Preventing Transmission of Respiratory Infectious Diseases

Subjects: Computer Science, Information Systems

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(This entry belongs to Entry Collection "COVID-19")

Definition

With the growing concern about the spread of new respiratory infectious diseases, several studies involving the application of technology in the prevention of these diseases have been carried out. Among these studies, it is worth highlighting the importance of those focused on the primary forms of prevention, such as social distancing, mask usage, quarantine, among others. This importance arises because, from the emergence of a new disease to the production of immunizers, preventive actions must be taken to reduce contamination and fatalities rates.

1. Introduction

From the emergence of new infectious diseases, new research studies are also being carried out in order to contribute to their treatment motivated not only because of health crisis, but also social and economic impacts. However, until new medications or vaccines are produced, preventive measures are recommended by health organizations in order to reduce transmission among the population, such as social distancing, mask usage, isolation and quarantine [1][2][3].

Being a topic of considerable importance, especially due to the social, health and economic impacts to society, studies focused on the application of technology in the primary forms of prevention of new infectious diseases have attracted much attention and concern from institutions and researchers.

The scope of this SLR was to identify relevant studies that adopt information technology solutions in the primary ways of preventing respiratory infectious diseases transmission/spread.

From the findings, it was possible to identify six application domain categories in which there was a greater trend in studies related to pandemic planning and, among the support mechanisms adopted, data and mathematical application-related solutions received greater attention.

2. Results and Discussions

In this section, results and discussions regarding the synthesis and analysis of the data extracted from the selected studies to answer the research questions are presented (including demographic data information).

2.1. Demographic Data

In order to provide an overview of the studies regarding publication venues, citation count, distribution by year of publication and countries, this section presents the demographic information on the selected studies. All included publications are listed in **Table A1** (Appendix A).

Publication Venues and Citation Count

Information regarding publication venues and citations may be potentially useful for researchers interested in conducting research on a relevant topic, as well as partially show the impact of a study, the quality or the maturity of the proposed techniques. This is why it is also important to provide information on the distribution of the selected works on publication venues (as presented in **Table A3**—Appendix A), as well as an overview of the citation count.

Table A4 (Appendix A) presents an overview of the citation count of the selected publications sorted in descending order (information obtained from Google Scholar on 1 August 2021).

From the descending ordered list in **Table A4**, it is possible to identify the publications which were most cited where, comparing the 10 most cited studies with the application domain categories as presented in Section 4.3.1, it is possible to identify that six publications (S5, S101, S102, S116, S125, and S132) adopted approaches focusing on pandemic planning application domain (CD4). Tracking, surveillance and Contact tracing (CD6) application domain contained three studies (S114, S208, and S212), and Healthcare and Clinical management (CD1) one study (S104).

Regarding adopted support mechanisms, analyzing the table mapping presented in Section 4.3.2, from the 10 most cited studies, seven publications (S5, S101, S102, S104, S116, S125, and S132) adopted data and mathematical application related solutions, two studies (S114 and S212) adopted internet of things and hardware, and three studies adopted Software/Systems/Apps/Programing languages as support mechanisms (some studies used more than one category of support mechanism).

In **Figure 1**, the number of selected papers published per year is presented where, from 2020 onwards, a considerable increase in studies can be observed which, as mentioned before, is the period that the COVID-19 pandemic began. In other words, based on these data, it is possible to note that only after a global epidemic crisis emerged that the number of studies focused on the application of technology in primary ways of preventing the transmission of respiratory infectious diseases increased.

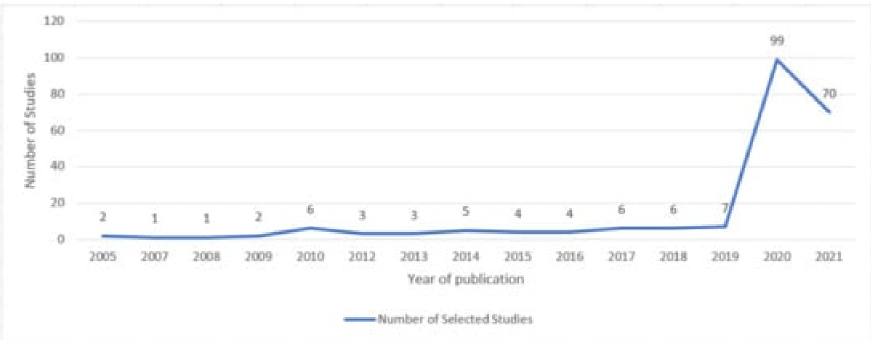

Figure 1. Number of selected papers published per year.

Table A5 (Appendix A) presents the distribution of the papers regarding the domain application categories (see Section 4.3.1) and the authors' institution country. China, United States and India were the countries that presented the largest number of papers (48, 38 and 31, respectively), representing 53.42% of the publications selected in this study.

