



## Using Environmental Education and Healthy Housing as Strategies for Household-Level Prevention of COVID-19

### Educación ambiental y vivienda saludable como estrategias de prevención del COVID-19 a nivel domiciliario

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### Abstract

**Context:** The COVID-19 is the most recent global health concern that affects human health mainly the respiratory system with more than 170 million people affected by the virus worldwide. Also, Latin America has been emerging as an epicenter of contagion, and transmission is gradually increasing among the communities in each of the countries analyzed. The infection of more than 30 million people in Latin America supposes the construction of new models and habits of public health that promote attitudes to reduce the number of cases and mortality.

**Method:** A proposal was defined based on three frameworks and models—the principle of healthy housing promoted by the Panamerican Health Organization, the four types of knowledge transfer without memorization proposed by the OECD, and the theory of social constructivism (in which knowledge is built from a present reality). This proposal aims to help a community to understand the health risks present at home so that they can prevent the spread of the virus COVID-19 through the use of good practices.

**Results:** The proposal shows categorized risk factors at home that increase the possibility of contagion of COVID-19 and getting infected; also, it presents possible solutions to these factors, which focus on good practices of healthy housing to improve habitability and prevent diseases that also allow the virus to spread.

**Conclusions:** It is necessary to implement strategies that humanize public health problems and that in turn include the

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knowledge that the field of engineering can contribute to solve these problems. In addition, these strategies must emerge from practical work focused on the community. An example of this is the proposal for good practices for healthy housing to prevent the spread of the COVID-19 virus.

**Keywords:** Water quality, constructivism, knowledge transfer, COVID-19.

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## Resumen

**Contexto:** El COVID-19 es el problema de salud global más reciente que afecta la salud humana principalmente el sistema respiratorio con más de 170 millones de personas afectadas por el virus en todo el mundo. Asimismo, América Latina se ha venido perfilando como un epicentro de contagio, y la transmisión va aumentando paulatinamente entre las comunidades de cada uno de los países analizados. La infección de más de 30 millones de personas en América Latina supone la construcción de nuevos modelos y hábitos de salud pública que promuevan actitudes para reducir el número de casos y la mortalidad.

**Método:** Se definió una propuesta basada en tres marcos y modelos: el principio de vivienda saludable promovido por la Organización Panamericana de la Salud, los cuatro tipos de transferencia de conocimiento sin memorización propuestos por la OCDE y la teoría del constructivismo social (en la que se construye el conocimiento) de una realidad presente). Esta propuesta tiene como objetivo ayudar a una comunidad a comprender los riesgos para la salud presentes en el hogar para que puedan prevenir la propagación del virus COVID-19 mediante el uso de buenas prácticas.

**Resultados:** La propuesta expone factores de riesgo categorizados en el hogar que aumentan la posibilidad de contagio y de contagiarse de COVID-19; además, presenta posibles soluciones a estos factores, las cuales se enfocan en buenas prácticas de vivienda saludable para mejorar la habitabilidad y prevenir enfermedades que también permiten la propagación del virus.

**Conclusiones:** Es necesario implementar estrategias que humanicen los problemas de salud pública y que a su vez, incluyan los conocimientos que el campo de la ingeniería puede aportar para solucionar estos problemas. Además, estas estrategias deben surgir de un trabajo práctico centrado en la comunidad. Un ejemplo de ello es la propuesta de buenas prácticas de vivienda saludable para evitar la propagación del virus COVID-19.

**Palabras clave:** Calidad del agua, constructivismo, transferencia de conocimiento, COVID-19.

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## INTRODUCTION

Coronavirus is now a large family of viruses that cause respiratory infections that result in diseases from simple colds to more serious illnesses such as the Middle East Respiratory Syndrome (MERS) or the Severe Acute Respiratory Syndrome (SARS) (WHO, 2004).

In December 31, 2019 the government of the People's Republic of China alerted the World Health Organization about the existence of the outbreak of a new strain of coronavirus, possibly causing a serious disease in humans, which would be referred to as SARS -CoV-2. The International Committee on Taxonomy of Viruses (ICTV) identified the new coronavirus SARS-CoV2 (COVID-19) in the Chinese city of Wuhan (Hubei Province) as the cause of acute respiratory syndromes in humans (Gorbalenya *et al.*, 2020, Lam *et al.*, 2020).

