Why COVID-19 affect people differently?

A SCALABLE HEALTH WHITEPAPER

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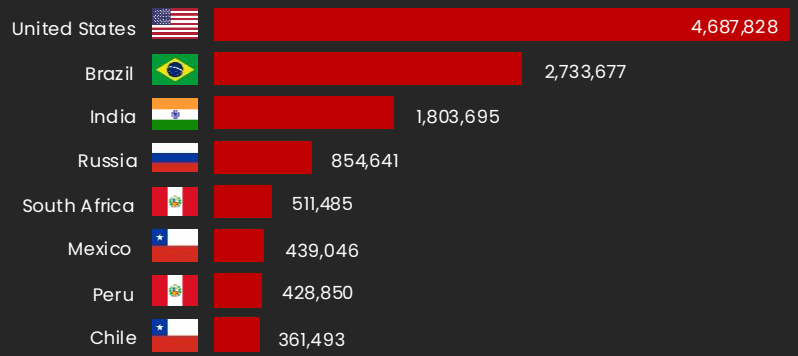
INTRODUCTION

Aside from the shocking rate at which COVID-19 spreads, the global health crisis has caused great unsettle because the symptoms have been different for various individuals. The US Centers for Disease Control and Prevention (CDC) has stated that 81% of those infected with the coronavirus will show few or mild symptoms, others might have to be put on a ventilator to assist them with breathing, and unfortunately for thousands, the virus has led to death.It has been shown that a robust immune system during the incubation period can stop the virus progressing onto more severe effects, lower the amount of the virus in the body and also prevent it from moving to the lungs. On the other hand, an immune system that is too strong can cause the body to react with too much inflammation leading to death.From what we have learned so far, children and younger people and healthy people are more inclined to be asymptomatic.The US has the highest number of confirmed cases and deaths in the world. According to Johns Hopkins, there have been 4,687,828 confirmed COVID-19 cases and 155,062 deaths as of Aug 03, 2020.

The Countries with the most covid-19 cases

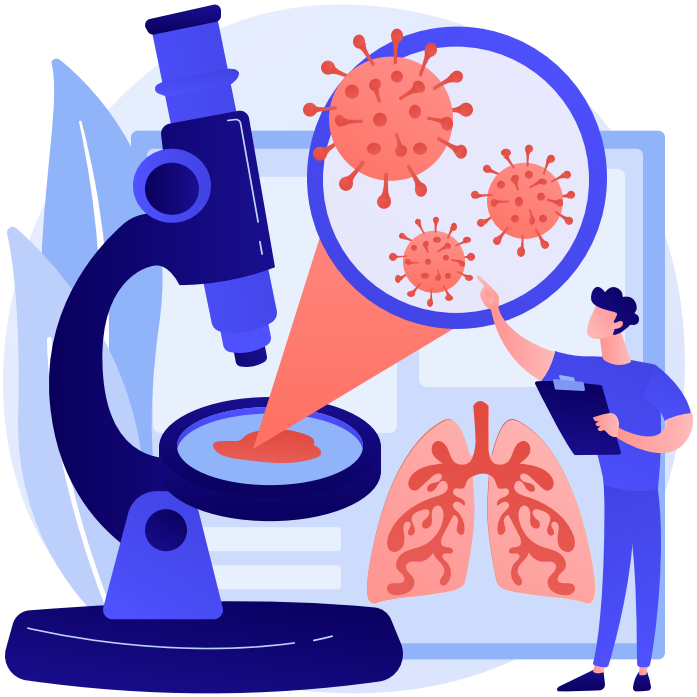
Total number of confirmed COVID-19 cases by country*

Source: Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)



WHAT OCCURS WHEN CORONAVIRUS PASSES INTO THE BODY?

For any virus to survive, it must enter the body so that it can begin to multiply. The virus has an outer shell where a particle will attach to a matching protein receptor, similar to a lock and key. These receptors, known as ACE2, are most frequently found in the lungs, kidneys, heart, and gut. The average incubation period is estimated to be 5 to 6 days; however, it can be as short as one day and up to 14 days. There have been reports which put the incubation period at up to 24 days. Once in the body, the severity of the infection will depend on the body's immune system. The strength of the immune system will impact how the virus develops and manifests.



