

## Coronavirus survival time on inanimate surfaces: a systematic review

Tempo de sobrevivência do coronavírus em superfícies inanimadas: uma revisão sistemática

Tiempo de supervivencia del coronavirus en superficies inanimadas: una revisión sistemática

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### **Angela Graciela Deliga Schroder**

ORCID: <https://orcid.org/0000-0002-1852-8423>

Center for advanced studies in Systematic Review and Meta-analysis, Brazil

E-mail: [dra.angela@digitalface.com.br](mailto:dra.angela@digitalface.com.br)

### **José Stechman-Neto**

ORCID: <https://orcid.org/0000-0002-0259-2420>

Tuiuti University of Paraná, Brazil

E-mail: [stechman1@gmail.com](mailto:stechman1@gmail.com)

### **Isabela Bittencourt Basso**

ORCID: <https://orcid.org/0000-0001-9511-047X>

Pontifícia Universidade Católica do Paraná, Brazil

E-mail: [isabelabbasso@hotmail.com](mailto:isabelabbasso@hotmail.com)

### **Flavio Magno Gonçalves**

ORCID: <https://orcid.org/0000-0002-7972-2844>

Tuiuti University of Paraná, Brazil

E-mail: [flaviomagno93@yahoo.com.br](mailto:flaviomagno93@yahoo.com.br)

### **Bianca L. Cavalcante Leão**

ORCID: <https://orcid.org/0000-0002-6170-1914>

Tuiuti University of Paraná, Brazil

E-mail: [bianca.leao@utp.br](mailto:bianca.leao@utp.br)

### **Glória Cortz Ravazzi**

ORCID: <https://orcid.org/0000-0002-6574-9878>

Tuiuti University of Paraná, Brazil

E-mail: [gcortz87@hotmail.com](mailto:gcortz87@hotmail.com)

### **Bianca Simone Zeigelboim**

ORCID: <https://orcid.org/0000-0003-4871-2683>

Tuiuti University of Paraná, Brazil

E-mail: [bianca.zeigelboim@utp.br](mailto:bianca.zeigelboim@utp.br)

### **Bruna Povh**

ORCID: <https://orcid.org/0000-0003-0624-1465>

Center for advanced studies in Systematic Review and Meta-analysis, Brazil

E-mail: [bruna\\_povh3@hotmail.com](mailto:bruna_povh3@hotmail.com)

### **Odilon Guariza-Filho**

ORCID: <https://orcid.org/0000-0001-9799-1223>

Pontifícia Universidade Católica do Paraná, Brazil

E-mail: [odilongfilho@gmail.com](mailto:odilongfilho@gmail.com)

### **Rosane Sampaio Santos**

ORCID: <https://orcid.org/0000-0001-6400-5706>

Tuiuti University of Paraná, Brazil

E-mail: [rosane.santos2@utp.br](mailto:rosane.santos2@utp.br)

### **Cristiano Miranda de Araujo**

ORCID: <https://orcid.org/0000-0003-1325-4248>

Tuiuti University of Paraná, Brazil

E-mail: [cristiano.araujo@utp.br](mailto:cristiano.araujo@utp.br)

## **Abstract**

This systematic review aimed to study the survival time of the virus from the coronaviridae family on various materials and surfaces, thus enabling the adoption of preventive measures mainly in public environments. The electronic databases selected as a source of information were PubMed/Medline, Excerpta Medica database (EMBASE), Latin American and Caribbean Literature in Health Sciences (LILACS), Web of Science, Scopus, and LIVIVO; grey literature (Google Scholar, ProQuest, and OpenGrey) was also examined. The last electronic search of the six databases retrieved 4287 references. After removing the duplicate references, the titles and abstracts (phase 1) were read, and 37 articles were selected for complete reading (phase 2), which resulted in 13 included studies. All the studies evaluated coronavirus survival on the following surfaces and objects: stainless steel, glass, plastic, wood, metal, cloth, paper, cotton, latex, polystyrene petri dish, aluminium, copper, cardboard, Teflon, polyvinyl chloride (PVC), silicone rubber and disposable fabric. On surfaces such as glass, plastic, and steel, the virus has greater

stability than it does on copper, fabric, paper, and cardboard. The conditions of temperature, relative humidity, absorption power, and texture were also considered important factors in the survival of the virus.

