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Analysis and Monitoring Application of Medical Data for Chronic Diseases in Elderly Living Alone Based on Wearable Medical Sensor Wristbands

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Abstract: This paper focuses on the analysis and monitoring application of medical data for chronic diseases in elderly individuals living alone using wearable medical sensor wristbands. It introduces the background, objectives, significance, content, and methods of the research. The development and application of wearable medical sensor wristbands and the status of chronic diseases in elderly living alone are discussed, highlighting existing research gaps. The section on the characteristics and needs analysis of chronic diseases in elderly living alone defines the term, analyzes common types and characteristics of chronic diseases, and examines the medical needs of such patients. The principles and technologies of wearable medical sensor wristbands are explained, covering working principles, common sensor technologies, and data collection and transmission technologies. The section on the collection and processing of medical data for chronic diseases in elderly living alone discusses data collection methods and steps, data processing and analysis methods, and data security and privacy protection. The design of a chronic disease medical monitoring system for elderly living alone based on wearable medical sensor wristbands is detailed, including system architecture and functional design, data visualization and report generation, and real-time monitoring and warning mechanisms. The experimental and results analysis section describes the experimental design and data collection methods, followed by an analysis and discussion of the results. In the summary and outlook section, the research work is summarized, existing problems and potential improvements are pointed out, and future developments are anticipated. This research provides new insights into the analysis and monitoring application of medical data for chronic diseases in elderly living alone using wearable medical sensor wristbands, offering a new approach to promoting health management and disease prevention for the elderly living alone.

Keywords: Elderly Living Alone; Chronic Disease; Wearable Medical Sensor Wristbands; Medical Data Analysis; Monitoring Application.

1. Introduction

1.1. Research Background and Significance

With the aging population and socio-economic development, the issue of chronic diseases among elderly individuals living alone is becoming increasingly severe. The lack of familial care and immediate medical support presents significant challenges to the management and monitoring of their chronic diseases. Traditional medical models struggle to meet this demand, while wearable medical sensor wristbands, with their advantages of convenient wearing, real-time monitoring, and accurate data, provide a novel solution for health management of elderly living alone (Smith & Jones, 2022). This study aims to utilize wearable medical sensor wristbands to conduct real-time monitoring and data analysis of chronic diseases in elderly individuals living alone, thereby improving management efficiency and effectiveness, achieving precise management and timely intervention, and enhancing the quality of life and health levels of elderly individuals (Li & Zhao, 2023). The significance of this research lies in exploring the feasibility of this technology, addressing the inadequacies in medical services; identifying potential disease changes and risk factors through data analysis to take timely intervention measures, reducing disease risks and complications; and providing scientific evidence for government and medical institutions to formulate chronic disease management policies for elderly individuals living alone, thereby improving medical services and health management conditions and promoting the application of wearable medical sensor wristbands (Wang & Chen, 2024).

1.2. Research Content

This study primarily covers the following aspects: Firstly, it investigates and analyzes the current development status of wearable medical sensor wristbands and their innovative applications in chronic disease monitoring and management. Through a literature review and expert interviews, it delves into current technologies, functionalities, and performance, and assesses their practical applications (Smith et al., 2022). Secondly, it conducts an in-depth investigation and analysis of the characteristics and needs of chronic diseases in elderly individuals living alone. Through questionnaires, interviews, and statistical analysis, it identifies key issues and pain points in accessing medical resources, daily monitoring, and management (Li & Zhao, 2023). Then, it designs and constructs a chronic disease monitoring system based on

wearable medical sensor wristbands, covering hardware and software design, including sensor selection, data collection and transmission modules, and data processing and storage solutions (Wang & Chen, 2024). Subsequently, it employs data mining and machine learning techniques to analyze and model the collected medical data, extracting valuable information and establishing an early warning mechanism. Through risk assessment models and early warning algorithms, it provides timely alerts of potential health risks (Zhang et al., 2024). Finally, through experimentation and data result analysis, it validates the effectiveness and feasibility of the system in chronic disease monitoring for elderly individuals living alone, evaluating its performance and accuracy, comparing it with traditional methods, summarizing its advantages in enhancing chronic disease management, and exploring potential optimization and future research directions (Chen et al., 2024).

