**ABSTRACT**

**Introduction:** The world is currently facing an all-out crisis over the coronavirus disease 2019 (COVID-19). This review study aimed to determine the applications of the assistive intelligent technologies of the Fourth Industrial Revolution (Industry 4.0) in occupational safety and health (OSH) and response to COVID-19.

**Material and Methods:** The given review was carried out from May to June 2020 and the search strategy was fulfilled in the databases of Google Scholar, PubMed, and Scopus. The keywords were collected from the Medical Subject Headings (MeSH) database and searched individually or in combination. Accordingly, the articles with the term “COVID-19” in their titles or abstracts and some other keywords such as “smart hospital, Industry 4.0, or intelligent technology” were selected and reviewed. Next, the titles, abstracts, and keywords of these studies were examined. To augment the sensitivity of the search, the keywords and the references of the selected articles were also surveyed. Then, the related studies were separated from the irrelevant ones and the duplicates were removed. Finally, the full texts of the selected articles were reviewed.

**Results:** In this respect, a total number of 175 studies, published in the databases of Google Scholar, PubMed, and Scopus in 2020 were retrieved. According to the inclusion and exclusion criteria and qualitative screening, 30 articles were included in this review. The assistive intelligent technologies such as artificial intelligence (AI), the internet of things (IoT), big data, virtual reality (VR), holography, cloud computing, autonomous robots (autorobots), three-dimensional (3D) scanning, 3D printing, and biosensors were established as useful ones to respond to COVID-19. In addition, AI and autorobots could be the most significant technologies of Industry 4.0 in the incoming articles.

**Conclusion:** These technologies can thus help governments to identify, track, monitor, and treat patients and increase resilience in society and workplace environments during the COVID-19 pandemic.

**Keywords:** Fourth Industrial Revolution, Covid-19, Epidemics, Assistive Technologies, Occupational Safety and Health, Intelligent Technologies

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**1. INTRODUCTION**

The coronavirus disease 2019 (COVID-19) pandemic has influenced all countries and has made a significantly unwelcome effect on health care systems. The rate of transmission and the global scale of infection with this virus are so wide that it is necessary to take basic measures in the areas of strategy, resource management, and infection control. Given the lack of any vaccines or proven antiviral treatments, actions in terms of prevention and protection through five major steps, including elimination, subscription, engineering control, administrative control, and personal protective equipment have been mainly introduced as available and practicable solutions. These strategies are being practiced in the form of good hygiene, social distancing, restrictions, quarantines, and large-scale screening across susceptible and high-risk populations (1). In such conditions, the use of smart technologies of the Fourth Industrial Revolution (Industry 4.0)
can help improve the performance of health care systems as well as occupational safety and health (OSH) for employees (2). The present study was a preliminary review to determine the applications of the assistive intelligent technologies of Industry 4.0 in identifying and controlling the COVID-19 pandemic in health care systems as one of the most hazardous work environments.

2. MATERIALS AND METHODS
The present systematic review was carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, from May to June 2020, wherein a comprehensive search strategy was fulfilled in the databases of Google Scholar, PubMed, and Scopus (Fig. 1). The keywords were selected based on the population, intervention, control, and outcomes (PICO) format, collected from the Medical Subject Headings (MeSH) database, and searched individually or in combination. The articles with the term "COVID-19" in their titles or abstracts along with each of the keywords, including "COVID-19, SARS, artificial intelligence, smart health care, smart hospital, intelligent hospital, inherent safety, health care, patient safety, patient care, hospital, smart, intelligence, clinical care, digital technology, infection control, infection prevention, smart disinfection, robotics, autonomous systems, smart health care, digital health care, intelligent technologies, assistive technologies, Industry 4.0, digital health care, internet of things, big data, virtual reality, holography, cloud computing, autonomous robots, 3D scanning, 3D printing, and biosensors" were selected and reviewed. Next, the titles, abstracts, and keywords of these articles were examined. To boost the sensitivity of the search, the keywords and the references of the selected articles were also surveyed. Then, the related studies were separated from the irrelevant ones and the duplicates were removed. Finally, the full texts of the relevant selected articles were reviewed and qualitative screening was done using the Quality Assessment Tool by Hawker et al. (3).

3. RESULTS AND DISCUSSION
At the first step of the search, a total number of 175 studies published in the databases of Google Scholar, PubMed, and Scopus in 2010 were retrieved. Then, according to the inclusion and exclusion criteria, screening and qualitative evaluation of the articles, and removal of duplicates, 155 articles were selected based on their titles, abstracts, and keywords. With reference to the inclusion and exclusion criteria, other 61 studies were excluded. Therefore, 94 articles remained and 64 of which were deleted during the full-text review and data extraction. At the end of the selection process, 30 studies remained. Of these, 22 studies were review articles, six studies were original articles, and there were one cohort study and one case study. The largest number of the articles belonged to India (n=16) together with China and Britain. The findings of this study showed that during Industry 4.0, technologies such as artificial intelligence (AI), the internet of things (IoT), big data, virtual reality (VR), holography, cloud computing, autonomous robots (autorobots), three-dimensional (3D) scanning, 3D printing, and biosensors could be predicted useful for identifying, tracking, monitoring, treating, and controlling COVID-19. In addition, AI (10 articles) and autorobots (6 articles) were the most significant assistive technologies in the incoming articles. In this sense, AI is a broad conceptual category of computer software designed to mimic or improve human decision-making. As a powerful tool, it can be very effective in infection assessment and population screening during the COVID-19 crisis. The use of AI with the help of computer tomography (CT) and laboratory test results as well as patient history can make it possible to diagnose patients with COVID-19 quickly and reliably (4). Rapid identification of patients employing machine learning in smartphones, preparing the history of contacts and travels, and assessing the health status of individuals are other applications of AI (2, 5, 6). VR, 3D printing, and biosensors had been also examined in four articles and IoT had been considered in three studies. As hospitals are one of the high-contact work environments, robots can further play an important role in controlling infections of interactive environments with high contacts or high interpersonal contact conditions. Patient Reception Robots, Nurse Robots, Ambulance Robots, Hospital Robots, Radiology Robots, and Rehabilitation Robots are some alternatives that can be exploited to reduce the exposure of the public and the health care system staff to the virus during COVID-19. Robotic and telerobotic systems can additionally mitigate the risks of transmitting infectious diseases to health care workers by allowing them to be eliminated, evaluated, monitored, and treated remotely and safely (7, 8).
4. CONCLUSION

This study was a systematic review of the assistive intelligent technologies in Industry 4.0 with particular attention to the control of the COVID-19 pandemic that can significantly reduce the risks facing infected patients and related costs for governments. In this line, Industry 4.0 is assumed as another strategy being utilized in the fight against COVID-19, since it is redefining life with its intelligent technologies. The combination of these measures can thus lead to managing the pandemic that significantly challenges the clinical frameworks. Modern technologies can also provide a novel approach to improved equity in access to health care services, improved intensive care for patients with COVID-19, and maintenance of OSH of health care workers. Following the application of these technologies, other benefits are similarly accrued for the public and governments such as increasing patient satisfaction, reducing hospitalization, boosting speed of treatment, and lowering health care costs. The use of these intelligent technologies, while improving the management by governments in the face of crises, can also help them quickly identify, track, monitor, and treat patients with COVID-19 in an effective manner and manage human resources, medicines, equipment, and time. It was concluded that Industry 4.0 could improve resilience in the public and workplace environments in terms of exposure to pandemic infectious diseases.

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6. REFERENCES


