



# Review on Health And Quality of Life of Elderly People: A Meta-Analysis from The Medical and Health Sciences

Ashish Agarwal <sup>1</sup> , Sachin Pradhan <sup>1</sup> 

## Abstract

In response to the increasing aging population, various initiatives aim to enhance the well-being of the elderly by addressing factors like physical and mental health, comorbid conditions, isolation, and relationships. Information and Communication Technology (ICT) systems have been developed to allow seniors to maintain independence, live comfortably at home, and enjoy better overall health. Internet of Things (IoT) systems, in particular, offer continuous remote surveillance, increased social engagement, improved sensory experiences, and support for an active lifestyle. This review highlights a framework for a unified IoT-based Smart Sensor system (IoT-SS) designed to discreetly observe and assist the elderly, complementing the care provided by trained medical professionals. The quality of life is crucial for the elderly, motivating them to stay resilient. The article introduces IoT and its application in improving seniors' health and quality of life in their homes and communities. This review is valuable for medical system developers and programmers working on technology-supported healthcare plans to serve and enhance the lives of the elderly in the future.

**Significance** | An IoT-based system enhancing elderly care, emphasizing QOL, independence, and support, aiding healthcare development for seniors' well-being.

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## 1. Introduction

Smart devices with eldercare features and technological aids can improve medical solutions and positively impact various aspects of an individual's health and Quality of Life (QoL) (Baraković, S., 2020) (Belkacem, A. N., 2020). This includes factors like health, mental well-being, beliefs, social connections, and elements of their surroundings (Halicka, K., 2022). There's a growing demand for a cohesive system supporting active aging that aligns with the older patient's lifestyle and preferences (Halicka, K., 2020).

Information technology can revolutionize healthcare by enhancing the quality of treatment, reducing costs, and bringing medical services to people's homes (Zhao, X., 2020) (Papachristou, N., 2023). Innovations like IoT and wearable tech show promise in improving senior care, allowing seniors to live independently and comfortably (Taiwo, O., 2020) (Hussain, I., 2022).

Caring for the elderly is a complex topic, and IoT plays a key role in ensuring a higher quality of life for seniors and those with chronic illnesses (Ho, A. 2020) (Ali, F., 2020). IoT-based smart sensor technology enhances the safety of the elderly with fall warnings, emergency response, and video monitoring (Papa, A., 2020). The Internet of Things can revolutionize how the aging population's health is managed, improving treatment quality, reducing costs, and speeding up emergency responses (Guizani, K., 2020) (Zhong, C. L. 2020). The elderly, especially those valuing autonomy, can benefit greatly, considering factors like age, wealth, health, and living situation (Garcia-Moreno, F. M., 2022).

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While there's been research on how IoT and wearables can improve healthcare for the elderly, most studies focus on specific cases or categories, leaving an information gap in their overall utility and implementation in medical care for the aged (Motwani, A., 2022) (Ramasamy, L. K., 2022).

The main objective of this review is to improve the quality of life for seniors by addressing various mental, physiological, and interpersonal aspects. Emphasizing the importance of considering the needs of the elderly, the article argues for the creation of technological devices that support a comfortable lifestyle and enhance overall well-being. The introduction of an Internet of Things-based framework, utilizing smart sensors (IoT-SS), aims to provide transparent surveillance and assistance to the elderly, contributing to their independence and satisfaction.

## 2. Literature Review

This review represents various studies conducted by different authors, each focusing on the development of innovative technologies to assist and enhance the lives of elderly individuals. In a study by Rossi et al. (2020), they developed augmented reality intelligent glasses (AR-IG) to assist those with mild cognitive loss due to age and sensory problems, allowing elderly individuals more time for independent living before needing nursing home assistance. Méndez et al. (2020) created fuzzy-inferential adaptable neural networks (FIA-NN) to analyze camera and speech data, helping experts understand elderly needs and provide recommendations for an improved quality of life. Dobre et al.'s (2023) vINCI technology is a novel tool identifying health indicators requiring professional care, enhancing the lives of the elderly. Taramasco et al. (2022) detailed the Quida platform, using unobtrusive sensors to track daily routines and intervene when needed, potentially aiding in medical assessments. Dobre et al. (2019) provided discrete supervision and assistance to older individuals using an evidence-based IoT platform, delivering sensible medical services in community settings. Alsulami et al. (2021) utilized ZigBee technology for a Real-Time Location System (RTLS) to monitor elderly individuals at home, issuing warnings for prohibited zones based on the findings.