**Keywords:** Coronavirus; Covid-19; Surface; Environment.

### Resumo

Esta revisão sistemática teve como objetivo estudar o tempo de sobrevivência do vírus da família coronaviridae em diversos materiais e superfícies, possibilitando assim a adoção de medidas preventivas principalmente em ambientes públicos. As bases de dados eletrônicas selecionadas como fonte de informação foram PubMed / Medline, base de dados Excerpta Medica (EMBASE), Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS), Web of Science, Scopus e LIVIVO; literatura cinzenta (Google Scholar, ProQuest e OpenGrey) também foi examinada. A última busca eletrônica das seis bases de dados recuperou 4.287 referências. Após a retirada das referências duplicadas, os títulos e resumos (fase 1) foram lidos e 37 artigos foram selecionados para leitura completa (fase 2), o que resultou em 13 estudos incluídos. Todos os estudos avaliaram a sobrevivência do coronavírus nas seguintes superfícies e objetos: aço inoxidável, vidro, plástico, madeira, metal, tecido, papel, algodão, látex, placa de petri de poliestireno, alumínio, cobre, papelão, Teflon, cloreto de polivinila (PVC), borracha de silicone e tecido descartável. Em superfícies como vidro, plástico e aço, o vírus tem maior estabilidade do que em cobre, tecido, papel e papelão. As condições de temperatura, umidade relativa, poder de absorção e textura também foram considerados fatores importantes na sobrevivência do vírus.

**Palavras-chave:** Coronavírus; Covid-19; Superfície; Ambiente.

### Resumen

Esta revisión sistemática tuvo como objetivo estudiar el tiempo de supervivencia del virus de la familia coronaviridae en diversos materiales y superficies, permitiendo así la adopción de medidas preventivas principalmente en entornos públicos. Las bases de datos electrónicas seleccionadas como fuente de información fueron PubMed / Medline, base de datos Excerpta Medica (EMBASE), Literatura Latinoamericana y del Caribe en Ciencias de la Salud (LILACS), Web of Science, Scopus y LIVIVO; También se examinó la literatura gris (Google Scholar, ProQuest y OpenGrey). La última búsqueda electrónica de las seis bases de datos recuperó 4287 referencias. Después de eliminar las referencias duplicadas, se leyeron los títulos y resúmenes (fase 1) y se seleccionaron 37 artículos para lectura completa (fase 2), lo que resultó en 13 estudios incluidos. Todos los estudios evaluaron la supervivencia del coronavirus en las siguientes superficies y objetos: acero inoxidable, vidrio, plástico, madera, metal, tela, papel, algodón, látex, placa petri de poliestireno, aluminio, cobre, cartón, teflón, cloruro de polivinilo (PVC), caucho de silicona y tela desechable. En superficies como vidrio, plástico y acero, el virus tiene mayor estabilidad que en cobre, tela, papel y cartón. Las condiciones de temperatura, humedad relativa, poder de absorción y textura también se consideraron factores importantes en la supervivencia del virus.

**Palabras clave:** Coronavirus; Covid-19; Superficie; Medio ambiente.

## 1. Introduction

The transmission mechanisms of Covid-19, which was declared a pandemic by the World Health Organization (WHO) in March 2020, are currently not fully elucidated. It is known that the primary means of transmission of the virus is through direct contact with the oral, nasal and ocular mucous membranes (Jin et al., 2020; Vinayachandran & Saravanakarthikeyan, 2020), but transmission also occurs indirectly through making contact with surfaces in everyday acts, such as the use of money (Thomas et al., 2008), the use of card payment machines and the recurring use of mobile devices (Pillet et al., 2016).

To limit transmission, precautions must be taken, such as careful personal hygiene, washing one's hands frequently, and wearing masks (Yang, Shang, & Rao, 2020; Zhang, Xu, Li, & Cao, 2020). The use of masks by those who are contaminated has proven to be efficient in reducing the dispersion of these droplets and is even more effective against the transmission of viral diseases than the use of masks by noncontaminated people (Diaz & Smaldone, 2010).

However, indirect transmission is an essential factor, as the droplets dispensed in the air by speech, coughing and/or sneezing (Noti et al., 2012; Tellier, Li, Cowling, & Tang, 2019) can settle on various surfaces (Li et al., 2008) and are thus able to remain virulent for minutes, hours or even days (van Doremalen et al., 2020).

The survival time of the virus on different surfaces and materials should be studied for a better understanding of the management of disinfection and asepsis protocols. In healthcare environments, such as doctor's offices, these protocols must be

adopted more effectively due to the higher possibility of cross-transmission (Meng, Hua, & Bian, 2020; Otter et al., 2016). The assessment of the risks arising from the transmission of coronavirus from surfaces requires data on the survival of this virus on different surfaces and on how that survival is affected by environmental variables, such as temperature (AT) and relative humidity (RH) (Lisa M. Casanova, 2010).

