

# Analysis of UV technologies for disinfection of public areas: a systematic literature review

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**Abstract**— At present we live a health problem because of the Covid-19, therefore the study carried out is a systematic review of the different technological UV alternatives that have been developed to reduce the spread of Covid-19 and other pathogens harmful to health, since it has been proven that the UV-C range which is considered to have a very powerful radiation. In the present investigation 34 scientific articles were synthesized, taken from databases such as: Scopus/Elsevier, ScienceDirect, IEEE Xplore, Researchgate. Of these, 39% are oriented towards the health area and 21% are used in the disinfection of public areas. In conclusion, the rates of use of this germicide and how to sterilize by means of ultraviolet radiation were announced.

**Palabras claves:** UV light, Covid-19, technology for disinfection, systematic review.

## I. INTRODUCTION

COVID-19 is an illness resulting from a severe acute respiratory syndrome typically referred to as SARS-CoV-2 virus. According to statistics from the World Health Organization (2020), while the most vulnerable populations are looking for a solution to curb the figures of contagion with different methods of protection and disinfection. Which use chemicals in liquids and gases these can contribute in eliminating pathogens, but would cause damage to the environment, which would become a second problem for humanity. Science has shown that UV technologies help in all aspects of sterilization [14]. Therefore, it could be implemented today in the midst of this health crisis, which by the end of July 2020 had recorded more than 17.03 million confirmed cases worldwide, of which 667,000 deaths have been reported and 9.96 million people have recovered, for a mortality rate of 3.91% [1].

It is also known that humanity has always faced problems in many scenarios that endanger its existence. In this regard, the World Health Organization explained that infections associated with health conditions are a major threat to public health due to the high rate of morbidity and mortality. As a response to this situation, the advance of science and technology has allowed the development of successful alternatives, given the knowledge developed. However, at present, the Covid-19 virus and its relationship with human mobility [2]-[3] is threatening people's health and lives, which is why different solutions are being proposed to deal with its spread and the risks it entails.

For this reason, according to international experiences, forms of disinfection of contaminated public places have been developed by means of mobile UV technology that

would allow people not to access or avoid transit through these places.

Therefore, this research is justified insofar as it seeks to solve a social and technological problem, since, firstly, it seeks to combat a problem that afflicts society; secondly, it is justified insofar as it seeks to test the progress of technology, since the aim is to answer the following question: How much is known about the use of UV technology for the disinfection of contaminated areas?

## II. METHODOLOGY

### A. Search process

For the development of the research, the bibliographic review was consulted in databases, where it was possible to discard articles that did not comply with the indications for the study, the search was supported by the use of keywords according to the scientific orientation of each repository. The main electronic sources and databases used were:

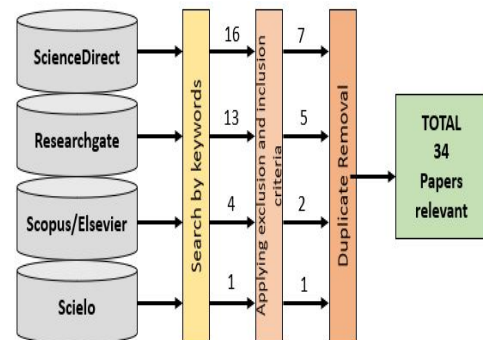


Fig. 1 Extracted and analyzed articles

### B. Inclusion and exclusion criteria

The studies taken into account for the research were eight years old, that is, from 2012 to 2020. Research was taken from the areas of engineering, robotics and medicine in Europe, the United States and Latin America. There were 34 scientific articles from prestigious academic journals taken into account for the research.

TABLE I. TABLE OF CRITERIA FOR RESEARCH ARTICLES

CRITERIA		
Inclusion	I1	Articles with the purpose of knowing the proper use of UV light in disinfection.
	I2	They were found in English and Portuguese
	I3	The publication years are from 2017 to 2020
Exclusion	E1	Some articles talk about the sterilization or elimination of pathogens
	E2	Some types of studies do not apply to engineering, robotics, medicine or public health
	E3	Articles that are not associated with the study variables.
	E4	There were other sources of compilation prior to 2012

### III. RESULTS

#### A. Extracted and analysed articles

The results of the research revolve around the findings of the research, the scientific journals consulted and their stratification by name and year. The process of analysis that was carried out was as follows.