Comprehensive Immunological Model of COVID-19

The cumulative dose of viral exposure from "donor" to "recipient" is a function of the viral load and shedding from the donor, the time and distance of the contact, and the number of contacts that the same recipient has with different donors.

SARS-COV2/nAbs low ratio:

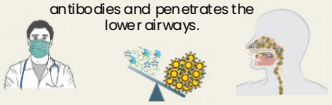
The balance of natural immunity (nIgM, nIgA, MBL) and viral exposure is relevant to decide if SARS-CoV-2 will penetrate the lower airways.

Upper airways:
Natural immunity can block the virus in the upper airways, especially if the dose of exposure is low.

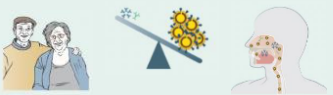
Extreme physical exercise through deep breathing facilitates deeper inhalation of the virus from the upper to the lower airways, and a decline of salivary igA antibodies.

Healing

Massive viral load can overcome normal natural antibodies and penetrates the lower airways.



SARS-COV2/nAbs high ratio



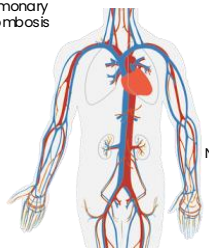
Low medium viral load can overcome minimal natural antibodies and penetrate the lower airways.

Pneumonia

Antibodies limit viral infectivity, but non-neutralizing antibodies may activate the complement system, the coagulation system and concur to cause the cytokine storm, by enhancing the infection ultimately leading to clinical complications.

Pneumonia

Pulmonary thrombosis

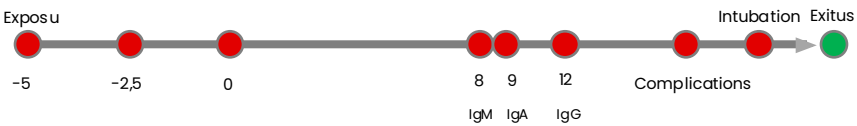


Myocarditis

Nephropathy

MBL and antibodies activate the complement system, the coagulation system and the Il-6 driven cytokine storm, causing complications

Death may be caused by coinfections, kidney or hearth failure, intravasal coagulation disseminated or limited to the lung