2.2. Study Quality Assessment

To perform the study quality assessment, the 219 studies were evaluated by the authors adopting the set of questions listed in **Table 1**, which were adopted and adjusted from the work presented by Chen et al. [4] and Dyba et al. [5]. Unlike the quality study proposed by the authors, the questions were not used to select the studies, but to validate the results.

Table 1. Quality assessment questions.

ID	Quality Assessment Question	Yes	Partially	No
Q1	Are the study objectives and goals clearly specified?	218 (99.5%)	1 (0.5%)	0 (0.0%)
Q2	Is the study context clearly defined?	113 (51.6%)	89 (40.6%)	17 (7.8%)

ID	Quality Assessment Question	Yes	Partially	No
Q3	Does the research design support the objectives/goals of the study?	135 (61.6%)	71 (32.4%)	13 (5.9%)
Q4	Does the study have an adequate description of the analysis of the data?	96 (43.8%)	67 (30.6%)	56 (25.6%)
Q5	Does the study present a clear statement of the findings and provide enough data to support them?	79 (36.1%)	81 (37.0%)	59 (26.9%)
Q6	Do researchers critically examine potential bias and/or influence in the study?	3 (1.4%)	33 (15.1%)	183 (83.6%)
Q7	Study limitations are discussed explicitly?	51 (23.3%)	66 (30.1%)	102 (46.6%)

During the analysis of the studies (see Section 3.4), each of the questions was answered according to a ratio scale ("Yes," "No" and "Partially"), in order to obtain information about the credibility of the results. As mentioned by Kitchenhamet et al. [6] and Chen et al. [4], the result of quality assessment may also reveal potential limitations of current research and guide future field studies.

As presented in **Table 1**, the answers regarding the objectives and goals of the studies (Q1) were all positive and, regarding the context definition (Q2), more than 92% of the studies defined them clearly.

Information regarding the nature and type of the organization, adopted software, team experience and research design to achieve the objectives (Q3) was provided in almost 94% of the studies, and about 75% presented an adequate description of the data analysis (Q4) as well as presented a clear statement of the findings (Q5).

However, the greatest concern was about the examination of bias or influence in the study (Q6), where about 83% did not provide enough (or any) information, as well as in discussions about the study limitations (Q7), where 46.6% of the papers did not present discussions.

2.3. Question Analysis

In the following sub-sections, the analysis and discussions of the research questions will be presented.

2.3.1. Available Approaches (RQ1) and Application Domains (RQ2)

During the studies analysis and information extraction phase, the proposed approaches were identified (descriptions presented in **Table A1**), and the application domains were recognized and grouped into six main categories. **Table 2** presents the proposed application domain categories (the number of studies for each category is presented in parentheses after the category name).

Table 2. Application Domain Categories.

Category	Studies
CD1: Healthcare and Clinical management (59)	S4, S11, S14, S21, S24, S25, S27, S31, S37, S38, S39, S40, S56, S57, S58, S59, S60, S61, S64, S70, S77, S80, S88, S89, S92, S93, S95, S103, S104, S112, S123, S126, S127, S133, S137, S139, S140, S141, S150, S151, S157, S158, S160, S168, S171, S181, S182, S183, S187, S191, S192, S197, S202, S203, S205, S206, S207, S218, S219
CD2: Infection Testing/Screening (14)	S26, S35, S65, S82, S118, S122, S128, S148, S159, S163, S177, S185, S193, S198
CD3: Mask Detection (16)	S6, S8, S47, S63, S74, S75, S76, S106, S107, S108, S121, S142, S143, S144, S152, S178

Category	Studies
CD4: Pandemic Planning (75)	S1, S2, S3, S5, S7, S15, S17, S23, S28, S29, S32, S36, S41, S43, S44, S45, S46, S48, S51, S53, S54, S55, S62, S66, S68, S71, S78, S81, S83, S85, S91, S96, S97, S98, S99, S100, S101, S102, S105, S111, S113, S116, S117, S120, S124, S125, S129, S130, S132, S138, S145, S146, S147, S153, S155, S156, S161, S164, S165, S169, S170, S173, S180, S186, S188, S189, S190, S199, S200, S201, S204, S209, S211, S215, S216
CD5: Quarantine/isolation/containment/social distancing (24)	S10, S16, S19, S22, S30, S50, S52, S69, S79, S84, S90, S109, S110, S119, S131, S135, S167, S172, S174, S179, S184, S194, S195, S213
CD6: Tracking, surveillance, and Contact tracing (31)	S9, S12, S13, S18, S20, S33, S34, S42, S49, S67, S72, S73, S86, S87, S94, S114, S115, S134, S136, S149, S154, S162, S166, S175, S176, S196, S208, S210, S212, S214, S217

The categories descriptions are presented below:

- Healthcare and clinical management (CD1): Category that covers approaches that seek to adopt technological solutions focusing on healthcare, case investigation, medical supplies, among others like the ones that seek to diagnose infected individuals, monitor clinical status, predict clinical outcomes, and provide capacity for telemedicine services, virtual care, and hygiene surveillance.

