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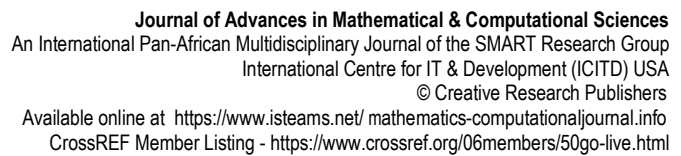
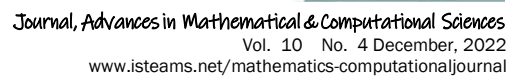
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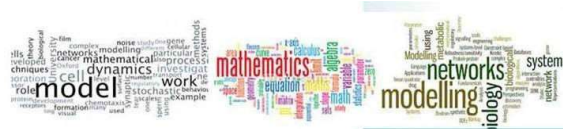


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Following the identification of Coronavirus Disease 2019 (COVID-19) in Wuhan, China in December 2019, AI researchers have teamed up with a health specialist to combat the virus. This study explores the medical and non-medical areas of COVID-19 that AI has impacted: the prevalence of the AI technologies adopted across all stages of the pandemic, the collaboration networks of global AI researchers, and the open issues. 21,219 papers from ACM Digital, Science Direct and Google Scholar were examined. Adherence to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework and utilizing the PICO (population, intervention, comparison, and outcome) paradigm, guided the inclusion of researches in the review. Tables and graphs were utilized to display the results. Analysis revealed that AI has impacted 4 molecular, 4 clinical, and 7 societal areas of COVID-19. Deep Learning among other AI technologies was traced to all aspects of the pandemic. 2173 authors and co-authors were traced to these achievements, while 32 of the most connected 51 authors were affiliated with institutions in China, 18 to the United States, and 1 to Europe. The open issues identified had to do with the quality of datasets, AI model deployment, and privacy issues. This study demonstrates how AI may be utilized for COVID-19 diagnosis, prediction, medication and vaccine identification, prognosis, and contact person monitoring. This investigation began at the beginning of the epidemic and continued until the first batch of vaccinations received approval. The study provided collaboration opportunities for AI researchers and revealed open issues that will spike further research toward preparing the world for any future pandemic

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This made the Pfizer/BioNTech immunization the initial to acquire the organization's Emergency Use Listing (EUL). Previously, this time window was only extended to December 2019.

Table 1: Framework for Determining The Eligibility Of Studies (PICO)

Criteria	Description
Population	COVID-19 cases
Intervention	Artificial Intelligence interventions on the Prediction, Diagnosis, Treatment or Prognosis of COVID-19.
Comparison	Not applicable in this review
Outcome	Prevalence of AI interventions on COVID-19 Prediction, Diagnosis, Treatment, or Prognosis

A comprehensive search strategy for a systematic review requires the building of an adequate queryset from the key concepts of a study. The queryset is a connection of search terms and search phrases using Boolean operators (AND, OR, and NOT). The resultant query set from the initial search queries for each of the research questions is (“COVID-19” or “SARS-COV-2” or “Novel Corona” or “2019-ncov”) and (“diagnostic model” otherwise “prognostic model” otherwise “prediction model” otherwise “machine learning” otherwise “artificial intelligence” or else “soft computing” otherwise “algorithm” otherwise “score” or “deep learning” or “regression”). The two distinct groups in the queryset are connected with the AND operators, just as the elements of each category are connected using the OR operator. This final query set used for the systematic literature review has been formulated to report the four investigative questions raised in this learning. The responses to the investigative questions, which constitute the contributions of this study are extractions, deductions, and derivations from AI-related studies on techniques, tools, and models for COVID-19 predictions, diagnosis, and prognosis.

2.2 Study selection

Four reviewers independently screened the publications in the respective databases. They considered the relevance of the title, keywords, and English language. The selected papers were collated into a library for further processing in the Endnote referencing software and literature screening program. The eligibility criterion was used to filter the initial collections for abstract and full-text screening. All disagreements arising from using the eligibility criterion to select studies were resolved through discussion and consensus.

2.3 Data extraction and synthesis

Significant data were obtained and harmonized by all authors. The data included title, first author, publication year, country, study design/type, Target population, COVID-19 areas, sampling method, dataset type, and AI technique.

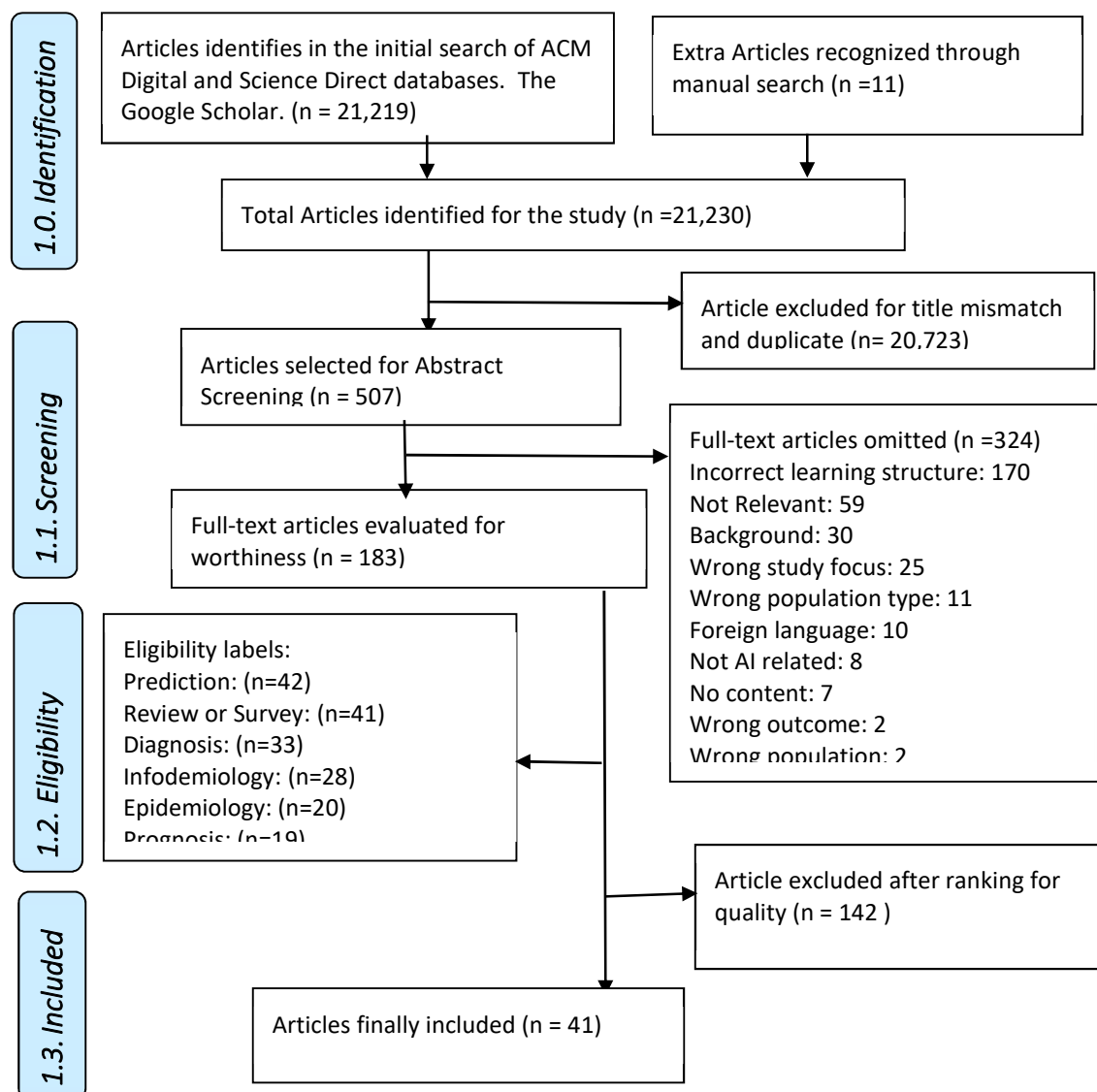
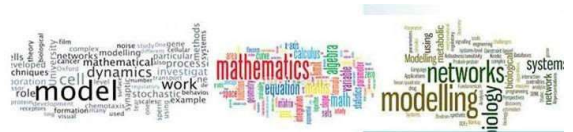


Figure 1: The PRISMA Diagram Describing the Selection of Artificial Intelligence Applications for COVID-19 articles³

3. RESULTS AND DISCUSSIONS

The four-level processes in the PRISMA model were used to select the articles required to gain insight into the contributions of AI technologies to COVID-19 from its discovery in December 2019 through July 2020 to December 2020.



