Indonesian Journal of Global Health Research
Volume 7 Number 4, August 2025
e-ISSN 2715-1972; p-ISSN 2714-9749
http://jurnal.globalhealthsciencegroup.com/index.php/IJGHR

DIABETIC SHOES WITH FOOT MOISTURE DETECTION SYSTEM TO SUPPORT THE FOOT CARE OF DIABETIC PATIENTS

Defrima Oka Surya[1]*, Ria Desnita[2], Anugrah Ilahi[3]
[1]DIII Nursing Study Programme, Universitas Mercubaktijaya, Surau Gadang, Nanggalo, Padang, Sumatera Barat 25173, Indonesia
[2]S1 Nursing Study Programme, Universitas Mercubaktijaya, Surau Gadang, Nanggalo, Padang, Sumatera Barat 25173, Indonesia
[3]Electrical Engineering, Faculty of Engineering, Universitas Andalas, Jl. Limau Manis, Limau Manis, Pauh, Padang, Sumatera Barat 25163, Indonesia
*defrima.okasurya@gmail.com

ABSTRACT
Diabetic Foot Ulcers (DFU) are one of the serious complications experienced by diabetes patients. Foot care for DM patients is very important to prevent foot ulcer complications. Foot care can be done by using the right shoes and also maintaining moisture on the foot skin. Wearing shoes for too long affects the moisture of the feet. Skin that is too dry or too moist can also cause damage to the skin, which can lead to ulcers. Special shoes for DM patients that have already been used still have limitations and do not monitor foot health optimally and in real-time. The aim of this research is to design diabetes shoes with a foot moisture detection system. The design of this research is a research and development approach (R&D). The stages conducted in this research consist of literature study, system design, design implementation, system testing, and analysis. Data analysis and system performance results will evaluate the sensor's function to detect foot moisture in patients while using the shoes. The result of this research is the development of diabetes shoes with a real-time moisture detection system. It is hoped that diabetes mellitus patients can independently perform foot care, one of which is by controlling foot moisture.

Keywords: diabetes; foot care; humidity; shoes

How to cite (in APA style)
Surya, D. O., Desnita, R., & Ilahi, A. (2025). Diabetic Shoes with Foot Moisture Detection System to Support the Foot Care of Diabetic Patients. Indonesian Journal of Global Health Research, 7(4), 585-588. https://doi.org/10.37287/ijghr.v7i4.5026.

INTRODUCTION

Type 2 Diabetes Mellitus is a type of Diabetes Mellitus caused by decreased sensitivity to insulin (insulin resistance) or due to a decrease in the amount of insulin production (1). Data from the Center for Disease Control and Prevention (CDC) states that around 38 million people suffer from Diabetes Mellitus, and approximately 90-95% of them have Type 2 Diabetes Mellitus. (2). According to the International Diabetes Federation (IDF), Indonesia ranks fifth among the top ten countries in the world for Type 2 Diabetes Mellitus cases, reaching 19.5 million people in 2021 and is predicted to increase to 21.3 million people by 2030 (3). Based on the Basic Health Research (Riskesdas) report data, the prevalence of Type 2 Diabetes Mellitus in Indonesia shows a significant increase from 2013 to 2018, with the highest number of cases being 713,783 people, where it increased from 1.5% to 2.0%. (4).

Diabetic Foot Ulcers (DFU) are one of the serious complications experienced by diabetes patients, manifested as wounds that appear on the feet due to diabetic neuropathy (loss of sensation in the feet) and impaired blood flow. Diabetes patients have a 15-25% risk of developing DFU over their lifetime. DFU can develop into necrotic tissue and can lead to amputations of the toes, feet, and limbs. Foot care for DM patients is very important to prevent foot ulcer complications. Foot care can be done by using the right shoes and also maintaining moisture on the foot skin. Pressure from wearing improper shoes can cause

damage to the skin and the soft tissues underneath (5). Foot moisture is also an important point in the foot care of DM patients. The neuropathy process also affects sweat production and impacts the moisture of the patient's feet. Wearing shoes for too long also contributes to foot moisture. Feet that are too dry or too moist can also cause skin damage that may lead to ulcers (6). Therefore, proper care and monitoring are essential to prevent complications in the feet of diabetic patients.