- Infection testing/screening (CD2): A category that covers approaches focusing on screening/testing individuals for diseases, either assessing for signs of disease in an apparently asymptomatic population, for example, or adopting technology with medical procedures to confirm the diagnosis in individuals.

- Mask detection (CD3): Covers approaches that adopt information technology solutions aiming to detect people who are (or are not) using the protective mask.

- Pandemic Planning (CD4): Covers approaches that aim at the identification/obtainment of new information that can be used or contribute to the prevention and/or control of transmission of infectious diseases, including anticipation of behaviors, transmissions, new outbreaks of epidemics, among others.

- Quarantine/isolation/containment/social distancing (CD5): Category of approaches involving the application of technology in order to restrict the spread of infection through the contribution to social distancing, containment or isolation of indeciduous; for example, monitoring quarantine patients, restricting social contact using global positioning systems or mobile phone applications, among others.

- Tracking, surveillance, and Contact tracing (CD6): Include approaches that aim at the identification, tracking or tracing of individuals who might have come into contact with an infected person in order to tracks viral spread; for example, monitors the spread of infection across locations, or to prevent onward transmission by alerting those who came in contact with the positive case.

Of the selected studies, we can highlight that most of the works (about 61.19%) focused on pandemic planning (CD4) and healthcare and clinical management (CD1) related application domains, obtaining a percentage of about 34.25% for the CD4 category, and 26.94% for the CD1 category.

Regarding tracking, surveillance, and contact tracing (CD6)-related approaches, 31 studies (14.15%) were found and, with respect to Quarantine/isolation/containment/social distancing (CD5) application domain, 24 studies (10.96%) were identified.

Mask detection (CD3) and infection testing/screening (CD2)-related application domains were the ones with the fewest studies with only 7.31% and 6.39%, respectively.

Figure 2 presents the quantitative distribution of studies by application domain category regarding the period of publication, where it is possible to observe that studies related to the categories CD3 and CD5 only appeared after 2020 and it was only in 2019 that studies related to the CD2 category emerged in publications.

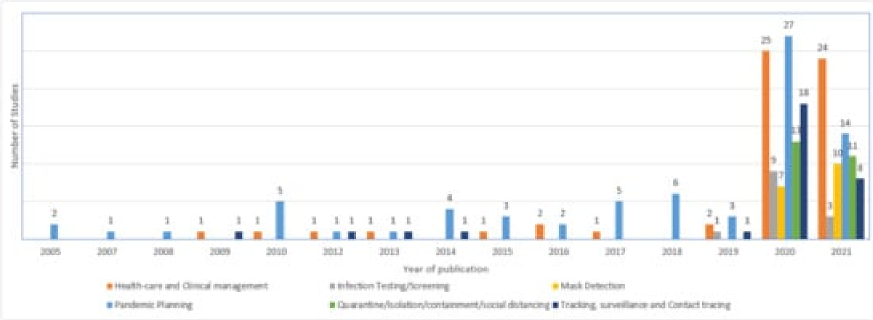

Figure 2. Distribution of studies by application domain and year of publication.

It should be added that the studies were categorized regarding application domains that received greater prominence; although, in some cases, some fell into more than one category. Studies with more than one application domain were: S10 and S693 (CD3 and CD5); S53 and S79 (CD5 and CD6); S82 and S185 (CD2 and CD3); S109 (CD2 and CD5); and S121 (CD1 and CD3).

2.3.2. Adopted Support Mechanisms (RQ3)

After the identification of application domain categories of the selected studies, another important step would be the identification and categorization of the adopted/proposed support mechanisms. The mapping of the identified mechanisms according to the proposed categories (and sub-categories) is presented in **Table 3** (the number of studies for each support mechanism is presented in parentheses).

Table 3. Support Mechanisms.