The duration period before the inactivation of the coronavirus on surfaces (liquid, solid or gaseous) is still debated, and it is possible to become infected with the virus by touching surfaces or objects on which the virus is present and then placing one's hands on the mouth, nose or eyes. A recent literature review retrieved only four articles on the subject, from a total of 25 references retrieved from 5 databases, which presented only a summary of the available information (Fiorillo et al., 2020). To date, no systematic review using a broader search strategy that addresses the virus's survival time on inanimate surfaces has been found. Therefore, this systematic review aimed to study the survival time of the virus from the coronaviridae family on various inanimate materials and surfaces, thus enabling the adoption of preventive measures mainly in public environments.

## **2. Methodology**

### **2.1 Study design, protocol and registration**

This review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist, and its protocol was registered on the International Prospective Register of Systematic Reviews (PROSPERO), website under number CRD42020185643.

### **2.2 Eligibility criteria**

The acronym "PECOS" was used to consider the eligibility of studies for this review as follows:

- P = population (inanimate surfaces)
- E = exposition (coronavirus)
- C = comparison (studies with any type of control or even studies that did not use a control group)
- O = outcomes (survival of coronavirus on different kinds of inanimate surfaces)
- S = Study design (in vitro studies)

#### **2.2.1 Inclusion criteria**

In vitro studies were included in which at least one type of surface was evaluated for the survival time of the coronavirus. There was no restriction on the study language or time of publication.

#### **2.2.2 Exclusion criteria**

The following exclusion criteria were applied: a) studies that evaluated only the air/aerosol and not the particles that were deposited on inanimate surfaces; b) studies that evaluated transmission by direct contact (speech, cough, sneeze, handshake); c) studies that only assessed the effect of temperature, air humidity or climate and did not mention the type of surface or the survival time of the virus; d) studies that did not evaluate coronavirus; e) studies that did not assess the outcome of interest or that had incomplete data; and f) descriptive studies, such as reviews, letters, conference abstracts, expert opinions, and case reports.

### **2.3 Information sources and search strategy**

Combinations of words and appropriate truncations were adapted for each of the six electronic databases selected as a

source of information: PubMed/Medline, Excerpta Medica database (EMBASE), Latin American, and Caribbean Literature in Health Sciences (LILACS), Web of Science, Scopus, and LIVIVO. Additionally, grey literature was used as a source of information through Google Scholar, ProQuest, and OpenGrey. The searches of the electronic databases and grey literature were conducted on May 15, 2020; then, references were managed, and duplicate studies were removed using appropriate software (EndNote® X7, Thomson Reuters, Philadelphia, PA). A search strategy for each database is available on the Open Science Framework platform ([https://osf.io/wd796/?view\\_only=e555c6490d7d49aac891bcbb573269d](https://osf.io/wd796/?view_only=e555c6490d7d49aac891bcbb573269d))

A manual search for references was performed on all included studies and according to the most current guidelines in the literature that have addressed the survival time of coronavirus on inanimate surfaces. An expert on the subject was consulted via e-mail to verify any possible publications on the subject and to indicate any relevant articles that could be included.

## **2.4 Study selection**

The selection of articles was carried out in two phases. In the first phase, two reviewers (A.G.D.S. and O.G.F.) independently reviewed the titles and abstracts of all the references. All articles that did not meet the previously established eligibility criteria were excluded at this stage. In the second phase, the same reviewers independently read the full text of the articles selected in the first phase. Whenever there was some disagreement and the lack of consensus persisted even after discussion, a third reviewer (B.L.C.L.) was involved in the final decision. To calibrate the selection of articles, the Kappa coefficient of the agreement was calculated.

To facilitate the independent reading in both phases, the Rayyan website (<http://rayyan.qcri.org>) was used, which shielded the reviewers from all evaluations, and a third member of the team (C.M.A.) acted as moderator.

## **2.5 Data collection process**

Two reviewers (A.G.D.S. and O.G.F.) independently collected the information from the included studies; this information was discussed with two other members of the team (J.S.N. and I.B.B.). The collected data consisted of characteristics of the study (author, year of publication, country, and design of the study), aspects of the surface, factors that can affect the survival time and completion. When data were missing or incomplete in the article, attempts were made to contact the authors to obtain the relevant unpublished information.

## **2.6 Risk of bias in individual studies**

Due to the lack of a specific validated tool for assessing the risk of bias in in vitro studies, the selected studies were evaluated using a risk of bias tool, i.e., the Meta-Analysis of Statistics Assessment and Review Instrument (MASTARI). Two reviewers (O.G.F. and I.B.B.) independently assessed the included studies, and the risk of bias was categorized as “high” when the study had a “yes” score of less than 49%, as “moderate” when the study had a “yes” score between 50% to 69%, and as “low” when the study had a “yes” score of more than 70% for bias risk questions. The domains of this tool that could not be applied to in vitro studies were classified as not applicable (NA).