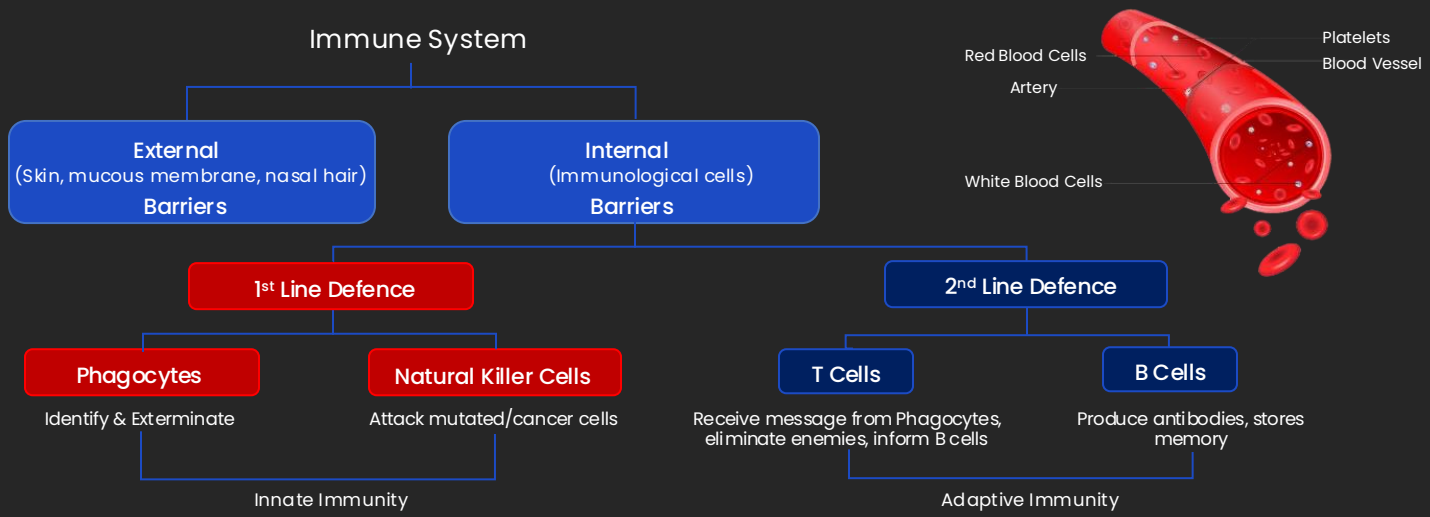


A BRIEF DESCRIPTION OF IMMUNE RESPONSE

The body defends against viruses through two primary mechanisms. First, physical barriers like skin and mucous membranes, alongside tissue-based proteins, provide initial protection. Second, a rapid, general immune response involves white blood cells attacking invading organisms. Despite this, one might expect children to be more vulnerable due to their developing immune systems. Contrary to expectations, children appear to exhibit a more effective natural immune response to coronavirus than adults. Their ability to rapidly clear the virus results in lower viral loads.

Beyond the initial response, we possess an adaptive immune system. While slower to activate, it provides targeted, long-term protection against specific infections. Genetic variations can influence illness severity. Early activation of the adaptive system allows the body to recognize and combat the virus during incubation. A healthy host is essential for an effective adaptive immune response.

The Immune System Our Ultimate Line of Defence



WHAT INFLUENCES HOW SICK YOU BECOME AFTER THE INCUBATION PERIOD?

SARS-CoV-2 will enter the body via the eyes, nose, or throat. If it survives this far, it could find its way to the lungs through the respiratory tract. The virus attaches to an ACE2 receptor in the lungs and begins to replicate itself. This process encourages the immune system to respond by cleaning out the infected cells further. The degree of sickness may also be determined by how much of the virus can make its way deep into the lungs. The fight between the virus and the immune system rages on, and the infected airway linings create excessive amount of fluid. This fluid fills the air sacs, meaning there is less space for oxygen to be transferred and carbon dioxide to be removed.

At this stage, the host will show symptoms of pneumonia, fever, cough with phlegm, and shortness of breath. The virus has been fatal for some due to the body's overreaction to the infection. A group of proteins called cytokines help the immune system respond to attacks on the body by sending signals to the cells. When these CYTOKINES overreact, we get a "cytokine storm." There is a fatal amount of inflammation and organ damage. The most common cause of death from SARS-CoV-2 is ARDS. COVID-19, along with SARS and MERS (previous coronaviruses), causes a buildup of fluid on the lungs or acute respiratory distress syndrome.

It is observed that older adults and those who already have chronic lung disorders are more prone to ARDS, and for this reason they make up a large percentage of overall deaths. We may assume that this group of people has fewer ACE2 receptors in their lungs. This appears counterintuitive, as logically, given the virus's reliance on ACE2 receptors for attachment and replication, one would expect this group to experience less severe effects.

ACE2 plays a crucial role in controlling inflammation. The elderly are at a higher risk of a cytokine storm because of the lower levels of ACE2 receptors. On the contrary, children have higher levels, which could be a reason not to become so sick. There have been some cases where immunosuppression has been able to treat the excessive immune response of those suffering from COVID-19. The research will continue for months, if not years, but from what has been gathered so far, we can learn that specific populations are more affected than others. We will now discuss the severity of COVID-19 on various communities based on the research so far.

Age

The initial identification of individuals over 60 as being at the highest risk for severe symptoms was made by China. Generally speaking, severe or critical symptoms include difficulty in breathing (frequency, blood oxygen levels, and the duration of symptoms), fever, and confusion. Symptoms are considered severe when immediate medical attention is needed.

According to the CDC, the following chart shows the percentage of U.S. patients that showed severe symptoms to need hospitalization.We will now break down the global statistics per age group.

Children under 10 years old

- In Spain, 34 of the 129 cases among children under the age of 10 needed to be hospitalized, 26%. One had to be transferred to the ICU (0.8%), and there have been no deaths.
- According to public sources, there have been no deaths in this age range in Italy, South Korea, or China.