Category	Sub-Category	Support Mechanism	Studies
	Algorithms, Theories, Mathematical/Statistical Models	Bootstrap Method (1)	S170
		Dijkstra Algorithm (1)	S16
		Discrete Fourier Transform (DFT) model (1)	S65
		General Algorithms, mathematical models/equations (12)	S9, S34, S49, S52, S69, S94, S102, S130, S156, S162, S210, S214
		K-nearest Neighbor Algorithm, Nearest-neighbour distance (2)	S13, S167
		Markov Model, Spatial Temporal Method, Graph Theory, NHPP, Monte Carlo (19)	S17, S18, S23, S34, S36, S44, S51, S53, S62, S85, S99, S101, S111, S116, S129, S149, S154, S215, S216
		Multi-agent (Model/simulation), Equation-based model (13)	S2, S3, S4, S5, S7, S91, S96, S99, S100, S125, S132, S160, S211

Category	Sub-Category	Support Mechanism	Studies
		Multiple Signal Classification (MUSIC) Algorithm (1)	S128
		Optimal Control Theory (1)	S161
		Regression models, Short-term Prediction, RMSE, MAE (5)	S15, S68, S128, S147, S169
		SEIR model, Grey Prediction Model, DSGE Algorithm, SLIR, SIS, SIR (24)	S21, S32, S55, S66, S91, S96, S97, S98, S116, S117, S129, S130, S145, S146, S153, S155, S161, S189, S190, S199, S200, S201, S209, S215
		Self-Propelled Entity Dynamics (SPED) model, LDS—Low Discrepancy Sequence (1)	S164
CS1: Data and Mathematical Application Related Solutions	Artificial intelligence, Deep learning, Machine Learning, Big Data and Data mining	Big Data (5)	S1, S42, S81, S123, S147
		Decision Tree, Regression Tree, CART (5)	S40, S41, S46, S123, S180
		DBSCAN—Density-Based Spatial Clustering of Applications with Noise (1)	S172
		Fuzzy Logic (3)	S125, S171, S192
		Heterogeneous Diffusion Network (1)	S154
		K-means (5)	S33, S44, S180, S214, S217
		LLA—Lexical Link Analysis (1)	S138
		Logistic Regression (10)	S27, S45, S46, S55, S104, S149, S154, S169, S170, S177
		Maximum Entropy Model (1)	S105
		Naive Bayes (2)	S27, S41
		NLP—Natural Language Processing (3)	S103, S137, S158

Category	Sub-Category	Support Mechanism	Studies
		Neural network (CNN, MTCNN, MobileNet, others), Feature Enhancement Module (FEM), Spatial Separable Convolution, SSD (41)	S6, S8, S10, S20, S40, S41, S45, S47, S48, S55, S57, S58, S59, S60, S61, S63, S64, S65, S70, S74, S75, S76, S88, S90, S106, S107, S108, S109, S112, S120, S121, S142, S143, S144, S152, S178, S182, S184, S185, S201, S206
		Random Forest, iForest (5)	S27, S33, S40, S41, S46
		Support Vector Machine (8)	S3, S27, S40, S41, S45, S46, S61, S104
		Vector Space Model (2)	S123, S141
	Market Software/Platform (Proprietary or Free/Open Source)	Android Studio (1)	S71, S135
		AnyLogic, Django Framework (1)	S2
		ArcGIS (3)	S28, S62, S208
		Autodesk Revit/Meshmixer, Rhino3D, AutoCAD, Grasshopper (4)	S83, S110, S188, S199
		AWS—Amazon Web Services (e.g., software, and load Balancer, elastic container, lambda, Greengrass, others) (3)	S12, S62, S137
		Bootstrap, Adobe Photoshop (1)	S204
		Business Model Canvas (BMC), Service Blueprint (1)	S124
		Ethereum (1)	S67
		Google Cloud Platform (2)	S62, S68
		Hadoop (1)	S42
		Hyperledger Fabric (1)	S117
		IOTA Tangle Platform (1)	S71
		Kibana (Elasticsearch) (1)	S62
		MATLAB (1)	S113
		Microsoft Azure Cloud (2)	S70, S78
		NetLogo (1)	S4
		NLTK—Natural Language Toolkit (1)	S158
		Node.js (2)	S62, S137
		Node-RED and Grafana (1)	S136

