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Internet Of Mirror (Iom) -A Smart Mirror For Comprehensive Health Monitoring And Real-Time Information

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Abstract:
Through the introduction of cutting-edge tools that improve ease and raise living standards, the Internet of Things (IoT) is completely changing contemporary lifestyles. One innovative use of the Internet of Things is the Reflectron smart mirror, which combines cognitive features with everyday activities. By providing real-time updates on important information like time, weather, calendar events, and news, it surpasses the traditional mirror. It features inspirational motivational quotations that promote happiness and productivity in order to support mental health. One of Reflectron's best features is its ability to track vital health metrics, such as body temperature, heart rate, and blood oxygen saturation (Spo2), enabling users to keep tabs on their physical well-being. Its facial recognition features can detect emotions, allowing for a personalized and simple user experience. Reflectron serves as an example of how IoT may be seamlessly integrated with lifestyle and personal health management. It emphasizes the revolutionary role IoT can play in enhancing daily life by fusing health tracking with necessary daily functions in an aesthetically pleasing device

Keywords: *Smart Mirror, Reflectron, Health and Well-being Raspberry PiIoT Integration Facial Recognition Emotional Recognition*

1. INTRODUCTION

By combining the Internet of Things, smart mirrors are transforming commonplace technology by offering individualized experiences and real-time updates. Through interactive displays, these gadgets can improve user engagement while simultaneously providing vital information like the time, the weather, and news updates. The incorporation of facial recognition algorithms, which allow smart mirrors to provide personalized content and improve user interaction, is a noteworthy development in this area [1]. IoT-enabled smart mirrors are becoming more adaptable, providing real-time data and adjustable features that improve user convenience, in contrast to traditional mirrors, which only have utilitarian uses [2]. Along with standard features, smart mirrors that employ IoT enable smooth device-to-device connectivity, which makes it possible to deliver dynamic content like alerts and weather updates. The Reflectron algorithm focuses on generic emotion recognition, which enables context-aware features without requiring safe access, even though many smart mirror systems employ facial recognition for security access [3]. This method increases the smart mirror's interactiveness and emotional intelligence, allowing it to modify the content it displays based on the user's preferences or mood. Additionally, the use of IoT technologies for real-time health monitoring is becoming more popular. These mirrors' built-in sensors monitor vital signs including body temperature and heart rate, providing ongoing health monitoring and real-time cloud access to the data [6],[8]. The possibility of promoting health in the workplace has also been investigated; smart mirrors can offer useful health information and feedback to motivate employees to adopt healthier habits [9]. These systems' development pushes the limits of smart mirror functionality and user experience by showcasing the increasing integration of IoT, AI, and machine learning technology. The functionality of getting aware of modules such as Sensors, actuators, refreshments, detailed snipping of tasks in versatile domains, considered as face of requirement for Internet of Mirror technology.