## **2.7 Summary measures**

Any outcome measure was considered, provided that the outcome of interest was assessed.

### **3. Results**

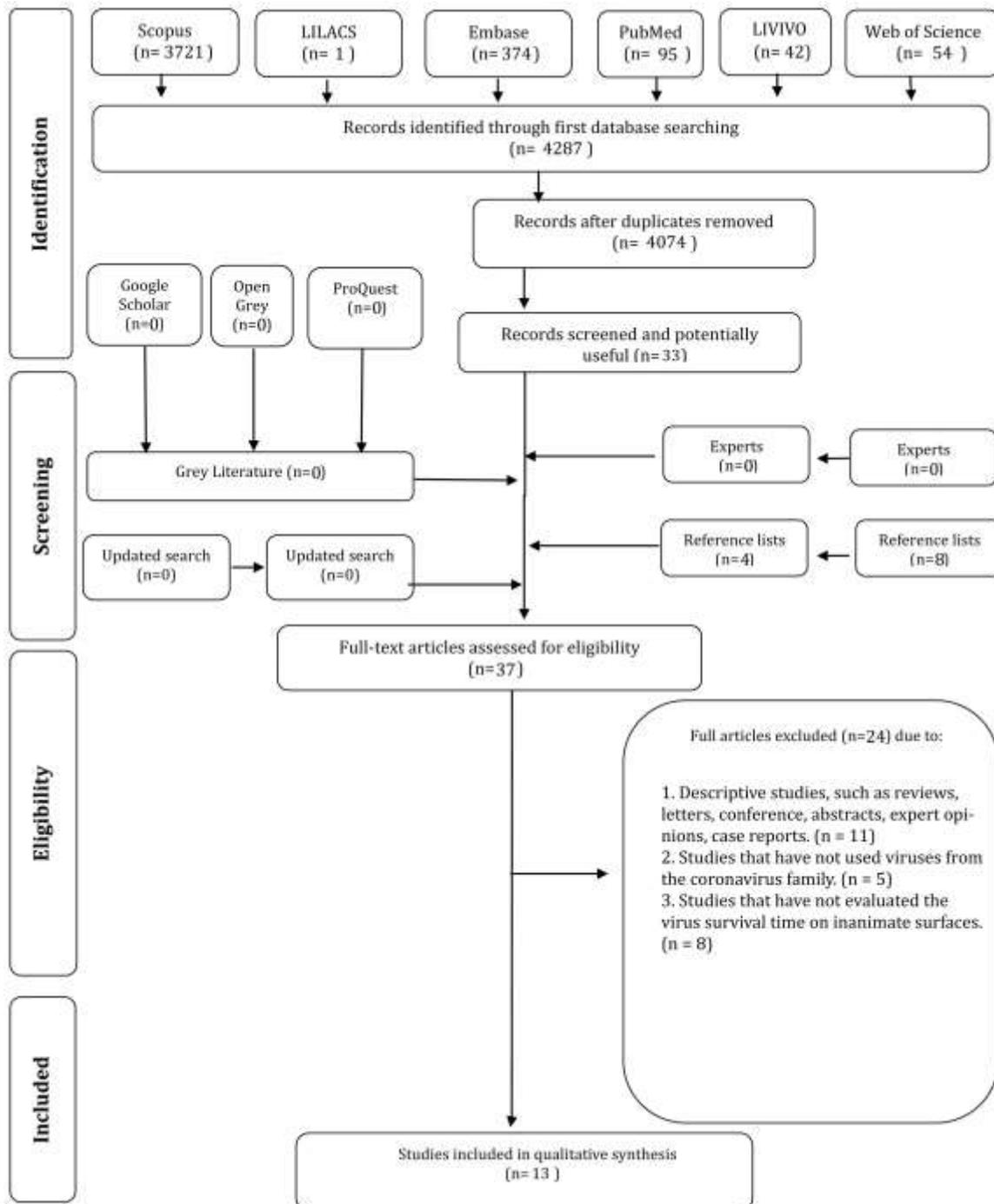
#### **3.1 Study selection**

The last electronic search in the six databases retrieved 4287 references. After removing the duplicate references, the titles and abstracts were read (phase 1), and 33 articles were selected for complete reading (phase 2). Also during phase 1, four additional articles were included from the reference lists, the grey literature, and a consultation with the expert. Finally, after phase 2, 24 articles were excluded, resulting in 13 articles being included for qualitative synthesis (Figure 1). The Kappa coefficient of the agreement value was  $>0.8$ , indicating excellent agreement.

