Review Research

COVID-19 And Cardiovascular Diseases: A Scoping Review

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Abstract

Coronavirus disease is an emergency condition worldwide that can affect various organs. This scoping review intended to categorize the current evidence of the relationship of the COVID-19 pandemic and the cardiovascular system. We conducted a literature search using the PubMed (Medline), Embase, Scopus, and ProQuest databases and Google Scholar search engine. We recruited 28 articles related to the aim of the study. According to the results, COVID-19 is associated with an increase in cardiovascular system disorders due to the role of coronavirus in increasing the risk of atherosclerosis, heart attack, arrhythmia, thromboembolism, myocarditis, and heart failure. On the other hand, increased anxiety and stress cardiomyopathy, cardiovascular complications of drugs used in the treatment of COVID-19, decreased rate of hospitalized patients with cardiovascular diseases, psychological distress and lifestyle changes during the COVID-19 pandemic quarantine, increase the rate of cardiovascular disorders.

Keywords: COVID-19, Cardiovascular system, Cardiovascular diseases, Scoping review

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Introduction

In late December 2019, a novel coronavirus reported in Wuhan, China (Xu et al., 2020) spread throughout the world and created a pandemic crisis. On January 30, 2020, the World Health Organization (WHO) declared COVID-19 as a public health emergency, and on February 12, 2020, the disease caused by the novel coronavirus was called coronavirus disease 2019 (COVID-19) (Zu et al., 2020). COVID-19 may be initially asymptomatic or associated with symptoms such as colds, bronchitis, and pneumonia (Mokhtari et al., 2020) However, the vast majority of the people with COVID-19 have reported a wide variety of symptoms at different intensity levels such as cough, fever, fatigue, shortness of breath, sore throat, runny nose, body aches, headache, diarrhea, short and hard breaths, and a loss of smell and taste (Pullen et al., 2020). It could gradually influence various organs such as the liver, kidney, gastrointestinal tract, hematopoietic and nervous systems over time. Furthermore, based on the literature COVID-19 affects the cardiovascular system and accounts for increased mortality rate in people with cardiovascular diseases (Hessami et al., 2021). Cardiovascular diseases (CVDs) are the highest cause of death globally, with 17.9 million deaths each year. Of these deaths, 85% were due to heart attack and stroke, and one-third of these deaths occur prematurely in people under 70 years of age (WHO, 2020). There is a high prevalence of cardiovascular disease globally, with 271 million in 1990 to 523 million in 2019. WHO aims to reduce cardiovascular mortality and disability by 25 percent by 2025; given the outbreak of COVID-19, its adverse impacts on the cardiovascular system and, increased number of deaths, certain actions need to be taken to achieve this goal by 2025. There is still a need for evidence based strategies to prevent and manage the cardiovascular complications of COVID-19 (Duffy et al., 2021). A growing body of literature has highlighted the significant role and great responsibility of the nurses in preventative care and wellness during COVID-19 that should be considered for reaching optimal outcomes (Edmonds et al., 2020). Much work on the relationship of the COVID-19 pandemic and the cardiovascular system has been carried out. The studies indicated that the COVID19 pandemic has direct cardiac effects such as myocardial injury, myocarditis, heart failure, dysrhythmias, and thromboembolism. In addition had strong implications on cardiovascular disease also without the direct involvement of the Corona virus (Chang et al., 2021; Ruzzenenti et al., 2021) Therefore, this scoping review intended to categorize the current evidence of the relationship of the COVID-19 pandemic and the cardiovascular system to provide an overview of the current evidence to inform practice and policymaking.

Method

We conducted this scoping review using Arksey and OMalley's framework (Arksey & O'Malley, 2005) to identify the extent, range, and nature of the current research of the relationship of the COVID-19 pandemic and the cardiovascular system. Six steps framework for this scoping review includes: 1) Determining the research question, 2) Identifying related literature, 3) Selecting studies, 4) Charting the data, 5) Combining and summarizing findings, and 6) Stakeholder consultation (optional) (Arksey & O'Malley, 2005). The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA) extension diagram for scoping reviews was used to track the number of studies at each stage (McGowan et al., 2020). PRISMA-ScR was developed by Levac et al. based on the edition and deletion of some PRISMA items to provide necessary guidance for reporting scoping reviews (Tricco et al., 2018).

Since in scoping review, the goal is to provide an overview of the available research evidence without evaluating information, qualitative evaluations of studies are often omitted (Arksey & O'Malley, 2005). Consequently, according to the

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purpose of the present study, a critical appraisal of studies has not been carried out.