1.2. Literature Survey

The study "Personalized Day-to-Day IoT-based Smart Mirror Using Facial Recognition," presented by P. B. et al. in 2023, [1], describes a framework for incorporating facial recognition technology into smart mirrors. Customization, safe access, and tailored user experiences are made possible by this integration. The technology improves user privacy and interaction by using IoT to give real-time updates like news and weather. A 2023 study by Srathak Bhake et al. [2] titled "Design of a Cost-Effective Smart Mirror Using Raspberry Pi" focuses on creating an IoT-enabled smart mirror with an emphasis on cost-effectiveness. Using a Raspberry Pi as its central piece of hardware, the system emphasizes affordability and usefulness while providing real-time information such as the time, weather, and news through an easy-to-use interface. An inventive method for converting traditional mirrors into interactive gadgets with IoT technologies is provided in "A Novel Two-Way Mirror with the Help of the Internet of Things" by Karthick K et al., [3] in 2023. With the use of smart sensors and centralized IoT connection, the system improves user convenience by providing real-time information on weather, news, and notifications. In 2024, M. Ramya et al. [4] described the creation of a smart mirror that uses a Raspberry Pi in their paper "Unveiling the Future: Design and Development of an Intelligent Raspberry Pi-Based Smart Mirror Design Using Internet of Things Assistance." In order to improve user convenience and engagement, this mirror has features including voice assistance, real-time updates, and customizable displays. In 2022, V. Viswanatha et al. [5]
presented a system that improves smart mirrors with real-time object detection, facial recognition, and interaction capabilities in their paper "IoT Based Smart Mirror Using Raspberry Pi 4 and YOLO Algorithm: A Novel Framework for Interactive Display." The YOLO algorithm and the Raspberry Pi 4 are used in the system to make the mirror interactive and context-aware. In their 2023 study "Design of Smart Mirror with IoT," Duraisamy, Kalaiyarasi, et al. [6] investigated how to incorporate IoT into smart mirrors to enable functions including news delivery, calendar integration, and real-time weather updates [21]. The usage of IoT sensors and cloud connectivity for dynamic content retrieval was highlighted in the report as a way to enhance user interaction and experience. In 2022, Leo Raju et al. [7] investigated how integrating IoT and AI technology can improve smart mirrors in their paper "Design of Intelligent Mirror System Using IoT & AI." The study illustrated how AI and IoT can collaborate to build a smooth smart home environment by highlighting capabilities like voice-activated control, real-time updates, and personalized recommendations [17]. IoT device integration for ongoing health monitoring was investigated in 2024 in "Real-Time Health Monitoring with IoT" by M.D. Nadil Khan et al. [8]. The study covered how sensors record vital signs including body temperature, blood pressure, and heart rate and send the data to cloud platforms for instant access and analysis. Last but not least, Oihane Gomez-Carmona et al. [9] presented a platform intended to encourage health in work settings in "SmiWork: An Interactive Smart Mirror Platform for Workplace Health Promotion." The smart mirror, which focuses on tracking important health data and promoting healthy habits among employees, offers health monitoring, user feedback, and personalized health recommendations by combining IoT with interactive interfaces. In their 2020 publication "Smart Mirror Using Raspberry Pi," Bhuvaneswari T et al. [10] describe the architecture of a Raspberry Pi-powered smart mirror system. The system shows current information such as the date, time, weather, and news and has rudimentary Internet of Things features [22]. It is accessible for a variety of applications because to its focus on simplicity and price.

Table 1. *Literature Survey Table*

S. No	Title of Research Paper	Purpose	Limitations
1	Internet-of-Mirrors (IoM) for Connected Healthcare and Beauty: A Prospective Vision (2024)	Proposes an interconnected system of smart mirrors integrating sensing and communication for healthcare and beauty services.	Conceptual framework; lacks practical implementation and real-world testing.

2	Smart Medical Mirror for Health Monitoring (2023)	Develops a non-invasive mirror-based health monitoring system tracking BMI, temperature, and weight using sensors.	Limited health metrics; lacks heart rate and SpO_2 monitoring.
3	IoT-Based Smart Mirror Using Raspberry Pi 4 and YOLO Algorithm: A Novel Framework for Interactive Display (2022)	Uses YOLO-based facial recognition and PIR sensors for smart mirror security and interaction.	High computational requirements; accuracy depends on lighting conditions.
4	MirrorME: Implementation of an IoT-Based Smart Mirror through Facial Recognition and Personalized Information Recommendation Algorithm (2021)	Integrates facial recognition (HOG & SVM algorithms) with personalized content recommendation; tested on 10 participants.	Achieves 86.75% success rate but lacks real-time health monitoring.
5	Smart Mirror: A Multipurpose IoT-Based System Using Raspberry Pi (2021)	Implements a Raspberry Pi-powered mirror for voice recognition, calendar updates, and smart home automation.	Security concerns due to motion detection storage; lacks biometric health tracking.
6	IoT-Based Smart Mirror Using Raspberry Pi (2021)	Displays daily updates (time, weather, news) and includes motion detection for security.	No facial recognition or health monitoring.
7	IoT-Enabled Smart Mirror for Enhanced Home Security and Convenience (2021)	Uses Arduino Uno to integrate sensors, actuators, and voice recognition for smart device control.	Limited health tracking features; primarily focused on home security.
8	Smart Mirror Fashion Technology for Retail Chain Transformation (2021)	Explores how smart mirrors can enhance retail service quality and customer experience.	Focused on retail applications; does not address health monitoring or home automation.
9	A Smart Mirror for Emotion Monitoring in Home Environments (2021)	Uses deep learning to detect facial expressions and emotional monitoring for personalized interactions.	Lacks health tracking and is limited to emotion-based applications.
10	A Novel Implementation of an Interactive Smart Mirror (2021)	Integrates IoT modules for home automation, real-time notifications, and environmental monitoring sensors.	Lacks health monitoring; focuses more on home automation and usability.
11	IoT-Based Smart Mirror for Health Monitoring (2020)	Uses biomedical sensors (ECG, temperature, blood pressure) with IoT for real-time health tracking and remote medical diagnosis.	No facial recognition or home automation integration.
12	Interactive Smart Mirror for Personalized Home Environment (2020)	Uses sensor data analytics to deliver fitness tracking and scheduling information with voice/touch interaction.	Limited to basic data personalization; lacks biometric health monitoring.