One of the foot treatments is using the right shoes. Special shoes for diabetes patients have been widely developed and sold, but they still have limitations in monitoring the condition of the wearer's feet. Previous research by Tri Laksono and Hapsari in 2020 developed shoes for the conventional monitoring of diabetic patients' foot health (7). Research by Kularathene et al. in 2019 also developed a device in the form of a mobile phone in shoes available on the market to monitor foot health, but the developed shoes only monitor the peak plantar pressure strength. Meanwhile, temperature, humidity, and abnormal pressure cannot be adjusted (8).The development of technology has provided new opportunities in the development of patient care with more effective and sophisticated monitoring solutions, particularly by utilizing programming and sensors for real-time detection. Based on the problems and limitations of previous research, one of the innovations to be developed is shoes for diabetes patients equipped with foot moisture detection sensors. The purpose of this study is diabetic shoes with foot moisture detection system to support the foot care of diabetic patients. This solution is expected to monitor the health of patients' feet while wearing the shoes, providing a useful tool for nurses in supporting patient care to prevent diabetic foot complications at an earlier stage.

METHOD

The design of this research uses a research and development (R&D) approach, which involves building and designing a system applied to medical devices. In this research, diabetes shoes equipped with moisture detection sensors will be developed. The stages of this research consist of a literature study, specifically in the initial design phase of diabetes shoes equipped with moisture detection sensors. Data collection and literature search were conducted by referring to journals that discuss real-time monitoring systems to obtain relevant information. In the system design phase, the identification of system requirements to be developed for the diabetes shoe product is carried out. The purpose of this system design is to provide an overall picture of the system that will be built. Implementation of Design and Program Development. This stage implements the design that has been created. Implementation is carried out using programming languages on the device. At the system testing stage, each program unit that has been created and meets the expected functions will be integrated and tested as a single cohesive system. The method used in this system testing is blackbox testing. Testing is also conducted to assess the calibration and accuracy of the sensors in the system. This testing will involve 5 users. After the system testing, an analysis will be conducted to ensure that the program aligns with the design that has been made and meets the product's requirements.

RESULT

This product is designed to support foot care for DM patients. One of the components of foot care to prevent complications is to maintain foot moisture at an optimal level, neither too damp nor too dry. Prolonged use of shoes can affect foot moisture, so this product was developed to allow patients to monitor foot moisture in real-time while wearing shoes. This diabetes shoe is planned to be equipped with a moisture detection sensor. The detection results will be displayed on a buzzer and a red indicator light. The system flow diagram in the shoe design uses a moisture detection sensor, where during testing, the sensor will be read. Arduino Nano will process the data according to the given programming. The data is sent and the alarm will be activated when the feet are wet at a temperature 34 ^{o}C.

The working principle of the detection sensor system is as follows:

1. Temperature Reading
   The DHT11 sensor directly measures the ambient temperature and sends the data to the microcontroller.
2. Temperature Threshold Check when the detected temperature reaches or exceeds 34°C.
3. High-Temperature Alarm Activation when the temperature reaches or exceeds 34°C, the system will automatically activate the buzzer and indicator light:
   - The buzzer functions as an audible alarm to provide a warning.
   - The indicator light turns on as a signal that the temperature in the shoes is excessive.
4. System Recovery
   The alarm will remain active until the temperature drops below the threshold. This indicates that the temperature has returned to normal.

This research involves three components, namely:

1. Input: Hardware components installed on smart shoes. This includes thermistor sensors to measure temperature. The data generated by these sensors will be processed further.
2. Process: This section involves software responsible for processing the data collected by the input sensors. This process is carried out using the C++ programming language in the Arduino development environment.
3. Output: The output component involves monitoring devices that will display an alarm if the foot temperature reaches or exceeds 34°C, the system will automatically activate the buzzer and indicator light.

The effectiveness of this detection system was also tested on 5 respondents with a history of Diabetes. This test was conducted to assess the functionality of the sensor and the duration the respondents wore the shoes until the system detected their feet as damp. The test results show that the device is functioning well. The time parameters of the test results for the respondents can be seen in the table below:

Table 1.
Average Foot Moisture Time Results from Testing Respondents

Respondent	Average Time for Dampt Feet
Respondent 1	35 minute
Respondent 2	40 minute
Respondent 3	50 minute
Respondent 4	37 minute
Respondent 5	45 minute

Based on these results, it can be concluded that the average foot moisture of patients is detected within a minimum of 35 minutes and a maximum of 50 minutes. For DM patients, the use of leather shoes poses a risk of hot and moist feet, so a detection system is needed to prevent prolonged foot moisture.