During the next two months, tens of hundreds of COVID-19 cases were detected in southern China with pneumonia symptoms of unknown etiology (De Felice *et al.*, 2020) and considered as an atypical disease under the following criteria: fever ( $\geq 38$  °C); radiographic evidence of pneumonia; low or normal white blood cell count, or low lymphocyte count; central system involvement; and no symptomatic improvement after antimicrobial treatment for 3 to 5 days following standard clinical guidelines.

In this sense, coronaviruses are important pathogens that can affect humans and animals, infecting the respiratory, gastrointestinal, liver, and central systems (Chen *et al.*, 2020). Despite being detected relatively quickly, the virus has shown a facility to spread, thus generating a significant increase of COVID-19 cases throughout the planet in a short period of time.

Currently, the World Health Organization reports 170.051.718 confirmed cases of COVID-19 and 3.540.437 deaths worldwide (as of May 31, 2021). Graph 1 shows the comparison between regions most affected by the virus globally. This graph shows significantly growing infections presented in Americas (67,178,933 infected).

The behavior among countries in Latin America has revealed them as an endemic region, one of the epicenters of the virus worldwide. On the one hand, Brazil has a high number of registered cases, close to seventeen million patients (16.391.930 total cases), and countries such as Argentina and Colombia (3.702.422 cases and 3.342.567 cases, respectively) show a trend indicating exponential increases (Yang *et al.*, 2020).

The guidelines for the spread of epidemics through the World Health Organization indicate that COVID-19 spreads through droplets from the mouth or nose (product of the patient's symptoms) (Yang *et al.*, 2020).

The infection of the person comes from the inhalation of these droplets that contain the virus. The epidemiological care guidelines require certain care and consideration of the contagion as serious: hand washing and use of anti-bacterial components for continuous use, social distancing, and in case of symptoms, quarantine for a total of 15 days.