13	Design of Smart Mirror Based on Raspberry Pi (2020)	Implements face recognition (LBPH algorithm), voice interaction, and home automation.	Lacks advanced AI-driven personalization and scalability for additional sensors.
14	Smart Mirror to Support Hair Styling (2020)	Uses Haar Object Detector from OpenCV for virtual hairstyling applications.	Limited to cosmetic and hairstyling applications; lacks IoT-based automation.
15	Enhancing Smart Mirror with Human Healthcare Perspective (2020)	Uses Raspberry Pi with temperature & humidity sensors for personalized health tracking and medicine reminders.	Lacks advanced health tracking such as heart rate & blood pressure monitoring.
16	Smart Mirror: A Novel IoT-Based Information Hub (2019)	Uses IoT to integrate notifications, calendar updates, and weather reports into a mirror interface.	Lacks biometric tracking and health monitoring; limited personalization.
17	Smart Mirror: A Secured Application of AI Recognizing Human Face and Voice (2018)	Uses neural networks for facial & voice authentication to improve smart home security and personalization.	Cloud-dependent AI processing raises privacy concerns.

2. MATERIALS AND METHODS

The proposed system's methodology is really easy to learn. In order to develop an interactive system that improves daily living through real-time updates, health monitoring, emotion identification, and facial recognition, the suggested model intends to combine IoT technologies with cutting-edge hardware. The needs collection, system design, hardware configuration, software development, integration, and testing phases make up the methodology's structure. Every stage ensures that the model goals

have been achieved effectively as shown in figure 1.

2.1. Proposed Model

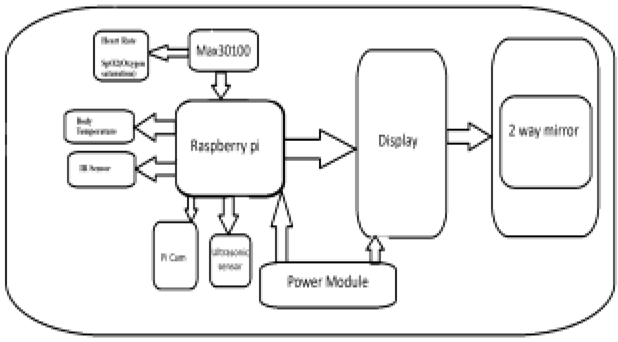

***Figure 1**. Block Diagram of the proposed system*

The model's suggested block diagram is shown in Fig. 1. The modular design of the smart mirror system ensures seamless hardware and software integration to provide interactive features, health tracking, and

***Figure 2.** Model of Raspberry P*

real-time updates. The Raspberry Pi, which serves as the main processing unit as shown in Fig. 2 and organizes data flow between many sensors, a
camera, the display module, and the power supply, is at the heart of the system. Numerous sensors are used by the system, such as the MAX30100 for heart rate and oxygen saturation (SpO2) monitoring, a body temperature sensor for health data, an infrared sensor for proximity detection, and an ultrasonic sensor for advanced interactions and user presence. Using a Pi Camera, facial photos are taken in order to identify emotions and provide personalized recommendations or inspirational sayings. The display module, which is an LCD screen behind a two-way mirror, shows current news, weather, and health information. The two-way mirror combines aesthetics and utility by serving as a display medium and a reflective surface as in Fig. 3. To ensure continuous operation, a power module provides steady energy. Finding the user is the first step in the system's workflow, which then moves on to data collection via sensors and the camera, processing via the Raspberry Pi, and display of customised outputs. This architecture emphasizes scalability, energy efficiency, and user-friendly design, leveraging IoT and AI technologies to provide a smooth and intelligent experience.

