changes were seen in those who continued working [89]. Despite decreases in physical activity level and changes in dietary habits in T1DM patients [90, 91], improvements in glycemic control could be attributed to lockdown measures that allow for a more regular schedule and time to monitor glycemic readings, which in turn promotes better compliance to medications, healthier meals, and facilitate a faster response to hypo- and hyperglycemia [83, 84].

Contrary to observations in patients with T1DM, T2DM patients have more often reported worsened glycemic control during the pandemic [92–94]. Approximately 40% of adults with DM reported all their appointments were canceled or postponed, and for those who switched to telehealth appointments, almost half (45%) reported lower satisfaction compared to in-person visits [95]. Patients with T2DM experienced greater levels of stress [95], or changes in dietary habits, physical activity levels, self-management practices, and medication adherence during the pandemic [96–100], which may in turn manifest as increases in body weight or HbA1c levels [101]. A 0.4% increase in HbA1c values 30 days after the outbreak was observed only among T2DM patients with good baseline glycemic control (HbA1c ≤ 7.0%) but not those with HbA1c ≥ 9.0% [101–103]. Admissions for severe hyper- and hypoglycemia also had significantly higher plasma glucose and HbA1c levels than during the control periods [104]. While the short-term impact of the COVID-19 pandemic in DM patients is manifested predominantly as poorer glycemic control, it remains uncertain if this temporary effect may predispose patients to greater risks of future macro- and micro-vascular complications.

**Chronic Kidney Diseases**

The global reduction in urological interventions in the COVID-19 era including specialty consultations, urological interventions, and transplantation substantially compromised the care for patients with chronic kidney diseases (CKD) [105–107]. The average number of consultations, medicine adjustments, and laboratory tests saw more than 60% reduction [105, 108] and that delay in services can exceed 8 weeks [106].

Medical and logistical challenges have led to postponed or suspended kidney transplantation in patients receiving dialysis [107]. Weekly hemodialysis sessions and kidney transplants were reduced by 10.3% and 57.2% respectively in the transplant center during the early phase of the pandemic [108]. Transplant centers in the United Kingdom renal transplant registry reported a 65% decrease in kidney-alone transplants in the COVID-19 era, due to a fear of donor-recipient transmission, and limited bed availability for organ donation and transplantation [109]. The closure of transplant center negatively impacted the quality of HLA-matching among recipients [109]. Patients waitlisted for transplantation were more likely to require hospitalization and had a higher risk of mortality than transplant recipients who subsequently acquired COVID-19 [110], suggesting that the delay in transplantation may not outweigh the risks of COVID-19 infection in immunosuppressed recipients. Notably, donor
kidneys were more likely to be allocated to recipients of white ethnicity during COVID-19 in the United Kingdom [109], raising the question of whether changes in organ allocation may place certain patients for worse prognosis in the future. Transplant candidates and their caregivers reported feelings of medical vulnerability, hopelessness, and devastation [107], further aggravating their physical stress from declining health and increased susceptibility to COVID-19.

### Chronic Respiratory Diseases

A UK-wide survey of 9,515 chronic respiratory patients showed that 45% of patients reported disruptions to care including cancellations of appointments, investigations, pulmonary rehabilitation, treatment, and monitoring [111]. Similarly, medical consultations and chronic obstructive pulmonary disease (COPD) complementary tests were cancelled in 90% of patients and replaced with medical telephone visits during the COVID-19 lockdown [112]. Admissions for acute exacerbation of COPD and asthma during the COVID-19 pandemic in Hong Kong decreased by 44.0 and 53.2%, respectively, possibly related to the universal masking and social distancing policies that prevented respiratory tract infections [113–115]. Worsening of respiratory symptoms have also been reported in patients with COPD confined at home [116]. Consistent decreases in rates of hospitalizations have been reported in asthma patients in Japan [117]. Asthma patients who showed poorer asthma control during the lockdown in the United States were more likely to be a minority individual (Black and Hispanic) and have a lower household income [118]. Despite so, up to 81% of patients perceived better feelings regarding general health during the lockdown and showed better compliance with lockdown policies [112] or with medication adherence [119]. Contrarily, high prevalence (up to 58%) of depression, insomnia, stress, and post-traumatic stress risk was observed in patients with COPD and asthma during the lockdown [120], raising potential concern for psychosocial consequences of COVID-19 prevention strategies.

