



Analysis of Physical Activity Patterns using Wearable Sensors in the Management of Heart Disease

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ABSTRACT

Heart disease is one of the leading causes of death worldwide. Adequate physical activity is an important factor in the management of heart disease, but accurately monitoring physical activity can be challenging. The use of wearable sensors offers a potential solution to measure and analyze physical activity patterns more precisely. This study aims to analyze physical activity patterns using wearable sensors in the management of heart disease. As well as to find out whether physical activity using wearable sensors can overcome heart disease. This research method uses a method with a quantitative approach. This study involves participants who suffer from heart disease and use wearable sensors to record their physical activity over a period of time. The physical activity data, including the number of steps, activity intensity, and activity duration, were analyzed using statistical methods and signal processing algorithms to identify activity patterns related to heart conditions. The results of the analysis showed different physical activity patterns between individuals with heart disease and healthy individuals. Individuals with heart disease tend to have lower levels of physical activity and less regular activity patterns. In addition, certain activity patterns, such as long periods of low-intensity activity, are associated with a higher risk for cardiac complications. The implementation of this research is that wearable sensors can be an effective tool in the management of heart disease by enabling accurate monitoring of an individual's physical activity. By analyzing physical activity patterns, we can better understand the relationship between physical activity and heart conditions, allowing for the development of more precise and personalized interventions in the management of heart disease.

Keywords: Heart Disease, Physical Activity, Wearable Sensors

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INTRODUCTION

Physical Activity Pattern

Physical activity plays an important role in maintaining a healthy body. A balanced and regular pattern of physical activity has a positive impact on physical and mental health (Chiang et al., 2014). In the world of health, physical activity patterns are a major focus due to their direct involvement in preventing various diseases and improving overall quality of life (Ahmad et al., 2016). In general, physical activity patterns in the health world can be broken down into several aspects, ranging from the type of activity, intensity, frequency, to the benefits for health. Understanding the right physical activity pattern is very important for every individual, both to prevent disease and to achieve optimal health (Butte et al., 2012). One important aspect of physical activity patterns is the type of activity. Physical activity can take many forms, from sports, light physical activities such as walking, to physical activities that are integrated in daily activities such as cleaning the house or gardening (Kristoffersson & Lindén, 2022). These different types of activities have different benefits for the body. For example, exercise has the benefit of increasing muscle strength and endurance, while light physical activity such as walking can help maintain a healthy heart and boost the body's metabolism. In the world of health, it is recommended to pay attention to the variety of types of physical activity so that all parts of the body can be properly trained.

In addition to the type of activity, the intensity of physical activity also plays an important role in physical activity patterns. The intensity of physical activity can be measured based on how hard a person works while doing the activity (Prieto-Avalos et al., 2022). The right intensity of activity will provide optimal health benefits. For example, high-intensity physical activities such as running or fast cycling can improve cardiovascular fitness, while low-intensity physical activities such as yoga or leisurely walking are suitable to help reduce stress and improve flexibility. In the world of health, it is important to choose the intensity of physical activity that suits each individual's physical condition to minimize the risk of injury and obtain maximum benefits. Frequency of physical activity is also an important part of physical activity patterns in healthcare (Kouris & Koutsouris, 2007). The recommended frequency of physical activity varies depending on the goals and physical condition of the individual. Ideally, physical activity should be done regularly, at least 150 minutes per week to maintain overall health. However, for specific goals such as weight loss, improving endurance, or recovering from an injury, the frequency and duration of physical activity can be adjusted accordingly. In the world of health, it is important for each individual to create a physical activity schedule that fits into their daily routine and remain consistent in doing so.

The benefits of a regular and balanced physical activity pattern are immense in the world of health. Physical activity can help maintain a healthy weight, improve heart health, lower the risk of developing chronic diseases such as type 2 diabetes, cancer and coronary heart disease, and improve sleep quality. In addition to the physical benefits, physical activity also has a positive impact on mental health, such as reducing stress, improving mood, and helping to maintain memory and cognition (Alam et al., 2023). Therefore, a regular pattern of physical activity implemented in daily life is essential in maintaining overall quality of life. In the world of health, it is important to note that proper physical activity patterns also require a personalized approach. Everyone has different needs and physical abilities, so effective physical activity patterns may vary from individual to individual. There are various factors to consider, such as age, health condition, and the purpose of the physical activity. In the world of health, it is advisable to consult a health professional or sports trainer to find a physical activity pattern that suits each individual's condition and health goals.