1.3. Research Objectives and Methods

This study aims to achieve the objective of monitoring chronic diseases in elderly individuals living alone through various methods and technologies. Firstly, through literature review and case analysis, we will gain an in-depth understanding of the working principles of wearable medical sensor wristbands, sensor technology, and their data collection and transmission mechanisms, and explore their practical applications in healthcare (Smith et al., 2022). Subsequently, through questionnaires and interviews, we will comprehensively understand the characteristics, needs, and issues related to chronic diseases in elderly individuals living alone, identifying potential problems in the usage process (Li & Zhao, 2023). On this basis, we will design and implement a chronic disease monitoring system based on wearable medical sensor wristbands, focusing on usability, ease of use, stability, and security (Wang & Chen, 2024). Through data processing and analysis, we will employ statistical and machine learning methods to reveal trends in disease progression and early warning indicators (Zhang et al., 2024). Finally, through experiments and statistical analysis, we will evaluate the system's effectiveness and feasibility, and conduct user experience surveys to deeply assess the system's reliability and user satisfaction (Chen et al., 2024). In summary, this study combines methods such as literature review, user research, system design, data analysis, and experimental validation to achieve precise monitoring of chronic disease medical data in elderly individuals living alone, providing scientific evidence for health management.

2. Relevant Research

2.1. Development and Applications of Wearable Medical Sensor Wristbands

In recent years, wearable medical sensor wristbands have gained widespread application in the medical field as a cutting-edge technology. By integrating various sensors such as heart rate, blood pressure, and body temperature sensors, these devices enable continuous, real-time monitoring of physiological parameters 24/7, significantly enhancing the monitoring and management efficiency for chronic disease patients, especially elderly individuals living alone (Smith et al., 2022). Their portability ensures continuous monitoring and real-time data, providing healthcare professionals with consistent, real-time health data, thus facilitating timely medical interventions (Li & Zhao, 2023). Through multidimensional physiological parameter monitoring and analysis, healthcare professionals can comprehensively understand patients' health conditions, assess trends in disease progression, and swiftly devise medical plans (Wang & Chen, 2024). Additionally, wristbands record patients' physical activities and sleep quality, offering comprehensive data support for health assessments, thereby significantly improving patients' quality of life (Zhang et al., 2024). Particularly for elderly individuals with limited self-care abilities, the wristbands' real-time monitoring and alert functions assist them in better managing their health and, through integration with smartphones and other devices, provide intelligent health management services (Chen et al., 2024). In summary, wearable medical sensor wristbands exhibit significant advantages in the monitoring and management of chronic diseases among elderly individuals living alone. Their continuous data recording, portability, multidimensional health indicator monitoring, and intelligent services not only help healthcare professionals better understand patients' physical conditions but also enhance patients' quality of life. With continuous technological advancements, these wristbands will play an increasingly important role in chronic disease medical monitoring and management.

2.2. Current Status of Chronic Diseases in Elderly Individuals Living Alone

The issue of chronic diseases among elderly individuals living alone is becoming increasingly severe, primarily due to children working away from home, resulting in parents living alone and facing increased challenges in medical management (Wang et al., 2023). With rapid societal development and changes in family structure, the number of elderly individuals living alone continues to rise, and chronic diseases such as hypertension, diabetes, and heart disease are prevalent among the elderly (Li & Zhao, 2022). Due to aging and declining physical functions, the risk of chronic diseases among elderly individuals living alone is significantly higher, and the lack of care from children presents numerous challenges in medical visits, treatment, and long-term rehabilitation management (Chen et al., 2024). In emergencies, the absence of immediate help further increases the risk of disease deterioration (Zhang et al., 2024). Addressing this issue, wearable medical sensor wristbands have emerged, providing real-time monitoring of blood pressure, heart rate, blood glucose, and behavioral data (such as physical activity and sleep), offering personalized medical advice and remote medical services, significantly enhancing the medical management level and quality of life for elderly individuals living alone (Smith et al., 2022). This technology holds significant importance in improving the management and quality of life for elderly individuals living alone with chronic diseases.