Patient care was also affected by the diminished availability of in-person pulmonary rehabilitation programs, and are replaced by online self-management courses [121]. Implementation of home-based interventions may be hampered by a lack of digital access in more than half of the patients with chronic respiratory diseases [122]. In addition, center-based exercise testing is performed in-home or remotely. However, in-home tests may not reveal the full extent of desaturation and have limited usefulness for exercise prescription, bringing into question the effectiveness of these home-based interventions.

### Musculoskeletal Disorders

The diagnosis, assessment, and treatment of patients with osteoporosis have been postponed in many countries. Osteoporosis outpatient clinics and Fracture Liaison Services have been scaled back or halted [123]. Fracture probabilities calculated using the Fracture Risk Assessment Tools (FRAX®) have replaced the gold standard dual-energy X-ray absorptiometry imaging for diagnosing osteoporosis [124, 125], yet retrospective analysis using Google Analytics on daily global usage of FRAX showed an average reduction of 58% between March and April 2020 [123]. Regimens that can be given as outpatient such as oral bisphosphonates have been recommended to replace intravenous drugs [124, 125] but this may raise the risk of further fracture especially for drugs (i.e., denosumab) where discontinuation could be undesirable.

Reports on admissions for low-energy fractures among older adults during the pandemic were mixed, with some reported no changes [126–128] or an increase in the proportion of fractures occurring at home [129]. A single-center study in China in patients with hip fractures found an increase in injury to hospitalization time, surgery wait time, and time of discharge after surgery compared to the previous year [127]. A study in the United Kingdom alternately found a decreased length of stay (average 13 days in 2016–19 vs. 5 days in 2020) in patients with hip fractures, with a greater switch to more conservative treatments [126]. Comparing the outcomes of delayed surgery and nonoperative therapy for patients with hip fractures in the post-COVID-19 era, patients who received surgery had improved hip function and a lower proportion of complications [130], suggesting that surgery is still the preferred treatment modality even if delayed.

Cancellation of elective surgeries has resulted in significant increases in waiting time for total hip arthroplasty for patients with osteoarthritis. Approximately 30,000 primary hip arthroplasty was estimated to be cancelled every week in the United States while COVID-19 restrictions remain in place [131]. Patients with hip or knee osteoarthritis experienced both psychological and physical toll such as increased pain and loss of joint function due to postponed arthroplasty [132]. Pain rated on the visual analog scale increased from 6.0 ± 1.8 before the lockdown, to 6.5 ± 1.8 and 6.6 ± 2.2 during and after the lockdown, respectively [132], with up to 90% of patients expressing willingness to undergo surgery despite the ongoing pandemic [133].

### Mental Health Disorders

Individuals with pre-existing psychological conditions may be more susceptible to adverse psychosocial outcomes (e.g., anxiety, depression, insomnia, and irritability), lockdown measures due to COVID-19 pose additional barriers for accessing treatment and regular follow-up visits [134], raising the risks for relapses or worsening of pre-existing mental health conditions. The number of psychiatric emergency consultations at psychiatric emergency rooms almost halved (58%) during the lockdown in Italy [135]. Pilot cross-sectional studies in China [136], Italy [137] and Australia [138] have consistently observed deterioration in symptoms of depression, anxiety, stress, psychotic symptoms, and insomnia among people with psychiatric or mood disorders. An increase in obsession and compulsion severity was reported in patients with obsessive compulsive disorders, with those having contamination symptoms or in remission more likely to report worsening of symptoms [139]. Longitudinal analysis of people with existing mental disorders in the Dutch psychiatry cohorts observed a positive and dose-dependent relationship between the number and chronicity of mental disorders, and impact on their mental health, fear, and coping abilities from the pandemic [140].
In a population-representative sample of adults from the United States and Canada, those with existing anxiety or mood-related disorders exhibited higher COVID-related stress, traumatic stress symptoms, and socioeconomic consequence, and a greater tendency to self-isolate [141]. Older adults with major depressive disorders experienced decreased quality of life and anticipated their mental health to deteriorate with continued physical distancing [142]. Maintaining continuous monitoring of patients in contact with mental health services will remain essential for providing high-quality care in both psychopathological and medical aspects. An in-depth understanding of mental health impact in both individuals with and without mental conditions will be required to appropriately inform needs for mental health services post-pandemic.