Older children and teens (10 – 19 years old)

- 15 of the 221 cases in this age group in Spain have been hospitalized (7%). While nobody has been admitted to the ICU, but there has been one death (0.4%).
- There have been no fatalities in Italy, South Korea, or the U.S.
- In China, 0.2% of cases within this age range have resulted in death.
- In the U.S., 1.6% of people under the age of 20 have been hospitalized.

It's inaccurate to assume pre-existing conditions are always present in severe COVID-19 cases among the elderly or children. As a CNN report illustrated with a healthy 12-year-old on a ventilator, serious complications can occur without underlying issues. Based on available data, primarily from Spain, older children appear to fare better than younger children, with lower hospitalization rates and reduced risk of severe outcomes in both age groups.

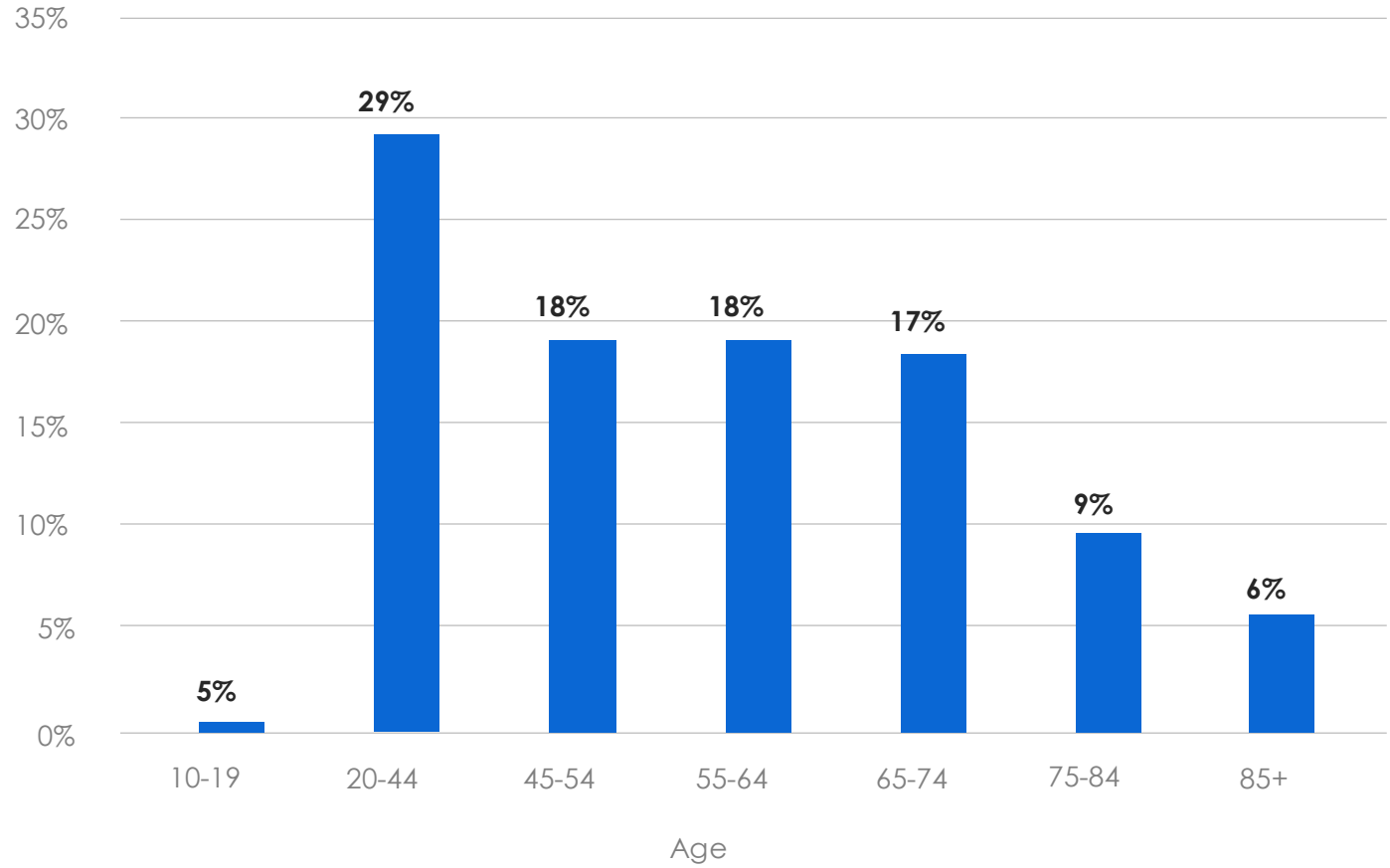
Young adults (20 – 29 years old)