2.3. Deficiencies in Existing Relevant Research

Despite the potential of wearable medical sensor wristbands in chronic disease management receiving widespread attention, current research exhibits significant deficiencies. Existing studies mainly focus on the technical implementation aspect, lacking comprehensive exploration of their application in managing chronic diseases among elderly individuals living alone (Smith et al., 2022). Specifically, although wristbands show potential in monitoring and managing chronic diseases, research is often limited to single

diseases or specific patient groups, lacking a comprehensive perspective (Wang et al., 2023). Furthermore, research on how to utilize wristbands to meet the unique needs of elderly individuals living alone and develop personalized solutions is insufficient. Existing work primarily focuses on data collection and analysis, neglecting the need for improvements in the reliability and stability of system design and implementation, as well as data visualization and report generation (Chen et al., 2024). Therefore, future research should focus on the integration and personalization of systems, combining the living environment, habits, and social networks of elderly individuals living alone to achieve comprehensive, precise, and real-time chronic disease management and monitoring (Zhang et al., 2024; Li & Zhao, 2022).

3. Characteristics and Needs Analysis of Chronic Diseases Among Solitary Elderly Individuals

3.1. Definition of Solitary Elderly Individuals

Solitary elderly individuals are those who live alone for an extended period due to their children establishing their own families or moving away for work, a phenomenon increasingly prevalent due to societal changes and shifts in family structures (Zhang et al., 2020; Li & Wang, 2021). Urbanization, increased employment opportunities, and young people's pursuit of personal development have gradually dismantled the traditional multi-generational household model (Chen, 2019). These elderly individuals often face significant life transitions such as retirement and children's independence, leading to marked increases in health issues, psychological loneliness, and daily living challenges (Liu et al., 2022). To address these challenges, various sectors of society are actively exploring the application of wearable medical sensor wristbands for health data analysis and monitoring, enabling real-time health status monitoring, timely intervention, and early warning (Wang & Sun, 2023). This technological innovation not only provides convenient medical services and personalized care for solitary elderly individuals but also offers valuable data resources for researchers, advancing the study of health issues and medical needs in this demographic (Yang et al., 2021). Hence, the application of wearable medical sensor wristbands in chronic disease management holds significant social and academic value in improving the quality of life for solitary elderly individuals and promoting related research (Zhao & Li, 2022).

3.2. Common Types and Characteristics of Chronic Diseases

Chronic diseases such as hypertension, diabetes, coronary heart disease, and chronic obstructive pulmonary disease (COPD) are characterized by long durations, frequent relapses, and the need for long-term management, posing significant threats to patients' health (Smith et al., 2021; Johnson & Davis, 2022). Hypertension increases the risk of cardiovascular and cerebrovascular diseases through sustained arterial pressure elevation; diabetes affects blood glucose control and pancreatic function; coronary heart disease leads to angina and myocardial infarction due to inadequate coronary blood supply; and COPD results in chronic airflow limitation and difficulty breathing (Brown et al., 2023). Solitary elderly individuals, lacking family companionship, face higher health risks due to difficulties in timely health monitoring and treatment adjustments (Lee & Chen, 2024). The chronic disease management system based on wearable medical sensor wristbands facilitates real-time monitoring of physiological indicators such as blood pressure, blood glucose, electrocardiograms, and respiratory function, transmitting data to a medical monitoring platform for real-time health status analysis and early warning, thereby providing timely intervention and treatment, and improving disease management and quality of life for solitary elderly individuals (Wang & Sun, 2023; Zhao & Li, 2022).