Category	Sub-Category	Support Mechanism	Studies
CS2: Software/Systems/Apps/Programing languages		OpenCV (2)	S109, S151
		Ultimaker Cura (1)	S110
		Unity Platform (e.g., WebGL, 3D) (3)	S83, S131, S179
		WeChat, WhatsApp, WhatsApp Bot (4)	S93, S109, S111, S117
		Wireshark Dumpcap (1)	S195
		Zoom Platform (1)	S207
	Mobile, Desktop, WEB or Cloud Application/Framework proposed as study contributions	Cloud Application (3)	S12, S31, S35
		Desktop Application (4)	S51, S83, S96, S113
		Mobile Application (24)	S12, S20, S33, S63, S70, S72, S73, S84, S92, S111, S115, S119, S123, S135, S150, S151, S165, S166, S175, S192, S194, S203, S204, S214
		Web Application/Framework (21)	S2, S14, S28, S29, S37, S41, S42, S62, S67, S68, S78, S82, S93, S123, S131, S158, S165, S166, S176, S204, S214
	Programming Languages	C#, C++ (2)	S83, S96
		Java (J2EE, J2ME, JNI, Hibernate) (5)	S14, S28, S37, S73, S92
		JavaScript Libraries/ API (e.g., jQuery, ReactJS, AJAX, Google Web Toolkits, Google Maps) (9)	S2, S67, S28, S29, S72, S151, S166, S196, S204
		PHP (2)	S166, S204
		Python (6)	S2, S83, S96, S158, S199, S216
		Visual Basic (1)	S51
	Data Base Management System	Firebase (4)	S71, S73, S92, S194
		Influx DB (1)	S136
		MongoDB (2)	S2, S42
		MYSQL (3)	S78, S123, S204
		MS Access (1)	S51
		Oracle (1)	S29
		PostgreSQL (2)	S37, S208
		Neo4j (1)	S12
		SQLite (1)	S83

Category	Sub-Category	Support Mechanism	Studies
CS3: Internet of Things and Hardware	*[1]	Wearable devices (e.g.,smartwatches, smartphones, smartbelt, and others) (17)	S19, S27, S40, S54, S56, S69, S70, S79, S111, S115, S139, S157, S163, S175, S181, S195, S213
	Sensors (mobile or fixed), Cameras, RFID (Radio Frequency Identification)	Cameras—photo and video (Fixed and mobile) (11)	S30, S74, S82, S106, S109, S118, S121, S122, S128, S193, S194
		Environment Sensors (e.g., Passive Infrared (PIR) Sensor, and others) (26)	S11, S16, S21, S30, S38, S47, S50, S54, S74, S77, S82, S89, S109, S114, S121, S122, S126, S127, S135, S136, S172, S177, S185, S191, S192, S193
		RFID (Radio Frequency Identification) devices (9)	S13, S27, S30, S35, S50, S182, S185, S192, S196
		Wearable and/or mobile body sensors (e.g., temperature, cough, oxygen, pressure, heart rate measurement) (14)	S21, S25, S26, S27, S31, S35, S44, S69, S86, S87, S118, S157, S159, S181
	Others (e.g., Printers, Spray, Chips, GPS/GSM/Bluetooth devices, WIFI routers, UV tech, WBAN, and others)	Bluetooth/WIFI/GPS/Wireless devices (e.g., module, routers, access point, receivers, SMS gateways, GPS chips, and others) (21)	S9, S18, S26, S31, S44, S50, S84, S86, S123, S124, S134, S136, S142, S148, S172, S175, S194, S196, S207, S212, S219
		Desktops, Laptops, and computer accessories (e.g., memory cards, processors, and other boards) (21)	S25, S31, S39, S47, S74, S86, S109, S114, S121, S123, S134, S136, S137, S139, S185, S191, S192, S197, S198, S207, S219
		Printer and scan devices (3)	S110, S174, S218
		Spray/Dispenser devices (6)	S11, S82, S168, S191, S205, S219
		UV technology (e.g., UVC, UV Chip, UV Led, UV Light, UV ray) (7)	S11, S24, S38, S95, S127, S133, S148
	Robot/Drones	Robot/Drones/Unmanned Aerial Vehicles (UAV) (14)	S18, S22, S43, S80, S90, S127, S140, S167, S173, S183, S187, S198, S205, S218
CS4: Blockchain	*[1]	Blockchain (7)	S43, S67, S71, S117, S162, S173, S186

[1] Fields with "" have no value.

Finishing the studies analysis and extraction of the support mechanisms information, four general categories (and nine sub-categories) were identified and adopted in order to group the selected studies. It should be added that it is common that some studies adopted more than one support mechanism, so they were included in more than one category.

Regarding studies that adopted algorithms, theories, mathematical/statistical models, a greater tendency was observed in the application of SEIR model, Gray Prediction Model, DSGE Algorithm, SLIR, SIS, SIR (24 studies), followed by Markov Model, Spatial Temporal Method, Graph Theory, NHPP, and Monte Carlo (19 studies). This grouping of studies was due to the fact that these studies used most of these mathematical models in their approaches or evaluations.

Regarding studies that applied artificial intelligence, deep learning, machine learning, big data and data mining, the greatest trend of the approaches applications was in neural network, feature enhancement module (FEM), spatial separable convolution, and SSD with a total of 41 studies.

Most of the studies that adopted mathematical models or machine learning focused on prediction for decision-making (or simulations) regarding present or future actions in pandemics, such as vaccination, social isolation, disease transmission and control, among others (see **Table A1** for descriptions of the proposed approaches). In addition to assistance in increasing the capacity and accuracy of identification of infectious diseases cases and their expansion, artificial intelligence, machine learning, and big data also received a lot of attention from studies that focused on screening, contact tracing, and diagnosis of infectious diseases.