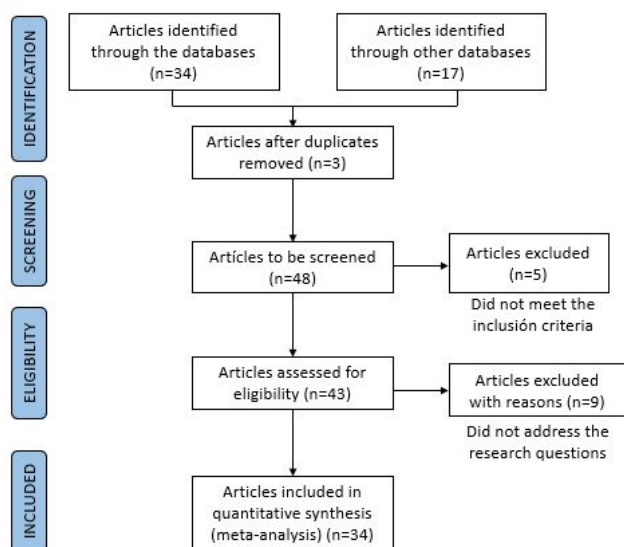


Fig. 2 Prism Diagram Methodology

A total of 12 articles were found to meet the pre-specified inclusion criteria. A total of 4 national and international repositories were used. Figure 2 shows a visual representation of the geographical origin of the studies consulted.

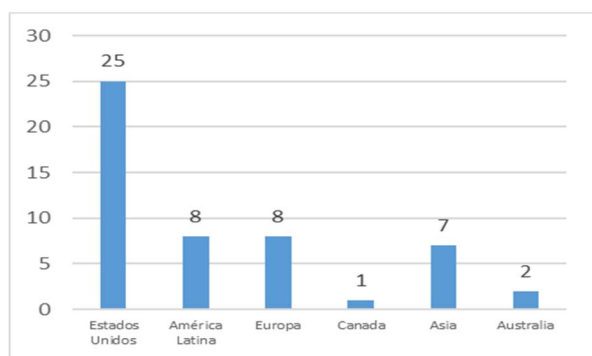


Fig. 3 Representación visual del proceso de análisis

In the following figure it can be seen that 41% of the total articles are oriented to the area of public health, and another 41% to hospital health, while 10% were related to the development and detection of UV energy sources and 8% to the area of instrumentation.

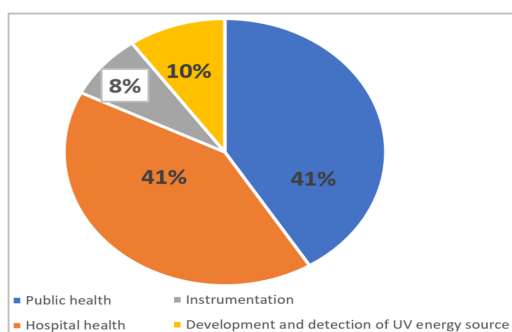


Fig. 4. Percentage distribution of the themes

In the search of diverse repositories to obtain information with respect to the topic of study, it was found in four known databases and others of support, of some universities that discussed the way to decontaminate, to compare the use of the ultraviolet radiation, to disinfect by means of the light UV-C and to eliminate virus with the germicidal methods that are employed at the moment of irradiating the environments from where they will be applied.

TABLE I. CITACION OF PAPER

TEMAS Y FUNCIONALIDAD	REFERENCES
Identification of disinfection methods	[1]
Efficiency of disinfection methods	[2], [5]
Efficiency of automated UV methods to disinfect spaces	[3], [4], [7],[8], [10],[11],[12], [28], [32],[35], [49], [50]
Effectiveness of non-automated UV methods for disinfecting spaces	[15], [16], [17], [18], [20], [22], [23], [27]
Ineffectiveness of UV methods to disinfect spaces	[26], [45]
Effectiveness of UV methods for disinfecting devices	[6], [14], [25], [31], [41], [42], [43]
Susceptibility of Covid 19 to UV methods	[29], [30]
Insufficient evidence of susceptibility of Covid 19 to UV methods	[46]
Covid prevention methods 19	[34]
Reduction of costs in the manufacture of UV equipment	[9]
Detecting the level of UV light in public spaces	[13], [21], [37], [51]
Development and detection of UV energy sources	[38], [39], [40], [44], [47], [48] [19], [24], [33], [36]

TABLE II. CLASSIFICATION OF PAPER ACCORDING TO SCIENTIFIC CONTRIBUTIONS

REFERENCES	UV TECHNOLOGY FOR DISINFECTION
[3], [4], [7], [8], [10], [11], [12], [28], [32], [35], [49], [50]	After the disinfection procedures were based on xenon (PX-UVC) giving as positive samples the use of ultraviolet radiation and at the same time causing negative effects to the immune system.
[15], [16], [17], [18], [20], [22], [23], [27]	They evaluated the cleaning time with the dose of UVC light for the disinfection of nosocomial materials and bacteria
[6], [14], [25], [31], [41], [42], [43]	They used intelligent devices for UV monitoring and prediction in public areas, while evaluating efficiency at the time of disinfection.
[13],[21],[37],[51]	Remote UVC light sources are used in public environments is safe and economical to reduce environmentally transmitted diseases.
[38], [39], [40], [44], [47], [48] [19], [24], [33], [36]	They performed detection methods in ultraviolet light in fields such as bioanalytics or pharmacokinetics, diagnostics in diseases.