## 3. Enhancing Elderly Care through Technology and Comprehensive Solutions

As society modernizes and the generation gap widens, older people face challenges adapting to contemporary life. Issues like not having enough money for medical care, a lower societal status, and difficulty retiring comfortably are common ( Briones et al,2021). Age, health, and other factors play a big role in shaping the needs and difficulties of older individuals. Many face exhaustion, cognitive decline, and physical weakness leading to dependence on others. To maintain a healthy balance, it's crucial

to provide physical, mental, emotional, and social support ( Brown,2019).. Basic needs include food, shelter, healthcare, and security, while dynamic needs involve a sense of belonging, autonomy, and feeling cared for. Intellectual stimulation, understanding of health, and opportunities to learn new activities are important, along with social interactions like talking to others and maintaining relationships. These needs may change over an older person's life, and tailored health and social services may be necessary for those with unique requirements ( Chung et al,2021). Figure 1 shows the importance of taking care of the elderly. The need and availability of care facilities for older people in the country are helping the industry grow. The demand for elderly care is expected to increase because of factors like an aging population, chronic diseases, and changes in family structures ( De Vito et al,2020). Unfortunately, a lack of attention to the elderly, possibly due to their reduced influence, has resulted in a shortage of facilities to support them. For instance, the current healthcare system struggles to meet the needs of a large aging population due to a lack of medical facilities, skilled staff, and funding. These challenges make care for older women largely overlooked in the healthcare system, and governments should prioritize addressing this issue considering the expected growth in this demographic ( Freeman et al,2020).

We need to improve how we assist the elderly by creating age-friendly environments, customizing care, providing modern medical technology, and sharing updated information. Technological progress is crucial for successful and innovative approaches to help the elderly. Combining health systems, patient-centered insights, and technological advancements into a single digital solution is essential ( House of Lords,2021). This application was developed using an individual profile model to address the increasing interest of app developers in innovative methods for meeting the needs of the elderly. We require a comprehensive perspective on the elderly that goes beyond just improving or maintaining their health. It should involve ongoing, personalized adaptive care, proactive assistance from a broader range of healthcare experts and informal caregivers, and the use of electronic devices to support the independence of the elderly and manage their personal needs and health services ( Kadylack et al,2021).

Understanding the constraints and needs of different age groups can be improved by creating a client profile. This involves investigating and analyzing users' needs, wants, and limitations. The user profile is like a blueprint for the intended audience, helping them understand the logic behind analyzing, planning, creating, and implementing healthcare solutions ( Marston et al,2013). To meet the needs of the elderly, healthcare product creators must conduct various analyses, research, and use techniques to make computer technology accessible to older

consumers. They should simulate and incorporate preferences of senior citizens into medical devices and analyze the results (Marston et al,2019). Non-intrusive technology for the elderly can bring benefits such as better adherence to medical advice, increased health knowledge, and more active community engagement. These positive impacts may improve clinical outcomes and the overall quality of life for older individuals (Musselwhite et al,2018). The use of IoT technology is gaining popularity in assisting seniors with cognitive impairments, although claims of improving patients' quality of life are often not fully realized by many apps.

Figure 2 illustrates that in older adults facing mild cognitive and physical impairments while living independently, the decline in cognitive and functional skills is often unpredictable. These individuals typically rely on informal caregivers, like family, friends, and neighbors, for primary assistance. Considering the older person's behavior at home and their mental and physical state, the aid mainly involves personalized support to help them with daily tasks (Nallam et al,2020). There's a growing need for improved healthcare for the elderly, emphasizing age-friendly environments, personalized care, appropriate medical technology, and access to relevant information and resources. Solutions for seniors with declining capacities contribute to health in three ways: socially, physically, and cognitively, by warning of potential risks (Ranieri et al,2021). Factors such as life satisfaction, self-esteem, social ties, and involvement play a crucial role in determining the quality of life for older individuals. Those in excellent physical health tend to report higher life satisfaction than those who are unwell, and elderly individuals relying on others for support often experience lower life contentment (Sheerman et al,2020).