- There have been 1,285 cases within this age range in Spain. One hundred eighty-three have been hospitalized (14%), 8 in the ICU (0.6%), and four people have died (0.3%).
- There have been no deaths in this age range in Italy or South Korea.
- China has reported a 0.2% death rate in this age group.
- The U.S. statistics cover the age group from 20-44 years old; 14.3% have been hospitalized, 2% have been in intensive care, and 0.1% have resulted in death.

According to the CDC, the following chart shows the percentage of U.S. patients that showed severe symptoms to need hospitalization.

Age distribution of U.S COVID-19 cases

Percent share of cases in each age bracket



Adults (30-49)

Spain has seen 5,127 people aged 30 to 49 with COVID-19, 1,028 of these people have had to be hospitalized (20%), 55 in the ICU (1.1%), and 12 people have died (0.2%).

Italy, China, and South Korea have all reported low death rates in this range, 0.3%, 0.2%, and 0.1%.

The CDC reported 21.2% of people aged 45-54 have been hospitalized, 5.4% had been in the ICU, and 0.5% had died.

In Los Angeles, a 34-year-old from Gaza died after being on a ventilator for five days. He was a cancer survivor, so not only those with underlying health conditions but also those who have had health problems and compromised immune systems are at higher risk.

Older adults (50 to 69 years old)

In Spain, there have been 6,045 cases, and 2,166 have been hospitalized (36%), 221 have been in the ICU (3.7%), and 83 people have died (1.4%).

When you look at Italy, South Korea, and China together, the death rate ranges from 0.4% to 3.6%.

In the U.S., the ages were from 55 to 64 years old; 20.5% have been hospitalized, 4.7% in the ICU, and 1.4% have died. For ages 65 to 74, 28.6% were hospitalized, 8.1% in the ICU, and 2.7% of cases ended up with fatalities.

The Elderly (70 and above)

- Spain has seen a 55% hospitalization rate- 3,388 out of 6,152 cases. One hundred ninety-nine people have been to the ICU (3.2%), and 705 people (11.4%) have died.
- Italy, South Korea, and China have fatality rates ranging from 6.2% to 20.2% within this demographic.
- For 75-84-year olds in the U.S., 30.5% have been hospitalized, 10.5% have stayed in the ICU, and there has been a 4.3% death rate. For over 85 years old, 31.3% of cases have ended up in the hospital, 6.3% in the ICU, and 10.4% have resulted in deaths.

All of these statistics point to a common trend: The older you get, the higher the probability of COVID-19 becoming more severe, and the higher risk of death.

THE IMPACT OF OTHER MEDICAL CONDITIONS

Older individuals, often with pre-existing health conditions, are at heightened risk for severe COVID-19 symptoms. However, this vulnerability extends beyond the elderly; certain medical conditions can significantly worsen COVID-19 symptoms in any age group.

- Chronic lung disease or moderate to severe asthma
- Serious heart conditions
- Immunocompromised patients- cancer treatment, smoking, bone marrow/organ transplants, immune deficiencies, immune weakening medications, poorly controlled HIV/AIDS
- Severe obesity (BMI of 40 or above)
- Diabetes
- Chronic kidney disease/dialysis
- Liver disease

Further studies still need to be carried out in this area, but anything that is causing damage to the lungs is going to intensify the symptoms of COVID-19. Medical conditions linked to our organs will change the way our immune system reacts to coronavirus.

Genes

As we have mentioned, it's the ACE2 receptors that play a fundamental role in the infection of COVID-19. Even the slightest alteration in the genetic blueprint of these receptors can determine how sick a person becomes. There is such a range of clinical outcomes from country to country, and one must question the genetic susceptibility, as Andrea Ganna, geneticist, explained to Science Magazine.