2.2. Advantages of the Architecture

Easy maintenance and updates are made possible by the system's independent yet flawlessly integrated components. Without altering the system's basic building design, more sensors or performs can be added. The objective of user centric design is to design an interface that is effortless to use that needs very little input from the user. Energy Efficiency: Uses proximity sensors to ensure the best potential use of energy.

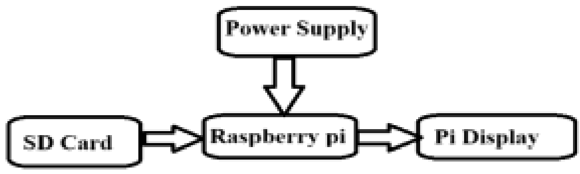

***Figure 3**. Working Block diagram of the proposed Method*

A smart mirror system's simplified architecture is shown in Fig. 3, which also highlights how key components are integrated. The Raspberry Pi is in the middle of everything, handling all operations as the primary processing unit. The operating system, software programs, and required data files are stored on an SD card, enabling the Raspberry Pi to operate efficiently. All of the system's components operate constantly since it is powered by a reliable power source. The output module is a linked Pi Display which displays the user important data like the time, the weather, and other interactive elements. This simple setup illustrates the fundamental design of a smart mirror, stressing dependable storage, effective data processing, and smooth display features.

2.3. System Design

The system's modular architecture allows for the smooth integration of software and hardware components, facilitating scalability and effective operation.

2.3.1. Hardware Components:

A two-way mirror preserves the functionality of the mirror while acting as a transparent medium and a reflective surface, enabling the inbuilt display monitor to present information.

2.3.2. Raspberry Pi: Serves as the brain center, coordinating all of the smart mirror's functions, such as data processing and sensor management.

2.3.3. Sensors: Contains a body temperature sensor for ongoing health monitoring, an infrared sensor for proximity detection, and pulse oximeter and heart rate sensors (MAX30100) for detecting vital signs such blood oxygen saturation and heart rate.

2.3.4. PI Camera: Used to identify emotions and detect faces to customize user interactions and improve the user experience.
2.3.5. Display Monitor: This device, which is positioned behind the two-way mirror, dynamically shows current information such as news updates, time, weather, and health measures.
2.4. Software Components:
2.4.1. Programming Framework: Python is the primary programming language, and it uses libraries like OpenCV for image processing and machine learning techniques for emotion recognition and customization.
2.4.2. Integration of IoT: The system integrates and controls the sensors using Python to guarantee real-time data collection and processing. Creation of graphical user interfaces: Through an easy-to-use graphical user interface, vital information such as time, weather, news updates, and health factors are shown in a dynamic and well-structured way.
2.5. Requirements Analysis: The first step is to identify and document the project requirements. Real-time update presentation, health monitoring, and emotion identification are examples of functional requirements. Excellent sensor and facial recognition accuracy, low latency, and an intuitive user interface are examples of non-functional requirements. Two-way mirror, camera, sensors, and Raspberry Pi
2.6. Hardware Assembly
The physical smart mirror is constructed by assembling the hardware components: The display monitor is positioned behind a two-way mirror. The Raspberry Pi is equipped with sensors to gather health data. For the best facial recognition, thecamera is placed in the upper center. The Raspberry Pi is set up to function as the main processing unit.
2.7. Software Development
To guarantee the smart mirror system's effectiveness and operation, the software development phase includes the following essential tasks:
2.7.1. Data Processing: Writing scripts to manage and process information gathered from the camera and other sensors in order to guarantee precise outcomes and smooth integration.
2.7.2. Facial Recognition: This feature allows for individualized user interactions by implementing facial detection and emotion analysis using OpenCV and machine learning models.
2.7.3. GUI Design: Using Tkinter, create a dashboard that is organized and aesthetically pleasing while dynamically displaying the user's health information, time, weather, and news updates. Real-time updates are supported by the interface to guarantee that the data shown is up to date.
2.7.4. Sensor Integration: Without depending on IoT protocols, real-time data collecting, processing, and display are made possible by using Python to directly integrate and handle sensor activities.
2.7.5. Integration of Systems: Following software development and hardware manufacturing, the parts are combined: Data inputs from the camera and sensors are synced with the display. The interface displays inspirational sayings or wellness advice that correspond with the emotion recognition findings. All data processing is controlled by the Raspberry Pi, which also makes sure that hardware and software communicate with each other seamlessly.
2.8. System Workflow
Fig.4 depicts the operational process of the smart mirror, starting from initialization to user interaction and display deactivation. Initially, the system activates the display after powering on. Facial recognition is then performed to identify the user. If the user is recognized, the system customizes the interaction; otherwise, it operates in guest mode. Once user interaction begins, the system branches into different functionalities: health monitoring, emotion recognition, or updating settings. Health monitoring gathers vital data such as heart rate, blood oxygen levels, and body temperature, while emotion recognition analyses facial expressions for personalized responses. The settings update allows users to modify preferences. The display dynamically updates