Retired individuals who actively contribute to society tend to be happier than those who isolate themselves. Married older adults often experience greater life satisfaction due to the social support and companionship they enjoy compared to unmarried individuals (Siu et al,2019). Elderly adults, especially those with disabilities, can significantly boost their happiness levels by participating in adult day activities. The fast-paced development of technology and society may pose challenges for older individuals to keep up, leading to a decline in their sense of self-worth (Stern et al,2012).. Thoughtfully designed healthcare products have the potential to improve the socialization and inclusion of the elderly by providing cognitive and emotional assistance. Social connections for older individuals are primarily built on three components: social networks, support, and integration, with family, friends, and neighbors forming the core of their social network (Tural et al,2021).

People who have many social connections receive more support, feel more involved in their communities, and tend to live longer

compared to those who are socially isolated. Social engagement for seniors involves activities like socializing, working with others, helping, and contributing to society. To protect the elderly from the negative effects of social isolation, it's essential to offer emotional support, opportunities for personal fulfillment, and information on leading a healthy lifestyle (Ummels et al,2020).

In this project, we use IoT (Internet of Things) technology to build a comprehensive care system for the elderly. Figure 1 illustrates the plan for this system. The goal is to enhance home health care by utilizing biological data to make it more effective and timely. Additionally, the study aims to create integrated services that simplify and secure the daily lives of senior citizens. The focus is on preventing accidents, such as falls, among the elderly. By actively monitoring their surroundings and providing early alerts, the system reduces the likelihood of falls, eliminating the need for future notifications or treatments. It also includes services related to understanding the home environment, ultimately improving the quality of life for the elderly at home (White et al,2020).

A sensor attached to the person being cared for collects health data, responds to requests from a base station, and sends the data wirelessly to the base station (see Figure 3). The wireless sensor transmits the data to the home wireless network, then relays it to a data transmitter through various intermediate stations. Finally, the physiological data reaches the health app server (Wu et al,2019). The server, running health improvement software, regularly sends the person's medical information to a treatment facility server over the Internet. Expert medical staff can use this technology to assess the extensive physiological data of care recipients, determining if they require assistance or health-related reminders (Kulik et al,2014).. The health promotion server also supports the delivery of contextual sensing services, gathering relevant signals to understand the user's current state and provide appropriate services. Additionally, sensors in the user's environment contribute to this data, and the software enables seniors to access their health information on their mobile devices (Majumder et al,2017).

This method doesn't rely on continuously collecting data from all sensors. Instead, it records information about how often specific events occur. Data integrator devices decide which sensor data to transmit during an event. In an incident monitoring setup, sensors typically gather data locally and send it to a central center for analysis (Deen et al,2015). The central center then makes inquiries. Rather than creating centralized fusion centers, we let the sensors themselves identify events and make selections. Events are defined using certain parameter threshold values. For instance, let's consider a healthcare system  $F$  with three sensor settings:  $A_1$ ,  $A_2$ , and  $A_3$ .