3.1 Search Results and Study Characteristic

The relevant articles collected from the Science Direct databases, Google Scholar, and ACM Digital were 3,679, 17,500, and 40 respectively which add up to 21,219. The addition of the 11 articles that were manually sourced gives the total number of articles to 21,230. After the application of the eligibility criteria, 507 of the articles were considered for abstract screening, and 20,723 were dropped for duplication and title mismatch. 183 of the articles screened for abstract were divided among the authors for further processing, the remaining 324 were dropped. The reasons for the exclusion of articles include wrong study design, non-AI, background article, wrong study focus, wrong publication type, foreign language, and no content (Figure 1).

In all, 943 keywords were auto-extracted from the 183 Articles. Ranking of the articles by weights of the 'included keywords' revealed the 41 articles with the highest concentrations of the keywords. This provided a pointer that such articles shall be good sources of the needed information about the AI models, techniques, and interventions for COVID-19. The forty-one (41) papers in this category were taken further to the full paper review stage. The co-occurrence keywords were determined using 86 keywords with a minimum number of 3 occurrences.

Exploration of the network reveals the prominent nodes on the network for the application areas of COVID-19 as forecasting, prognosis, epidemiology, triage, and oncology. Others include otolaryngology, palliative care, infection control, humanism, and healthcare worker safety. On the AI technology and techniques, the nodes are deep learning, intelligence, and algorithms. The nodes on dataset types include computed tomography, lung, chest, and biological marker. The nodes on consequences and outcomes show mortality, stroke, inflammation, thrombosis, hyposmia, and anosmia. The countries in the network include Italy and Brazil (Figure 2).

The general overview of the referenced papers is in Appendix A. They are categorized into application areas of AI / AI models/technologies for COVID-19. The fourth category is the Dataset and Data Source for COVID-19. The deductions from these collections were used to respond to the formulated investigative questions. Also, the list of abbreviations and acronyms employed in this research is listed in Appendix B for better clarification.



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3.2 Taxonomy of areas of COVID-19 AI Applications and Open-Issues

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graph LR
    Root[Artificial Intelligence for COVID-19] --> App[Application Areas]
    Root --> Tech[Technologies]
    Root --> Data[Dataset and Data Sources]
    Root --> Issues[Open Issues]
    
    App --> AppType[By type of Medicine]
    App --> AppHealth[By Public Health Concern]
    App --> AppPersp[By Perspectives]
    
    AppType --> Molecular[Molecular]
    AppType --> Clinical[Clinical]
    AppType --> Societal[Societal]
    
    Tech --> Core[Core Design Paradigm]
    Tech --> Embedded[Embedded AI Devices / Initiatives]
    
    Core --> ML[Machine Learning]
    Core --> Other[Other AI Methods]
    
    ML --> Deep[Deep Learning]
    ML --> Tradition[Tradition ML Techniques]
    
    Data --> Dataset[Dataset]
    Data --> Source[Data Source]
    
    Dataset --> Text[Text Dataset]
    Dataset --> Image[Image Dataset]
    
    Text --> Bio[Bio-Medical]
    Text --> NonBio[Non-Bio-Medical]
    
    Source --> Open[Open Source]
    Source --> Closed[Closed Source]
    
    Issues --> Inadequacy[Datasets Inadequacy]
    Issues --> Deployment[Model deployment and Benchmarking]
    Issues --> Policy[Policy effectiveness]
    Issues --> Privacy[Privacy and Human Rights]
  
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Figure 4. Taxonomy of the Application Areas of AI and the Open Issues on COVID-19

The suggested approach may benefit from new data, increasing the ability to identify CT images. The results revealed that the sensitivity of COVID-19 patient identification has improved.

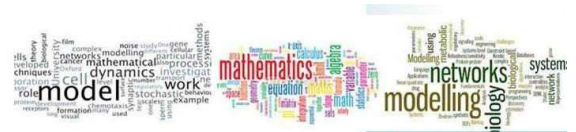
3.5.2 Contribution of AI to COVID-19 Non-Invasive Tracking and Patient Outcome Prediction

Prognosis, or patient outcome prediction, is a medical term for forecasting the likely result or course of an illness, as well as the likelihood of recovery or recurrence [60]. The impact of AI on this component of COVID-19 is conspicuous. The importance of developing a predictive tool to recognize risky patients was emphasized by [61] to aid in the construction of treatment strategies. The study included 366 patients with severe COVID-19 from four different sites, of whom 296 survived longer or received a cure, compared to 70 who passed away within 14 days of their initial CT scan. Patients in these two groups were categorized as high-risk and low-risk, respectively. With the use of a 3D densely coupled convolutional neural network, CT and clinical data were examined to determine whether COVID-19 patients were more likely to fall into the high-risk or low-risk categories. The area under the curve (AUC) for the De-COVID-19-Net model is 0.952. De-COVID-19-Net has shown its capability to predict the patient's impending death non-invasively using the patient's initial CT scan. Thus, the technique may be used to identify high-risk individuals and provide therapy early.

Similarly, the need for early COVID-19 diagnosis and the identification of risky patients with a poor prediction for early inhibition and therapeutic resource optimization was stressed in [56]. The researchers suggested a completely automated DL approach for COVID-19 diagnosis and predictive investigation using regular computed imaging. A reflective report of 5372 patients with computed imaging scans was conducted in seven cities or provinces. For external validation of the DL system, pre-training was done with computed CT scans of 4106 patients and 1266 patients from six cities or provinces. The DL algorithm distinguished COVID-19 from further pneumonia with an AUC of 0.87 and viral pneumonia with an AUC of 0.86. As a result, the DL system can emphasize on anomalous areas with consistent features with reported radiological findings without the need for human intervention. It was successful in categorizing patients into high-risk and low-risk categories, with significant differences in hospital stay time of $p=0.013$ and $p=0.014$, correspondingly.

In [62], a collection of 58 clinical and biological factors, as well as chest CT scan information, from 1003 COVID-19-infected patients from two French clinics was done to discover predictors of COVID-19 severity and priority. To predict severity, a DL model based on CT scans was built. Urea, gender, oxygenation, platelet, and age are among the five multimodal clinical and biological factors used to create AI severity scores. The neural network analysis of CT images provides unique prognostic information that outperformed 11 previous AI-severity ratings significantly.

The lack of a defined COVID-19 stage description and progression characterization [63] was identified as a snag [63]. As a result, a temporal DL strategy based on a time-aware long short-term memory (T-LSTM) neural network has been presented. The model can understand active relations in sporadically tested time series after being trained with blood samples from 485 patients. By taking into account both biomarkers and irregular periods, it can predict the fate of COVID-19 patients. Finally, the T-LSTM unit for patient representations was employed to subtyped the patient phases and explain COVID-19 disease development. There were four (4) phases of COVID-19 evolution identified, each with differing patient ranks and death concerns.

