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# Health Technologies and Demographic Challenges

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February 13-14, Salinas, Ecuador, Vol 2

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# The Importance of Using Biometric Sensors in Elderly People



Teresa Guarda , José A. M. Victor , and Isabel Lopes 

## 1 Introduction

The world population is aging. Aging brings several health issues that society is challenged to overcome. There is a pressing need to have effective solutions to monitor the health conditions of the elderly population. Keeping track of elderly health conditions can prevent some diseases and allow early diagnosis and treatment, enhancing the elderly's quality of life. Biometric sensors are a great solution because they do not just measure health conditions but are able to provide a picture of how an individual is. Studies have already shown the potential of using biometric data for researching new health prevention approaches, improving selected aspects of health care, and personalizing hyper medication. The ultimate goal would be to achieve the so-called personal medicine [1]. These considerations invite an examination of the state of the art of the technologies used on this topic.

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Health information technology continues to have a significant effect on improving the healthcare industry, ranging from computerized record-keeping to new devices for remote patient treatment. Long periods of hospitalization are a source of stress and depression for both the patient and family members [2]. A better solution is to have patients receive treatments in the comfort of their homes [3]. Another alternative is to keep the patient in a healthcare center where healthcare professionals can monitor the patient's physiological signals through face-to-face communication. The implementation of an intelligent physiological signal system integrated with smart homes or healthcare centers, electronic pill boxes, and artificial sensory diagnostic devices can help prevent the onset of health problems and can reduce the hospitalization period [4]. Any anomalous changes in the elderly's body information can be quickly evaluated by senior centers. The evaluation can be easily assessed by the healthcare teams who are responsible for evaluating the general users via cloud-enabled ubiquitous physiological signal monitoring [5]. The rapid evaluation can enhance the early warning system so that the healthcare team can take the necessary measures earlier to contain the affluent-level information related to anxiety, stress, and depression. Early interventions allow the healthcare team to manage the overall situation to effectively reduce the disease burdens and unnecessary emergency responses.

The objectives are (1) to familiarize the reader with biometric sensors, their potential impact on healthcare overall, and their significance for geriatric care, (2) to discuss the advancements in the technologies, and (3) to examine the advantages and obstacles of biometric measurements in the care of elderly individuals. The understanding of various aspects of biometric sensors is incomplete. Despite the absence of comprehensive reviews on the subject, the importance of delving into various distinct aspects lies in their potential for interconnection and the interest they generate in clinical research studies. Additionally, certain health-related factors are overlooked in technology reviews on biometric sensors, even though they may significantly impact decisions on the physiological parameters to be considered for an improved quality of care for older individuals.

## 2 Biometric Sensors

Biometric sensors or biosensors, measure and monitor an individual's biometric characteristics, sensing biometric information by different types and sizes of biosensors. Biometric signal recording sensors convert signals from an individual's body, often from exposed skin, into electrical equivalents, ready to be further processed by a computer [6]. This allows for close control of functions such as automatic electronic payment systems, healthcare systems, and home security systems. Biometric sensors can be broadly divided into distinct categories, including mechanical sensors, chemical sensors, and sensors based on physiological signals [7]. Among the most popular forms of biometric sensors are those capable of detecting and monitoring important health indicators [8].

Biometric sensors in healthcare form a major component of the healthcare management process and are particularly useful for the elderly [9]. A key method for tracking important biometric signals is to utilize different sensors categorized according to modalities. These include touch-based sensors such as fingerprint recognition sensors, which are embedded in various wearable devices. Remote sensors include wristbands and wearable devices equipped with additional cardiac monitoring features, including heart rate monitoring, skin sensors, pulse sensors, activity trackers, and medical earbuds. Whether it involves home automation systems, ATM machines, or hospital registration with smart cards, biometric sensors manage several services in a truly touchless system [10].

In this context we can consider three types of sensors: biometric sensors, physiological monitoring sensors, and behavioral sensors [11].

Biometric sensors measure physiological signals arising from human organs and the operation of the human body. They register, measure, and evaluate vital signs, monitoring elder behavior based on wearable sensors or mobile applications using different modalities: behavior, physiology, or identification [12].

Physiological monitoring sensors measure physical and chemical changes in the body; they are unobtrusive and are used for health issues [13]. They are important in monitoring heart diseases, high blood pressure, and conditions such as diabetes. Such sensors can build “an unobtrusive profile of health including respiration, skin conductance, heart rate, light levels, and wrist movement,” and are used to evaluate sleep quality [14]. When selecting a wearable device, features such as electrocardiography, electromyography, skin temperature, and humidity should be monitored [15].