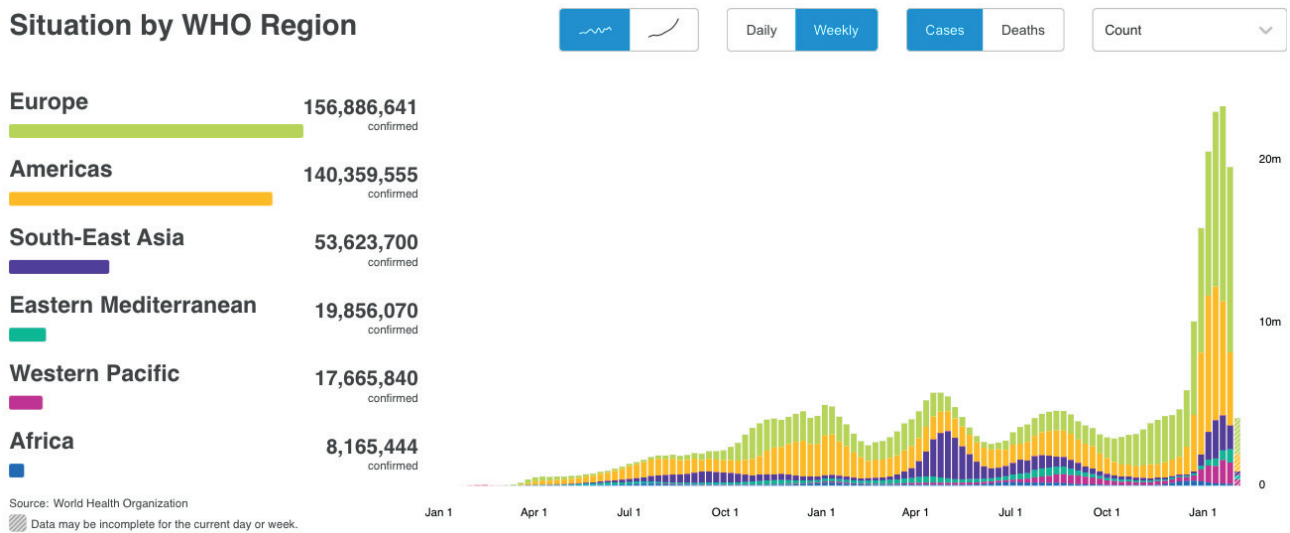


Figure 1. COVID-19 cases by regions. World Health Organization, 2021

Source: <https://covid19.who.int/>

Given the limited knowledge of the disease, the WHO indicates as characteristic symptoms in people infected by COVID-19 dry cough, fatigue, and high fever. On some occasions, some cases have reported nasal congestion, muscle aches, sore throat, conjunctivitis, diarrhea, and alterations in the senses of taste and smell (Chen *et al.*, 2020, Huang *et al.*, 2020).

The governments throughout the world have implemented different policies and actions such as isolation and social distancing to reduce the number of infected cases in their respective countries. Particularly in Latin America, the need to decrease the number of infected and deceased has been a prevailing requirement given the alarming spread of the virus.

Isolation refers to the separation of people who are ill with COVID-19 symptoms and who may be contagious, thus preventing the spread of the disease. The quarantine restricts individual activities and isolates those asymptomatic people who have been exposed to the virus. The main objective is to prevent the spread of the disease, from the moment the exposure happens, after the patient presents any symptoms, and until those symptoms disappear or reduce their intensity. Physical distance of approximately 1.5 meters between individuals is also recommended.

In short, the spread of the disease and the significant advance of the COVID-19 virus has required a series of actions from the different public and private entities that support mitigating the transmission of the virus and reducing the economic impact that has emanated from this problem.

The research group called Management and Technology for the Sustainability of Communities (Faculty of Engineering of the Catholic University of Colombia), the Institute of Technology, Infrastructure, and Territory (Federal University of Latin-American Integration), and the Civil Engineering program of the University of Salerno (Italy) have created a synergy of work under the juxtaposition of objectives with universal social responsibility. This COVID-19 pandemic has produced a need to

promote initiatives to transfer knowledge from different disciplines in various academic and research institutions, that is, information that help to reduce the risk of contagion at home.

The study presented is based on the principle of healthy housing based off a strong social component and community work. This study relates concepts of public health and quality of life in informal communities with a high-risk profile of contagion by COVID-19. Exposure continues in spaces with reduced hygiene (in some cases unhealthy) at home; and poor hygiene and health practices encourage the transmission of this highly contagious virus. Therefore, a study of the variables that help to spread the virus at home was necessary to try and prevent the spread of COVID-19, considering the possibility of contagion in the context of informal homes and inadequate housing designing (which is common in informal homes).

Determining the strategies and new models that intervene positively in informal communities is a technical and academic component for regions with high degrees of vulnerability, and it was also crucial for the development of this study. Thus, adoption of techniques and methodologies throughout the life cycle of the project was part of the process to guarantee sustainability standards that would improve the life of communities that are exposed to COVID-19 infections.

Consequently, this public health emergency in Latin America may also be seen as an opportunity to build better health strategies within different communities and to reduce the problems that trigger health-disease processes.

Understanding the current configuration of a vulnerable community facilitates the creation of new perspectives that may help to rearrange such communities from a social, dynamic, and historical point of view. Addressing norms, values, attitudes, and cultural patterns is fundamental in the analysis of vulnerability to contagion of COVID-19.

Furthermore, the socialization of a project like this, oriented to communities is an essential part of the expansion of new perspectives in the context of urban or social habitat development because communities tend to adopt and endorse technical interventions like this one whether they are a success or a failure.

The construction of processes and strategies allows for the development of sustainable competencies in its four axes—economic, social, environmental, and cultural, to plan new prevention mechanisms to attain good sustainable housing practices. This study represents a new participatory educational model that motivates informal communities to internalize the problems that cause processes of health-disease in the context of housing and to understand the importance of living in healthy environments.