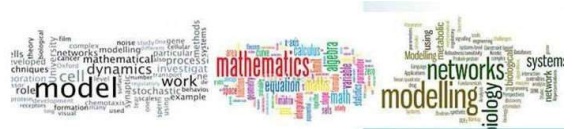


To recognize persons in video sequences, the system employs the YOLOv3 object recognition paradigm. The transfer learning process is also used to improve the model's accuracy. In this method, the detection algorithm employs a pre-trained algorithm that is linked to an additional trained layer that utilizes an additional human data set. The detection model uses bounding box information to identify persons. The model's tracking accuracy improves from 92 percent to 98 percent using the transfer learning method.

In [69], deep learning-based time series techniques were investigated to anticipate worldwide COVID-19 cases in advance for short-term and medium-term dependencies using adaptive learning. A real-world COVID-19 dataset was used for preprocessing the data and extraction of features. Following that, Auto-Regressive Integrated Moving Average (ARIMA), Long Short-Term Memory (LSTM), Stacked Long Short-Term Memory (SLSTM), and Prophet Approaches were used to model the prediction of cumulative confirmed, death, and recovered global cases. Multivariate LSTM models were used to forecast COVID-19 cases over the long run. All of the models' performance indicators were computed, and the prediction results were compared to determine which model is the most dependable. In comparison to the other evaluated algorithms for the studied performance measures, the Stacked LSTM method produces superior accuracy with an error of less than 2%, according to the results.

The work in [8] was to inspect the dispersion of Arabic language conversations and break down the idea of Internet search practices connected with the worldwide COVID-19 pandemic through Twitter and Google Trends in Saudi Arabia. A bunch of Twitter Arabic information connected with COVID-19 was gathered and dissected. Utilizing Google Trends, web search practices connected with the pandemic were investigated. Well-being and hazard discernments and data connected with the reception of COVID-19 infodemic markers were explored. In addition, Google versatility information was utilized to survey the connection between different local area exercises and the pandemic transmission rate. Similar information was utilized to explore how changes in versatility could anticipate new COVID-19 cases. The outcomes show that the top COVID-19-related terms for deception on Twitter were people cures from bad quality sources. The quantity of COVID-19 cases in various Saudi regions has a solid negative relationship with COVID-19 hunt questions on Google Trends (Pearson $r = -0.63$) and measurable importance ($p < 0.05$). The decrease in portability profoundly corresponded with a diminished number of all-out cases in Saudi Arabia. At last, the absolute cases are the main indicator of the new COVID-19 cases.

Also, [99] investigated web search exercises and practices connected with the COVID-19 pandemic from February 20, 2020, to May 6, 2020, using Google Trends and Instagram hashtags. The research examined the names used to distinguish the infection, well-being, and hazard discernment, life during the lockdown, and data connected with the reception of COVID-19 infodemic monikers (query, hashtag, or phrase that generates or feeds fake news, misinterpretations, or discriminatory phenomena). The best six COVID-19-related terms looked in Google were "coronavirus," "corona," "COVID," "virus," "coronavirus," and "COVID-19." Countries with a larger number of COVID-19 cases had a bigger number of COVID-19 questions on Google. The monikers "coronavirus ozone," "coronavirus laboratory," "coronavirus 5G," "coronavirus conspiracy," and "coronavirus bill gates" were generally circled on the web. Around 66 ($n=48,700,000$, 66.1%) of Instagram clients utilized the hashtags "Coronavirus" and "Covid" to spread infection-related data.



3.7 Artificial Intelligence (AI) Technologies Deployed for COVID-19

The AI technologies that were employed to construct COVID-19 solutions are discussed in this section. The success of ML and AI applications in earlier pandemics provided the incentive for academics around the world to use AI technology to combat the COVID-19 (SARS-CoV-2) outbreak [3]. The next paragraphs cover some of the works that showcase these technologies and their usage. Although health requirements are not always available or known during the early stages of any outbreak, outbreaks are frequently controlled with existing capacity. Modern technology for COVID-19 mitigation has been recognized as Data Science and Deep Learning [1]. However, DL necessitates huge datasets and sophisticated computing resources, both of which are in short supply during a pandemic. Deep Transfer Learning (DTL) and Edge Computing were both seen as viable options. Edge Devices (ED) such as the Internet of Things (IoT), Webcams, Drones, Intelligent Medical Equipment, and Robots, among others, are useful in the pandemic. The primary computational methodologies reviewed in [2] are ML techniques and deep learning techniques, as well as mathematical and statistical methods in the domain of COVID-19 categorization, prediction, and prevention.

The Deep Convolutional Network, CNN, and Support Vector Machine are the technologies identified by [4] for the screening and treatment of COVID-19. For contact tracing, mobile applications were created using various technologies such as Bluetooth, GPS, and social graphs. Models were created using stacking-ensemble with the support vector regression algorithm and the supervised multi-layered recursive classifier XGBoost for prediction and forecasting. In addition, a Deep Neural Network model was developed to aid in the development of new medications and vaccines. From the standpoint of the patients, Deep-CNN, 2D deep Convolutional Neural Network, 3-dimensional DL, and Modified Inception Transfer-Learning Model were among the AI technologies highlighted by [70] for diagnosis using radiological pictures. To estimate infected persons, identify respiratory patterns, and forecast the trajectory of an outbreak, the Time Dependent Susceptible-Infected-Recovered (SIR) model, GRU Neural Network, and SEIR (Susceptible, Exposed, Infectious, and Removed or Recovered) model were employed. Prediction models based on the Supervised XGBoost classifier and ML were used to predict mortality risk and the length of a patient's stay in the hospital, respectively, as AI technologies for patient health prediction.

Since COVID-19's discovery, smart city initiatives technology has been playing major roles in the handling. Sensor-based monitoring stations, social media data mining, and individual monitoring of health issues via devices or wearable sensors are some of the technologies utilized for monitoring and detecting outbreaks, as highlighted by [7]. Automated hospitals and healthcare systems, smart transportation, response teams, and alerting and notification messages are all part of the alert and mitigation strategy. Berlin - ambient-assisted living; web-based services; Helsinki - Helsinki smart region; London - Digital Health. program; New York - NYC; SHIN-NY; Seoul - big data, AI, blockchain; self-quarantine app, corona 100 m apps, Coronamap; New York - NYeC; SHIN-NY; Seoul - big data, AI, blockchain; self-quarantine app, corona 100 m app, Corona Shanghai - robots are driven by 5G; Singapore has a contact tracing tool, as well as a WhatsApp group, webpages, and educational games, My health record, secure texting in Sydney; records exchange, Alipay QR, quarantine code, smartphone tracking in Wuhan.



Several efforts have been made to correct these concerns, but, truly, the impressions are pointers to ethical and human issues regarding the development, validation, and administration of vaccines. The significant roles played by AI techniques in achieving this height are evident in the literature and the impacts are obvious on improved diagnosis, treatment, and health research. However, many of the techniques have also raised ethical, legal, and social concerns. The anxieties about AI in medicine range from deep-fake videos and photo fraud [110] to, the obscurity of AI processes especially the black-box approaches and potential job loss as a result of robotics [109]. Progress has been made to standardize ethics and legal implications of AI application in medicine, [112] extracted Ten Commandments of ethical medical AI, which is a clear concise checklist of understandable principles for stakeholders.