Dementia

Dementia care including memory clinics, outpatient clinics, and daycare centers has been suspended as a result of lockdowns [143]. Forced suspension of social groups and therapies contributed to feelings of isolation, anxiety and depression, and general disruption to daily routines of patients with dementia [144]. Declines in cognitive, psychological, and neuropsychiatric symptoms, quality of life, worsening or emergence of aggression and depression-related behavioral disturbances, as well as functional independence have been observed in patients with dementia [145–149]. The severity of neuropsychiatric symptoms positively related to the duration of home confinement in patients with Alzheimer’s disease [150], potentially accelerating the rate of disease progression and institutionalization post-pandemic.

Lack of understanding for safeguard measures in patients with dementia, and the inability to maintain social isolation exposes them to higher chances of infection. People with dementia have limited access to accurate information about COVID-19, and without comprehending the reason for social distancing or abrupt changes in their normal routine, it may cause further frustration, anxiety, and depression as regular routine provides comfort and predictability [143, 144]. Caregivers reported higher levels of stress and exhaustion during the pandemic [147]; individuals with dementia may also experience second-hand distress from caregivers [144], creating a vicious cycle in patients and caregivers during the pandemic.

Banning visitors to long-term care facilities and hospices resulting in loss of face-to-face contact with family members may accelerate the progression of dementia symptoms. The lack of support from relatives, and inability to relate their symptoms may present atypically as falls or delirium [151, 152]. Those who rely on family relatives for feeding may be deprived of nutrition and develop symptoms of appetite disorders [153], evident from a greater proportion of patients with advanced dementia admitted for poor oral feeding during the COVID-19 era [154]. Symptoms of depression and suicidal thoughts intensified in residents after ending group activities, in addition to more complaints of weakness and muscle atrophy [151]. Delays in seeking medical assistance may also increase the risk of poor clinical outcomes in conditions common in the aged population including myocardial infarction and stroke. The need for extensive and all-rounded dementia care is vital post-COVID-19, to ensure the community of dementia patients receive proper care and reduce the disease progression speed.

DISCUSSION

This review provided a preliminary view of the early indirect impact of the COVID-19 pandemic across a spectrum of NCDs patients who have not been infected by COVID-19. Disruption in healthcare services, hampered by the fear of seeking medical attention, in addition to social distancing policies and lockdowns of different extents have consistently led to undesirable impacts on both the physical and psychological health of NCD patients. The COVID-19 pandemic provided an opportunity to identify which patient populations and services came to be regarded as lower priorities, and how redistribution of resources towards more essential services is needed to reduce morbidity and mortality. Understanding the extent to which patient populations and services are affected, can in turn inform resource allocation in response to the burden of the problem. Development of a concrete framework with detailed care plans adjusted to the needs of specific populations will be crucial for reorganizing care to include NCDs in national response and preparedness plans and improve the adaptability of the healthcare system for similar future events [3].

Assessing the impact on those with NCDs could inform modification of care processes so standards of care could be maintained while the risk for nosocomial infection is minimized. The pandemic has forced various governments to make policy decisions to determine what activities are truly essential, but their implications (e.g., limiting activity or access to preventive service) on NCDs management may not be fully understood. Multiple intersecting vulnerabilities including socio-economic status, ethnicity, language, gender, and immigration status may prevent certain individuals from accessing COVID-19 information and healthcare [155]. Identification of such social determinants of health will further shed light on the health disparities that are magnified by the pandemic. Governments must also consider if certain policies may disproportionately affect vulnerable populations and find the balance in terms of the overall impact on mitigating the pandemic against the preservation of equity.