#### **3.2 Study characteristics**

The included articles were published between 2000 and 2020 and were conducted in Germany, Canada, China, the United States of America, Hong Kong and the United Kingdom. All the included studies had an in vitro laboratory design and evaluated the survival of the coronavirus on the following surfaces and objects: stainless steel, glass, plastic, wood, metal, cloth, paper, cotton, latex, polystyrene petri dish, aluminium, copper, cardboard, teflon, polyvinyl chloride (PVC), silicone rubber, disposable fabric (polypropylene material - 35 g/m<sup>2</sup>, coated with a polyethylene film – 15 g/m<sup>2</sup>), surgical masks and N95 respirators. The full description of the included studies is available in Table 1.

**Figure 1.** Flow Diagram of Literature Search and Selection Criteria.



Source: Research data (2021).

**Table 1.** Characteristics of included studies (n = 13).

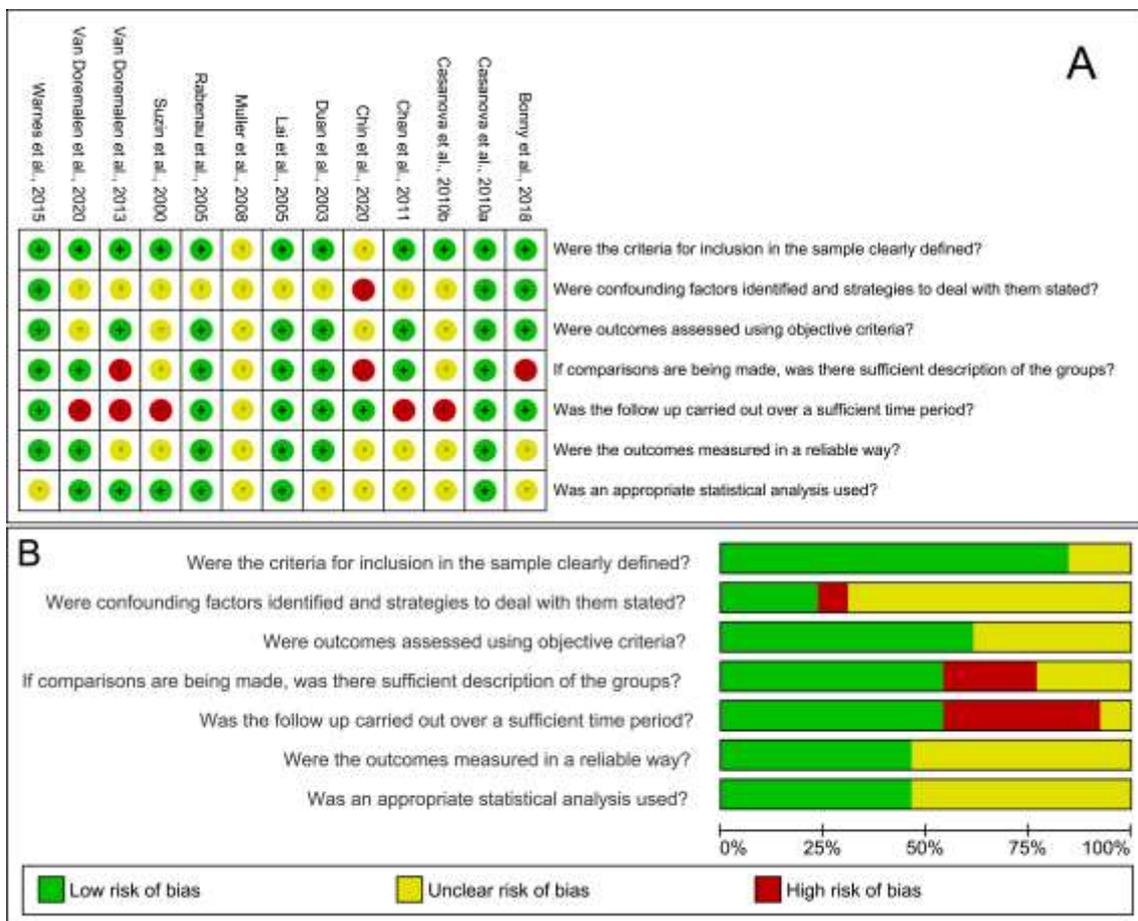
Author, year (Country)	Type of Surface	Virus	Persistence	Conclusions
Bonny et al., 2018 (USA)	stainless steel hard plastic glass	coronavirus 229E	7 days	CoV-229E can remain infectious on environmental surfaces, and potentially poses a biohazard by contact transmission.
Casanova et al., 2010 (USA)	N95, latex gloves, scrub fabric, contact isolation gown, nitrile gloves	TGEV e MHV	at least 4h in all materials and up to 24h in N95 and gown	The potential long-term survive of viruses on contaminated PPE is an important factor when formulating recommendations for removal and handling of used PPE and reuse of PPE in the pandemic setting. It also highlights the continued importance of reinforcing good hand hygiene after PPE removal for preventing the spread of infection.
Casanova et al., 2010 (USA)	Stainless steel	TGEV e MHV	5 to 28 days	Survival data for TGEV and MHV suggest that enveloped viruses may remain infectious on surfaces long enough for people to come into contact with them, representing a risk of exposure that leads to infection and possible transmission of disease.
Chan et al., 2011 (Hong Kong)	Plastic	SARS-CoV	5 days - 2 weeks	SARS-CoV is stable virus that may potentially be transmitted by indirect contact or fomites
Chin et al., 2020 (Hong Kong)	paper tissue paper wood cloth glass banknote stainless steel plastic surgical mask	SARS-CoV-2	paper: 3h; tissue paper: 3h; wood: 2 days; cloth: 2 days; glass: 4 days; banknote: 4 days; stainless steel: 7 days; plastic: 7 days; surgical mask: 7 days	SARS-CoV is more stable on smooth surfaces. Overall, SARS-CoV-2 can be highly stable in a favourable environment, but it is also susceptible to standard disinfection methods