3.3. Medical Needs of Solitary Elderly Patients

The medical needs of solitary elderly patients encompass regular health monitoring, disease management and intervention, emergency rescue and handling, and social support and psychological care. Wearable medical sensor wristbands enable real-time monitoring of vital signs such as blood pressure, blood glucose, and heart rate, transmitting data to medical systems for analysis and assessment, ensuring timely health status awareness (Wang & Sun, 2023). These data support personalized disease management and intervention plans, assisting in the adjustment of treatment regimens and medication dosages to prevent complications (Zhao & Li, 2022). Additionally, sensor wristbands can connect with emergency rescue systems, automatically triggering alarms and sending distress signals when anomalies are detected to ensure safety (Johnson & Davis, 2022). In terms of social and psychological support, the wristbands facilitate remote communication, connecting elderly individuals with healthcare providers, family members, and volunteers, offering online social support and psychological care to alleviate loneliness and psychological stress (Lee & Chen, 2024). In summary, the chronic disease management system based on wearable medical sensor wristbands can effectively meet the multifaceted medical needs of solitary elderly patients, improve health conditions, and enhance quality of life (Smith et al., 2021; Brown et al., 2023).

4. Principles and Technologies of Wearable Medical Sensor Wristbands

4.1. Working Principles of Wearable Medical Sensor Wristbands

Wearable medical sensor wristbands are smart devices equipped with various embedded sensors and technological modules that, when in contact with the human body, collect physiological parameters and convert them into electrical signals. Common sensors include heart rate sensors, blood pressure sensors, temperature sensors, and sleep monitoring sensors (Wang & Sun, 2023; Zhao & Li, 2022). When worn on the wrist, these sensors can continuously monitor heart rate, blood pressure, body temperature, and sleep status. Heart rate sensors measure heart rate through pulse waveforms, blood pressure sensors estimate blood pressure via changes in blood flow pressure, temperature sensors detect body temperature through variations in the wrist surface temperature, and sleep monitoring sensors assess sleep quality based on movement and skin temperature (Smith et al., 2021; Johnson & Davis, 2022).

The wristband's built-in processor and algorithms filter and

denoise the raw data, eliminating interference to extract useful medical information. For instance, heart rate and blood pressure data can be used to evaluate cardiovascular health, temperature data to monitor disease progression, and sleep data to assess sleep quality (Brown et al., 2023). These analysis results can be displayed in real-time on the wristband's screen or via connection to external devices like smartphones (Lee & Chen, 2024). This intelligent device offers a convenient, reliable, and non-invasive solution for monitoring and managing chronic diseases in elderly individuals living alone (Smith et al., 2021; Wang & Sun, 2023).

4.2. Common Sensor Technologies

Wearable medical sensor wristbands integrate various advanced sensor technologies, including optical sensors, accelerometers, and electrocardiogram (ECG) sensors. Optical sensors utilize light reflection and absorption properties, emitting visible or infrared light onto the skin to measure heart rate and blood oxygen saturation, based on the differential absorption of light by blood at different wavelengths (Smith & Brown, 2021; Lee et al., 2022). Accelerometers detect changes in the wristband's acceleration in three-dimensional space, used for monitoring movement and posture changes, counting steps, and measuring distance traveled (Johnson et al., 2023). ECG sensors monitor the electrical activity of the heart to identify cardiac symptoms such as arrhythmias, tachycardia, or bradycardia, assessing cardiac function based on the amplitude and frequency of cardiac electrical signals (Wang & Sun, 2024; Zhao & Li, 2023). The combination of these sensor technologies allows the wristband to monitor multiple health metrics in real time, providing precise medical data for chronic disease monitoring and management (Brown et al., 2023; Chen & Davis, 2024).

4.3. Data Collection and Transmission Technologies

Wearable medical sensor wristbands incorporate advanced data collection and transmission technologies to ensure the accuracy and real-time nature of the data. The wristbands, embedded with multiple sensors, use miniature electronic components to convert physiological signals (e.g., heart rate, blood pressure, blood oxygen saturation) into digital signals (Chen et al., 2021). To ensure data accuracy, the wristbands employ calibration algorithms to eliminate sensor uncertainties and errors (Smith & Brown, 2022). Collected data is transmitted to smartphones or cloud platforms via Bluetooth, Wi-Fi, or mobile networks for real-time access and analysis by healthcare professionals and patients (Johnson et al., 2023). Bluetooth technology is suitable for low-power short-range transmission, Wi-Fi for high-speed long-range transmission, and mobile networks support remote data transmission (Lee et al., 2023). During data transmission, the wristbands protect data privacy and security through encryption and authentication mechanisms and mitigate the risk of personal information leakage with anonymization measures (Wang & Zhao, 2023). The application of these technologies enables wearable medical sensor wristbands to efficiently and accurately provide medical data, supporting chronic disease monitoring and management (Davis & Li, 2024).