Behavioral sensors can identify activities, determine the normal or sudden deviation of activity patterns, and score sleep quality. They can also supervise people who live alone and are helpful for cognitively impaired individuals. They are employed to determine duty fatigue in workers. The sensor can monitor the number of steps taken by a person and display this via smartphones, relating to the normal value. For example, heartbeat sensors in a chair can help maintain improved heart rates in elderly patients [16]. Studies should indicate the most appropriate sensors for selection, emphasizing aspects such as technological advancement, accuracy, social acceptance, and data privacy [17].

### **3 Benefits of Biometric Sensors**

The healthcare sector has significantly evolved in recent years, with many connected systems now available to offer early insights into health disorders. Biometric sensors are increasingly used to analyze physiological or physical markers to generate valuable health-related information [18]. These sensors can be particularly valuable for senior health, as older adults are more susceptible to chronic diseases and cognitive. The stigma surrounding aging is challenging to change, even in the

digital era. Therefore, if older adults use biometric sensors to monitor their activity and safety, the resulting care is likely to be more accepted [19].

The regular monitoring of physical activity, combined with sleep, activities of daily living, and vital signs, allows for the early discovery of medical conditions, making treatment more efficient [18]. Moreover, the continuous collection of biometric data has the potential to facilitate follow-up and update treatment plans to personalize care for individuals. This approach can help prevent personalized medical issues. The use of biometric sensors in older adults primarily aims to enhance quality of life and prevent health deterioration, alongside providing direct economic benefits [20]. Life expectancy among older adults is influenced by their quality of life. By intervening early in cases of frailty, it is possible to more effectively prevent diseases that commonly affect seniors, such as cancer, diabetes, obesity, chronic obstructive pulmonary disease, and cardiovascular diseases. Reducing the direct and indirect costs associated with monitoring can improve the cost-effectiveness of interventions. Addressing the societal impacts of aging on health is crucial, particularly as frailty develops. These insights suggest that employing biometric sensors should be a foundational step in improving care for the elderly [21].

### ***3.1 Early Detection of Health Issues***

Biometric sensors such as smart watches, fitness bands, smart clothing, and jewelry, which are equipped with sensors and wires, have been shown to play a major role in the early detection of diseases in the elderly. Continuous monitoring can provide real-time alerts in case of health concerns [21]. For example, subtle changes in vital signs can be detected through continuous data streams and identification rules, allowing for reliable classification of vital signs [22]. These early warning signs enable timely interventions before health events, such as falls or symptoms associated with health issues, occur. Remote monitoring of the elderly represents a proactive healthcare intervention with substantial clinical impact, making affordable care possible.

Biometric sensors utilize various modalities, including temperature, electrocardiography, electroencephalography, electromyography, photoplethysmogram, capacitive sensors, respiratory rate, heart variability, blood pressure, ultrasound, and inertial measurement units, which are effective for monitoring both normal and abnormal physiological and psychological activities, such as vital signs, quality of life, mood, and chronic medical conditions [23]. Furthermore, these sensors can provide continuous supervision for maintaining quality of life in chronic diseases like hypertension, obesity, diabetes, and cardiovascular or pulmonary diseases [24]. All these chronic conditions significantly impact vital signs.

Currently, a clear cohort of data can only be established after continuous monitoring for 24/7 over a period of at least 3–6 months, which may be too late for effective intervention [13]. The biometric sensors used for monitoring and detecting vital signs or disease trends will be discussed further below.

Several studies and systematic reviews have highlighted the relevance of biometric sensors that monitor vital signs, including electrocardiography and photoplethysmogram, for detecting fatigue, along with heart rate, skin temperature, and sweating. In particular, their tests were conducted on conditions such as dry age dystonia, which is a common tremor disorder in older adults [25]. It is well established that cardiovascular diseases, fatigue, and gastrointestinal issues can occur in patients with severe appetite suppression [25].

### ***3.2 Monitoring Physical Activity and Vital Signs***

Monitoring physical activity and vital signs is essential for understanding the overall health status of the elderly. Continuous tracking of physical activity promotes a healthy lifestyle and helps prevent health problems [26]. Additionally, regular tracking of vital signs, including non-invasive measurements of blood pressure and heart rate, enhances understanding of an individual's well-being [27]. Various sensors can be utilized to monitor different parameters in managing such a system. Heart rate and blood pressure sensors can continuously monitor these parameters in the home environment of the elderly. Most sensors meet the criteria for wearable sensors and body sensor network modulation when considering vital signs and exercise signals [28].