The research question in the present study:

What is the relationship of the COVID-19 pandemic and the cardiovascular system?

Search strategy

To conduct a comprehensive review it is suggested that multiple data sources searched simultaneously (Bramer et al., 2017). Therefore, we conducted a comprehensive search using an electronic database including Medline/PubMed, Embase, Scopus, ProQuest, and Google Scholar. The search keywords were: COVID-19, cardiovascular complications (such as myocardial infarction (MI), atherosclerosis, arrhythmia, embolism, myocarditis, heart failure), in combinations with drugs, or psychological effect, quarantine in English from 2019 to 2021. The search strategy is shown in Table 1.

Inclusion and Exclusion Criteria

The studies in English (from 2019 to 2021), on the relationship between cardiovascular disease and COVID-19, were selected. In this study, all the individuals over the age of 18 related to the subject were included. There was no limitation to the type of study design. The literature on previous epidemics, without available full text, and non-English literature were excluded.

Identification and selection of study

Two researchers independently searched the literature and then selected the studies. The research results were then compared, and duplicate studies were removed. Disagreements between the two researchers were resolved by discussion, and, if necessary, a consultation with the third, senior researcher was held.

To determine eligibility, two independent researchers first reviewed the titles and abstracts of articles. They then categorized the studies as relevant or irrelevant. If they were relevant, full texts articles should be evaluated further according to inclusion and exclusion criteria. The search strategies for each database were recorded and stored. Moreover, search results were stored in the information resource management tool (EndNote-X8). A total of 1583 original articles and gray literature (including dissertations from the ProQuest site) were identified. After reviewing the articles, 1297 items were deleted due to a lack of inclusion criteria or being a duplicate. Only 286 articles were relevant to the titles and abstracts of articles. At this stage, 229 articles were excluded based on exclusion criteria, and then 57 full-text articles were screened for final eligibility that 29 articles were excluded because they met exclusion criteria: 23 were not relevant for the objectives of this study, 4 articles were not available in full text, and 2 articles were not in English. Lastly, 28 eligible studies remained in the present study. It is also worthy to note that if one of the articles discussed more than one result, we listed it across the different themes (Figure 1).

Recording and classifying key findings

We designed a data extraction form, and two independent investigators reviewed 28 selected studies and entered the data according to the study title, authors, date of publication, country, type of study, sample size, and key findings.

Results

The methodological characteristics and the key findings are summarized in Table 2. The type of the literature included 13 reviews (Aggarwal et al., 2020; Aygün et al., 2020; Bader et al., 2021; S. Bhaskar et al., 2020; Clerkin et al., 2020; Dennison Himmelfarb & Baptiste, 2020; Driggin et al., 2020; Liu et al., 2020; Mattioli et al, 2020; Rehman & Ahmad, 2020; Shchendrygina et al., 2021; Soumya et al., 2021; Li et al., 2020), nine observational studies (De Filippo et al., 2020; De Rosa et al., 2020; Klok et al., 2020; Severino et al., 2020; Shi et al., 2020; Sidor & Rzymski, 2020; Tobaiqy et al., 2021; D. Wang et al., 2020a, 2020b), four letters to the editor (Desai et al., 2020; Giustino et al., 2020; Mattioli et al., 2020; Ruan et al., 2020), one correspondence(stergaard et al., 2021), and one commentary (Mattioli et al., 2020). A variety of sampling methods were used in observational studies, records (De Filippo et al., 2020; De Rosa et al., 2020; Klok et al., 2020; Severino et al., 2020; Shi et al., 2020; Tobaiqy et

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al., 2021; D. Wang et al., 2020) and online questionnaires (Sidor & Rzymski, 2020; Wang et al., 2020). The minimum and maximum sample sizes reported in observational studies were 138 and 544571 respectively. The studies were conducted in India, Canada, United States, China, Columbia, Poland, Emirates, Russia, Australia, Netherlands, Turkey, Demark, several European Union countries, and Italy. Most of the literature-based sources were conducted in Italy.

These studies were reviewed to answer the question "What is the relationship of the COVID-19 pandemic and the cardiovascular system?" The findings are presented in 5 categories as follows:

1. Cardiovascular complications in COVID-19 infection

Based on clinical manifestations of cardiovascular involvement, it has been shown that the COVID-19 has direct effects on the cardiovascular system (Soumya et al., 2021). Indeed, in addition to the fact that coronavirus disease is more severe in people with cardiovascular disease, the virus can also cause cardiovascular complications (Liu et al., 2020).