$$F = \{A_1, A_2, A_3\} \quad (1)$$

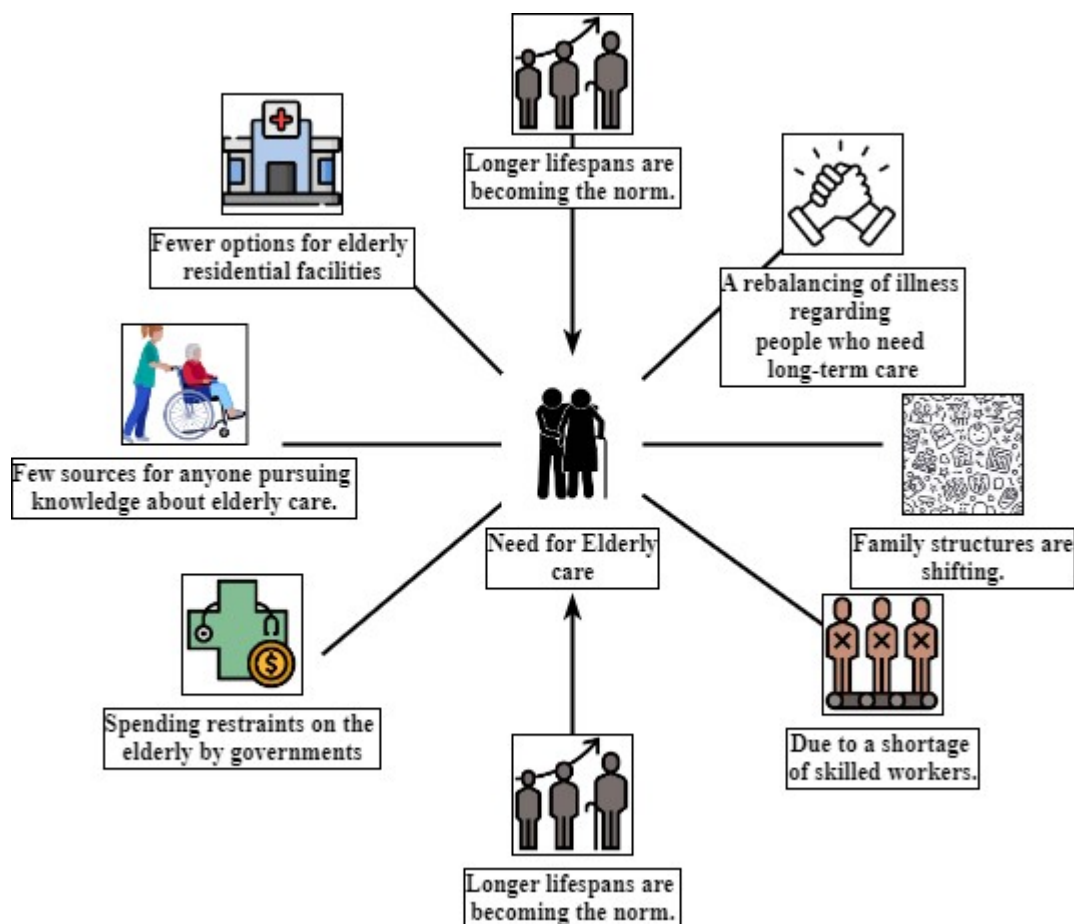


Figure 1. Needs of Elderly care

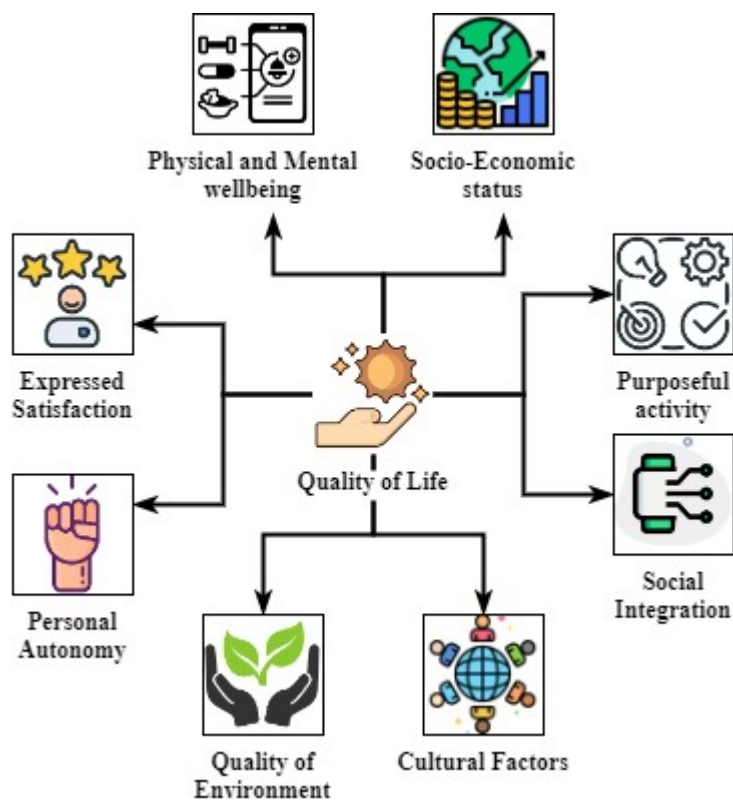


Figure 2. Framework of Elderly's Quality of Life

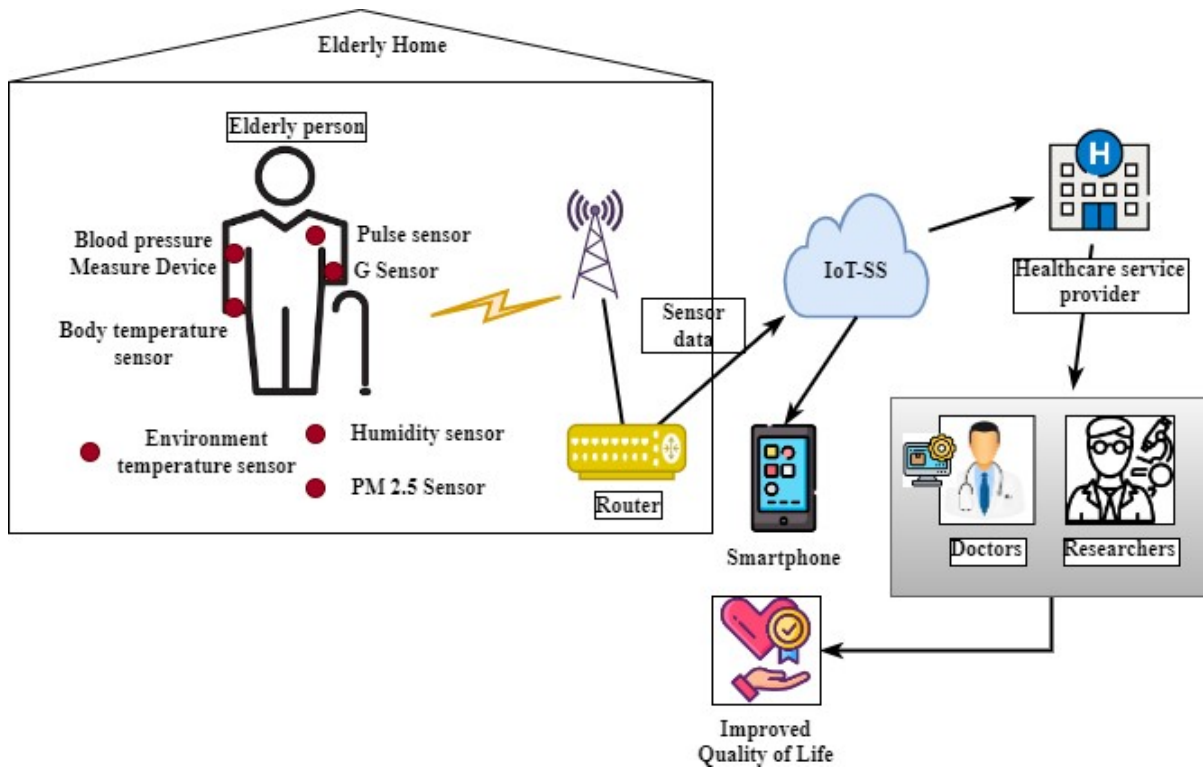


Figure 3. Conceptual framework of IoT-SS on Elderly care

It is possible to construct the collecting data function in terms of the acceptable thresholds of  $A_1$ ,  $A_2$ , and  $A_3$  if the parameter values are dependent on one another  $A_{1th}$ ,  $A_{2th}$ , and  $A_{3th}$ , as follows:

$$q(F_s) = \begin{cases} q(A_1) & \text{if } A_1 < A_{1th} \\ q(A_1, A_2) & \text{if } A_1 < A_{1th} \ \& \ A_2 < A_{2th} \\ q(A_1, A_2, A_3) & \text{otherwise} \end{cases} \quad (2)$$

This event-based data collection significantly reduces the time and effort spent on communication. However, health information, being sensitive, should not be subjected to a threshold. Providing the current values of each metric makes health information more meaningful. Given the anticipated growth in the senior population, it's crucial to allocate substantial resources to leverage advanced ideas and technologies like the Internet of Things (IoT) for elderly care ( Agoulmine et al,2011).