In the modern world of healthcare, technology also plays an important role in facilitating healthy physical activity patterns. Smart fitness apps or devices have now become a popular tool for individuals to monitor and manage their physical activity patterns. With this technology, users can track their step count, heart rate, calories burned, as well as receive physical activity recommendations according to their health goals. Smart fitness devices also create greater awareness of physical activity patterns, as users can see their progress and achievements in real time (Khurshid et al., 2023). As the healthcare community becomes more aware of the importance of healthy physical activity patterns, many programs and initiatives are being launched to encourage people to be physically active. These programs can be in the form of campaigns to raise awareness of the importance of physical activity, the provision of easily accessible sports facilities, and increased education on the benefits and proper way of doing physical activity. Collaborative efforts between the government, private sector and civil society are also key in strengthening healthy physical activity patterns in society. In the world of health, it is important to remember that physical activity is not just a daily routine, but also a lifestyle. Awareness of the importance of healthy physical activity patterns is the first step in preventing various health problems. With proper physical activity patterns in place, individuals can maintain their physical and mental health, reduce their risk of developing serious diseases, and achieve a better overall quality of life. Therefore, in the world of health, physical activity patterns should be a priority for anyone who wants to live a healthy and fit life.

Use of Wearable Sensors in Heart Disease Management

Wearable sensors in the management of heart disease have experienced more advanced developments in recent years (Kańtoch, 2018). Wearable sensors are technology that can be worn or worn on the user's body, generally in the form of a small device attached to clothing or accessories such as bracelets or watches (Phillips et al., 2018). These sensors can measure various physiological parameters such as heart rate, blood pressure, physical activity and even sleep patterns. In the context of

heart disease management, wearable sensors are very important because they enable continuous and real-time monitoring of the patient's condition, thus allowing for early intervention and more effective treatment. First of all, the role of wearable sensors in the management of heart disease is very important in continuously monitoring the patient's condition. Traditionally, heart rate and other physiological parameters are only measured when patients visit health facilities or clinics. However, with wearable sensors, this data can continue to be monitored without disturbing the patient's daily activities. This provides a more complete and accurate picture of the patient's health condition, allowing for prevention or early intervention if significant changes occur (Bleser et al., 2015). For example, wearable sensors can detect cardiac arrhythmias in real-time and alert the patient or medical team to take immediate action. Sensor technology used in wearable devices for the management of heart disease also continues to develop. These sensors are now capable of measuring with high accuracy, even under intense physical activity. Apart from that, the connectivity capabilities of wearable sensors with smart devices such as smartphones or tablets also make it easier for patients to monitor their condition. The measured data can be directly synchronized with health applications or electronic medical record systems (Fortunato et al., 2020), making it easier for doctors or medical teams to analyze and make decisions regarding the management of patients' heart disease.

The benefits of using wearable sensors in the management of heart disease are urgently needed. In addition to providing continuous monitoring, these sensors also allow for personalization in the management of heart disease (Bate et al., 2023). With data collected continuously, doctors or medical teams can be more precise in determining heart disease management strategies that suit the patient's condition. Apart from that, wearable sensors can also provide motivation for patients to be more proactive in managing their condition. Through features such as physical activity tracking, patients can monitor how active they are in living a healthy lifestyle, which in turn can influence their quality of life and heart disease prognosis (Oba et al., 2023). Despite having various benefits, the use of wearable sensors in the management of heart disease also faces several challenges. One of them is related to measurement accuracy. Although sensor technology continues to develop, strong validation is still needed regarding the measurement accuracy of these sensors. Apart from that, the nature of wearing sensors attached to the body also needs to be considered, whether they can be worn comfortably for long periods of time, especially in patients with heart disease who may lead an active lifestyle.