Various mechanisms may be involved in COVID-19-induced cardiovascular damage (complications): ischemia, systemic inflammation, pathogen-induced damage, cytokine storm, hypoxia, and imbalance between increased metabolic demands and decreased cardiac reserve. (Dennison Himmelfarb & Baptiste, 2020). All of which are reviewed in the following sections.

1.1. Myocardial infarction and atherosclerosis

An increase in cardiac injury biomarkers and enhanced incidence of MI has been identified in patients with COVID-19. A study of 138 hospitalized patients with confirmed COVID-19 in Wuhan, China, reported an increase in heart injury as evidenced by elevated levels of troponin, abnormalities in ECG, or echocardiography in 7.2% of patients and in 22% of patients who received ICU care (D. Wang et al., 2020). Another prospective study in Wuhan on 416 patients with COVID-19 demonstrated that 19.7% of hospitalized COVID-19 patients had myocardial damage and increased cardiac troponin (Shi et al., 2020).

1.2. Arrhythmia

Cardiac arrhythmias are also regarded as the main complications of COVID-19 infection and may result from metabolic disorders, hypoxia, or inflammatory responses in these patients (Driggin et al., 2020). A prospective study of 134 patients with COVID-19 in China indicated that 16.7% of the patients developed cardiac arrhythmias during hospitalization (D. Wang et al., 2020). Therefore, ECG parameters should be checked regularly in COVID-19 patients (Sonu Bhaskar et al., 2020).

1.3. Thromboembolism

COVID-19 can lead to arterial and venous thrombosis in patients may be due to the inflammatory state, hypoxia, immobility, and intravascular coagulation. A study of 184 patients with COVID-19 in the Netherlands showed that more than 31% of patients had vascular embolism (Klok et al., 2020).

1.4. Myocarditis

Viral infection can cause acute myocarditis and result in damage to the heart muscle. In this regard, the virus can directly enter endothelial cells and myocardial cells and cause myocardium damage (Shchendrygina et al., 2021). Myocarditis is a serious complication of coronavirus, and a study of 150 patients with COVID-19 showed that 7% of 68 deaths were associated with myocarditis, and in 33% of cases myocarditis likely has played a contributing role to worsening outcomes in COVID-19 patients (Ruan et al., 2020).

1.5. Heart failure

Heart failure is a crucial disorder in patients with COVID-19. Heart failure accompanied by COVID-19 is a great challenge that can complicate the manifestation, management, and prognosis of the disease. In previous studies, heart failure was found in almost a quarter of hospitalized COVID-19 patients without a history of heart problems and resulted in ICU admission of nearly one-third of the patients. Studies suggest

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that heart failure in COVID-19 patients may be due to a direct effect of the virus on the heart muscle or may be due to damage from systemic inflammation (Bader et al., 2021).

2. Prevention and treatment of COVID-19 and its cardiovascular complications

So far no definitive treatment has been identified for COVID-19. Since the emergence of COVID-19, several drugs have been investigated as possible treatments that in some cases adverse effects have been reported for them, with the most common complications that were related to the hematopoietic system and cardiovascular system. Moreover, polypharmacy used in the treatment of COVID-19 infection could cause dangerous interactions in the heart (Aygün et al., 2020). Use of drugs such as hydroxychloroquine, chloroquine, azithromycin, Remedsivir, interferon, lopinavir, and ritonavir to treat COVID-19 have caused cardiovascular side effects such as QT prolongation, cardiomyopathy, and ischemic heart disease in the patients, and thus patients should be appropriately monitored when receiving these medicines (Aggarwal et al., 2020). Presently, the most effective way to control the COVID-19 pandemic and prevent further mortality is vaccination but cardiovascular complications such as thromboembolism and thrombocytopenia have rarely been observed after the Oxford-AstraZeneca COVID-19 vaccination, and thus, it is necessary to increase monitoring of the vaccine recipients (Fazel et al., 2005; Tobaiqy et al., 2021).