To create the optimization model, we need to consider several steps ( Park et al,2013) such as:

- Define  $G$  as the pool of potential wearables,  $v_x$  as the price of a specific wearable  $x$  in  $G$ , and  $Y$  as the maximum budget for these wearables.
- Identify the required set of metrics, denoted as  $R$ .
- Use input  $i_{xm}$ , where  $\forall x \in G$  and  $y \in R$ , it is 1 if the wearable  $x$  screens measurements  $y$ , and 0 otherwise.
- Introduce set  $W$  as the program's assets, with  $i_{xm}$  representing the wearable system that uses  $x \in G$  as the resource output.
- Consider the system's throughput of  $m \in W$  and  $L_m$  resources.
- The goal is to minimize overall costs, avoid exceeding resource capacity, and stay within the budget while addressing all metrics in set  $R$ .
- Introduce binary variable  $B_x$ ,  $\forall x \in G$ , set to 1 if the wearable  $x$  is selected or suggested and 0 otherwise.
- This optimization model aims to determine the smart sensors from set  $G$  that meet all metrics in set  $R$ , considering cost constraints, resource capacity, and budget limitations.

$$\text{Min} \quad \sum_{x \in G} v_x \cdot B_x \quad (3)$$

$$\text{Subject to:} \quad \sum_{x \in G} i_{xy} \cdot B_x \geq 1, \forall y \in R \quad (4)$$

$$\sum_{x \in G} i_{xm} \cdot B_x \leq L_m, \forall m \in W \quad (5)$$

$$\sum_{x \in G} v_x \cdot B_x \leq Y \quad (6)$$

$$B_x \in \{0,1\}, \forall x \in G \quad (7)$$

Equation (3) aims to minimize the cost of the final smart sensors, while equation (4) ensures that the selected wearable group can track all relevant metrics. Equation (5) sets budgetary limits, and equation (6) safeguards the storage capacity for each service. The choice variables in equation (7) can only take one of two possible values ( Rotariu et al,2011). The optimization model is designed to produce an ideal collection of smart sensors for the specific individual, utilizing a vast database of healthcare Internet of Things (IoT) and wearable technology. It creates a mapping table linking measurements, health concerns, and available solutions. If no suitable wearable or IoT sensors exist for a specific measure, this information can be sent to software developers or sensor designers to encourage the creation of on-demand technology ( Movassaghi, et al,2014).

Various solutions have been suggested to support the elderly, either by addressing current challenges or lessening potential future problems. Figure 3 illustrates some existing products and services. Numerous initiatives, both large and small, have been introduced to meet the needs of the aging population. We analyze key Internet of Things (IoT) apps and services focused on remote monitoring of the elderly ( Takei et al,2015). Recognizing the importance of monitoring, we aim to evaluate these initiatives with a fresh perspective, prioritizing the elderly and categorizing them based on their qualities and benefits in daily life. The system offers reports, recommendations, early alerts, and remote monitoring apps. To ensure that caregivers, medical professionals, and emergency services can assist the elderly during crises, the system shares information with external parties. Third-party contributions can enhance the system's user-friendliness and performance. Addressing concerns like data integrity, authenticity, and confidentiality is crucial for such systems (Abo-Zahhad et al,2014).

#### 4. Discussion on A Comprehensive IoT Approach for Enhanced Well-being and Efficiency

A comprehensive Internet of Things (IoT) system for monitoring seniors can connect various devices to understand their well-being. Despite challenges like scalability and accessibility, data analysis can process large amounts of diverse information to extract meaningful insights. Besides analyzing real-time sensor data, historical and additional data can be used for more extensive services. The system needs to be user-friendly, considering that elderly individuals may have various disabilities and memory issues. Deploying sensors should also be easy, as it's impractical to attach many of them to a user's body for an extended period ( Miorandi et al,2012).

Regarding the dataset, researchers supported by the National Institutes of Health propose leveraging wearable technologies like smartwatches and fitness trackers, which are increasingly

common. These wearable sensors aim to predict clinical test results and serve as early indicators of underlying health conditions ( Zanello et al,2014).