## METHODOLOGY

A relationship was found between the regulations for housing management in vulnerable communities and the incidence and increase of infections in families, and it indicates that the design of

a house should consider systemic components related to public health in terms of the spaces in the house. It also allowed to develop design guidelines in housing that may help to face the current COVID-19 problem, facilitating the teaching-learning process and the transmission of knowledge about this topic ([Organización Panamericana de la Salud, 2003](#)).

The methodology developed shows categories and risk factors in a home that make people more susceptible to the contagion of COVID-19, as well as possible solutions focused on good practices of healthy housebuilding and homemaking.

This proposal supports new ways of awareness of habitat development, both in the communities and in the academic sphere, promoting educational spaces for participatory learning. Therefore, when transferring knowledge to communities in situations of vulnerability due to direct exposure to COVID-19, it is important to transmit community learning skills and their management. In the academic environment, teamwork, managerial participation in the community, and the application of new technologies are encouraged.

To address the issue of health at home, it is necessary to bear in mind the cultural and socio-economic aspect of the population who benefits from it; this will provide necessary elements to communicate and identify their housing reality, proposing pedagogical tools that generate critical thinking and become a bridge between theory and practice. This tool also needs to consider behavior patterns, values, social skills, and the previous knowledge of the community.

This work does not aim for the memorization of data by the people within the addressed community, but that they elaborate their own concepts through the identification and association of their current situation at home, with previously established risk factors.

The objective is to bring awareness to people about the risks associated with the transmission and contagion of COVID-19 and their relationship with unsanitary conditions and incorrect design and hygiene practices at home. This initiative seeks to generate and transmit knowledge from community work, capitalizing on the prevention of COVID-19 transmission from home as an axis of integration; therefore, it is necessary to explain how this work intended to be carried out.

([Sveiby, 1997](#), p.37) proposes that knowledge is “a capacity to act;” it is a dynamic and above all tacit topic that cannot be described in words. The author explains that in the everyday environment of social interaction, the idea of knowledge can be explained with the concept of competences, which contain explicit knowledge, skills, experiences, and value judgments.

The Organization for Economic Cooperation and Development OECD (1996) proposes four types of key knowledge when establishing a transfer of concepts without memorization:

**Know-what:** It refers to the data or specific information about any aspect. For example: How many children and older adults are at risk of COVID-19 infection in vulnerable communities in the country? What kind of good practices in healthy housing have been applied in houses to prevent contagion?

This is encoded knowledge known as “information,” and it is obtained by reading books or accessing databases.

**Know-why:** This is the scientific knowledge of laws and principles of nature, such as knowing the effect that an infectious disease has on a host that lives in a contaminated environment.

The OECD explains that this type of knowledge generates in specialized spaces such as research centers and universities. Like know-what, it is codifiable knowledge easily accessed through books and databases.

**Know-how:** This is the skills to be able to do something. For example, the ability of a person to perform a specific task, such as adapting a living space with grids to promote ventilation in the home. Despite having the list of materials and instructions for its construction, not all people perform this task well because it requires a certain skill based on experience.

**Know-who:** refers to knowing who knows what and who knows how to do what. Its importance lies in the possibility of easily accessing experts inside or outside an organization or community if they are needed.

This knowledge can be encoded and generally develops from social relationships. If one is going to make a locative improvement in a house to upgrade the lighting, and there is no one with experience to do it, there will be a need to look for someone who knows how to do it well. The same applies to the formulation of a project: there will be professionals with a lot of experience who can be entrusted with the task.

(Chaparro, 2001, p. 19) defines Knowledge Societies as “societies with the capacity to generate knowledge about their reality and their environment, and with the capacity to use this knowledge in the process of conceiving, forging, and building their future. That is, to use knowledge in the permanent process of building society, through the development, permanent transformation, and consolidation of its main social institutions.

In this way, knowledge becomes not only an instrument to explain and understand reality, but also an engine of development and a driving force for social change, which is why the educational component is so valuable in the prevention of COVID-19 since it allows a change in behavior within the individual and allows communities to generate knowledge from experience.

Finally, to accomplish the objective of this work the theory of social constructivism was used. This theory states that people construct knowledge together from the knowledge that each of them possesses, which is more than the tacit kind of know-how. Starting from their present reality, which in this case focused on the health emergency caused by COVID-19 and risks generated at home.