3. COVID-19, anxiety, stress and cardiovascular diseases

In addition to the physical health effects of COVID-19 infection, the patients report higher rates of psychological disorders including anxiety and depression. A study of 1210 people from 194 cities in China indicated that 28.8% of COVID-19 patients had moderate to severe levels of anxiety and 8.1% had moderate to severe stress levels (C. Wang et al., 2020). The psychological effects induced by COVID-19 infection may be due to quarantine and isolation, uncertainty about health status, the lack of adequate knowledge about COVID-19, fear of death, fear of getting sick of family members, financial instability, and job loss (Bell et al., 2015; Li et al., 2020; C. Wang et al., 2020). Evidence suggests that anxiety can increase the risk of development, progression, and death from cardiovascular disease in people with smoke cigarettes, alcohol consumption, low level of physical activity, and poor nutrition (Mattioli & Ballerini Puviani, 2020). An analysis of 46 studies has also shown that anxiety is associated with increased mortality and poor cardiac outcomes such as coronary heart disease, heart attack, and heart failure (Emdin et al., 2016). In addition, psychological, social, and economic stress associated with COVID-19 can cause stress cardiomyopathy. Stress cardiomyopathy, also known as Takotsubo syndrome, is more common among women and usually is caused by increased anxiety or physical stress, resulting in left ventricular dysfunction. It is also associated with respiratory infections or failure (Desai et al., 2020; Giustino et al., 2020). A prospective study demonstrated a significant increase in the incidence of stress cardiomyopathy from 1-2% to 7-8% in the COVID-19 pandemic accompanied by an increase in the hospital length of stay from 4-5 days to an average of 8 days (Desai et al., 2020).

4. COVID-19 and reduction of hospital admission of patients with cardiovascular diseases

During the COVID-19 pandemic, health care systems are exposed to a large number of acutely ill patients which in turn can delay rapid triage of non-COVID-19 patients including patients with cardiac disease. In addition, a high rate of referral hospitals for COVID-19 patients may adversely influence the provision of optimal health care for patients with acute cardiovascular disease and worsen their health condition due to delayed receiving medical care. Although changes in the pattern of hospital admissions due to COVID-19 may be beneficial for controlling COVID-19 infection, it has no significant effect on the proper

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management of cardiovascular disease patients with COVID-19 (De Filippo et al., 2020; Severino et al., 2020).

A retrospective study in 15 Italian hospitals found that from February 20 to March 31, 2020, the mean admission rate for patients with acute coronary syndrome was 13.3 per day, while this rate was 18 admissions per day during the previous year. This decreased mortality rate suggests that some deaths from acute coronary syndrome have occurred due to a decrease in the rate of referral hospitals and lack of optimal follow-up for the patients during the COVID-19 pandemic (De Filippo et al., 2020). In another study in Italy, a 48.4% decrease in admissions for acute MI was observed throughout one week during the COVID-19 outbreak compared to the equivalent week in 2019. Several factors are likely involved in this reduced rate of referral hospitals including fear of contagion at the hospital, diffusion of the news that COVID-19 extensively spreads through hospitalized patients and healthcare workers due to shortage or lack of personal protective equipment in the respect of COVID-19. The health care system along with media and patients should focus on the COVID-19 pandemic to properly manage the disease (De Rosa et al., 2020).

5. COVID-19, quarantine and cardiovascular disease

Quarantine and isolation are some measures that can prevent or reduce the transmission of infectious diseases and have been used in various infectious diseases such as Ebola outbreaks. In China, quarantine decreased the spread of the COVID-19 by nearly 60%. Nevertheless, quarantine is often an unpleasant and distressing experience associated with loss of freedom and uncertainty about the status of the disease. Thus, the potential obligatory advantages of quarantine should be considered against possible prolonged negative impacts on health, i.e. cardiovascular disease (Mattioli et al., 2020). Complications of quarantine include psychological distress such as stress and anxiety, enhanced frustration and irritability, insufficient supplies, incomplete information, and financial losses. Stress can activate the adrenergic system, increase inflammatory responses, cause endothelial dysfunction and thus promote atherosclerotic formation. Activation of the sympathetic system also affects the cardiovascular system by increasing heart rate, blood pressure, and peripheral vascular resistance, and arrhythmias (Mattioli et al., 2020a, 2020b). Other consequences of quarantine include changes in lifestyle and nutrition. In addition, quarantine has been shown to increase alcohol consumption and smoking, by 14.6% and 45%, respectively, in subjects. In turn, an increase in smoking and alcohol consumption during quarantine could increase susceptibility to the COVID-19 and cardiovascular diseases (Mattioli et al., 2020; Sidor & Rzymski, 2020).