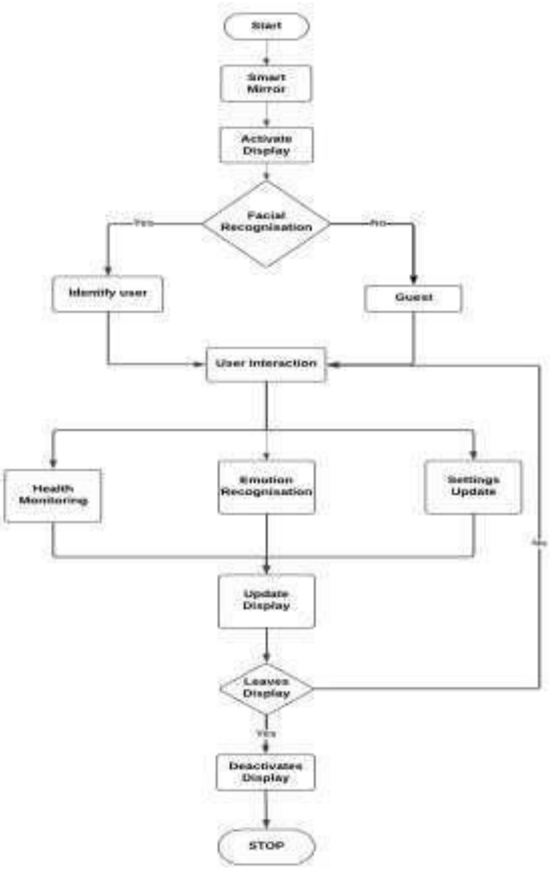

Figure. 4 *workflow of the model*

based on the selected functionality, providing real-time information. When the user leaves, the system detects inactivity and deactivates the display to conserve power, subsequently ending the operation. This workflow ensures an intelligent, user-centric experience while maintaining energy efficiency and modular functionality.

3. RESULTS AND DISCUSSIONS

3.1. Mirror Reflection

The mirror reflection is observed once the process is enabled in the system with all the functionalities included, the prototype switched on and the mirror is working perfectly as a new reflection mirror as shown in Fig 5.

Figure.5 *Mirror reflection enablement*

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3.2. Mirror Interface with API

The time and date API is enabled with the proposed design and mirror functionality is also simultaneously (as shown in Fig. 6) running as an add-on to the further functional units that are discussed in next sections of this chapter.