Also, the WHO (2021) report titled “WHO guidance on Ethics & Governance of AI for Health” identifies the ethical challenges and risks of the use of AI in health. These challenges include assessing whether AI should be used, issues of data collection and usage, accountability and responsibility for decision-making with AI, bias, and discrimination associated with AI, risks of AI technologies to safety and cybersecurity, and impacts of AI on labor and employment. The six consensus principles to ensure AI works to the public benefit of all countries are protecting autonomy; promoting human well-being, human safety, and the public interest; ensuring transparency, explainable and intelligibility; fostering responsibility and accountability; ensuring inclusiveness and equity; promoting AI that is responsive and sustainable. All these are open issues and pose a lot of challenges to the AI community in future research.

4. CONCLUSIONS

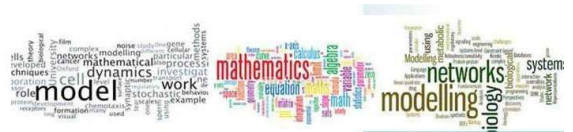
This study brings forth an interpretable review of the impact of AI on the global COVID-19 Pandemic. It provides the impacts of the technology on the molecular, clinical, and societal handling of the pandemic. An extended taxonomy of the areas of application of the technology was formulated and discussed. The systematic review revealed the generalizable capabilities of deep learning in various areas of the pandemic though spotted the roles of transfer learning and federated learning among other AI technologies. The work provides the implications and efficacies of various AI-developed models.

Furthermore, the paper explores the controversies that trailed the discovery of the COVID-19 vaccine and systematically sets future research agenda for the AI community on proactive control measures, and policy effectiveness as well as balancing the privacy and human right in the research on this and any future pandemics. It is envisaged that the open issues revealed in this study will spike further collaborative research in the adoption of AI for better assessment, treatment, and monitoring of infected patients. Extension of study beyond the range covered in this work is recommended, this will reveal the extent to which the identified open issues have been managed for better global health care and as efforts towards preparing the world for any future pandemic.

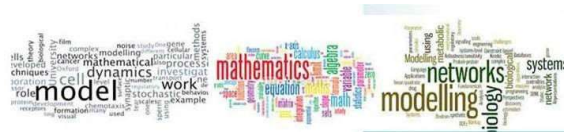
Declarations

Author contribution statement

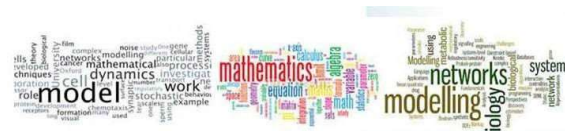
All authors listed have significantly contributed to the development and the writing of this article.



- [11] R. M. Elavarasan and R. Pugazhendhi, "Restructured society and environment: A review on potential technological strategies to control the COVID-19 pandemic," *Science of The Total Environment*, vol. 725, p. 138858, 2020/07/10/ 2020.
- [12] O. S. Albahri, A. A. Zaidan, A. S. Albahri, B. B. Zaidan, K. H. Abdulkareem, Z. T. Al-qaysi, et al., "Systematic Review of Artificial Intelligence Techniques in the Detection and Classification of COVID-19 Medical Images in Terms of Evaluation and Benchmarking: Taxonomy Analysis, Challenges, Future Solutions, and Methodological Aspects," *Journal of Infection and Public Health*, 2020/07/01/ 2020.
- [13] M. T. Vafea, E. Atalla, J. Georgakas, F. Shehadeh, E. K. Mylona, M. Kalligeros, et al., "Emerging Technologies for Use in the Study, Diagnosis, and Treatment of Patients with COVID-19," *Cellular and Molecular Bioengineering*, pp. 1-9, 2020.
- [14] M. Ahamad, S. Aktar, S. Uddin, P. Lió, H. Xu, M. A. Summers, et al., "A Machine Learning Model to Identify Early Stage Symptoms of SARS-Cov-2 Infected Patients," *Expert Systems with Applications*, p. 113661, 2020.
- [15] S. F. Ardabili, A. Mosavi, P. Ghamisi, F. Ferdinand, A. R. Varkonyi-Koczy, U. Reuter, et al., "COVID-19 outbreak prediction with machine learning," Available at SSRN 3580188, 2020.
- [16] S. Mohanty, M. Harun Ai Rashid, M. Mridul, C. Mohanty, and S. Swayamsiddha, "Application of Artificial Intelligence in COVID-19 drug repurposing," *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, vol. 14, pp. 1027-1031, 2020/09/01/ 2020.
- [17] C. Jalaber, T. Lapotre, T. Morcet-Delattre, F. Ribet, S. Jouneau, and M. Lederlin, "Chest CT in COVID-19 pneumonia: A review of current knowledge," *Diagnostic and Interventional Imaging*, vol. 101, pp. 431-437, 2020/07/01/ 2020.
- [18] J. Shuja, E. Alanazi, W. Alasmay, and A. Alashaikh, "COVID-19 Datasets: A Survey and Future Challenges," *medRxiv*, 2020.
- [19] F. Shaikh, M. Anderson, M. R. Sohail, F. Mulero, O. Awan, D. Dupont-Roettger, et al., "Current landscape of Imaging and the potential role for Artificial intelligence in the management of COVID-19," *Current Problems in Diagnostic Radiology*, 2020/06/27/ 2020.
- [20] A. Ahmada, S. Garhwal, S. K. Ray, G. Kumar, S. J. Malebary, and O. M. O. Barukab, "The Number of Confirmed Cases of COVID-19 by using Machine Learning: Methods and Challenges," *arXiv preprint arXiv:2006.09184*, 2020.
- [21] A. Kumar, P. K. Gupta, and A. Srivastava, "A review of modern technologies for tackling COVID-19 pandemic," *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, vol. 14, pp. 569-573, 2020/07/01 2020.
- [2] J. Kurreck and C. A. Stein, *Molecular Medicine: An Introduction: Molecular Medicine: An Introduction*, 2016.
- [23] K. A. Arash, W. Julia, S. Milad, C. Emmanuel, C-T. Stacie, G. Niloofar, et al., "Artificial Intelligence for COVID-19 Drug Discovery and Vaccine Development," *Frontiers in Artificial Intelligence*, vol. 3, 2020.
- [24] S. Yu-Tao, L. Xin-Xin, L. Zhe, and C. Kuo-Chen, "pLoc_Deep-mHum: Predict Subcellular Localization of Human Proteins by Deep Learning," *Scientific Research* vol. 12, 2020.
- [25] B. R. Beck, B. Shin, Y. Choi, S. Park, and K. Kang, "Predicting commercially available antiviral drugs that may act on the novel coronavirus (SARS-CoV-2) through a drug-target interaction deep learning model," *Computational and Structural Biotechnology Journal*, vol. 18, pp. 784-790, 2020/01/01/ 2020.