There have also been studies on whether a person's blood type can impact the degree of symptoms. A preliminary investigation by scientists in Shenzhen and Wuhan discovered that the symptoms of blood type A were more severe than those with blood type O. That being said, the studies are still in their early days.

Gender

Similar to SARS, influenza, Ebola, and HIV, COVID-19 disproportionately affects men. Hospitalization rates in China showed 58% were male, with similar trends in the US and Italy. Data from Global Health 5050 indicates a male-to-female death ratio of approximately 2:1 in several countries, including Denmark, Greece, Ireland, Italy, and Switzerland.

Possible explanations for the gender disparity in COVID-19 include differences in hygiene habits and biological factors, such as X-chromosome related immune boosts and fewer comorbidities in women.

Gender and infection rates

A higher death ratio doesn't necessarily mean that more men are infected. Greece, Italy, Peru, and Australia do have more men with COVID-19 than women. In Norway, Sweden, and Germany, the ratio is 50/50%. Nevertheless, returning to Denmark, men are twice as likely to die from COVID-19, yet 54% of the infections were in women. It won't be possible to draw complete conclusions for some time, but here are other countries where women have higher infection rates than men.

Percentage of infected women:

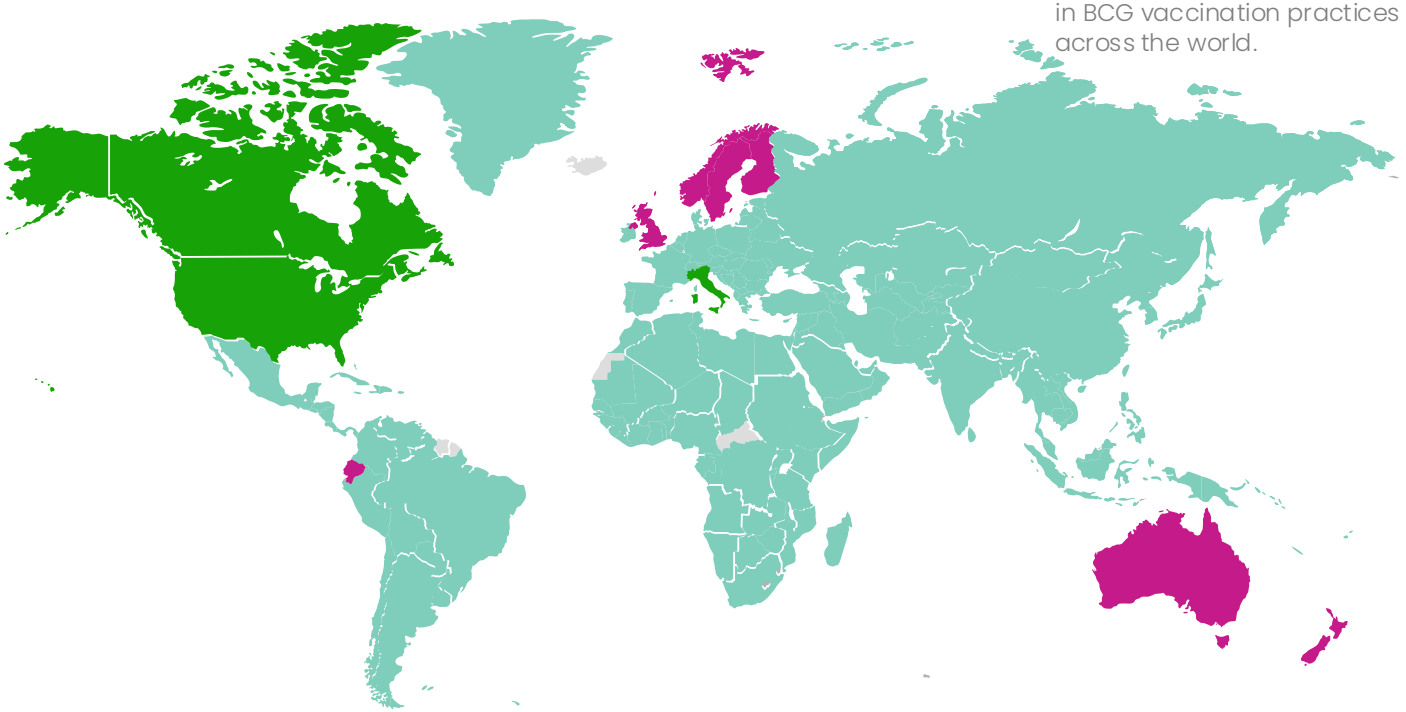
- South Korea-60%
- Portugal-57%
- Belguim-55%
- Switzerland- 53%
- Netherlands-53%
- Canada-52%
- Ireland-52%
- Spain-51%