The quarantine can also lead to poor nutrition likely due to decreased access to foods and products, caused by limited store opening hours. During quarantine, people often use packaged foods instead of fresh foods due to fear of facing food future shortages, which in turn could decrease the consumption of antioxidants and subsequent protective effects on arteries, resulting in an increased risk of cardiovascular diseases (Mattioli et al., 2020a, 2020b). On the other hand, some people respond to stress induced by quarantine by eating more fatty and sugary foods, which in turn can increase the risk of weight gain. In this regard, a cross-sectional study of 1,097 people showed that during quarantine, about 52% of people reported eating more food and snacks, and approximately 30% of people gained weight likely due to eating fewer vegetables, fruits, legumes and increased consumption of meat, dairy, and fast foods. Obesity and weight gain could cause renal dysfunction and increase the risk for hypertension, diabetes, and vascular disorders, which in turn can enhance vulnerability to cardiovascular diseases (Sidor & Rzymski, 2020). Physical activity levels are also decreased in subjects during quarantine. During quarantine,

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governments usually restrict unnecessary outdoor activities such as walking and swimming. In turn, this causes people to spend more time at home and in sedentary behaviors including watching television and playing video games. Low levels of physical activity can lead to an imbalance between free radicals and antioxidants, leading to vessel inflammation and endothelial cell death, leading to an increased risk of cardiovascular diseases (Mattioli et al., 2020; Rehman & Ahmad, 2020).

Discussion

This review gathered evidence on the relationship of the COVID-19 pandemic and the cardiovascular system. The findings from this scoping review provided further evidence and confirmed that the COVID-19 significantly increases the prevalence of cardiovascular implications in various forms and can lead to a worsening of the cardiac condition. The findings demonstrated that the COVID-19 pandemic lead to various cardiovascular complications, including myocardial infarction and atherosclerosis, arrhythmia, thromboembolism, myocarditis, heart failure. We identified several risk factors including measures of prevention and treatment of COVID-19, reduction of hospital admission of patients with cardiovascular diseases and various psychological problems.

The COVID-19 was associated with cardiovascular complications including MI, myocarditis, arrhythmias, thromboembolism, and acute coronary syndrome (Driggin et al., 2020). In addition, a study on 75 patients with COVID-19 admitted to the ICU indicated that MI was the cause of death in two-fifths of the patients (Peiris et al., 2003) which are in line with the first category of the results of the present study.

In the second category of present study results, it was pointed out that lack of definitive treatment of COVID-19 and the use of various drugs in these patients has led to cardiovascular complications. In this regard, Roden et al. (2020) indicated that drugs used for patients with COVID-19 can increase the risk for cardiac complications such as increased QT fraction, arrhythmias, and tachycardia. Also, Chen et al. (2021) showed that the drugs such as dexamethasone, which is prescribed for many of these patients, can lead to cardiovascular complications such as hypertension, cardiac hypertrophy and cardiac fibrosis.

As stated in the third category of the results, COVID-19 was also associated with an increased prevalence of mental illnesses, such that of the 500 people included in a study in Hong Kong, 25.4% experienced mental health disorders and 14% experienced anxiety during the COVID-19 outbreak (Choi et al., 2020). Anxiety can be a risk factor for cardiovascular disease, and levels of anxiety have been shown to increase the risk of cardiac complications such as coronary heart disease, congestive heart failure, arrhythmia, and sudden death. Also, some of the preventive measures related to COVID-19 include quarantines, and social distancing contribute to stress which led to increase in heartbeat, high blood pressure, weight gain, poor exercise and alcohol use that are common risk factors for cardiovascular diseases (Priya, 2020).

Bravo et al. (2020) in Spain showed that COVID-19 infection was associated with a 56.5% decrease in emergency hospital visits and a 46.9% decrease in hospitalized patients with heart failure which in turn could result in worsening complications in patients with cardiovascular disorders. Also, throughout the medical emergency, many hospitals were forced to adapt their capacity to meet the changing demands in order to admit more COVID-19 cases that caused several difficulties in hospital routine activities, including cardiology services. However, non-urgent procedures were suspended; at least 95% of the elective coronarographies in patients with a positive stress test were reduced or completely stopped as a consequence; a higher mortality rate has been reported. Outpatient visits were interrupted for a long time, especially at the beginning of the pandemic and follow up of many cardiologic patients was discontinued (Ruzzenenti et al., 2021). It is worthy to highlight that all these

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studies are in line with the fourth category of our results.

As stated in the fifth category of this study to contain the diffusion of the COVID-19 virus, governments have enforced restrictions on outdoor activities or even collective quarantine on the population. One important consequence of quarantine is a change in lifestyle such as reduced physical activity and unhealthy diet that carries some long term effects on cardiovascular disease, mainly related to unhealthy lifestyle and anxiety (Mattioli & Ballerini Puviani, 2020).