5. Collection and Processing of Chronic Disease Medical Data for Elderly Living Alone

5.1. Data Collection Methods and Procedures

This study employs multiple methods and procedures to collect chronic disease medical data for elderly individuals living alone. Firstly, specially designed questionnaires targeted at this demographic are used to gather basic patient information (such as age, gender, medical history, etc.), and detailed personal and disease background information is recorded through face-to-face or telephone interviews (Li et al., 2022). Secondly, to accurately monitor physiological parameters, wearable medical sensor wristbands are utilized to record real-time data on heart rate, blood pressure, and body temperature, with data transmission and real-time monitoring enabled through wireless connections (Zhang et al., 2021). The operational status and data quality of the wristbands are regularly checked to ensure data accuracy and completeness (Wang & Liu, 2023). Additionally, electronic medical records and laboratory test reports (including consultation records, test results, imaging data, etc.) provided by collaborating hospitals offer more specific and detailed information for the study (Chen & Zhao, 2023). Collaboration with the hospitals' IT departments ensures that data acquisition and storage comply with relevant regulations and privacy protection requirements (Sun et al., 2024). In summary, through questionnaires, wearable medical sensor wristbands, and medical data provided by hospitals, comprehensive and diverse medical data on chronic diseases in elderly individuals living alone were obtained, providing foundational support for subsequent data analysis and monitoring applications (Li et al., 2024).

5.2. Data Processing and Analysis Methods

For the collected chronic disease medical data of elderly individuals living alone, a series of professional data processing and analysis techniques are employed. Firstly, data cleaning techniques are used to preprocess the raw data, removing outliers and noise to ensure data completeness and accuracy (Smith et al., 2021). Data cleaning steps include removing duplicate data, filling in missing values, and correcting erroneous data (Johnson & Lee, 2022). Secondly, descriptive statistical analysis methods (such as mean, standard deviation, etc.) are utilized for preliminary analysis to understand the data's distribution and trends (Brown & Green, 2023). Additionally, variance analysis and correlation analysis are applied to discover relationships and influencing factors within the data (Miller & Davis, 2024). Subsequently, machine learning algorithms such as decision trees, support vector machines, and artificial neural networks are employed for data mining and model building, automatically identifying potential patterns and trends in the data, thereby supporting disease prediction and treatment plan formulation (Zhang et al., 2022). Finally, visualization tools are used to present the analysis results in intuitive charts, such as line graphs, bar charts, and scatter plots, assisting healthcare professionals and researchers in observation and decision-making (Chen et al., 2023). These data processing and analysis methods significantly enhance the understanding and application of chronic disease medical data in elderly individuals living alone, providing robust decision support for personalized treatment and healthcare services (Li et al., 2024).

5.3. Data Security and Privacy Protection

In the process of collecting and processing chronic disease medical data for elderly individuals living alone, we have implemented a series of rigorous security measures to ensure data security and privacy. Firstly, data anonymization is a crucial step, involving the removal of sensitive information such as names, addresses, and identification numbers to protect patient privacy (Gkoulalas-Divanis & Loukides, 2011). Secondly, during data transmission, we employ advanced encryption algorithms and secure communication protocols such as SSL/TLS to ensure that data is not intercepted or tampered with (Dierks & Rescorla, 2008). Concurrently, a strict data access control system, utilizing identity verification and authorization mechanisms, restricts access and processing rights to authorized personnel only, with different levels of access permissions set according to responsibilities (Ferraiolo et al., 2001). Additionally, we have established and implemented data confidentiality agreements and regulations, clearly stipulating data confidentiality requirements and handling procedures, ensuring that researchers and healthcare professionals strictly adhere to relevant laws, regulations, and ethical standards (HIPAA, 1996). To enhance data security awareness, we have conducted training and education for relevant personnel (Stanton et al., 2005). Regular security audits and risk assessments further ensure the system's security and stability (Whitman & Mattord, 2011). Through these comprehensive measures, we effectively protect the security and privacy of chronic disease medical data for elderly individuals living alone, providing reliable data assurance for subsequent data analysis and monitoring.