From this reality, the social constructivism promotes an internal organization that encourages the formation of teaching communities that ensure the development of participatory instruction; this way it is possible to identify, categorize, apply, and solve a common problem by interacting with others (Cubero Pérez, 2005).

To be clear about this working method, Table I relates the transfer of knowledge to communities from a daily situation that requires clear actions so that people understand how a residential space is likely to promote the transmission of COVID-19.

**Table I.** Knowledge transfer to COVID-19

Learning proposal Social Behaviorism	Types of knowledge (OECD)	Actions / type of knowledge
<p><i>Internal organization:</i>                      Finding relationships within a present reality, which may require favoring association mechanisms to understand and internalize concepts and situation is in the long-term memory.</p>	<p>Know-what                      Know-why</p>	<p><i>Identify.</i>                      It consists of analyzing the information acquired and understanding what and why it is important for a community.</p> <p><i>Categorize.</i>                      It refers to the management of information to establish relationships between facts, concepts, principles, and procedures.</p>
<p><i>Learning Communities:</i>                      The members of a community guided by experts work actively. Members with actions of cooperation and help each other during the learning.</p>	<p>Know-who</p>	<p><i>Apply.</i>                      It implies making use of the knowledge already acquired and reasoning in a participatory way, knowing who does what</p>
<p><i>Participatory instruction:</i>                      The community works with the support of experts to carry out more complex tasks, and in this way, carry out activities in a participatory way where the expert provides a guide and a methodological structure throughout the process, providing the community with more and more responsibility as your competence and experience increase.</p>	<p>Know-how</p>	<p><i>Solve problems:</i>                      From the analyzed information, it is possible to establish causes, consequences, effects and conclusions, and transfer knowledge to the communities</p>

**Source:** Own elaboration, 2021

## RESULTS AND DISCUSSION

Based on what is established in the methodology, a work proposal has been determined that contemplates the four types of knowledge proposed by the OECD and the risk factors in housing are related based off social constructivism and the actions taken by the residents of a community accompanied by good practices in healthy housing to decrease the risk of contagion of COVID-19. With this work structure, it is possible to interact within an educational space with communities that are at greater risk of getting sick with pandemic disease because of ill-fitting designs in their housing units.