Many public healthcare systems are structured on the historically necessary model of in-person patient-clinician interactions. Amid COVID-19, patients face the difficult choice between risking iatrogenic exposure and postponing needed care. Telemedicine emerged as an alternative for overcoming some of the barriers to accessing care during the pandemic [156, 157]. A permanent transition to increased reliance on telemedicine is likely the way forward for providing accessible, cost-effective, and high-quality healthcare for people with NCDs. This mandates a framework to authorize, integrate and reimburse telemedicine visits as an equivalent of in-person care.
Finally, in response to the WHO’s call to address the historic underinvestment in NCDs [158], policymakers must re-evaluate efforts for NCD prevention, early diagnosis, and screening as they will likely increase the burden of any future pandemic. The true scale of at-risk groups is likely underestimated due to the underdiagnosis of many chronic conditions. The demand for healthcare services will likely increase in the post-COVID-19 era due to the forgone healthcare and increased burden of chronic diseases related to mitigation interventions. Improving the resilience and sustainability of healthcare systems will therefore be of paramount importance, not only at times of the pandemic but during similar acute shocks in the future.

The strength of this review includes the broad overview of the early indirect impact of the COVID-19 across a spectrum of patients with major NCDs. Although prior work has extensively described excess mortality in the COVID-19 pandemic [1, 2, 159], any changes in acute disease control maybe equally important as they serve as important predictors of premature deaths and healthcare costs in the future. Despite international differences exist in the severity of COVID-19 caseloads and mitigation policies, the consistent disruption to care of NCD patients observed across countries highlighted the importance of a global plan to resume care.

There were also several limitations to this review. Most available evidence included in this review reported service disruptions that occurred within early 2020 and were mostly restricted to reports from developed countries. Generalizability to low- and middle-income countries (LMIC) with different healthcare settings, and where the outbreak has lagged that of developed countries may be limited. Future work that focuses exclusively on LMIC will be needed. The patterns of patient care and outcomes will vary along with the different phases of the pandemic as lockdown measures are lifted, this provides an opportunity for a future update to this review, and to determine what are the changes in long-term outcomes, disease severity, and healthcare costs in NCD patients if any. Finally, as we set out to ask a broad research question on potential patient outcomes consequential to disruption of healthcare services related to COVID-19, we reckon a narrative review would be best suited for this purpose. However, as with any narrative reviews, risks of bias of published studies were not formally assessed, and results were limited to a qualitative synthesis of available evidence. We therefore cannot exclude the possibility of potential biases in reporting of results, and some studies may have been missed.

The unprecedented global reduction in healthcare utilization makes a compelling case for prioritizing efforts that address the unmet needs of those with NCDs. This review summarized some of the immediate impact of the pandemic in patients with NCD, but the long-term outcomes because of service disruption and social distancing policies remained to be determined. There is increasing concern that a pandemic will result in a significant surge of people battling lasting illnesses and disabilities precipitated by COVID-19, further aggravating the existing burden of NCD on the healthcare system. Monitoring of the long-term impacts of this missed care with focus on patient-centered outcomes will be crucial; in addition to public campaigns urging people to seek medical care and better preparedness for reducing collateral damage in future waves of the pandemic.

**AUTHOR CONTRIBUTIONS**

IM, EW, EY, and CL were responsible for the conception and design of the article. IM, EW, TW, and WL drafted the manuscript. All authors revised the manuscript critically, have read the manuscript, and approved the version to be published.

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**CONFLICT OF INTEREST**

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The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

**SUPPLEMENTARY MATERIAL**

The Supplementary Material for this article can be found online at: https://www.ssph-journal.org/articles/10.3389/phrs.2022.1604121/full#supplementary-material
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