Another challenge is related to data privacy and security. Wearable sensors collect sensitive data about patient health, and strong measures need to be taken to keep this data confidential and secure (AlShorman et al., 2021). Apart from that, it is also important to ensure that the data collected can be interpreted properly by the doctor or medical team, so that it can provide added value in decision making regarding the management of heart disease. Apart from that, regulatory aspects are also one of the challenges in implementing wearable sensors in the management of

heart disease. Wearable medical devices need to pass a series of clinical trials and gain approval from regulatory authorities before they can be widely used in the management of heart disease. This requires a lot of time and resources, but it is very important to ensure that the wearable sensors used are safe and effective. In facing these challenges, collaborative efforts between wearable device manufacturers, healthcare providers, researchers, and regulatory authorities are critical (Teixeira et al., 2021). This collaboration can accelerate the development and validation of wearable sensor technologies for heart disease management, and ensure that these devices can be widely applied in society with proven safety and effectiveness. So the general conclusion is that wearable sensors have a very important role in managing heart disease (Rutkowski et al., 2021). With their ability to provide continuous monitoring, offer accurate data, and provide benefits in personalized heart disease management, wearable sensors can help patients and medical teams deal with heart disease more effectively. Even though it still faces several challenges, with collaboration between various parties, wearable sensor technology in the management of heart disease has great potential to have a positive impact in improving the quality of life and prognosis of heart disease patients.

There are several previous research opinions. The first research according to Aripadono, (2021), with the research title Analysis of the Technology Readiness and Acceptance Model (TRAM) on the Use of Sport Wearable Technology. The results of his research stated that Users have a high positive assessment (positive technology readiness) on sports wearable technology through the Perceived Ease of Use (PEOU) factor compared to the Perceived Usefulness (PU) value of the wearable technology. The second research according to Somantri et al., (2022), with the research title Self Services And Monitoring Of Weak Heart Disease Based On The Internet Of Things And Mobile App Using Certainty Factor. The results of his research stated that application can also accommodate the patient's heart rate history data into a database as a data storage medium. This application system uses IoT technology, which makes it easy for users or patients and practitioners to see the results of a heartbeat to find out whether a patient has a weak heart or not, in real-time via a smartphone (smartphone) without interfering with patient mobility. The third research according to Kamajaya et al., (2023), with the research title(Kamajaya et al., 2023) Iot Based Health Telemonitoring System . The results of his research stated that artificial intelligence which aims to provide early diagnosis of diseases suffered by humans according to the results of measurements. By creating this health telemonitoring system, it is hoped that it will make it easier for people to telemonitor health practically and efficiently.

RESEARCH METHODOLOGY

This research uses quantitative research methods with an observational approach to analyze physical activity patterns using wearable sensors in the management of heart disease (Kang et al., 2020). Participants were selected based on inclusion criteria

that included individuals who had been diagnosed with heart disease by a doctor and were able to use wearable sensors. This study was conducted at a heart health center associated with a leading hospital. The research procedure began with participant recruitment through advertisements in hospitals, heart health centers, and through direct invitations to individuals who met the inclusion criteria (Flandrin et al., 2021). After obtaining consent from participants, they were given an explanation about the use of wearable sensors and the purpose of the research. Each participant is then asked to wear the wearable sensor at all times during a predetermined study period, which generally lasts two weeks to a month. The wearable sensor used in this research is a type that is capable of recording physical activity data such as number of steps, distance traveled, intensity of activity and duration of activity (Pitta et al., 2006). This sensor is equipped with technology that can transfer data to a storage device or smartphone application for further analysis. Participants were given instructions to wear the sensor consistently on the appropriate part of the body, such as the wrist or waist, and not to remove it except for showering or sleeping

Physical activity data recorded by wearable sensors were collected periodically throughout the study period. This data includes information about participants' daily activity, including number of steps, time and duration of activity, and estimated activity intensity. In addition, information about sleep patterns was also recorded to gain a more holistic understanding of participants' physical activity and sleep behavior. After the data collection period is complete, the data that has been recorded by the wearable sensors is collected and analyzed using statistical methods and signal processing algorithms. First, the raw data from the sensors is processed to remove noise and artifacts, and to convert the data into a format that is easier to interpret. Next, the data is processed to calculate relevant physical activity parameters, such as the total number of steps, average activity duration, and frequency of high-intensity activity. During the analysis process, the physical activity patterns of each participant were evaluated taking into account the differences between individuals with heart disease and healthy individuals. Variability in activity patterns, such as the length of periods of low-intensity activity or high levels of physical activity during weekdays versus weekends, was explored to uncover patterns potentially related to heart conditions.

Finally, the results of the analysis are interpreted to understand the relationship between physical activity patterns and heart conditions. Activity patterns typical for individuals with heart disease are identified, along with other factors that may influence physical activity such as age, gender, and other underlying health conditions. Through this approach, it is hoped that this research will provide a better understanding of physical activity patterns in individuals with heart disease and identify more effective management strategies. The conclusion of this research method is that analyzing physical activity patterns using wearable sensors is a potential approach in managing heart disease. By enabling accurate and continuous measurement of an individual's physical activity, wearable sensors can help in

monitoring heart conditions more effectively and provide valuable information for the development of better clinical interventions.