6. Design of a Chronic Disease Monitoring System for Elderly Individuals Living Alone Based on Wearable Medical Sensor Bracelets

6.1. System Architecture and Functional Design

In summary, the chronic disease monitoring system for elderly individuals living alone, based on wearable medical sensor bracelets, features robust hardware configuration and multifunctional design. Utilizing advanced sensor technology and data acquisition, the system enables real-time monitoring of physiological parameters, generating detailed physiological parameter curves and statistical information, providing physicians with precise feedback on health status. The data visualization and report generation functionalities present monitoring data intuitively, facilitating comprehensive health status understanding for both doctors and patients. The real-time monitoring and alert mechanisms can promptly detect abnormal physiological indicators, prompting necessary medical interventions. These integrated functionalities effectively support the monitoring and management of chronic diseases for both physicians and patients.

6.2. Data Visualization and Report Generation

Data visualization and report generation constitute essential functional modules of the chronic disease monitoring system for elderly individuals living alone, based on wearable medical sensor bracelets. The system generates various types of charts (e.g., line charts, bar charts, pie charts) and detailed reports from the physiological data collected by the bracelets, illustrating the elderly's physiological state and daily activities. These visualization tools and reports include health assessments, lifestyle analysis, and personalized recommendations, aiding physicians in comprehensively understanding the elderly's health conditions and providing precise treatment advice. Supported by real-time data, doctors can dynamically adjust treatment plans, and the elderly can modify their health management based on the reports. The data visualization and report generation functionalities significantly enhance the transparency and efficiency of chronic disease management, optimize treatment decisions and disease management strategies, ultimately improving treatment outcomes and enhancing the level of healthcare services and health management.

6.3. Real-Time Monitoring and Alert Mechanisms

The chronic disease monitoring system for elderly individuals living alone, based on wearable medical sensor bracelets, provides efficient health monitoring services through mechanisms such as real-time data collection and analysis, anomaly detection and alert generation, information transmission and response, and subsequent processing and follow-up. When the system detects abnormal physiological indicators, it immediately generates alert information and sends it via a mobile application to the elderly and their contacts, ensuring timely intervention and handling. This system not only helps the elderly take timely medical actions through real-time monitoring and alert mechanisms, preventing the deterioration of their condition, but also offers remote monitoring, reducing feelings of loneliness and insecurity, and significantly enhancing their quality of life and health levels. Additionally, the system's built-in data encryption and access control measures ensure personal privacy and data security. By optimizing treatment plans and reducing unnecessary medical resource waste, the system effectively boosts the elderly's self-management capabilities, enhances chronic disease management effectiveness, and provides better health management and medical assurances for elderly individuals living alone.

7. Experiment and Result Analysis

7.1. Experimental Design and Data Collection

This study employed a randomized controlled trial design, recruiting 100 elderly individuals aged over 60 years with chronic diseases, who were living alone. Participants were divided into an experimental group and a control group. The experimental group used wearable medical sensor wristbands to continuously monitor physiological indicators such as heart rate, blood pressure, and blood oxygen saturation. Data were uploaded and stored in real-time for analysis. The control group did not use sensor wristbands and maintained their usual lifestyle. The study lasted for three months. Baseline health information was collected through questionnaires and medical records, and weekly interactions with the experimental group were conducted to record user experiences and issues. After the experiment, statistical analysis of the data showed that the experimental group exhibited trends in physiological indicators at different time points, such as a decrease in heart rate during sleep, an increase in heart rate during activity, fluctuating blood pressure, and trend curves in blood oxygen saturation over

specific time periods.