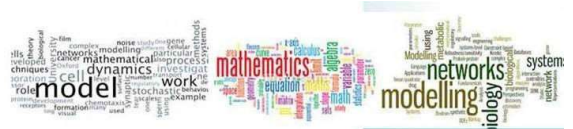
- [26] M. Abdel-Basset, V. Chang, H. Hawash, R. K. Chakraborty, and M. Ryan, "FSS-2019-nCov: A deep learning architecture for semi-supervised few-shot segmentation of COVID-19 infection," *Knowledge-Based Systems*, vol. 212, p. 106647, 2021/01/05/ 2021.
- [27] Z. Xiangxiang, S. Xiang, M. Tengfei, P. Xiaoqin, Z. Yadi, H. Yuan, et al., "Repurpose Open Data to Discover Therapeutics for COVID-19 Using Deep Learning," *Journal of proteome research*, vol. 19, pp. 4624–4636, 2020.
- [28] J. H. T. Beigel, K. M. Dodd, L. E. Mehta, A. K. Zingman, B. S. Kalil, A. C. Lane, H. C., "Remdesivir for the treatment of COVID-19," *New England Journal of Medicine*, vol. 383, pp. 1813-1826, 2020.
- [29] T. K. Manabe, D. Akatsu, "Favipiravir for the treatment of patients with COVID-19: a systematic review and meta-analysis," *BMC Infect Dis* 21, vol. 489, 2021.
- [30] S. S. Tong, Y. Yu, Y. Wu, C. Chen, J. Wang, S. Jiang, J., "Ribavirin therapy for severe COVID-19: a retrospective cohort study," *International journal of antimicrobial agents*, vol. 56, 2020.
- [31] M. R. Balasubramaniam, R. J. S., "Computational target-based drug repurposing of elbasvir, an antiviral drug predicted to bind multiple SARS-CoV-2 proteins," *ChemRxiv*, 2020.
- [32] H. W. Ohashi, K. Saso, W. Shionoya, K. Iwanami, S. Hirokawa, T. Wakita, T., "Potential anti-COVID-19 agents, cepharanthine and nelfinavir, and their usage for combination treatment," *Iscience*, vol. 24, 2021.
- [33] A. A. Elfiky, "Anti-HCV, nucleotide inhibitors, repurposing against COVID-19," *Life sciences*, vol. 248, 2020.
- [34] F. S. Roozbeh, M. Alizadeh-Navaei, R. Hedayatizadeh-Omran, A. Merat, S. Wentzel, H. Shamshirian, A., "Sofosbuvir and daclatasvir for the treatment of COVID-19 outpatients: a double-blind, randomized controlled trial," *Journal of Antimicrobial Chemotherapy*, vol. 76, pp. 753-757, 2021.
- [35] Z. L. Zhu, Z. Xu, T. Chen, C. Yang, G. Zha, T. Xue, Y., "Arbidol monotherapy is superior to lopinavir/ritonavir in treating COVID-19," *Journal of Infection*, vol. 81, 2020.
- [36] K. W. C. Lam, K. W. Vo, J. Hou, W. Li, H. Richman, P. S. Duong, T. Q., "Continued in-hospital angiotensin-converting enzyme inhibitor and angiotensin II receptor blocker use in hypertensive COVID-19 patients is associated with positive clinical outcome," *The Journal of infectious diseases*, vol. 222, p. 1256, 2020.
- [37] H. O. Asakura, H., "Potential of heparin and nafamostat combination therapy for COVID-19," *Journal of Thromb Haemost*, vol. 18, pp. 1521-1522, 2020.
- [38] R. E. A. Ferner, J. K., "Chloroquine and hydroxychloroquine in COVID-19," *thebmj*, vol. 369, 2020.
- [39] A. U. O. Ibrahim, M. Serte, S. Al-Turjman, F. Yakoi, P. S., "Pneumonia classification using deep learning from chest X-ray images during COVID-19," *Journal of Cognitive Computation*, vol. 1, 2021.
- [40] D. M.-O. Echeverría-Esnal, C. Navarrete-Rouco, M. E. De-Antonio Cuscó, M. Ferrández, O. Horcajada, J. P. Grau, S., "Azithromycin in the treatment of COVID-19: a review," *Expert Review of Anti-infective Therapy*, vol. 19, pp. 147-163, 2021.
- [41] A. E. G. Malek, B. P. Kontoyiannis, D. P. "Doxycycline as a potential partner of COVID-19 therapies," 2020.
- [42] A. I. Cortegiani, M. Greco, M. Granone, V. Protti, A. Gregoret, C. Cecconi, M., "Rationale and evidence on the use of tocilizumab in COVID-19: a systematic review," *Journal Pulmonology*, vol. 27, p. 52, 2021.



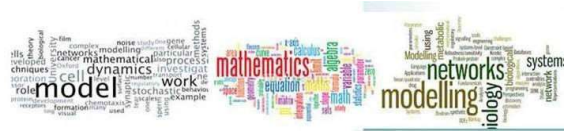
- [90] M. E. Yousefzadeh, P. Movahed, S. M. George, S. Rahmati, D. Abedini, A. Nadji, S. A. Haseli, S. Bakhshayesh Karam, M. Kiani, A. Hoseinyazdi, M. Roshandel, J. Lashgari, R., "AI-corona: Radiologist-assistant deep learning framework for COVID-19 diagnosis in chest CT scans," *PLOS ONE*, vol. 16, 2021.
- [91] F. K. Paiva Proença Lobo Lopes, F. C. Prado, G. F. Kuriki, P. E. Garcia, M. R., "Machine learning model for predicting severity prognosis in patients infected with COVID-19: Study protocol from COVID-AI Brasil," *PLOS ONE*, vol. 16, 2021.
- [92] K. W. Gong, D. Arru, C. D. Homayounieh, F. Neumark, N. Guan, J. Buch, V. Kim, K. Bizzo, B. C., Ren H., Tak, W. Y. Park, S. Y. Lee, Y. R. Kang, M. K. Park, J. G. Carriero, A., L., Masjedi, M. Talari, H. Li, Q., "A multi-center study of COVID-19 patient prognosis using deep learning-based CT image analysis and electronic health records," *European Journal of Radiology*, vol. 139, 2021.
- [93] A. W. Keshavarzi Arshadi, J. Salem, M. Cruz, E. Calad-Thomson, S. Ghadirian, N. Collins, J. Diez-Cecilia, E. Kelly, B. Goodarzi, H. Yuan, J. S., "Artificial intelligence for COVID-19 drug discovery and vaccine development," *Frontiers in Artificial Intelligence*, vol. 3, 2020.
- [94] M. Jamshidi, A. Lalbakhsh, J. Talla, Z. Peroutka, F. Hadjiloei, P. Lalbakhsh, et al., "Artificial Intelligence and COVID-19: Deep Learning Approaches for Diagnosis and Treatment," *IEEE Access*, vol. 8, pp. 109581-109595, 2020.
- [95] K. M. Z. Saravanan, H. Hossain, M. T. Reza, M. S. Wei, Y., "Deep learning-based drug screening for COVID-19 and case studies. ," *Methods in Pharmacology and Toxicology*, 2021.
- [96] B. M. H. Bakadia, F. Souho, T. Lamboni, L. Ullah, M. W. Boni, B. O. Ahmed, A. A. Mukole, B. M. Yang, G., "Prevention and treatment of COVID-19: Focus on interferons, chloroquine/hydroxychloroquine, azithromycin, and vaccine," *Journal of Biomedicine & Pharmacotherapy*, vol. 133, 2021.
- [97] M. Javaid, A. Haleem, R. Vaishya, S. Bahl, R. Suman, and A. Vaish, "Industry 4.0 technologies and their applications in fighting COVID-19 pandemic," *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, vol. 14, pp. 419-422, 2020/07/01/ 2020.
- [98] J. C. Sipior, "Considerations for development and use of AI in response to COVID-19," *International Journal of Information Management*, p. 102170, 2020/06/09/ 2020.
- [99] R. Alshahrani and A. Babour, "An Infodemiology and Infoveillance Study on COVID-19: Analysis of Twitter and Google Trends," *Sustainability*, vol. 13,8528, 2021.
- [100] I. Dayan, H. R.Roth, A. Zhong, A. Harouni, A. Gentili, A. Z. Abidin, and Q. Li. "Federated learning for predicting clinical outcomes in patients with COVID-19". *Nature was medicine*, vol. 27, 10, pp.1735-1743. 2021.
- [101] B. Liu, B. Yan, Y. Zhou, Y. Yang, and Y. Zhang, "Experiments of federated learning for COVID-19 chest x-ray images," *arXiv:2007.05592*. 2020.
- [102] W. Zhang, T. Zhou, Q. Lu, X. Wang, C. Zhu, H. Sun, and F. Y.Wang. *Dynamic-Fusion-Based Federated Learning for COVID-19 Detection*. *IEEE Internet of Things Journal*, 8(21), 15884-15891."2021.
- [103] R. Kumar et al., "Blockchain-federated-learning and deep learning models for COVID-19 detection using CT imaging," *arXiv:2007.06537*. 2020.
- [104] WHO: World Health Organization, "WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020". <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020> (assessed on 13 July 2021).
- [105] WHO: World Health Organization, "WHO Coronavirus (COVID-19) Dashboard". <https://covid19.who.int> (assessed on 31 March 2021).