DISCUSSION

Foot care for DM patients is one of the important treatments to prevent complications such as diabetic ulcers. Foot care can be performed by using the right shoes and also maintaining the moisture of the foot skin. Pressure from improper shoe use can cause damage to the skin and the underlying soft tissue (5). Wearing shoes for too long affects the moisture of the feet. Skin that is too dry or too moist can also cause skin damage that may lead to ulcers (6). It is important for DM patients to regularly inspect their feet for any signs of redness, blisters, or cuts, as these can be early indicators of potential ulcers. Properly fitting shoes that provide adequate support and cushioning can help prevent pressure points and reduce the risk of skin damage. Additionally, applying moisturizer to the feet daily can help maintain the skin's

integrity and prevent cracking. By taking these measures, DM patients can effectively manage their foot health and reduce the risk of developing diabetic ulcers.Special shoes for DM patients that have been used so far still have limitations and do not monitor foot health optimally and in real-time. In previous studies, foot health while using the shoes was only monitored manually and observed directly. Previous research recommended the need for monitoring foot health while using the shoes, one of which is foot moisture. (8). Further analysis based on the developed tool, foot health monitoring with shoes equipped with sensors and moisture detection alarms can make foot care a self-managed task for patients' health because this technology facilitates patients in monitoring the condition of their feet.

By having sensors in the shoes that can detect moisture levels, individuals can be alerted to potential issues such as excessive sweating or fungal infections before they become serious problems. This proactive approach to foot health can lead to early intervention and prevention of complications. With the advancement of technology, individuals can now take a more active role in caring for their feet and overall health. (QuillBot, 2024) By utilizing moisture detection alarms, patients can take control of their foot care routine and make informed decisions about their health. This technology allows individuals to track changes in moisture levels over time, enabling them to adjust their foot care regimen accordingly. Overall, these advancements in health technology empower individuals to prioritize their well-being and prevent potential foot-related issues before they escalate. (QuillBot, 2024) For example, a diabetic individual can use a moisture detection alarm to monitor their feet for any signs of infection or injury, allowing them to seek medical attention promptly. This proactive approach can help prevent serious complications such as ulcers or amputations, ultimately improving their quality of life and reducing healthcare costs. (QuillBot, 2024)

CONCLUTION

Based on the results of the diabetes shoe design, it is known that wearing closed leather shoes for at least 35 minutes causes the patient's feet to become damp, making this a focus in the care and education provided to patients regarding foot care. The use of sensors for detection and alarms as warnings for patients can help with foot care during daily activities.

REFERENCES

Black, Hawk. Medical-surgical nursing: Clinical management for positive outcome. Saunders Elseviers; 2014.

CDC. Diabetes Type 2. 2023 [Internet]. Available from: https://www.cdc.gov/diabetes/basics/type2.html

IDF. IDF diabetes Atlas: Global estimates of undiagnosed diabetes in adults for 2021. Diabetes Research and Clinical Practice. 183:1–9.

Kemenkes RI. Riset Kesehatan Dasar. Jakarta: Balitbang Kemenkes RI; 2018.

Ariyani I, Widiyanto B. Pengaruh Perawatan Kaki Dengan Senam Kaki Terhadap Risiko Ulkus Kaki Diabetik Pada Pasien Diabetes Mellitus. Indonesian Nursing Journal of Education and Clinic. 2023;3(1).

Moulaei K, Malek M, Sheikhtaheri A. A smart wearable device for monitoring and self-management of diabetic foot: A proof of concept study. International Journal of Medical Informatics. 2021 Feb;146:104343.

Laksono. Sepatu Untuk Mencegah Luka Pada Kaki Penderita Diabetes. Universitas Mercu Buana Jakarta; 2020.

Nethmi Kularathne, Udara Wijayathilaka, Nethmi Kottawaththa, Shashika Hewakoralage, Samantha Thelijjagoda. Dia-Shoe: A Smart Diabetic Shoe to Monitor and Prevent Diabetic Foot Ulcers. International Conference on Advancements in Computing (ICAC). 2019;410–5.