So why are there more female infections yet more male deaths? Researchers believe it could be down to sex chromosomes and sex hormones that play a part in the response of a person's immune system.

The Impacts of Previous Vaccinations

The BCG (Bacillus Calmette-Guerin) vaccine is obligatory in many countries as protection against tuberculosis. In such countries, there have been fewer cases and deaths from COVID-19. Some of the worst-hit countries like Italy, the US, and the Netherlands do not have this vaccination program.

BCG World Atlas shows variations in BCG vaccination practices across the world.



HOW CAN TECHNOLOGY HELP US WITH THE FIGHT AGAINST COVID-19?

It is today's advanced technology that is going to assist us with finding a vaccine. Until then, it can also help us to track the virus. Artificial Intelligence could help us with prediction, diagnosis, and treatment. Natural-language processing (NLP) algorithms can be used to monitor multiple languages and sources for reports on virus outbreaks. AI can also be used in airports and other areas of transport to track the arrivals and departures of infected people. AI, along with expert human knowledge, can be used to follow the spread of diseases worldwide. Along with flight data and movement patterns information from health organizations, hotspots can be quickly detected. The algorithms used in AI will be able to group data and then analyze it, not only helping to track a disease but also diagnosing it sooner and can enable governments to take action earlier and save thousands of lives.

AI AND COVID-19

AI will be able to accurately predict the likelihood of someone having COVID-19 based on their symptoms. By analyzing patient records, AI could identify those who are in the highest risk groups and underlying health conditions. Equipment and resources can then be concentrated on those who require them most. A mathematical model has already been created and is already at 80% accuracy.

AI will also be used in determining other testing methods rather than the limited viral test kits we have at the moment. Chest x-rays and CT scans are more readily available in hospitals and other medical centers. A solution for the future would be to use AI and deep learning algorithms to analyze chest x-rays and CT scans to determine the difference between COVID-19 and the flu. At the moment, it is too challenging for humans to diagnose COVID-19 in the manner accurately.

Chest X-rays for Progression Monitoring

Daily bedside chest x-rays can monitor the progression of the virus. It takes just seconds for an automated overread. It doesn't require additional work for the radiologists. This will estimate the percentage of the infected lung area and monitor the changes from one chest x-ray to the next.

HOW CAN WE USE MODERN TECHNOLOGY TO REGISTER AND TRACE COVID-19?

Many governments are now discussing the use of apps to monitor people and COVID-19. This will allow access from any device with an internet connection. The apps will be able to register confirmed cases, access daily symptom checks, receive alerts, and send linked contacts who might be at risk.

Then we have wearable devices that can be used to continuously track symptoms after patients have been released from hospitals or even healthy patients who might be at risk. Such devices use a set of data algorithms designed to spot the early symptoms of COVID-19.