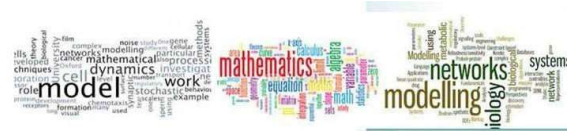
[7]	(2020)	An Evaluation of COVID-2019 Information Computational Systems for Epidemic Detection, Medical Identification, National Policy agenda, and Care Coordination	To conduct a comprehensive analysis of data gathered from an operational standpoint, to handle collected information in COVID-19-related investigations at a preliminary phase.	The purpose of this study was to perform research from the standpoint of data-driven statistics. It looked into the most up-to-date options for epidemic computer models, medical assessment, legislative efficacy, and disease surveillance. Furthermore, models with the most recent data were reviewed to see how well they have performed since their original publication and to gather sources of data for research analysis.
[8]	(2020)	Cognitive computing's significance in COVID-19 diagnosis and treatment: An up-to-date evaluation	To give an understanding of the major machine learning algorithms utilized in COVID-19 prognosis, classifications, and prediction. Also, to compare the influence of machine learning and other competing strategies, such as modeling and simulation on the COVID-19 challenge.	The foundations of SARS-CoV-2 and its influence on world health are traced in this study. Machine learning algorithms, Deep learning methods, and Computational and Scientific strategies are explained as part of the established Computing techniques in the categorization, prognosis, and mitigation of COVID-19. Analytical inquiry and performance overview of different advanced computational methodologies, the effectiveness of the COVID-19 prediction method, and the development of COVID-19 academic publications by methodologies, papers, and nations are also completed. The data and information used in COVID-19-related studies, and the obstacles, were also reviewed. Furthermore, there are indeed significant drawbacks, perhaps with a lack of labeled medical data and learning on limited data samples.
[9]	(2020)	Evaluation of Machines and Learning Models for Coronavirus Classification and Prevention	To understand the disease epidemiology, identify major preventive measures and assess machine and deep learning-based architectures	A review was done based on a literature search of articles that have utilized machine and deep learning algorithms on medical images to solve a clinical problem. A comparison of the algorithms was also carried out based on output and performance



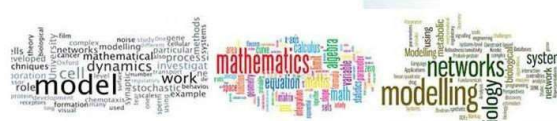
[10]	(2020)	A Consideration of Technological Aspects Methods for Controlling the COVID-19 Epidemic in Reorganized Social and Environmental issues	To identify different applied methods for COVID-19 management, predictions, detection, intervention, and impact.	Google Scholar, Elsevier, PubMed, and IEEE were used to conduct the evaluation. Trusted sources included the World Health Organization (WHO) as well as other recognized reporting and tracking sources such as the World Economy Forum, Stats, MIT technology evaluations, and headlines. Publications that matched the acceptance requirements were divided into two categories: pandemic-controlling technical techniques and pandemic-supporting scientific methods. According to the findings, implementing AI technology in the battle against COVID-19 can boost the infected defensive structure. The investigation does caution, nevertheless, that this is up to people to stop the infection from spreading.
[12]	(2020)	Review Of the literature on Machine Learning for COVID-19 Medical Image Recognition and Prevention	To offer insight into current and novel COVID-19 medical image detection technologies powered by AI investigations.	A systematic review of the literature was carried out on different digital databases including Science Direct, Scopus, IEEE, Web of Science, and PubMed between 2010 and May 5, 2020. 11 articles met all the inclusion criteria with the following distribution across the databases: 4 from Science Direct, 3 from IEEE, 2 from PubMed, 2 from Scopus and none from Web of science. The remaining publications were grouped into two groups: a review of the research groupings, with one literature review and ten scientific articles in each group. Binaries, multi-class, multi-variable, and structured and multi-class categorization were the four sub-groups of the concepts and tools. Following that, a technique for analyzing and evaluating the COVID-19 subgroups classification was developed.
[13]	(2020)	New Technology for the Investigation, Diagnostics, and Medication of COVID-19 Individuals	To provide an overview of technology advancement being used in the research, diagnosis, and medication of COVID-19.	An evaluation of the strategies used to combat COVID-19 was conducted. Artificial intelligence (AI), computational intelligence, nanotechnologies, innovative vaccination and medicinal innovations, innovative computational analysis, deep learning, internet - of - things (IoT), telehealth, robotics, and 3D printing technology are among the innovations. The paper finishes by emphasizing the importance of collaboration as a key to the public acquisition of information, techniques, and skills. Innovation can be used to help the scientific profession react immediately to the increasing population and impact of COVID-19.



[14]	(2020)	A Computational Approach to Recognize SARS-Cov-2 Affected Patients' Early-Stage Symptoms	To investigate patient features, case history, contraindications, indications, diagnostics, and prognosis to make quick medication and isolation recommendations.	The most significant clinical COVID-19 predictive features were (in descending order) respiratory infection, sore throat, pneumonia, sneezing, health records, flu, isolation, age, sore muscles, diarrhea, and gender. According to this investigation, developed and implemented a variety of machine learning techniques to generate models to use the predictor to forecast the degree of COVID-19.
[15]	(2020)	COVID-19 epidemic prediction with machine learning	To evaluate the suggested ML models' prediction performance and accuracy for various lead-times	In total instances over 30 days, data was acquired from https://www.worldometers.info/coronavirus/country for five countries: Italy, Germany, Iran, the United States, and China. To create the needed model, logic, linear, logarithm, quadratic, cubic, compound, powers, and exponential formulas were used. Evolutionary techniques such as GA, particle swarm optimizer, and grey wolf optimizer were used to estimate the parameters. The root means square error (RMSE) and correlation coefficient were used to assess the results. Improvement of model results with high dimensionality would be impossible due to inherent disparities between outbreaks in distinct countries. A single epidemic is unlikely to be duplicated elsewhere, as several studies have seen and documented.
[16]	(2020)	For the COVID-19 pandemic, the intelligent Internet of Medical Things will be used.	To solve the worldwide dilemma, the Cognitive Medical Things Internet (CloMT), a unique application of cognitive radio (CR)-based IoT precise for the medical area, is being investigated. The CloT concept is well suited to the epidemic	CloMT is a capable technology for fast detection, integrated surveillance, and tracking, improved care, and management, without spreading the virus to others. In Google Scholar, Scopus, PubMed, ResearchGate, and IEEE Xplore databases, a comprehensive literature survey is undertaken using the words "COVID-19" and "Cognitive IoT" or "Coronavirus" and "IoT." The most recent evidence and references from government websites and records are used to further evaluate and examine the application areas