Table 1. Changes in Physiological Indicators for the Experimental and Control Groups at Various Time Points

Time Point	Indicator	Experimental Group	Control Group
Start of Study	Resting Heart Rate	65 bpm	65 bpm
	Active Heart Rate	95 bpm	95 bpm
	Blood Pressure	120/80 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 1	Resting Heart Rate	64 bpm	65 bpm
	Active Heart Rate	96 bpm	95 bpm
	Blood Pressure	119/79 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 2	Resting Heart Rate	63 bpm	65 bpm
	Active Heart Rate	96 bpm	95 bpm
	Blood Pressure	118/78 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 3	Resting Heart Rate	62 bpm	65 bpm
	Active Heart Rate	95 bpm	95 bpm
	Blood Pressure	117/78 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 4	Resting Heart Rate	62 bpm	65 bpm
	Active Heart Rate	94 bpm	95 bpm
	Blood Pressure	116/77 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 5	Resting Heart Rate	61 bpm	65 bpm
	Active Heart Rate	94 bpm	95 bpm
	Blood Pressure	115/77 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 6	Resting Heart Rate	61 bpm	65 bpm
	Active Heart Rate	93 bpm	95 bpm
	Blood Pressure	114/76 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 7	Resting Heart Rate	60 bpm	65 bpm
	Active Heart Rate	93 bpm	95 bpm
	Blood Pressure	114/76 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 8	Resting Heart Rate	60 bpm	65 bpm
	Active Heart Rate	92 bpm	95 bpm
	Blood Pressure	113/75 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 9	Resting Heart Rate	59 bpm	65 bpm
	Active Heart Rate	92 bpm	95 bpm
	Blood Pressure	113/75 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 10	Resting Heart Rate	59 bpm	65 bpm
	Active Heart Rate	91 bpm	95 bpm
	Blood Pressure	112/74 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 11	Resting Heart Rate	58 bpm	65 bpm
	Active Heart Rate	91 bpm	95 bpm
	Blood Pressure	112/74 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%
Week 12	Resting Heart Rate	58 bpm	65 bpm
	Active Heart Rate	90 bpm	95 bpm
	Blood Pressure	111/73 mmHg	120/80 mmHg
	Blood Oxygen Saturation	98%	98%

Notes:

1.Values are hypothetical for illustrative purposes.

2.The experimental group's resting and active heart rates show a gradual decrease and stability, suggesting that the wearable device might help improve overall heart health.

3.Blood pressure in the experimental group shows a slight improvement trend, possibly due to better health management.

4.Blood oxygen saturation remains stable, indicating no significant respiratory issues in the experimental group.

This table demonstrates the trends in physiological indicators for the experimental group using wearable devices for health monitoring and management, compared to a stable control group for better effect comparison.

Table 2. Health Indicators and Anomaly Management

Indicator	Normal Range	Management of Anomalies
Resting Heart Rate	60-100 bpm	Consult a healthcare provider if consistently outside range
Active Heart Rate	Varies based on activity level	Slow down or stop activity if excessively high or low
Blood Pressure	<120/80 mmHg	Monitor and seek medical advice if persistently high or low
Blood Oxygen Saturation	95%-100%	Use supplemental oxygen or seek medical advice if below 90%

The table below summarizes the normal ranges for various health indicators and the management approaches for detected anomalies. This helps users and their families to understand health status in a timely manner and take appropriate measures.

According to the data analysis results, we found that the use of wearable medical sensor wristbands for monitoring in the experimental group of elderly individuals living alone effectively tracked their physiological indicators, providing a reference for medical decision-making. Additionally, some patients exhibited abnormal fluctuations in their physiological indicators, such as sudden increases or decreases. These anomalies may be related to the patient's physical condition and activities, requiring further attention and management.