Regarding support mechanisms related to software/systems/apps/programing languages (CS2) category (with 66 papers), studies were included that used existing market paid/free software or developed software/mobile apps as research contributions (programming languages and database management systems were also included).

With regard to studies that proposed Mobile, Desktop, WEB or Cloud applications or frameworks (see **Table A1** for details of the approaches), for the case of Web and Cloud applications, there was a trend towards solutions focused on support for decision making, disease surveillance, and issuing alerts of critical areas with higher incidences of disease cases.

For Mobile applications, there was a greater tendence in contact tracing, social distancing, and body-symptoms detection/analysis. Regarding Desktop application, the proposed solutions focused on the containment of infectious disease outbreaks using geographical information with mathematical methods/models' application.

Although many studies have proposed software or mobile apps as contributions in their approaches, there was a lack of detailed information regarding the adopted programming languages and database management systems (see **Table 3**). These situations usually occurred more in studies that also proposed the application of algorithms, theories, mathematical/statistical models and/or artificial intelligence, deep learning, machine learning, big data and data mining (CS2).

Regarding mobile applications, despite the lack of detail in the adopted programming languages or database management systems, most studies reported that the applications were developed with versions available for smartphones with Android and IoS (Apple), except for studies S72, S73, S92, S150, S151, and S194.

Regarding the adoption of internet of things and hardware (category CS3), most studies adopted sensors like environment (26 studies) and body (14 studies) sensors. In the case of environment sensors, there was a greater trend in the adoption for screening potential infectious diseases carriers from distance (e.g., temperature measurement/scanning), local position or movement measurement, automation of devices for hygiene (e.g., hand hygiene), and monitoring occupancy of places (e.g., monitoring elevator occupancy using a Passive Infrared (PIR) sensor).

Regarding studies that adopted wearable and/or mobile body sensors (14 studies), there was a greater tendence towards the verification of a Pearson's heart rate, temperature, blood oxygen level and blood pressure. Video and photo cameras (11 studies) were used in devices such as smartphones, tablets, smart gates, cabins, doors, among other places, in order to collect video and/or image for purposes such as detecting use of masks, population monitoring, among others.

To enable communication between various IoT devices (e.g., mobile devices communicating among each other or with a centralized access point or server), devices with bluetooth/wifi/wireless technology (21 studies) or with RFID technology (9 studies) were adopted.

Desktops, laptops and computer accessories such as memory cards, processors, and other boards (e.g., Raspberry pi, Arduino Uno, BeagleBoard-Xm, AT89S52 microcontroller, and others) have been adopted in 21 studies as accessories for the proposed approaches (see **Table A1** for descriptions of the proposed approaches) or to be adopted with others support mechanisms, as well as printers and scan devices (3 studies). Manufacturer names and device versions were not considered for the mapping of the identified hardware.

Along with sensors and cameras, drones and/or unmanned aerial vehicles were adopted in 14 studies, with a greater tendency in population monitoring for purposes such as information collection of social distancing and contact tracing.

Regarding surface disinfection in private or public spaces (including hand hygiene), automatic sprays and robots were adopted (see **Table A1** for descriptions of the proposed approaches) and, with regard to studies that adopted Blockchain (7 studies), there was also a greater concern with the security in the sending and storage of the user data.

In **Figure 3**, the quantitative distribution of the selected papers by sub-categories of support mechanisms is presented.

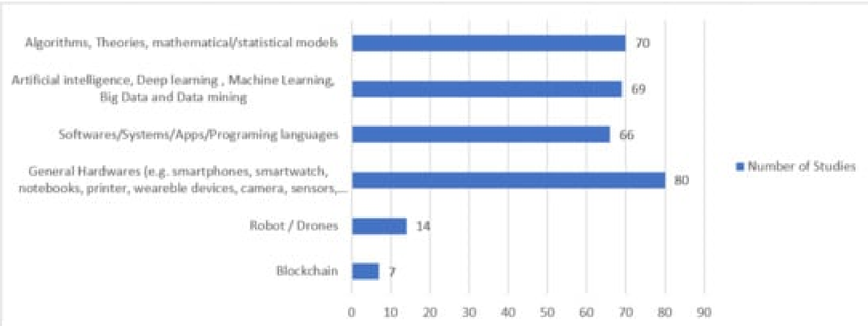

Figure 3. Quantitative distribution of the studies by support mechanisms.

Of the selected studies, there was a greater tendency (139 studies) to adopt data and mathematical application related solutions (CS1), where most studies focused on the application of algorithms mathematical/statistical models (70 studies), and artificial intelligence, deep learning, machine learning, big data and data mining (69 studies).