**Table II.** Factors and good practices in the face of COVID-19 infections

Risk Factors at Home	Suggested Actions	Good Practices in Healthy Housing	Reference Parameters to Achieve Habitability and Health Conditions	Preventable - Foreseeable Diseases that Intensify the Contagion of COVID-19
Lack of access to drinking water.	Improve drinking water supply	<ul style="list-style-type: none"> <li>● Improvement or installation of the storage tank.</li> <li>● Rush arrangement.</li> <li>● Change of taps.</li> <li>● Build sedimentation systems.</li> <li>● Filtration and disinfection at home.</li> <li>● Install savings systems.</li> </ul>	Minimum vital water of 50 liters per person per day. Ensuring consumption and basic hygiene (WHO, 2004)	Gastrointestinal infections, intestinal parasites, typhoid fever, cholera, diarrhea, leptospirosis, skin diseases, coronary heart diseases, cancer.
Lack of sufficient and separate spaces (Overcrowding).	Promote hygiene and separation of spaces	<ul style="list-style-type: none"> <li>● Good hygiene practices.</li> <li>● Reorganization of spaces.</li> <li>● Manufacture of cleaning and cleaning products with biodegradable materials.</li> <li>● Division of spaces in the house.</li> <li>● Favor privacy.</li> <li>● Installation of doors.</li> <li>● Installation of shower curtains in showers.</li> </ul>	<ul style="list-style-type: none"> <li>● Maximum 3 people per room.</li> <li>● Separation of spaces between kitchen, toilets and rooms.</li> <li>● Exclusive room for parents different from that of children, and rooms separated by gender.</li> <li>● Private spaces (rooms) separated from social (kitchen-dining room) - and circulations-</li> <li>● Width of circulations and stairs minimum of 80cm (MAVDT, 2011).</li> </ul>	Airborne spread of viral infections, tuberculosis and meningococcal diseases, gastroenteritis, skin problems, chest infections and high levels of accidents, mental health problems, depression, domestic violence, dissatisfaction and fear of crime
Inadequate basic sanitation (sanitary units and kitchen).	Review of bathroom and kitchen facilities	<ul style="list-style-type: none"> <li>● Install water savers in toilets and taps.</li> <li>● Manufacture of natural disinfectants.</li> <li>● Use of racks in dishwashers.</li> <li>● Installation of soap dishes and towel racks in bathrooms.</li> <li>● Use of non-porous materials to finish wet areas.</li> </ul>	<ul style="list-style-type: none"> <li>● Wet areas in bathrooms and kitchens veneered and their design should facilitate maintenance (MAVDT, 2011).</li> </ul>	Schistosomiasis, soil-transmitted helminths, vector and rodent diseases, diarrhea, intestinal parasites, stomach cancer and skin diseases.
Air pollution and poor ventilation.	Promote indoor air circulation.  Encourage ventilation of fuel-based kitchens.	<ul style="list-style-type: none"> <li>● Installation of grids.</li> <li>● Manufacture of natural air fresheners.</li> <li>● Manufacture of cleaning products.</li> <li>● Cleaning with biodegradable materials.</li> <li>● Opening windows once a day. Do not smoke in closed spaces.</li> <li>● Maintenance of stove burners.</li> <li>● Review of the connections and / or gas cylinders.</li> </ul>	Minimum ventilation areas for air renewal and hygrothermal comfort: <ul style="list-style-type: none"> <li>● 1/15 to 1/12 of the floor area in rooms and social spaces.</li> <li>● 1/12 to 1/10 of the kitchen and bathroom floor area (NTC 4595).</li> <li>● Ensure ventilation to evacuate gases from the burning of fuels in the kitchen (MAVDT, 2011).</li> </ul>	Acute respiratory infections (Bronchitis and Pneumonia), Perinatal effects, heart diseases, chronic lung diseases  Acute and chronic diseases of the respiratory tract, depression, insecurity, neurosis.

Table II continued from previous page

Risk Factors at Home	Suggested Actions	Good Practices in Healthy Housing	Reference Parameters to Achieve Habitability and Health Conditions	Preventable - Foreseeable Diseases that Intensify the Contagion of COVID-19
Floors, ceilings, and walls with holes or cracks.	Floor, wall and ceiling maintenance	<ul style="list-style-type: none"> <li>● Plug holes in walls, ceiling, doors and windows.</li> <li>● Finished in non-porous material on floors, walls and ceiling (carraplas or graniplas).</li> <li>● Cleaning with biodegradable materials.</li> <li>● Check the adhesive mortar on walls.</li> </ul>	Floors <ul style="list-style-type: none"> <li>● Underlayment tile waterproofing walls.</li> <li>● Use of adhesive mortar in vertical joints.</li> <li>● Use of flanges in wall ties.</li> </ul> Covers <ul style="list-style-type: none"> <li>● Waterproofing of slabs with adequate sloping and leveling.</li> <li>● Decking materials securely anchored.</li> <li>● Slopes and overlaps of material according to technical requirements. (Torres &amp; Arias, 2019)</li> </ul>	Increased mortality from respiratory diseases in children under 5 years of age and in those over 60 years of age, strongyloidiasis, hookworms, accidents, neurosis.
Poor food handling	Correct food storage and handling	<ul style="list-style-type: none"> <li>● Smooth surfaces in the kitchen (counters, tables to prepare food).</li> <li>● Non-perishable food shelf storage with doors.</li> <li>● Respect the cold chain of perishable foods (refrigerators, cold storage in clay).</li> <li>● Cleaning with biodegradable materials and natural disinfectants.</li> <li>● Location of the clean holder and disposable towels.</li> </ul>	<ul style="list-style-type: none"> <li>● Use of space and equipment for cooking, washing and storage off the floor in the kitchen (MAVDT, 2011)</li> </ul>	Poisoning, plague, gastrointestinal infections, diseases due to microbiological toxins, cancer.
Inadequate handling of excreta and solid and liquid waste.	Sewage and garbage disposal.	<ul style="list-style-type: none"> <li>● Separation campaigns at the source.</li> <li>● Waste reduction, reuse and recycling strategies.</li> <li>● Bin location to facilitate temporary and transitional storage.</li> <li>● Toilets connected to the sewer network and in good condition.</li> <li>● Construction of septic tanks, latrines or dry toilets.</li> <li>● Constant hand washing.</li> </ul>	<ul style="list-style-type: none"> <li>● Adequate waste management. In plastic bags and easy-to-clean cans located in a clean and dry place.</li> <li>● The use of elements or designs that facilitate the presence of stagnant water avoided.</li> <li>● The laundry room must have the possibility of covering the water tank (MAVDT, 2011).</li> </ul>	Gastrointestinal infections, intestinal parasites, typhoid fever, cholera, diarrhea, amoebiasis, diseases transmitted by vectors and rodents, wounds, burns.
Clutter and uncleanliness.	House cleaning and care.	<ul style="list-style-type: none"> <li>● Use of personal and household hygiene kits.</li> <li>● Make soap with used cooking oil.</li> <li>● Reorganization of spaces.</li> <li>● Discard items that are not used.</li> <li>● Use of ecological cleaning products.</li> </ul>	<ul style="list-style-type: none"> <li>● Bedrooms should have furniture to store clothes that are easy to clean (MAVDT, 2011)</li> </ul>	Respiratory diseases, skin infections, infectious diseases, diseases transmitted by lice and fleas (Typhus), diseases transmitted by vectors.