5	CEPHARANTHINE	Atkin Chemicals	China	Cepharanthine (CEP) is a medication that is used to diagnose a range of acute and chronic conditions, such as leukopenia, snake bites, xerostomia, and alopecia. In the broad class of bisbenzylisoquinoline alkaloids, it is the sole medication licensed for human use [32].
6	IDX-184	Idenix	USA	IDX-184 is an antimicrobial agent that acts as an NS5B RNA polymerase inhibitor and was established as a therapy for hepatitis C. [33].
7	SOFOSBURIN	Gilead Sciences	USA	C22H29FN3O9P is an antiviral medication that is administered orally alongside other antiretroviral drugs (such as ribavirin) to combat hepatitis C infection [34].
8	LOPINAVIR- RITRONAVIR	AbbVie Inc.	USA	It is used to treat HIV infection (the virus that causes AIDS). It's also being researched for use in the treatments of some cancers. Lopinavir/ritonavir inhibits HIV's capacity to replicate itself, which may improve the efficacy of other anticancer medications or inhibit cancer cell proliferation [35].
9	DARUNAVIR	AbbVie Inc	USA	Darunavir belongs to a class of drugs known as protease inhibitors. It helps to lower HIV levels in the bloodstream.
10	ARBIDOL	Pharmstandard	Russia	Arbidol is a Russian antiviral drug that appears to be efficient against a variety of viruses, such as influenza A, B, and C, respiratory syncytial virus (RSV), SARS-related coronavirus (SARS-CoV), adenovirus, parainfluenza, poliovirus, rhinovirus, coxsackievirus, Zika virus, and hepatitis B and C. [35].



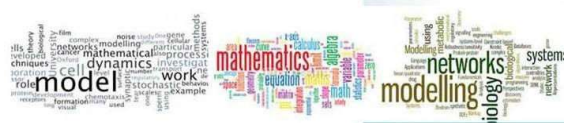
16	AZITHROMYCIN	Pfizer	USA	Azithromycin is an antibiotic that is used to treat many different types of bacterial illnesses. It belongs to the macrolide family of antibiotics. It works by preventing bacteria from growing. This medicine is ineffective against infectious diseases (such as the common cold, and flu). Any antibiotic's effectiveness can be reduced if it is used or misused unnecessarily [40].
17	DOXYCYCLINE	Pfizer	USA	Pimples, urinary tract diseases, intestinal infections, lung problems, eye diseases, chlamydia, gonorrhea, hepatitis, periodontist (tooth cancer), as well as other microbial diseases are asymptomatic with doxycycline [41].
18	TOCILIZUNAB	Roche	Switzerland	Tocilizumab (Actemra) is a reverse transcriptase humanized anti-human interleukin (IL)-6 antibody recombinant immune response signified for limiting clinical symptoms in older patients with tolerably to sometimes several rheumatoid arthritis (RA) who had insufficient reactions between one or even more disease-modifying antirheumatic drugs [42].
19	AURANAFIN	Medichem	Spain	Rheumatoid arthritis is treated with auranofin, as well as rest and nondrug treatments. It alleviates arthritic signs such as aching or sensitive bones, swelling, and extreme fatigue [43].
20	TRAMETINIB	GlaxoSmithKline	UK	Trametinib is being used to treat melanoma (skin cancer) which has expanded or cannot be surgically removed, either alone or in combined application with dabrafenib. It is also used in combination with dabrafenib to assist in keeping melanoma from returning after surgery [44].



21	WITHAFERIN A	Kavya Pharma	India	Withaferin A is a steroidal-structured natural substance. With its anti-inflammatory, anticarcinogenic, and neuroprotective characteristics, withaferin A offers a wide range of potential therapeutic applications. It's been utilized as a flavor and fragrance ingredient as well [45].
22	PARTHENOLIDE	Tocris Bioscience	UK	Parthenolide is a germacranolide sesquiterpene lactone that naturally occurs in the plant chaste berry (Tanacetum parthenium), which it will be termed. The largest concentrations are found in the flowers. Parthenolide's viability as a medicine is limited by its inability to absorb water and its poor bioavailability [46].
23	SORAFENIB	Bayar	Germany	Sorafenib is a drug that is used to treat advanced renal cell carcinoma, liver cancer (hepatocellular carcinoma) that cannot be cured surgically, and distinct thyroid cancer which has returned or disseminated to other body regions. Sorafenib is a cancer-fighting drug called antineoplastic. [47].
24	AURANOFIN	Henan Daken Chemicals	China	Auranofin is used to treat rheumatoid arthritis, primarily chronic rheumatoid arthritis that has not responded to chemotherapeutic drugs [48].
25	SELUMETINIB	AstraZeneca	UK	Selumetinib is a small chemical with potential antineoplastic action that can be taken orally. It inhibits mitogen-activated protein kinase (MEK or MAPK/ERK kinase) without requiring ATP. 1, 2, and 3. MEK 1 and 2 are dual specificity kinases that are important mediators in the activation of the RAS/RAF/MEK/ERK pathway [49]



6	UNESCO	Governme nt policy	To limit the global pandemic, governments all around the world have closed educational institutions. Over 100 nations adopted nationwide closures, affecting more than half of the world's student population, according to UNESCO monitoring. Several other countries have enacted limited school closures, and if these closures become widespread, millions more students would be affected.	https://en.unesco.org/sites/default/files/covid_impact_education.csv
7	HDX	Vaccinatio n	For nations with Humanitarian Response Plans, this information covers COVID-19 vaccine dosage availability projections as well as actual delivery. The vaccine availability projections were manually taken from COVAX's Facility Interim Distribution Forecast, which was released on February 3, 2021. The dataset includes the source(s) for each such vaccination delivery, such as press releases, official announcements, or articles.	https://docs.google.com/spreadsheets/d/e/2PACX-1vTVzu79PPTfaA2syevOOfyRRjy63dJWitquOfFbXIOCzoUn9K9TiMWMRvFGg1RBsnLmgYugzSEiAye2/pub?gid=992438980&single=true&output=csv
8	HDX	Cases and deaths	This data offers a summary of COVID-19 monitoring in the 34 UCPM Participating States plus Switzerland, based on sub-national statistics (admin level 1) on numbers of infections and deaths acquired directly from National Authoritative Sources (National monitoring websites, when available).	https://raw.githubusercontent.com/ec-jrc/COVID-19/master/data-by-region/jrc-COVID-19-all-days-by-regions.csv
9	HDX	Cases and deaths	The number of confirmed cases, recoveries, and fatalities caused by the COVID-19 pandemic in Afghanistan are listed in this dataset.	https://proxy.hxlstandard.org/data.csv?dest=data_view&url=https%3A%2F%2Fdocs.google.com%2Fspreadsheets%2Fd%2F1F-AMEDtqK78EA6LYME2oOsWQsgJi4CT3V_G4Uo-47Rg%2Fedit%23gid%3D1539509351



