



# Digital Biomarkers: The New Era of Wearable Technology

by Geetesh Garg & Akul Raina

# Executive Summary



In the field of human health, biomarkers are proving a boon that is improving the understanding of the earlier diagnosis of disease.

Biomarkers are helping in the delivery of more effective, safer therapies at much earlier stages. The COVID-19 pandemic demonstrated the need for such a mechanism wherein early detection can help save people's lives.

One such method is **human perspiration**, which contains ample amounts of physiologically relevant information but has been an underutilized resource for non-invasive health monitoring.

Recent research in the field of wearable sensors has paved the way for many technological advancements related to sweat sensing. Such sensors are now capable of gleaning even minute insights into the dynamics of our bodies.

In this paper, we highlight the potential value of non-invasive sweat-based wearable devices and discuss opportunities to make earlier disease diagnoses, resulting in saved lives.





What are Digital  
Biomarkers?

# Digital biomarkers enable the collection of an individual's health-related information through digital health technologies for better disease management.

This helps predict and/or explain health-related outcomes and will eventually bring healthcare from a reactive towards a more preventive approach.

With the health data available through digital biomarkers, researchers could predict future health outcomes and explain diseases in a more data-driven manner.

In the increasingly widespread use of wearable technologies, we see these devices seamlessly become a functional part of the user's lifestyle.

Wearable devices can be categorized as fashion wearable, electronic wearable, and smart devices worn close to or over the skin. These devices help integrate electronics into daily chores and routines, tracking data on a real-time basis.

They can connect and communicate via the Internet and formulate a data exchange between networks.



# Wearables and Market Research





Wearable devices are becoming popular in healthcare services, particularly given society's increasing interest in health, well-being, disease prevention, and fitness. We're seeing a paradigm shift toward healthcare that is personalized and controlled by individuals.

The COVID-19 pandemic is expected to significantly impact market growth and has expanded the role of wearable devices in the healthcare sector. As per industry analysts' reports, data is the new oil and becomes even more critical regarding health monitoring. For example, remote monitoring of families associated with individuals diagnosed with COVID-19 can provide valuable data about the acceleration of transmission and symptom onset.

Wearable sensor data may alert patients to forthcoming infection before symptoms become severe. COVID-19, along with other viral illnesses, is associated with several physiological changes that can be monitored using these sensors.

## The COVID Scenario

COVID has left no one untouched since its inception in 2019. Recent research published in the Lancet publication entitled "Clinical Features of Patients Infected with the 2019 Novel Coronavirus in Wuhan, China," found that a cytokine storm is witnessed as a common phenomenon in COVID-19 patients. This phenomenon is so strong that it is a major cause of death.

Cytokines are glycoproteins produced by various types of cells throughout the human body. Glycoproteins are proteins in many physiological functions such as immunity, communication between cells, and body protection. Cytokines are omnipresent molecules widely present in body fluids such as blood, sweat, tears, saliva, gut, stool, and urine. Cytokines are useful in moderation for the functioning of the body. However, a severe immune reaction in which the body releases too many cytokines into the blood too quickly is known as a cytokine storm. This overproduction of cytokines causes positive feedback on other immune cells, which allows for more immune cells to be recruited to the site of injury. This can lead to organ damage.

# The Traditional Method of Detecting a Cytokine Storm

Various methods are used to detect the cytokine storm, including traditional laboratory blood tests.

Decreased immune cells, elevation in markers such as CRP (C-reactive protein), elevated ferritin levels, and medical imaging such as X-ray provides clues for cytokine storms related to COVID-19.

Traditional methods of detecting cytokine storms are tedious and time-consuming, with low precision. They do not provide real-time results.

The cytokine storm may have started many hours before it was detected and could have caused much damage to multiple vital organs. It can happen quickly, making it important to treat a patient's symptoms as soon as possible to minimize damage to the body.