Table II continued from previous page

Risk Factors at Home	Suggested Actions	Good Practices in Healthy Housing	Reference Parameters to Achieve Habitability and Health Conditions	Preventable - Foreseeable Diseases that Intensify the Contagion of COVID-19
Lack of comfort in the home (Defects in construction), lighting, temperature, noise, humidity.	Improve lighting, humidity, noise, balance the temperature in the housing unit.	<ul style="list-style-type: none"> <li>• Change of tiles in poor condition.</li> <li>• Installation of skylights.</li> <li>• Relocation of furniture and fixtures.</li> <li>• Organization and / or setting of light bulbs.</li> <li>• Handling of light surfaces (walls, ceilings).</li> <li>• Reinforce the edges of the windows.</li> <li>• Cleaning the house with vinegar solution.</li> <li>• Location of charcoal in the corners that present water vapor.</li> </ul>	Illumination: <ul style="list-style-type: none"> <li>• Bedrooms 50 lux.</li> <li>Headboard in bedrooms 200 lux.</li> <li>• Bathrooms 100 lux.</li> <li>• 100 lux room. Reading space 500 lux.</li> <li>• Dining room 300 lux.</li> <li>• Kitchen 300 lux. 500 lux working area.</li> <li>• 100 lux ladder.</li> <li>• Studio 300 lux.</li> </ul> (Comunidad de Madrid, 2004). Humidity: <ul style="list-style-type: none"> <li>• Comfortable range between 20 % and 80 % relative humidity.</li> </ul> (Ramos <i>et al.</i> , 2017) Noise: <ul style="list-style-type: none"> <li>• Rooms 35dB day and 30dB night.</li> <li>• Corridors and kitchen: 40dB day and 35dB night.</li> <li>• Common access: 50dB day and 40dB night.</li> </ul> (Comunidad de Madrid, 2004). Temperature: <ul style="list-style-type: none"> <li>• Divide into 4 the Annual Average Temperature and this adds 17.2°C.</li> </ul> To this value add and subtract 2.8°C to define the comfort zone or band (Ramos <i>et al.</i> , 2017)	Diseases transmitted by vectors, by rodents, animal bites, by the presence of animal excreta, diseases caused by overcrowding, by the presence of dust and humidity, wounds, respiratory problems (bronchiolitis, pneumonia, rhinitis and asthma), heart diseases and thrombosis, depression, insecurity, neurosis, violence, crime, vandalism, alcoholism, and drug addiction.