Figure.6 *API of Time and Date*

3.3. Facial Recognition and Emotion Detection

Once the mirror and API is activated, it is possible to enable the touch user i.e. activating

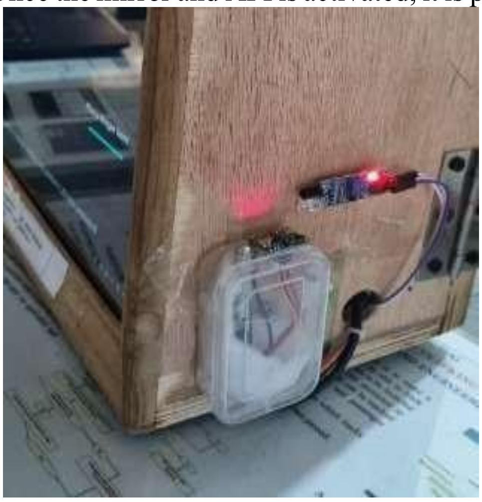

Figure.7 *Thumb identification using the smart mirror*

the biometric identification as shown in Fig.7. Once the finger is sensed using the sensor, the parameters like temperature, heart rate and SpO_2 are recognized and shown in Fig. 8 and 9.

Figure.8 *Facial Recognition and Emotion Detection*

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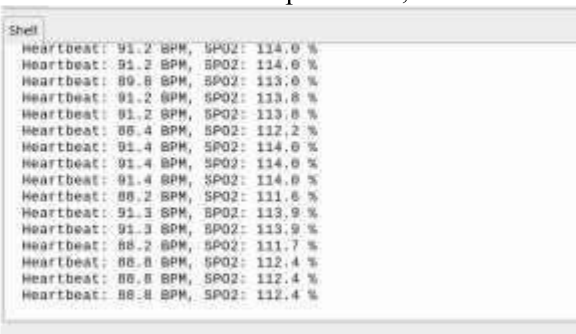
Also the overall demand of the API and health parameters of the user to get the update of versatile creative features.

Figure.9. *Snapshot of a Pulse Oximeter in smart mirror with a only display*

The Fig. 10 shows the window of output values in terms of heart beat, SpO2 and temperature. Once the biometric sensor data is processed, the same is displayed in the mirror screen as shown in Fig. 11 .



```
Shell
Heartbeat: 91.2 BPM, SPO2: 114.0 %
Heartbeat: 91.2 BPM, SPO2: 114.0 %
Heartbeat: 89.8 BPM, SPO2: 113.0 %
Heartbeat: 91.2 BPM, SPO2: 113.8 %
Heartbeat: 91.2 BPM, SPO2: 113.8 %
Heartbeat: 88.4 BPM, SPO2: 112.2 %
Heartbeat: 91.4 BPM, SPO2: 114.0 %
Heartbeat: 91.4 BPM, SPO2: 114.0 %
Heartbeat: 91.4 BPM, SPO2: 114.0 %
Heartbeat: 88.2 BPM, SPO2: 111.6 %
Heartbeat: 91.3 BPM, SPO2: 113.9 %
Heartbeat: 91.3 BPM, SPO2: 113.9 %
Heartbeat: 88.2 BPM, SPO2: 111.7 %
Heartbeat: 88.8 BPM, SPO2: 112.4 %
Heartbeat: 88.8 BPM, SPO2: 112.4 %
Heartbeat: 88.8 BPM, SPO2: 112.4 %
```

Figure.10. *Snapshot of a Heartbeat and SpO2 in output window*

Figure.11. *Snapshot of a Heartbeat and SpO2 in mirror*

4. CONCLUSIONS

Reflectron is more than just a mirror—it's a smart assistant that enhances daily life with real-time updates, health monitoring, and emotion recognition. Powered by a Raspberry Pi and equipped with sensors, it keeps users informed about their well-being while offering an interactive experience. Facial recognition adds a personal touch, displaying dynamic content based on user preferences. With a scalable design, Reflectron is built for future upgrades. Python and OpenCV ensure efficiency and reliability, while real-time data processing delivers seamless updates on weather, news, and schedules. As an example of IoT-driven innovation, it bridges the gap between technology and personal wellness, making everyday routines more efficient.

5. Future Scope

Future improvements to Reflectron could include AI-driven health insights that use predictive analytics to identify possible health problems early. While smart home integration will increase convenience by integrating with home automation systems, voice control can facilitate hands-free engagement, increasing accessibility. Wellness tracking can be expanded with advanced health monitoring via more sensors, and customized AI recommendations can provide specialized advice for skincare, fitness, and general well-being. Users will be able to monitor their data from any location at any time thanks to cloud and remote access, and augmented reality (AR) capabilities can enhance the user experience by introducing virtual try-ons for skincare and fashion.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
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- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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