For more than four decades, nurses have had an important role in managing cardiovascular disease risk factors, and their healthcare programs and appropriate management have had favorable and cost-effective outcomes in developed and developing countries (Hayman et al., 2015). Managing cardiovascular disease risk factors needs counseling, education, motivation, support, and management of the person's health and clinical conditions. Since nurses are the largest group of healthcare professionals who play a critical role in health care system (Berra et al., 2006) therefore, they can play an effective role in managing and preventing cardiovascular problems. During the COVID-19 pandemic, the nurses have played a vital role in educating, preventing, screening, evaluating, gathering information, diagnosing, treating, and managing patients (Minissian et al., 2021). Patients regard nurses as trusted individuals for receiving information, thus, a critical role of nurses for control of the current pandemic should not be ignored (Sugg et al., 2021). Indeed, consideration of risk factors for cardiovascular disease during the COVID-19 pandemic is one of the priorities of policy-making and planning of the community health system and nurses are ideal health care professionals to increase public knowledge and support the prevention of cardiovascular disease during the pandemic of COVID-19 (Berra et al., 2006; Ganatra et al., 2020).

Strengths and Limitations

In relation to study reliability, the researchers used a comprehensive approach to searching the articles, extracting and analyzing the results. However, this review has some limitations. This review only included the English studies and excluded the studies published in other languages. Furthermore, according to Arksey and O'Malley's framework, a critical appraisal of studies has not been carried out. So, the results of the current study should be interpreted cautiously in light of this shortcoming.

Recommendations for Further Research

This study has thrown up many questions in need of further investigation on the long-term and delayed cardiovascular complications of COVID-19. We hope that this study will serve as a base for future studies on the management and prevention of cardiovascular complications following COVID-19. We also propose that further research should be undertaken in each mentioned category of cardiovascular complications to help policymakers and healthcare workers to make evidence-based decisions.

Conclusion

This scoping review demonstrated that the COVID-19 pandemic increases the incidence of cardiovascular disorders including atherosclerosis, myocardial infarction, arrhythmia, thromboembolism, myocarditis, heart failure and worsen cardiac outcomes in patients with cardiovascular diseases. On the other hand, high prevalence of anxiety and stress, cardiomyopathy, cardiovascular complications of drugs used in the treatment of COVID-19, decreased rate of hospitalized patients with cardiovascular disorders, quarantine, psychological distress, and lifestyle changes following quarantine can increase susceptibility to the cardiovascular problems. Accordingly, appropriate COVID-19 prevention and control require comprehensive policy-making and planning focusing on the proper management of risk factors for cardiovascular disorders. In this respect, the critical role of the nurses in health

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care, education, counseling, and their supportive relationship with patients can be a major component in improving outcomes.

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Table & Figure:

Table 1: Search Strategy

1. “COVID-19” AND “cardiovascular complications” OR “myocardial infarction” OR “atherosclerosis” OR “arrhythmia” OR “embolism” OR “myocarditis” OR “heart failure” OR “drugs” OR “psychological effect” OR “quarantine”