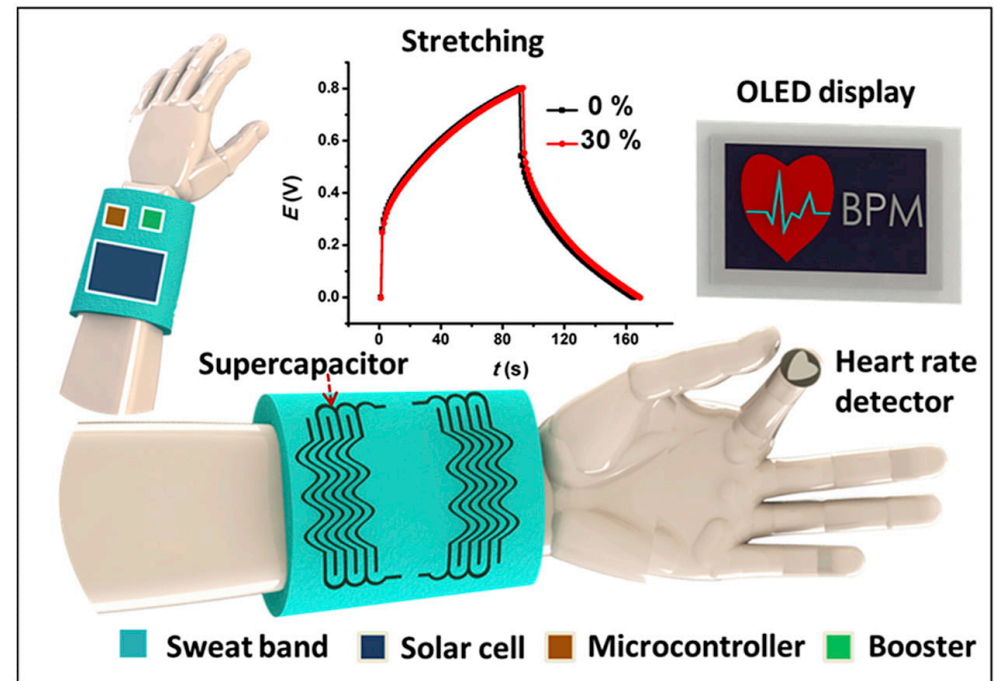
# Wearable Technology: A Modern Way of Detecting Cytokine Storms

Patients experiencing a cytokine storm have elevated levels of inflammatory proteins (biomarkers) such as IL-6 (interleukin-6), IL-8, TNF- $\alpha$  (tumor necrosis factor- $\alpha$ ), TNF-related apoptosis-inducing ligand, IL-10, interferon- $\gamma$ -induced protein-10, and C-reactive protein.

Most of the cytokine biomarkers found in blood, which is used for the detection of a cytokine storm, are also found in sweat. Next-generation sensors, the core of wearable technology, can be used to detect the increased levels of cytokine biomarkers through sweat.

Dr. Vinu Mohan, A.M., working as a Scientist at CSIR-Central Electrochemical Research Institute (CECRI), and Tamil Nadu, a recipient of the INSPIRE Faculty Fellowship instituted by the Department of Science & Technology, Government of India, have introduced a flexible, low-cost, wearable sensor that can track sweat for monitoring the health and physiological status of the human body (pictured at right).

It can obviate the necessity of blood and other invasive tests.



*Image source: Indian Scientist Unveils A Flexible Low Cost Wearable Sensor that Tracks Sweat for Monitoring Health and Physiological Status, IndianWeb2*

Ensuring early detection of the elevated levels of the biomarkers (IL-6, IL-8, TNF- $\alpha$ , IL-10, and CRP) through sweat can help in the early detection of a cytokine storm in COVID-19 patients, resulting in less damage to vital human organs.

# Parting Thoughts

The global pandemic has forced the human race to rethink our traditional ways of confronting life-threatening diseases.

The advent of futuristic technologies has enabled mankind to devise new ways of early disease detection, thereby saving human lives.



Wearable technologies are one such avenue that will further strengthen the foundation of capturing, detecting, and processing biomarker indices (IL-6, IL-8, TNF- $\alpha$ , IL-10 and CRP) in real-time.

Biomarkers will revolutionize the process of detecting cytokine storms in COVID-19 patients.

Disease detection with the help of wearable technology in a non-invasive manner is still in nascent stages and a lot of research is being carried out in this space.

The next step for researchers is to test the sensor in more people and validate their initial findings in patients.

In summary, with our new normal it will be far more crucial to get an accurate and timely diagnosis as the new approach for early detection is still being examined.

Achieving a greater level of sensitivity and specificity in these sensors will be a challenge and an opportunity at the same time to revolutionize the way we diagnose critical diseases like COVID-19.

# References & About the Authors

# About the Authors

**Geetesh Garg** is a Consultant within GlobalLogic's Business Solutions & Consulting (BSC) group. He has more than a decade of business consulting experience in the insurance industry and working with Senior Executives on process transformation. He also has expertise in IT system modernization, digital strategies, and roadmap definitions across different functions. He has worked for several leading insurers and financial institutions across the globe.

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