RESULT AND DISCUSSION

Heart disease is a major health problem worldwide that can have a serious impact on a person's quality of life and life expectancy. According to the World Health Organization (WHO), heart and blood vessel disease is the number one cause of death in the world. Therefore, preventing heart disease is very important to reduce the public health burden and improve the quality of life. One effective way to prevent heart disease is to do regular physical activity and adopt a healthy lifestyle. The use of wearable sensors in monitoring physical activity has opened the door to a more personalized and effective approach to heart disease prevention. Physical activity has a very important role in maintaining a healthy heart and blood vessels. Various studies have shown that doing regular physical activity can reduce the risk of heart disease. Regular physical activity can help increase heart muscle strength, control blood pressure, increase good cholesterol (HDL) levels, and control body weight, all factors that contribute to good heart health. However, to effectively prevent heart disease by engaging in physical activity, continuous monitoring of physical activity patterns is required.

Wearable sensors have become a popular tool in monitoring daily physical activity. By using sensors such as smartwatches or activity trackers, individuals can track the number of steps taken, distance traveled, calories burned, and even their sleep patterns. These wearable sensors allow users to monitor their physical activity levels more accurately and provide feedback that can help in improving the consistency and intensity of physical activity. Through physical activity monitoring using wearable sensors, individuals can gain a better understanding of their daily physical activity patterns. They can see how active they are each day, identify patterns of underactivity, and set realistic targets to improve. By continuously monitoring physical activity patterns, individuals can identify changes in their activity levels over time and take the necessary steps to improve their lifestyle. The use of wearable sensors can also help in increasing motivation to engage in regular physical activity. Features such as reminders to move, achieving daily goals, and competition with friends or family can be strong motivating factors for individuals to stay active. With immediate feedback from wearable sensors, individuals can see their progress over time, which can increase their sense of accomplishment and motivation to continue a healthy lifestyle.

Additionally, the use of wearable sensors in monitoring physical activity can also provide valuable information to health professionals. By continuously collecting data on patients' physical activity patterns, doctors and health professionals can monitor patients' physical activity levels and make recommendations accordingly. They can use this information to adjust treatment plans and provide more specific advice about the type and intensity of physical activity recommended for a particular patient. However, it is important to remember that wearable sensors are only an aid and not a replacement for professional medical consultation. Although wearable

sensors can provide valuable information about a person's physical activity patterns, they cannot provide medical diagnosis or treatment. Therefore, it is important for individuals to stay in contact with their doctors and follow the medical guidance provided. In the context of preventing heart disease, the use of wearable sensors to monitor physical activity can be a very useful tool in helping individuals to stay active and healthy. By providing continuous feedback and motivation to stay active, wearable sensors can be valuable partners in the effort to maintain heart health and prevent serious heart disease.

Implementing steps using wearable sensors to prevent heart disease is an innovative and effective approach in managing heart health holistically. With technology continuing to develop, wearable sensors such as smartwatches or activity trackers have become popular tools in helping individuals maintain a healthy lifestyle and reduce the risk of developing heart disease. Here are some steps that can be taken to utilize wearable sensors in preventing heart disease. The first step in using wearable sensors to prevent heart disease is to monitor physical activity regularly. Wearable sensors can be used to track the number of steps taken, distance traveled, and calories burned each day. By regularly monitoring physical activity, individuals can ensure that they stay active and reach recommended daily activity targets to maintain heart health. Furthermore, individuals can use wearable sensors to set realistic and achievable physical activity goals. For example, they can set a target for the number of steps or duration of physical activity they want to achieve daily or weekly. By having clear goals, individuals can be more motivated to stay active and consistent in doing physical activity. Wearable sensors can also be used to monitor the intensity of physical activity. For example, some wearable sensors can track heart rate during physical exercise and provide information about optimal heart rate zones for burning fat or improving cardiovascular fitness. By monitoring the intensity of physical activity, individuals can ensure that they are exercising intensely enough to obtain optimal heart health benefits.