One of the key services of this system is physical activity monitoring, which aims to increase and promote physical activity levels among older adults. The platform monitors various biometric values such as blood pressure, heart rate, steps, and calories burned [18]. Sensor data can motivate the elderly to engage in daily activities, helping to maintain healthy physiological parameters. Regular physical activity data will be shared with elderly individuals to highlight any unusual changes and encourage increased activity. Additionally, the platform will present outcomes from daily activity measurements to healthcare workers, who can use continuous monitoring to detect depressive or anxiety states in elderly individuals [29]. These recordings will also provide family members and caregivers with valuable insights into the general activity and functional status of older adults. Improvements in overall well-being will enable older adults to maintain independence and take charge of their health more effectively.

## **4 Challenges and Concerns**

Potential barriers will face us, many elderly persons are reluctant to use new technical devices. Ensuring the acceptance of these new technologies for the elderly constitutes a challenge in that many people are afraid of becoming dependent on technical assistance. Indeed, to use biometric sensors and contactless technologies for elderly people, especially for those who do not appreciate using new technical

devices, sensors have to be seamlessly integrated into the described assistants [18]. Many elderly people have a low level of technical literacy, interfaces need to be easily understandable and intuitively controlled independent of the user's technical knowledge. Privacy and data protection play a major role, mostly because data stored in the systems can reveal the health status of the persons, potentially opening up senior citizens to numerous security risks [30].

While nonconsensual disclosure of health-related data often counts as sensitive activity, healthcare entities have a moral obligation to ensure patients' healthcare status and maintain data privacy [31]. In this setting, the ownership of the data collected and shared by IoT devices is evolving. There is a shift towards users aiming to have the ability to control their information without third-party intervention, which aligns with their rights to personal data ownership [30]. Informed consent is generally regarded as a critical safeguard of fundamental human rights and dignity [30]. In the healthcare data-sharing ecosystem, rather than constraining the inherent values of sharing sensitive healthcare data, which are expected to bring broad-spectrum benefits to the public, we aim at reconciling fundamental issues, such as trust and veracity requirements, medical liability, and the right to own and access one's data [32]. Many such systems are also mainly sensor-based and face challenges and limitations, in particular, some sensors may be intrusive when worn over longer periods or may consume considerable battery power.

On top of the most important external constraints and challenges, one may note that external sensors, acquired from consumer electronic producers, are not always 100% reliable or counterfeit-proof [15]. There is also evidence indicating that constant activity data may not always directly concern the registered person but rather the system's operation [33]. Many elderly individuals are reluctant to swap physical sensors, particularly on wearable's, due to the fear of losing subsequent data stored on the device. Ensuring the absence of any risk is demanding and impossible, and biometric characteristics collected from elderly subjects are furthermore sensitive [29]. Therefore, the proper storage of such data and restricted accessibility are significant concerns. Identity theft or the abuse of extremely sensitive personal information could arise from unauthorized access [30]. Furthermore, information may be taken by unauthorized parties and utilized for illegal activities like identity theft. Some diseases may be deduced from biometric recognition. Patient consent is mandatory, along with personal data protection and compulsory data-sharing transparency [34]. One risk of biometric sensors is data mismanagement. This technology further requires data in transit encryption, safe and secure data storage in a carefully protected server, and compliance with data protection regulations [30]. For these reasons, regulatory frameworks need to define the restraints and proper security measures for the deployment of biometric sensors on elderly individuals.

Biometric data are sensitive, unique to individuals, and cannot be changed or replaced if compromised [30]. Regardless of the level of personal data gathered, actions to prevent the collection of unnecessary data constitute a valuable safeguard. The aim is to maintain a balance between the interests involved in this field of research and respecting ethical principles. Within this framework, the privacy of the elderly must be preserved. Personal data cannot be treated in a way that goes against the stated, explicit, and legal purposes for which it was collected.

## 5 Conclusions

Biometric sensors are revolutionizing senior care and present a possible answer to the problems associated with an aging population.. These advanced tools consistently track vital signs and identify early health problems, facilitating prompt interventions and tailored care. By empowering older individuals to manage their health more effectively, biometric sensors improve their quality of life and reduce the pressure on healthcare systems. However, the extensive adoption of these technologies raises concerns about data privacy, security, and user acceptance, particularly among older people with minimal technical understanding. Creating strong regulatory frameworks is vital to guarantee ethical management of data and safeguard sensitive information.

With the world's population getting older, the incorporation of biometric sensors is becoming more essential. Future studies ought to prioritize improving sensor precision, ease of use, and data protection strategies. By tackling these issues, we can leverage the complete capabilities of biometric technology to develop a more efficient, empathetic, and effective healthcare system for elderly individuals.

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