According to the articles found and in compliance with the selection criteria, the most relevant to the research were included. Within these journals it was possible to know that the implementation and use of devices that emit ultraviolet light, in public areas, are hospital rooms, among others.

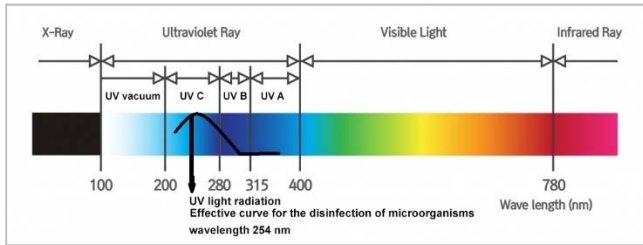


Fig. 5 Ultraviolet sterilization process [32]

Figure 5 represents the function of UV radiation when using type C rays, which is very harmful to people, its wavelength is very short, which makes it more effective in eradicating pathogens.

#### A. Implementation of intelligent devices

Whenever science and technology advance hand in hand, they tend to do a lot to subsist from various diseases that arise, so they make implementations in intelligent devices that help to disinfect quickly and effectively, so they can control the ability to reduce bacteria on surfaces.

TABLE III. SOURCE SELECTION BY STUDY

DEVICE IMPLEMENTATION	
References	Type of study
[3], [4], [7], [11]	Quantitative - Experimental
[10], [12], [32]	Experimental

#### B. Use of ultraviolet radiation in environments

Another relevant aspect of the literature review is that, out of the total number of documents reviewed, 60% of the researches demonstrated feasibility and effectiveness of automated UV methods to disinfect spaces, while only 4% did not have enough evidence to support this postulate. The remaining 36% did not present conclusive evidence that would allow relating their results to the object of study (See Figure 6).

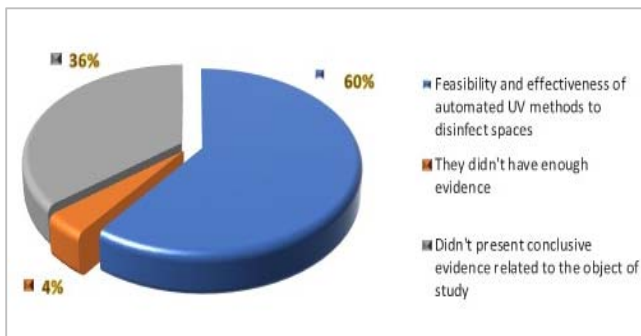


Fig. 6 Percentages of evidence in results

To support the use on surfaces was considered on the dose of germicides next to hydrogen peroxide and based on xenon (PX-UVC) can reduce nosocomial pathogens on the surfaces of hospital places.

TABLE IV. DEGREE OF EFFECTIVENESS OF SCIENTIFIC ARTICLES

N°	Results	Quantity	Reference
1	>75%	3	[38], [44], [19]
2	75%<<90%	4	[48], [24], [33], [47]
3	<95%	3	[39], [36], [40]

## IV. DISCUSIÓN

Many studies have shown that UV light can be used in different ways. According to the Table II, the insufficiency was studied to verify if the UV light is really safe eliminating pathogens from surfaces, Likewise the collected articles demonstrated positivity when possessing effectiveness against pathogens, demonstrating that really is very reliable its use, which other studies have corroborated the effectiveness with different methods to which it can be adapted. It should be noted that in Table III, the different types of rays that UV light has, as well as the times that it should be used, therefore, it was found that UV light type C has greater effectiveness, this has the most powerful radiation to sterilize water, surfaces and air, its advantage is that it is affordable and does not harm the environment. In Table IV, we identify the study carried out as experimental. In Table V, it is worth noting that, by comparing results from different scientific articles, it was possible to see that the use of ultraviolet radiation is 95% effective by adapting it to different methods for its use.

## V. CONCLUSIÓN

According to the research question: How much is known about the use of mobile UV technology for the disinfection of contaminated areas? it is revealed that there are studies on the usefulness of land mobile devices with the use of UV technology to remove and deactivate pathogenic microorganisms from contaminated surfaces in public areas 60%. On the other hand, only 40% of the investigations contemplated in this study did not find sufficient scientific evidence to determine the influence of UV technology on the control of the spread of pathogens in infected areas. From this, it can be concluded that there are sufficient studies on the positive use of this type of technology in the control of the disinfection of contaminated areas. Finally, it is recommended to continue research on UV light to be applied in a variety of situations that require.

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