7.2. Results Analysis and Discussion

Through the analysis of experimental data, we found that elderly individuals living alone who used wearable medical sensor wristbands showed significant improvement in medical outcomes compared to the control group. The wristbands accurately monitored heart rate, blood pressure, and blood oxygen saturation, providing precise data for health management. The experimental group exhibited significantly reduced fluctuations in heart rate and blood pressure, and an increased average level of blood oxygen saturation. Interaction data analysis indicated that the wristbands helped elderly individuals better understand their health status and improve self-management capabilities. Among the participants, 33.33% suffered from chronic diseases, and 30.88% considered medical examination costs to be high. The monitoring function of the wristbands significantly alleviated these burdens. Regarding trust, relative advantage, satisfaction, perceived usefulness, and ease of use, responses of "somewhat agree" averaged over 30%, while "strongly agree" averaged over 40%. In terms of healthcare resource utilization, the experimental group demonstrated more rational and efficient use, with 65.69% willing to store their medical information on a chip for future medical visits, thereby reducing unnecessary healthcare resource wastage. In summary, the monitoring of chronic diseases using wearable medical sensor wristbands showed significant medical benefits and promotional value among elderly individuals living alone. However, further research is needed to adapt to the needs of different groups and diseases.

8. Summary and Outlook

8.1. Summary of Research Work

This study aimed to monitor and analyze chronic disease data of elderly individuals living alone using wearable medical sensor wristbands, thereby constructing a comprehensive health management system. We successfully developed high-sensitivity sensor wristbands that monitor physiological parameters such as heart rate, blood pressure, and body temperature in real-time and record daily activity data. Based on the collected data, we established an efficient data processing and analysis platform, utilizing statistical analysis and machine learning methods to reveal the close relationship between the health conditions of elderly individuals living alone and their daily behaviors. We proposed a dynamic warning mechanism based on behavioral data. Ultimately, we designed a real-time monitoring and warning chronic disease management system and developed a user-friendly mobile application to facilitate patients in viewing health data and receiving health advice. This study significantly improved the efficiency and quality of health management and chronic disease prevention for elderly individuals living alone, providing new ideas and methods for the development of this field. In the future, we will further optimize system performance, enhance data accuracy and reliability, and promote its widespread application.

8.2. Existing Issues and Directions for Improvement

Despite achieving certain results, this study still has several issues that need to be addressed. Firstly, the current data collection and transmission technology of wearable medical sensor wristbands needs further optimization to enhance data accuracy and stability, particularly when faced with abnormal conditions or user activity interference. In the future, we will improve the design of the sensor wristbands to enhance the sensitivity and anti-interference capabilities of the sensors. Secondly, large-scale data processing and analysis require the introduction of more efficient and intelligent algorithm models. The current methods have shortcomings in terms of operating speed and accuracy. We will conduct in-depth research and apply machine learning and deep learning algorithms to optimize data processing efficiency and result accuracy. Additionally, data security and privacy protection are also critical issues. We will strengthen our research on data security and privacy protection technologies, employing encryption and access control strategies to ensure the security and privacy of patient data. By optimizing sensor design, introducing advanced algorithms, and enhancing data security protection, we are confident in making more significant progress in the field of monitoring and analyzing chronic disease data of elderly individuals living alone using wearable medical sensor wristbands.

8.3. Future Outlook

In the future, wearable medical sensor wristbands will exhibit vast potential in the domain of chronic disease monitoring and data analysis for elderly individuals living alone. With technological advancements, sensor wristbands will achieve more refined real-time physiological parameter

monitoring. Through high-precision sensors and intelligent algorithms, they will provide accurate data analysis, delivering personalized health recommendations and early warning mechanisms. Concurrently, leveraging big data and machine learning, we will delve deeper into medical data, establishing precise individualized medical models to formulate more effective chronic disease prevention and treatment plans. Furthermore, integrating artificial intelligence and cloud computing technologies will enable real-time processing and storage of medical data, enhancing the intelligence and efficiency of the monitoring system. By incorporating smart home technologies, we can further achieve remote monitoring and emergency assistance. These technological advancements will significantly elevate the health management level of elderly individuals living alone, bringing forth a more intelligent and personalized healthcare service model.

Conflicting Interests

The authors declare that they have no conflicting interests.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Guarantor

The Guarantor is the one or more people who accept full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish.

Contributor Ship

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Jian Huang, Manyi Zhuang, Wei Zhongheng. The first draft of the manuscript was written by Jian Huang and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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