Source: Own elaboration, 2021

The proposal seeks to transfer knowledge and build a bridge between theory and practice by identifying, categorizing, applying, and contributing to solve a problem that began recently with the spread of COVID-19, a problem that also occurs because homes do not meet design criteria that provide comfort and safety for their occupants. Table II presents the aspects, practices, and justification from public health of the knowledge that a community must implement in their home to improve habitability based on the concept of healthy housing and promote a theoretical-practical exercise to improve housing and its spaces, while understanding the level of risk to which its residents are exposed everyday due to the public health emergency.

Based off the table above, this study seeks to ensure that communities understand the risks to which they are exposed in their housing units and that they can acquire codified knowledge and improve tacit knowledge they already have to prevent the contagion of this global disease. The skills that communities can internalize in this participatory proposal relate to the following objectives that are set out to justify the importance of the issues presented in Table II:

- Identify the risk factors that are likely to increase the possibility of contagion of COVID-19 at home.
- Promote teamwork to apply the knowledge acquired in the promotion of good practices in healthy housing.
- Understand the dimension of the problem to which they are exposed by relating their home and environment to the identified risks that affect public health and represent a detriment to their quality of life.
- Strengthen relational ties in the community.
- Improve hygiene habits at home to promote healthy spaces that do not promote sources of contagion for COVID-19 or any other virus.
- Improve the skills of the populations around the application of good practices proposed in healthy housing.
- Promote initiatives and identify actors to improve the conditions of family and community life.
- Cope with the pandemic by changing poor hygiene habits and acquiring *know-how* knowledge of localized arrangements with low resources and reorganization of spaces.

Likewise, it is recommended to use situated learning as a didactic strategy to carry out this transfer of knowledge to the communities. This strategy consists of directly connecting those involved in the public health problem with its possible solution.

Therefore, it supposes the construction of knowledge from real situations, not from theories or in a decontextualized way, since the proposed work is framed within the theme of housing and the factors of risk that arise have a direct impact on the probability of contagion of COVID-19 (Ramírez, 2012).

Furthermore, following the good practices in healthy housing that suggest limiting the exposure to the risk factors mentioned above and diseases that increase the probability of contagion of this coronavirus. It is necessary to use linked techniques to situated learning such as working within neighborhoods, presenting specific cases of housing in the sector (with the support of digital materials and virtual spaces if possible), debates, comparison and analogies of similar cases, and practical work focused on good practices in healthy housing. Finally, it is worth noting that communities are

capable of analyzing, reasoning, and criticizing on a real scenario and can motivate the application of alternatives to try to solve a public health problem related to the identified risk factors.

This gives them the possibility to assess good practices in healthy housing that could increase the desire to learn new techniques to improve their livability, reduce the rate of transmission of the COVID- 19, and strive for collaborative community work. Nobody is better than the subject who learns to know what he really knows.

## CONCLUSIONS

- Promoting environmental education and community work is a fundamental part for projects related to engineering work in communities to reach a positive impact and achieve significant improvement of the quality of life. In this case, the good practices implemented aimed at healthy housing to prevent the spread of the COVID-19.
- For integrating processes to study a specific problem, it is important to associate with the communities since their participation makes the process more dynamic and results can be visible in the short term. also, working on risk factors to promote good practices in healthy housing promotes participatory processes and knowledge exchange.
- Good practices in healthy housing can integrate communities into participatory learning, which is inclusive and generated from the current reality of the territories during a pandemic situation to which they are exposed; this involvement is the reason why the promotion of healthy spaces ought to regard these communities.
- The proposal to transfer good healthy housing practices corresponds to communities' request to have solutions that are technically, economically, environmentally, and culturally sustainable. This requires educational processes aimed at communities willing to learn, so that they consider the importance of these practices for their quality of life and to prevent the spread of a virus that has such an impact to public health.
- The share expertise related to issues of public interest promotes selfless interventions from engineering, and it promotes environmental education, sanitation, and achievements of communities that have poorly planned self-built and unhealthy housing.
- The humanization of public health problems and the commitment of engineering in solving them must begin with practical community-oriented work, such as the one proposed from good practices in healthy housing. Society benefits from this, especially in those areas with scarce resources that need effective, immediate, and sustainable solutions to their problems, which in this case is COVID-19 infection.

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