Duan et al., 2003 (China)	Woor board, glass, metal, cloth, paper, filter paper, plastic	SARS-CoV	>72h all surfaces and cotton; >120h on metal, cloth and filter paper	The survival ability of SARS coronavirus in human specimens and in environments seems to be relatively strong. Heating and UV irradiation can efficiently eliminate the viral infectivity.
Lai et al., 2005 (China)	Paper NPA Cotton gown disposable gown	SARS-CoV	paper: < 5 min; NPA: > 7 days; Cotton gown: 5 min; disposable gown: 1h	Paper contaminated with a higher concentration of virus was not infectious after 3h and no viral infectivity was shown after 24h. Transmission through droplet-contaminated paper and cotton grows is unlikely and common household detergents can be effective decontaminating agents.
Muller et al., 2008 (Germany)	Latex gloves, thermometer caps, stethoscopes, plastic table, polystyrene petri dish	HCoV-NL63, human metapneumovirus	up to 7 days	The results support the hypothesis that direct person-to-person transmission is the major route of HMPV and HCoV-NL63 spread. Consequently, contact and droplet isolation of patients seems to be the most important intervention to contain the nosocomial spread of these pathogens.
Rabenau et al., 2005 (Germany)	plastic	SARS-CoV e H-CoV	6 days	Despite its considerably higher environmental stability compared to the previously characterised human coronavirus HCoV-229E, SARS-CoV can easily be inactivated thermally and chemically
Sizun et al., 2000 (Canada)	aluminium, cotton gauze, latex gloves	H-CoV	2h-6h	This study suggests that surfaces and suspensions can be considered as possible sources of contamination that may lead to hospital-acquired infections with HCoV and should be appropriately disinfected.
Van Doremalen et al., 2013 (USA)	Steel and plastic	MERS-CoV	Steel: 48h and 8-24h; plastic	Steel and plastic surfaces do not affect virus stability differently
Van Doremalen et al., 2020 (USA)	Cooper Cardboard stainless steel plastic	SARS-CoV-1 SARS-CoV-2	Cooper: 4-8h; cardboard: 8-24h; stainless steel: up to 72h; plastic: up to 72 h	Our results indicate that aerosol and fomite transmission of SARS-CoV-2 is plausible, since the virus can remain viable and infectious in aerosols for hours and on surfaces up to days.
Warnes et al., 2015 (United Kingdom)	Teflon, PVC, ceramic, glass, Stainless steel, Silicon rubber	H-CoV	5 days for all and 3 days for silicon rubber	Natural contamination of common surface material with very few coronavirus particles could represent a considerable risk of infection spread if touched and transferred to facial mucosa