The second category that showed greater adherence (94 studies) regarding the use/proposal of support mechanisms was related to the general use of internet of things and hardware (CS3) such as, for example, drones, robots, smartphones, smartwatch, wearable devices, camera, sensors, among others.

2.3.3. Available Evidence (RQ4) and Context Application (RQ5)

In order to obtain information regarding available evidence (RQ4) and context application (RQ5), data extraction was performed based on the items presented in **Table 4**, also aiming to investigate the maturity of the selected studies.

Table 4. Summary of items extracted from each study including research questions and quality criteria.

Objective	Item	Objective	Item
General Data	Title	RQ5	Context
	Author(s)	Q1	Objective of the Study
	Publication Year	Q2	Description of the Context
	Venue	Q3	Description of the Research Project
	Paper Summary	Q4	Analysis of the Data
RQ1	Approach	Q5	Conclusions Presentation
RQ2	Application Domain	Q6	Critical Analysis Description
RQ3	Adopted Support Mechanisms	Q7	Description of Limitations and Bias
RQ4	Level of Evidence		

In **Table 5**, the distribution of the studies regarding the evidence levels (as described in **Table 6**) and context application (academic or industrial) is presented (the number of studies for each context/evidence level is presented in parentheses).

Table 5. Study distribution regarding evidence level and context.

Evidence Level	Context	
	Academic (121)	Industrial (98)
0: No evidence (13)	S3, S11, S20, S25, S53, S56, S70, S124, S126, S141, S150, S177, S181,	*[1]
1: Example or demonstration (36)	S1, S5, S9, S12, S26, S30, S31, S33, S36, S50, S67, S69, S79, S81, S82, S84, S87, S101, S107, S127, S133, S134, S140, S146, S163, S165, S166, S175, S179, S185, S191, S193, S197, S208, S213, S214,	*[1]
2: Specialists Notes (7)	S14, S47, S71, S72, S86, S174, S194,	*[1]
3: Experiment in laboratory (117)	S2, S7, S8, S10, S13, S16, S18, S34, S40, S43, S44, S49, S51, S52, S54, S59, S62, S64, S66, S75, S80, S89, S90, S91, S94, S96, S98, S99, S100, S102, S103, S104, S105, S109, S112, S115, S119, S121, S122, S129, S132, S142, S145, S151, S153, S156, S158, S159, S161, S162, S164, S171, S172, S173, S180, S182, S186, S190, S200, S206, S209, S210, S211, S215, S219	S4, S6, S17, S23, S37, S38, S39, S41, S60, S61, S65, S68, S74, S76, S77, S92, S95, S106, S108, S110, S111, S113, S116, S117, S118, S120, S123, S125, S128, S136, S138, S143, S147, S148, S152, S155, S160, S167, S170, S183, S184, S187, S188, S189, S195, S196, S198, S199, S202, S204, S216, S218
4: Empirical Investigation (24)	*[1]	S19, S22, S27, S28, S29, S32, S46, S55, S73, S83, S85, S88, S93, S130, S131, S135, S139, S154, S169, S176, S203, S205, S207, S212,
5: Strict analysis (22)	*[1]	S15, S21, S24, S35, S42, S45, S48, S57, S58, S63, S78, S97, S114, S137, S144, S149, S157, S168, S178, S192, S201, S217

[1] Fields with “” have no value.

Table 6. Levels of Evidence.

Level	Classification	Description
0	No evidence	No evidence was presented regarding evaluation or validation
1	Example or demonstration	Application description is provided with an example to aid its description
2	Specialists Notes	Qualitative or textual assessments are provided. Example: advantages and disadvantages contrasts/comparation
3	Experiment in laboratory	Results are reached from simulations with artificial data in real experiments. Evidence collection is performed formally or informally.
4	Empirical Investigation	Real context investigation of the behavior of the proposed approach
5	Strict analysis	Evaluation/validation of the study is performed using a formal methodology. Example: questions and variables definition for analysis after the application of the approach

From the distribution presented in **Table 5**, only 13 studies did not present any evidence and, regarding demonstrations or examples, 36 studies presented application descriptions in the academic context.

Most studies carried out experiments both in academic contexts (65 studies) with fictitious data, and in industrial contexts (52 studies) with data obtained from real case scenarios. Expert observations such as textual, qualitative or opinion evaluations were provided in eight studies limited to the academic context.

Adding the studies carried out in laboratories (117 papers) with the studies that carried out both empirical investigation (46 papers) and strict analysis (22 papers), it can be seen that studies aimed at preventing the transmission of infectious diseases through the use of technology have, for the most part, some evidence with tests (total of 163 papers).