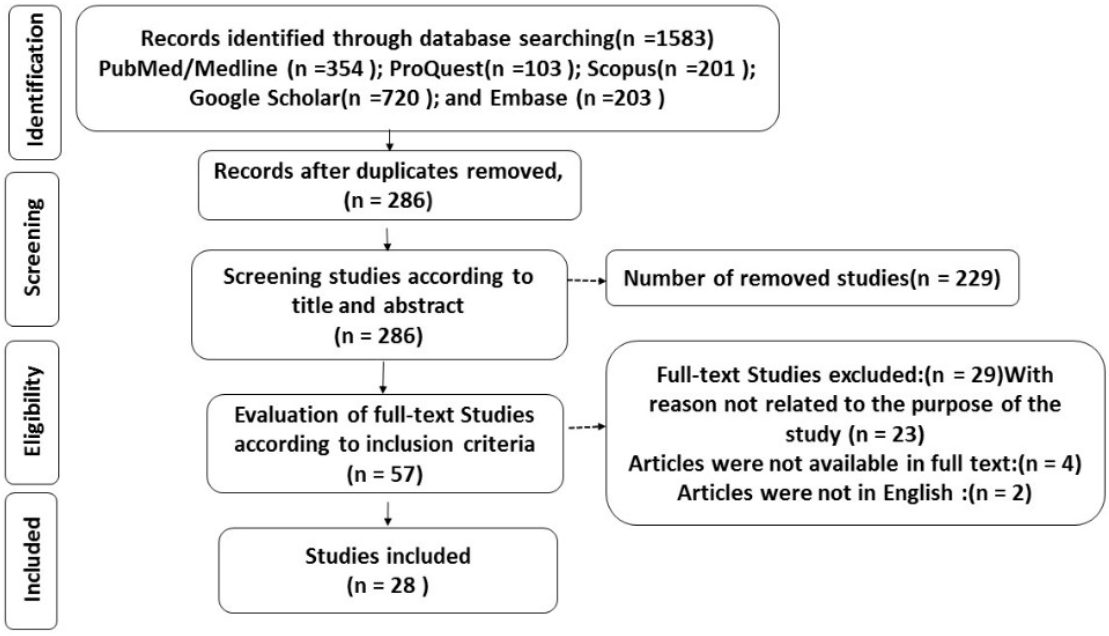

Figure. 1 PRISMA-ScR flow diagram for database search of studies

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Table 2: Characteristics of included studies

No.	Title	Author / Country	type of study	Sample	key findings
1	Impact of COVID-19 on the Cardiovascular System: A Review of Available Reports	Soumya et al (2020)/ India	Narrative review	-	Occurrence of cardiovascular complications: coagulation disorders, MI and vascular abnormalities, and drug side effects such as QT prolongation
2	The Science Underlying COVID-19 Implications for the Cardiovascular System	Liu et al (2020)/ Canada	Narrative review	-	Occurrence of myocarditis after COVID-19 infection, leading to heart failure, arrhythmias, and sudden death.
3	Coronavirus Disease (COVID-19) Implications for Cardiovascular and Socially At-risk Populations	Cheryl et al (2020)/ United States	Narrative review	-	Acute and chronic cardiovascular complications result from different mechanisms including ischemia, systemic inflammation, pathogen-mediated damage, cytokine storm, hypoxia, and imbalance between increased metabolic demand and decreased cardiac reserve
4	Clinical Characteristics of 138Hospitalized Patients With 2019 Novel Coronavirus–Infected Pneumonia in Wuhan, China	Wang et al (2020)/ China	Retrospective Study	138 COVID-19 patients	Prolonged prothrombin time, coagulation disorders, arrhythmias, and cardiac injury in a study of 183 COVID-19 patients
5	COVID-19 and Cardiovascular Disease	Kevin et al (2020)/ Columbia	Narrative review	-	Myocardial injury in more than 7% of patients with COVID-19
6	Association of Cardiac Injury With Mortality in Hospitalized Patients With COVID-19 in Wuhan, China	Shi et al (2020)/ China	Prospective study	416hospitalized patients with COVID-19	Myocardial injury in 19.7% of COVID-19 patients
7	Cardiovascular Considerations for Patients, Health Care Workers, and Health Systems During the COVID-19 Pandemic	Driggin et al (2020)/ United States	Narrative review	-	Deleterious effects of COVID-19 on the cardiovascular system with MI, myocarditis, acute coronary syndrome, arrhythmia, cardiomyopathy, venous thrombosis, and adverse drug reactions.
8	Dietary Choices and Habits during COVID-19 Lockdown: Experience from Poland	Sidor et al (2020)/ Poland	online survey	1097 people in quarantine	More snacking and consumption of food during quarantine, leading to weight gain.
9	COVID-19: quarantine, isolation, and lifestyle diseases	Rehman et al (2020)/ India	Review	-	Obesity complications including cardiovascular diseases, type 2 diabetes mellitus following quarantine accompanied by psychological effects, reduced physical activity, and dietary changes during the COVID-19 pandemic
10	Heart failure and COVID-19	Bader et al (2020)/ Emirates	Narrative review	-	Abnormal cardiac biomarker and increased incidence of heart failure
11	COVID-19 myocarditis and prospective heart failure burden	Shchedrygia et al (2021)/ Russia	Narrative review	-	COVID-19 is a vital threat to cardiovascular involvement