Source: Research data (2021).

### 3.3 Risk of bias within studies

Six of the included studies had a low risk of bias (Lisa M. Casanova, 2010; Duan et al.; Lai, Cheng, & Lim; Rabenau et al.; Vinayachandran & Saravanakarthikeyan, 2020; Warnes, Little, & Keevil, 2015), one had a moderate risk (Bonny, Yezli, & Lednicky, 2018) and six studies showed a high risk of bias (Lisa M. Casanova, 2010; Chan et al., 2011; Muller, Tillmann, Muller, Simon, & Schildgen, 2008; J. Sizun, M. W. N. Yu, & P. J. Talbot, 2000b; van Doremalen, Bushmaker, & Munster, 2013). All the articles that presented a high risk of bias gave “unclear” as the most common response, thereby increasing the risk of bias due to the lack of information available in the article (Figure 2).

**Figure 2.** Meta-Analysis of Statistics Assessment and Review Instrument (MASTARI) critical appraisal tools. Green indicates a low risk of bias, yellow indicates an unclear risk of bias, and red indicates a high risk of bias. A. Risk of bias summary; B. Graph.



Source: Research data (2021).

### 3.4 Results of individual studies

Coronavirus survived on surfaces over a wide range of RH and temperature levels. High temperatures and high UR levels had a synergistic effect in inactivating the viability of SARS-CoV. In contrast, lower temperatures and low RH levels supported the prolonged survival of the virus on contaminated surfaces (L. M. Casanova, Jeon, Rutala, Weber, & Sobsey, 2010; Chan et al., 2011; Chin et al., 2020). Although the viral inactivation rates were lower at lower temperatures and faster at 50% RH, humidity appeared to have a more significant effect on viral inactivation than temperature. The virus, when deposited on steel at ambient temperatures of approximately 20°C, lost only 1 to 2 log<sub>10</sub> of infectivity in 2 days and survived for at least

three days at 50% RH and for up to 28 days at 20% RH (L. M. Casanova et al., 2010). The SARS-CoV virus survived on plastic for at least two weeks, especially in conditions similar to the humidity and temperatures levels found in air-conditioned environments (Chan et al., 2011); the virus remained stable at temperatures of 4°C, 20°C and 37°C for at least 2 hours without significant change in infectious capacity, but it lost its infectivity after exposure for 90, 60 and 30 minutes at 56°C, 67°C and 75°C, respectively (Duan et al., 2003). Likewise, the MERS-CoV virus was more stable on steel and plastic in conditions with low temperature and low RH. The virus was still recovered after 48 hours at 20°C and 40% humidity, while at 30°C and 80% RH and at 30°C and 30% RH, the virus remained viable for eight and 24 hours, respectively (van Doremalen et al., 2013).

Coronavirus survival, when deposited on personal protective equipment (contact insulation aprons, latex gloves, N95 respirators, hospital scrubs, and nitrile gloves), was detectable on all materials for at least 4 hours. In the N95 respirators and aprons, a small portion of the virus was lost in the first 2 hours, but was still detectable for up to 24 hours (loss of 3 log<sub>10</sub>). In nitrile gloves, latex gloves, and hospital scrubs, the presence of the virus decreased considerably after 4 hours (L. Casanova, Rutala, Weber, & Sobsey, 2010). Chin et al. (2020) observed that a detectable level of the infectious virus was still present on the outer layer of a surgical mask on the seventh day (Chin et al., 2020). When isolating the coronavirus on the surfaces of a classroom (24°C and 50% relative humidity) at a university, it was observed that laminated desktops and the door handle were the most commonly contaminated surfaces, with a reduction of approximately 2.5 log<sub>10</sub> after seven days; however, a significant amount of the virus remained active (Bonny et al., 2018).

Coronavirus survived on eight different surfaces commonly found in a home environment (wood board, glass, mosaic, metal, cloth, press paper, filter paper, and plastic); however, its infectivity decreased significantly after 3 to 4 days of exposure and was almost undetectable after five days at room temperature (Duan et al., 2003). The absorptive power of the material seemed to demonstrate an influence on virus survival. Among the eight tested materials, wood was the material with the lowest infectivity, probably due to its absorptive power (Duan et al., 2003). Likewise, a rapid loss of infectivity was observed for paper and cotton, while on impermeable surfaces, this time was longer, even with a high level of concentration of the virus; i.e., the droplets lost all infectivity after 1 hour in the tissue, in comparison with the 24 hours needed for non-absorbent disposable aprons (Lai, Cheng, & Lim, 2005). When considering the differences between virus survival in suspension or on dry surfaces, there was a lower rate of survival on dry surfaces (Muller et al., 2008; Rabenau et al., 2005; J. Sizun, M. W. Yu, & P. J. Talbot, 2000a).

Segundo Chin et al. (2020) also considered surface texture as a factor that can influence the survival of SARS-CoV-2 (22°C - 65% RH); the authors observed greater stability on smooth surfaces, with the virus surviving for 3 hours on printing paper and silk, two days on wood and fabric, four days on glass and money notes and seven days on stainless steel and plastic (Chin et al., 2020).