As the studies analyzed in this systematic review focus on the application of technologies in the primary ways of preventing the transmission of respiratory infectious diseases, it is also interesting to identify the context in relation to the diseases. Thus, **Table 7** presents the distribution of studies regarding diseases in which the use of technology was proposed to contribute to their prevention (the number of studies for each disease category is presented in parentheses).

Table 7. Papers distribution according to the studied diseases.

Diseases	Studies
Infectious diseases in general (using or not some disease as examples) (62)	S1, S3, S4, S5, S13, S21, S23, S28, S29, S36, S37, S42, S49, S53, S76, S85, S96, S101, S103, S105, S111, S113, S117, S118, S122, S123, S124, S126, S128, S129, S130, S132, S133, S146, S147, S149, S150, S151, S154, S156, S159, S160, S161, S162, S164, S165, S168, S172, S173, S177, S181, S182, S186, S187, S196, S197, S204, S208, S211, S213, S215, S219
COVID-19 (139)	S6, S8, S9, S10, S11, S12, S14, S15, S16, S18, S19, S20, S22, S24, S25, S26, S27, S30, S31, S32, S33, S34, S35, S38, S39, S40, S41, S43, S44, S45, S46, S47, S50, S52, S54, S55, S56, S57, S58, S59, S60, S61, S62, S63, S64, S65, S66, S67, S68, S69, S70, S71, S72, S73, S74, S75, S77, S78, S79, S80, S81, S82, S83, S84, S86, 87, S88, S89, S90, S92, S93, S94, S97, S98, S104, S106, S107, S108, S109, S110, S112, S119, S120, S121, S127, S131, S134, S135, S136, S137, S138, S139, S140, S141, S142, S143, S144, S145, S148, S152, S153, S157, S158, S163, S166, S167, S169, S170, S171, S174, S175, S176, S178, S179, S180, S183, S184, S185, S188, S189, S191, S192, S193, S194, S195, S198, S199, S200, S202, S203, S205, S206, S207, S209, S210, S214, 216, S217, S218

Diseases	Studies
Influenza (H1N1, H5N1, and others) (17)	S2, S7, S17, S48, S51, S91, S99, S100, S102, S114, S115, S116, S125, S155, S190, S201, S212
Klebsiella pneumoniae (1)	S195

It should be added that the use of the term “Infectious diseases in general” was adopted to group studies that, despite using or not diseases as an example, have their approach generalized to infectious diseases in general, whose transmission can be reduced through primary forms of prevention, such as social distancing, mask usage, isolation and quarantine. Therefore, they were grouped separately from those studies whose approaches were proposed specifically for the diseases listed in **Table 7**.

As presented in **Table 7**, it is possible to identify a greater concentration of studies focused on the use of technology in the primary ways of preventing COVID-19 (139 studies), followed by infectious diseases in general (62 studies).

3. Conclusions

In the race against the spread of transmissible infectious diseases, there has been a growing interest in the use of technological solutions in the primary ways of preventing the transmission of these diseases.

Due to the importance of the subject, mainly due to its economic and social impact to society, it is equally important to systematically identify, analyze and document what is being carried out and studied, discovering new directions, as well as having a better understanding of how technologies are being used in this scenario, its main objectives, adopted support mechanisms, level of evidence reported, gaps that need to be deepened in research, as well as to organize the knowledge to support the technological transition.

For this purpose, this work presented the design, execution, and results of a comprehensive systematic literature review of relevant studies on information technology applications in the primary ways of prevention of new infectious diseases transmission.

Based on the findings, it was possible to identify issues relevant to interested researchers and practitioners, as well as contributing to the availability of an evidence-based guide to select appropriate technologies, approaches, solutions, or support mechanisms based on the different needs or scenarios.

From the results presented in this literature review, it was possible to identify six application domain categories of the selected studies in which there was a greater trend in studies related to pandemic planning and, among the support mechanisms adopted, data and mathematical application related solutions received greater attention.

From the mapping of support mechanisms carried out, it was also possible to identify a trend towards the application of artificial intelligence, deep learning, and machine learning technologies in primary ways of preventing transmission of respiratory infectious diseases. Thus, a thorough analysis and comparison of these algorithms (e.g., analysis of the success rate of the algorithms) is proposed as future works.

Regarding quality assessment analysis, most of the studies did not provide enough (or any) information about the examination of bias or influence in the study, as well as in discussions about the study limitations. Regarding available evidence, most of the studies presented some evidence (with tests).

From the findings, a greater tendency of studies focused on the use of technology in the primary ways of preventing COVID-19 was identified, followed by infectious diseases in general.

While it cannot be said that the study is exhaustive, it is believed to be a useful resource for interested researchers and practitioners regarding the use of technological solutions in the primary ways of preventing the transmission of infectious diseases.

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Keywords

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