Apart from physical activity, wearable sensors can also be used to track a person's sleep patterns. Sleep disorders such as insomnia or sleep apnea have been closely linked to an increased risk of heart disease. By monitoring sleep patterns using wearable sensors, individuals can identify sleep disorders they may be experiencing and find solutions to improve the quality of their sleep. Wearable sensors often come with alert and reminder features that can help individuals stay active and adopt a healthy lifestyle. For example, they can set a reminder to stand up every hour or a reminder to move after a certain period of inactivity. This feature can help individuals to break up prolonged sitting time and encourage them to engage in regular physical activity. Finally, it is important to remember that wearable sensors are only an aid and are not a substitute for professional medical consultation. Before starting a new physical activity program or adopting a healthy lifestyle, individuals are advised to consult with their doctor or health care professional. Doctors can provide appropriate advice based on individual health conditions and help in planning an effective heart disease prevention program

Table 1: Results of observations made on patients in hospital

NO	Analysis Method	Observation Results
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1	Identify Sleep Patterns	Patients with heart disease often experience sleep disorders, such as not sleeping soundly or being disturbed by shortness of breath.
2	Daily Activity Monitoring	Patients with heart disease tended to have lower activity patterns than controls.
3	Activity Intensity Recording	There is significant variation in the intensity of physical activity between patients with different levels of heart disease severity.
4	Evaluation of Therapy Effectiveness	Wearable sensors can be used to evaluate the effectiveness of therapy and lifestyle changes in patients with heart disease.

From the above table, it can be understood that the identification of sleep patterns is an important aspect in the management of heart disease as sleep disturbances are often related to underlying heart conditions. Wearable sensors allow continuous monitoring of a patient's sleep patterns, thus enabling early detection of sleep disturbances that may worsen the heart condition. The study found that patients with heart disease often experience sleep disturbances, such as poor sleep or interrupted by shortness of breath, which highlights the importance of appropriate interventions in the sleep management of patients with heart disease. Daily activity monitoring through wearable sensors enables accurate measurement of patients' physical activity levels. In this study, it was found that patients with heart disease had activity patterns that tended to be lower compared to the healthy control group. This indicates the potential to use wearable sensors as a monitoring tool to identify high-risk patients or changes in their health condition. Recording physical activity intensity also provides valuable insights in the management of heart disease. Using wearable sensors, this study found that there was significant variation in physical activity intensity between patients with varying degrees of heart disease severity. This information can be used to design an individually tailored cardiac rehabilitation program, taking into account the patient's level of physical activity tolerance. Wearable sensors can also be used to evaluate the effectiveness of therapy and lifestyle changes in patients with heart disease. By continuously monitoring physical activity, wearable sensors enable healthcare professionals to track changes in patients' activity patterns over time. This allows a more accurate evaluation of response to therapy and helps in individualizing heart disease management plans. The use of wearable sensors in the analysis of physical activity patterns has opened the door to more personalized and effective management of heart disease. By providing more detailed information about a patient's physical activity, sleep, and activity intensity, wearable sensors have great potential to increase our understanding of heart disease and improve patient health outcomes.

CONCLUSION

Based on the results and discussion above, it can be concluded that analyzing

physical activity patterns using wearable sensors in the management of heart disease is important in an effort to improve the quality of life for individuals experiencing heart health conditions. With the advancement of wearable sensor technology, more accurate and continuous data can be collected about a person's physical activity, which can be very useful in monitoring and managing heart disease. In the use of wearable sensors for physical activity pattern analysis, it is possible to look at daily activity patterns, exercise intensity, duration of physical activity, and rest, which collectively provide valuable information for medical practitioners in managing heart disease. In this regard, a key benefit of using wearable sensors in physical activity pattern analysis is their ability to provide more accurate and continuous data on a user's physical activity. The resulting data can assist medical practitioners and patients in understanding individual activity patterns in greater detail. With better information about daily physical activity, medical practitioners can make more informed decisions in designing heart disease management programs that suit each patient's conditions and needs. In addition, the use of wearable sensors also provides an opportunity to monitor changes in physical activity patterns over time, which can be an important indicator in evaluating the effectiveness of a given intervention or treatment. Besides the benefits, there are also some challenges. One of them is the issue related to the validity and reliability of the data generated by wearable sensors. Although sensor technology continues to evolve, there are still concerns about how accurate and reliable the data collected from wearable sensors is, especially in the context of measuring specific physical activities such as strenuous exercise or complex physical activities. In addition, other challenges include privacy and data security concerns, and the availability and cost of procuring wearable sensors which may be a barrier for some individuals who need heart disease management. With proper supervision and support these challenges can be overcome quickly.

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