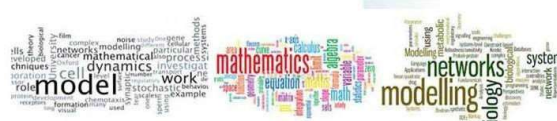
10	ACAPS	Government policies	This dataset compiles all the steps taken by governments around the world in response to the COVID-19 pandemic. The information that has been gathered falls into five categories: Social estrangement, Restrictions on movement, Measures to improve public health, and Economic and social indicators. Each category is subdivided into several different sorts of measurements. ACAPS used information from the government, the media, the United Nations and others	https://data.humdata.org/dataset/e1a91ae0-292d-4434-bc75-bf863d4608ba/resource/4fb08b98-9af5-43d7-8dae-89076dbf5ead/download/acadps_covid19_government_measures_dataset.xlsx
11	HERA - Humanitarian Emergency Response Africa	Cases and deaths	Infections (new cases), Deaths, Recoveries, and Gender data per region for COVID-19 in Nigeria daily (only April - October).	https://data.humdata.org/dataset/f5c35452-d766-468a-a272-4bd82d0a3be0/resource/cba924c0-2bce-4832-bd30-8b8c662fa484/download/nga_subnational_covid19_hera.xlsx
12	HDX	Cases and deaths	The number of tested cases, confirmed cases, recoveries, and fatalities due to the COVID-19 pandemic in Myanmar are all included in this dataset.	https://docs.google.com/spreadsheets/d/e/2PACX-1vQ9GWLx9wsSxy253wGLjRqq79cQ1n4_X5N4dx6JemV7evq3DeGXSDdpnu4M9K4Rceujw3rt_CJRS5aD/pub?output=csv
13	iMMAP	Mobility Report	While communities throughout the world struggle with COVID-19, health officials have disclosed that the same type of aggregated and anonymized data that they use in Google Maps could help them make crucial decisions in the fight against the virus. The goal of these Local Mobility Reports is to give useful information on changes in people's mobility because of initiatives implemented to prevent COVID-19. These studies detail movement trends over time in several kinds of venues, such as shops and recreational spaces, supermarkets and pharmacies, parks, public transportation stations, workplaces, and residential areas, and are organized by geographical areas.	https://www.gstatic.com/covid19/mobility/Global_Mobility_Report.csv?cachebust=2dcf78defb92930a



14	Dalberg	Government policies	The database contains data for 20 nations in the Global South – as well as six countries in the Global North for reference – where Dalberg employees are either based or have extensive knowledge. The database's material is based on publicly available data and, more importantly, on-the-ground knowledge from Dalberg employees. The database includes a comprehensive list of 100 non-pharmaceutical interventions, which are grouped in a framework that makes it easier to spot common differences in the scope of key interventions	https://docs.google.com/spreadsheets/d/e/2PACX-1vR87PvMa1iClyXiyna6tPfp8w9aGPxWEKk3lLidVTwgYlqeOX1mdOxcoRL6lIFRnxCxOHLRkm00aLMj/pub?output=xlsx
15	HDX	Cases and deaths	The number of confirmed cases, fatalities, and recoveries related to the COVID-19 pandemic in Mozambique are all included in this dataset.	https://data.humdata.org/dataset/96f9bc99-28ee-4046-8a96-9f7c1a1462d7/resource/2857979e-a528-429e-b7ce-e4b1c3317718/download/mozambique-COVID-19-cases.xlsx
16	ISI Foundation / Cuebiq Inc	Mobility report	Estimates of changes in human mobility during the COVID-19 outbreak in Italy are included in the dataset.	https://data.humdata.org/dataset/40a9ea9e-0edb-49f7-a440-6aee3015961b/resource/5319b9e6-17e5-43ce-81be-c4a801c9a454/download/od_matrix_daily_flows_norm_full_2020_01_18_2020_06_26.csv
17	HDX	Mobility report	Since the beginning of the COVID-19 pandemic, a few organizations have been tracking PHSM deployment around the world, utilizing various data-gathering methods, database designs, and classification schemes. WHO, the London School of Hygiene and Tropical Medicine, ACAPS, the University of Oxford, the Global Public Health Intelligence Network, US Centers for Disease Control and Prevention, and the Complexity Science Hub Vienna collaborated to bring these datasets together into open-content for public use	https://data.humdata.org/dataset/b8a55c73-8491-4c89-96fb-61850d1a3547/resource/fb5b2952-26df-4a44-9056-576ffa0e42a7/download/clean_data_2020_04_29.csv



18	World Bank Group	Socio-economic	The collection contains standardized metrics derived from World Bank and partner high-frequency phone surveys. The surveys document the socioeconomic effects of the COVID-19 pandemic on homes and individuals throughout the world. Over 90 indicators in 14 theme categories, including education, food security, income, safety nets, and others, are available.	https://development-data-hub-s3-public.s3.amazonaws.com/ddhfiles/1235981/data-coviddash-latest.xlsx
19	Code for Venezuela	Mobility Report	The Premise Data mobile application was used to crowdsource data from Venezuelans. Users are only asked to complete the survey once, and it attempts to gather current COVID-19 awareness about testing availability and symptoms, as well as users who have migrated to a different state in the previous year.	https://data.humdata.org/dataset/76f85e19-9b9a-45d4-977c-7a563e8f75d3/resource/e1826a77-691d-4b2e-a5f5-c1956e283a14/download/open_one_time_covid_impact.csv
20	HERA - Humanitarian Emergency Response Africa	Cases and deaths	Since the outbreak began, Ethiopia has had COVID-19 cases (infections, recoveries, deaths, and cumulative cases) as contained in this dataset	https://globalhealth5050.org/?covid-data=datasettable&extype=csv
21	HDX	Cases and deaths	This dataset shows the number of confirmed cases, recoveries, and fatalities in Palestine as a result of the COVID-19 pandemic.	https://docs.google.com/spreadsheets/d/e/2PACX-1vSLwvIS7euU8VhMkrijPKU-3IzOPQU01et7zWn8o7EFMqE1NApp-ITX6dpLP-2peUJmeZalrmrkNN_J/pub?gid=1539509351&single=true&output=csv
22	<u>Qatar Computing Research Institute</u>	Social Media	At three layers, this dataset depicts the geographical distribution of Twitter users and messages connected to the COVID-19 pandemic. The AIDR system gathered and analyzed the information.	https://data.humdata.org/dataset/70c2c71b-1322-4d44-83fc-6135e450b098/resource/06394e45-2833-490b-a15a-6562bfe0fe6e/download/cc_geo_place.xlsx



23	United Nations Development Coordination Office	Socio-economic	An inter-agency task committee led by UNDP and DCO produced the UN framework for the immediate socio-economic response to COVID-19 (approved in April 2020) to guide the reaction over the next 12 to 18 months. UN entities established a simple monitoring framework with 18 programming indicators to gauge the UN's support for the socioeconomic response and recovery (endorsed by the UNSDG in July 2020). Lead entities were nominated to lead the production of methodological notes for each indicator and the collection of data at the country level, based on their mandate and comparative advantage. Every quarter, through UN Info, these main bodies reported the collective UN results through the Office of the Resident Coordinators. By March 2021, all 2020 statistics had been reported. This is the first thorough assessment of the UN development system's collective programming contribution and outcomes.	https://data.humdata.org/dataset/6b32fade-9f68-4269-b3e2-308aab2a22d6/resource/a69f5f7e-0bae-491e-be79-991bb72ec8e5/download/serp-programme-indicators-results-2020.xlsm
24	Metabiota	Websites	The dataset comprises data from multiple sources at multiple spatial resolutions in cumulative and non-cumulative forms. This repository is designed to give a single point of access to data from a variety of sources.	https://data.humdata.org/dataset/c8b99f91-79be-46f9-a6f0-4bd92cee959c/resource/8403502a-5c61-4a17-9567-dd1c50829f0f/download/data_ncov2019.csv
25	Mobile Accord. Inc. (GeoPoll)	Vaccination	SMS conducted this research in late November in Côte d'Ivoire, the Democratic Republic of Congo, Kenya, Mozambique, Nigeria, and South Africa. The continued effects of COVID-19 on finances, physical and mental health and consumer spending are all discussed. The study also looks at people's opinions on vaccine safety and effectiveness, as well as their willingness to get the COVID-19 vaccine.	https://data.humdata.org/dataset/42f41a4b-17d6-4897-92f5-5369766a1509/resource/3ced8ae-1a92-469b-9018-b2ef38f0824d/download/geopoll-year-end-study-raw-data_no-adm.xlsx

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