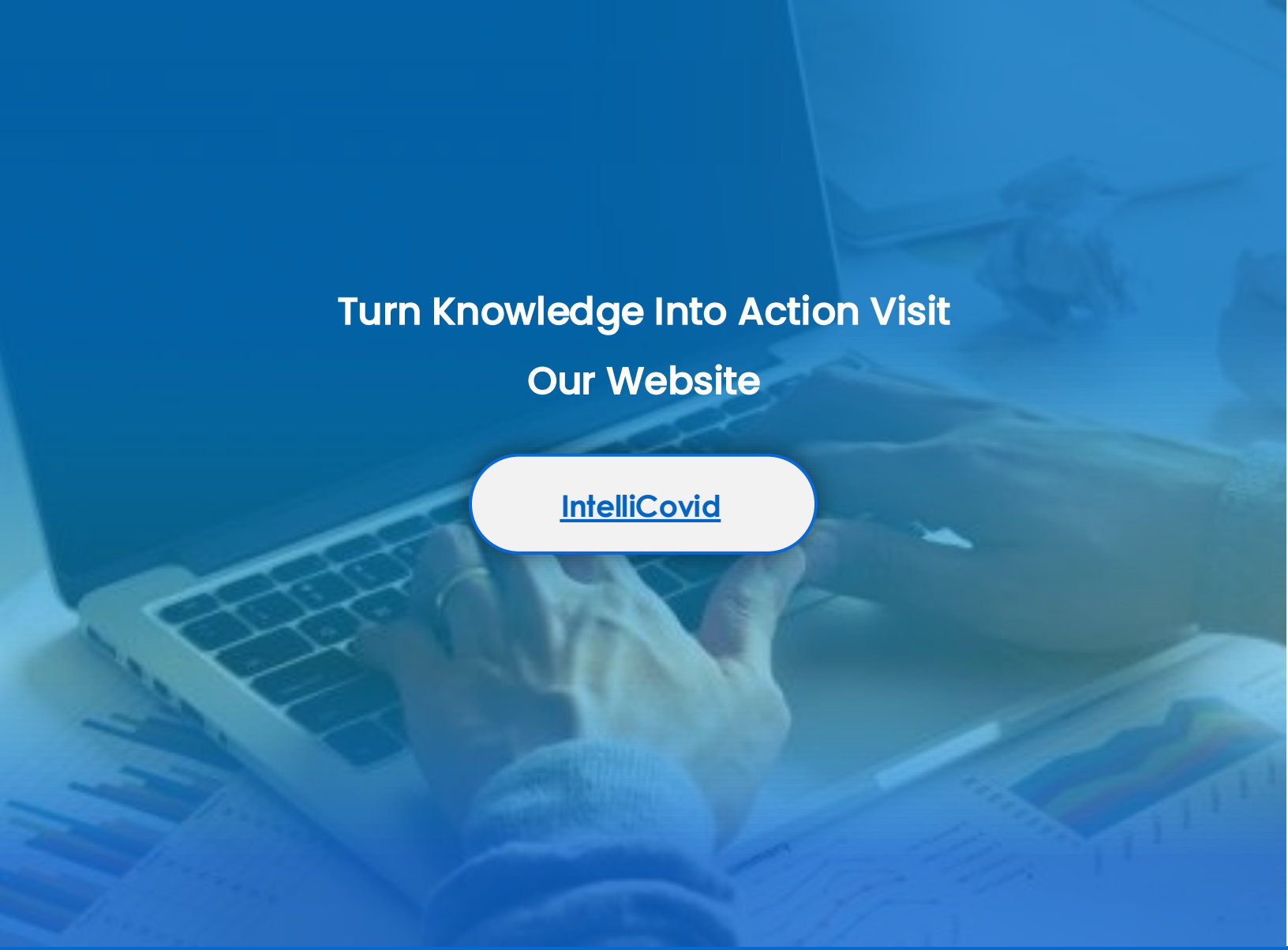
These devices can be worn 27x4 and will provide medical practitioners with invaluable real-time data that can be used to fight this virus and possibly others. Finally, wearable devices can be used as a warning system for those at higher risk, not just patients, but frontline workers who work tirelessly to save lives.

CONCLUSION

What we can say for sure, is that modern technology will continue to play a critical role in the fight against coronavirus. Scientists can work with AI and machine learning to teach computers to spot the symptoms and detect COVID-19 in patients, freeing up resources for critical cases. Data algorithms in smartwatches and biosensors can inform the medical staff of a patient's symptoms and recovery without seeing them. Smartphones and apps will trace the virus and alert scientists when clusters appear, helping cities and countries to prevent further spreading. Though we still have a lot to learn, many would say that we have already learned a great deal.

Scalable Health Solutions:

- Covid Patient Input Form
- Post discharge follow up application
- Supply Chain Analytics
- Risk Stratification Analytics
- Operation and workforce optimization analytics



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