Surface composition also showed a relationship with the virus's survival time. Plastic and steel surfaces did not affect stability differently between the coronavirus and the MERS-CoV virus (van Doremalen et al., 2013). On the other hand, the SARS-CoV2 virus showed greater stability on plastic and steel surfaces than on copper and cardboard surfaces, with a viable virus able to be detected up to 72 hours after application on these surfaces. (van Doremalen et al., 2020). Likewise, the Hu-Cov229E virus showed higher inactivation rates when exposed to a surface containing at least 70% copper, with the rate of inactivation being proportional to the percentage of copper (Warnes et al., 2015). In copper, no viable amount of SARS-CoV-2 virus was measured after 4 hours, and no viable amount of SARS-CoV-1 was measured after 8 hours. On cardboard, no viable amount of SARS CoV-2 was measured after 24 hours, and no SARS-CoV-1 was measured after 8 hours (van Doremalen et al., 2020). On other surfaces, such as Teflon, PVC, ceramic, and glass, the virus remained viable for at least five days, while on silicone rubber, it remained viable for three days (21°C and 30-40% RH) (Warnes et al., 2015).

#### 4. Discussion

According to the WHO, the transmission of the SARS-CoV-2 virus can occur through direct contact with infected people or through indirect contact with surfaces or objects that have been contaminated by an infected person (World Health Organization, 2020). Therefore, this systematic review aimed to determine how long coronavirus survives on different inanimate surfaces. The qualitative synthesis of the results demonstrated that the virus's survival time varies according to humidity, temperature, surface absorption power, and texture. Lower temperatures, low RH levels, low absorption power, and smooth surface texture support the virus's prolonged survival.

The condition by viruses is represented by the fact that they do not replicate outside living cells but may persist on surfaces for extended periods (Chan et al., 2011). The results of the present review show that coronavirus can survive on different surfaces for minutes, hours, or days, depending on the environmental condition to which the surface is exposed; however, humidity seems to have a more relevant effect on virus inactivation than other factors. According to the data presented by Duan et al. (2003), coronavirus remains more stable in low-temperature conditions, and the higher the temperature is, the shorter the time required for its inactivation (Duan et al., 2003). On the other hand, this relationship does not seem to show the same linearity when assessing the change in RH. The study by Casanova et al. (2010) showed higher survival or a more significant protective effect in low-RH conditions (20%) and high-RH conditions (80%) than in UR to a moderate degree (50%) (L. M. Casanova et al., 2010). The lack of linearity presented in the relationship between coronavirus survival time and RH and the different temperatures to which surfaces can be exposed make this relationship complex and may explain the different results found in the literature.

Due to the latency period of the virus, surfaces are potential vectors for the transmissibility of infections in the hospital environment and the community (L. Casanova et al., 2010; Chan et al., 2011). The results of this review show that coronavirus, when deposited on personal protective equipment (contact insulation aprons, latex gloves, N95 respirators, hospital scrubs, and nitrile gloves), can survive for at least 4 hours. Even with a high concentration of the virus, the droplets lose infectivity on tissues more quickly than on disposable non-absorbent aprons. According to Sizun et al. (2000), human coronavirus can remain viable for 3 hours on surfaces after drying, although it remains viable for many days in liquid suspension (Sizun et al., 2000a). This evidence must be taken into account regarding the material of the aprons present in the health area, i.e., choosing either disposable materials that can be changed between each patient or fabric coats with greater absorption ability and drying power because of the possible exposure to contaminated droplets.

The constituent components of the surface can also influence the survival time of the coronavirus. Chin et al. (2020) (Chin et al., 2020) reported that surface texture might play an essential role in the stability of the SARS-CoV-2 virus, with smoother surfaces having greater stability. On the other hand, the presence of copper can also influence the behaviour of the virus, with a higher inactivation of the virus occurring when it is exposed to surfaces containing higher amounts of copper in their composition (Warnes et al., 2015). The results of the present review show that coronavirus, when exposed to different materials in the same environmental conditions, survives longer on glass, stainless steel and plastic and, in contrast, has a shorter survival time on cardboard, fabric, wood, copper, and paper. These results can be explained by the characteristics of each material, mainly due to their physical-chemical features, absorption power, and texture.

The limitations of this review must be pointed out, and the heterogeneity of the studies and the different environmental conditions make it impossible to carry out quantitative analysis on the subject. However, the systematic survey of the available evidence on this topic can assist in decision-making involving biosafety in general environments (health related or not) and in public health policies to combat the indirect contamination of SARSCoV-2.

## 5. Conclusion

The results of this systematic review indicate that contaminated surfaces play an important role in the transmission of coronavirus in healthcare environments and the community. On surfaces such as glass, plastic, and steel, the virus has greater stability than it does on copper, fabric, paper, and cardboard. It is concluded that although the virus does not replicate on inanimate surfaces, the survival of coronavirus varies according to the humidity and temperature of the environment. The virus can withstand longer exposure times in environments with low temperatures and low relative humidity levels. For this reason, there is a wide range of coronavirus half-lives in different environments, taking into account the differences in ambient temperature, relative humidity levels, and the physical-chemical characteristics of surfaces.

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