**a) Increased effectiveness of regular procedures:**

Figure 4 illustrates how everyday tasks like collecting health data and revising care plans become more efficient. In an IoT system, the proposed setup enables caregivers to collect real-time biometric data and synchronize it efficiently through cloud-based services. This eliminates the need for manual entry into spreadsheets, saving caregivers significant time ( Alam et al,2012). Specifically, the time spent on daily check activities is reduced by 83.8% compared to manual methods when using IoT-SS. Additionally, the time needed for evaluating medical information and developing care plan details has been reduced from 22 minutes to 1 minute and from 15 minutes to 4 minutes, respectively. With IoT, adjusting the treatment strategy now takes 76.4% less time, thanks to the starting point provided by the existing care plan and more efficient problem-solving based on various healthcare options ) Abbasi-Kesbi et al,2017).

**b) Improved satisfaction with medical treatment:**

As depicted in Figure 5, in the absence of IoT, the nursing home relies on the time-consuming and error-prone manual collection of biometric data three times a day. The introduction of IoT brings real-time data collection and monitoring, representing an improvement over the traditional method for caregivers ( Wang et al,2016). With IoT, caregivers can promptly respond to changes in the elderly's vital signs through a pop-up alert system, preventing further health decline. This leads to fewer complaints about healthcare service delays. The IoT data analytics features not only monitor health but also support providers in making evidence-based adjustments to patient treatment plans. Families have the right to stay informed and involved in their loved one's care, accessing current health data and treatment information easily (.Zhang et al,2017). Therefore, maintaining open communication with the elderly's loved ones is crucial for caregivers to understand expectations, ease tension, and consistently provide high-quality care.

**c) Interaction and societal integration for QOL:**

Elderly individuals naturally enjoy being part of a community and benefit significantly from social interactions. Engaging with others through various activities enhances their quality of life. While email, phone calls, and online messaging services have connected people globally, some elderly individuals, especially those with mental or neurological disorders, struggle with social media and other forms of interaction (refer to Figure 6). Therefore, IoT aims to prevent social isolation among the elderly and disabled by providing accessible ways for them to stay connected and engaged ( Amiribesheli et al,2015). Recently, various methods have emerged to assist older individuals in their daily lives. However,

there is a lack of user-focused research in the current literature. This study takes a fresh approach by examining the state of technology in IoT-based senior monitoring systems, prioritizing the needs of the elderly. Researchers proposed a hierarchical framework and a revised categorization system to explore current methods, goals, and challenges ( Amato et al,2015). The study provides insights into the current state of the field, analyzes available solutions, and outlines primary goals and trends for future IoT-based remote senior care ( Huijnen et al,2011). This review introduces an IoT-SS (Internet of Things Smart Sensor) designed to monitor seniors' activity levels and vital signs. Healthcare devices for vital sign assessment, along with smart sensors, are deployed to enhance independent living and safety for older individuals at home. A website-based program tailored to specific needs facilitates the efficient installation and configuration of these devices. The gathered data is securely stored and processed in the cloud through the installed IoT infrastructure.

## 5. Conclusion

In conclusion, addressing the needs of the elderly in the context of modernization, health care, and technological advancements is crucial for ensuring their well-being and quality of life. From the challenges they face, such as financial constraints and declining societal status, to the solutions proposed, including improved assisted living, individualized care, and innovative technologies like IoT-based senior monitoring systems, it is evident that a comprehensive and user-centered approach is necessary.

The significance of social connections, cognitive and emotional support, and the impact of technology on the lives of older individuals cannot be overstated. As the elderly population continues to grow, there is a pressing need for healthcare systems, policymakers, and technology developers to collaborate in developing solutions that cater to the unique requirements of this demographic.

The proposed optimization models, interconnected care systems, and smart-sensor integrated IoT solutions showcase promising avenues for enhancing the health and well-being of older adults. By prioritizing their needs, focusing on user-centered research, and integrating technology effectively, we can strive towards creating a future where the elderly not only age gracefully but also lead fulfilling, connected, and empowered lives.

## Author Contributions

A.A. and S.P. conceptualized, wrote, and reviewed the article.

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## Competing financial interests

The authors have no conflict of interest.

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