Table 2 : Continued

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No.	Title	Author / Country	Methods	Sample	key findings
12	Key Strategies for Clinical Management and Improvement of Healthcare Services for Cardiovascular Disease and Diabetes Patients in the Coronavirus (COVID19) Settings: Recommendations From the REPROGRAM Consortium	Bhaskar et al (2020)/ Australia	Narrative review	-	The incidence of life-threatening cardiac arrhythmias in patients who need more careful monitoring
13	Incidence of thrombotic complications in critically ill ICU patients with COVID-19	Klok et al (2020)/ Netherlands	Observational	184 patients admitted to the ICU	The incidence of pulmonary arterial and vein emboli in COVID-19 patients admitted to the ICU
14	Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China	Ruan et al (2020)/ China	Letter	-	Respiratory failure, myocardial injury, circulatory failure, and myocarditis were the cause of death in patients with COVID-19
15	Identifying side effects of commonly used drugs in the treatment of VOVID-19	Aygun et al (2020)/ Turkey	Review	-	The highest side effect rate due to drug use was included in the hematopoietic system and cardiovascular systems.
16	Cardiovascular Safety of Potential Drugs for the Treatment of Coronavirus Disease 2019	Aggarwal et al (2020)/ United States	Narrative review	-	Occurrence of cardiac complications such as conduction abnormalities, prolonged QT interval, cardiomyopathy, and ischemic heart disease following Treatment for COVID-19.
17	Analysis of Thrombotic Adverse Reactions of COVID-19 AstraZeneca Vaccine Reported to EudraVigilance Database	Tobaiqy et al (2021)/ several European Union countries	Retrospective cohort study	54571 reports	Incidence of thromboembolism among recipients of Astrazanka vaccine.
18	Immediate Psychological Responses and Associated Factors during the Initial Stage of the 2019 Coronavirus Disease (COVID-19) Epidemic among the General Population in China	Wang et al (2020)/ China	Survey	1210 respondents that participated an online survey.	COVID-19 outbreak and it's devastating psychological consequences such as depression and anxiety
19	Progression of Mental Health Services during the COVID-19 Outbreak in China	Li et al (2020)/ china	Review	guidelines and instructions for mental health services during the COVID-19 outbreak in China between 26th Jan and 20th Feb, 2020	The outbreak of the COVID-19 and it's tremendous psychological problems in different subpopulations
20	Thromboembolism and the Oxford–AstraZeneca COVID-19 vaccine: side effect or coincidence?	Østergaard et al (2021)/ Denmark	Correspondence	-	Incidence of 30 cases of thromboembolism among recipients of Astrazanka vaccine
21	Lifestyle at Time of COVID-19: How Could Quarantine Affect Cardiovascular Risk	Mattioli et al (2020)/ Italy	Narrative review	-	Increased number of cardiovascular events due to unhealthy lifestyle and anxiety

Table 2 : Continued

No.	Title	Author / Country	Methods	Sample	key findings

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22	Takotsubo Cardiomyopathy in COVID-19	Giustino et al (2020)/ United States	Letters	-	Incidence of stress cardiomyopathy or Takotsubo syndrome in patients
23	COVID-19 pandemic induced stress cardiomyopathy: A literature review	Desai et al (2020)/ India	Letter to Editor	-	The higher prevalence of Takotsubo syndrome following anxiety is caused in COVID-19 patients.
24	Reduction in heart failure hospitalization rate during coronavirus disease 19 pandemic outbreak	Severino et al (2020)/ Italy	Retrospective study	505Patients admitted with heart failure	Reduction in admissions and referral of patients with heart failure during the COVID-19 pandemic
25	Reduced Rate of Hospital Admissions for ACS during Covid-19 Outbreak in Northern Italy	Filippoet al (2020)/ Italy	Retrospective study	547Patients with acute coronary syndrome in 15 Italian hospitals	Decreased admission of diagnosed patients with acute coronary syndrome from 18 patients per day to 13.3 per day
26	Reduction of hospitalizations for myocardial infarction in Italy in the COVID-19 era	De Rosa et al (2020)/ Italy	Survey	319 Patients admitted to the CCU with acute myocardial infarction	Decrease in patients admitted with acute myocardial infarction and increased morbidity and mortality
27	Quarantine during COVID-19 outbreak: Changes in diet and physical activity increase the risk of cardiovascular disease	Mattioli et al (2020)/ Italy	commentary	-	Quarantine during the COVID-19 pandemic results in unhealthy dietary, decreased physical activity, and changes in lifestyle, leading to increased risk for cardiovascular diseases
28	COVID 19 outbreak: impact of the quarantine-induced stress on cardiovascular disease risk burden	Mattioli et al (2020)/ Italy	Editorial	-	Quarantine during the COVID-19 pandemic results in psychological stress, which in turn increases the risk for cardiovascular diseases

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