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Detecting Sleep Apnea with Smart-tech: Scientific Breakthrough or Overhyped Technology?

Aleksandra Głowacka

Independent Public Complex of Health Care Facilities in Ostrow Mazowiecka

S. Dubois 68, 07-300 Ostrów Mazowiecka, Poland

glowale13@gmail.com

ORCID: 0009-0000-9389-7731

Paulina Grzeszczuk
University Clinical Hospital in Bialystok
M. C. Skłodowskiej 24a, 15-276 Białystok, Poland
grzeszczukp2@gmail.com
ORCID: 0009-0003-3522-1567

Iwona Skorulska
University Clinical Hospital in Bialystok
M. C. Skłodowskiej 24a, 15-276 Białystok, Poland
iskorulska21@gmail.com
ORCID: 0009-0006-6326-2464

Agnieszka Kalisz
University Clinical Hospital in Bialystok
M. C. Skłodowskiej 24a, 15-276 Białystok, Poland
kalisz.a39@gmail.com
ORCID: 0009-0001-2996-7691

Marta Ignatiuk-Chilkiewicz
University Clinical Hospital in Bialystok
M. C. Skłodowskiej 24a, 15-276 Białystok, Poland
m.ignatiuk.chilkiewicz@gmail.com
ORCID: 0009-0005-7002-0829

Weronika Grywińska
Independent Public Complex of Health Care Facilities in Wyszkow
KEN 1, 07-200 Wyszków, Poland
wgrywinska@gmail.com
ORCID: 0009-0004-8609-9626

Julia Kozakiewicz
University Clinical Hospital in Bialystok
M. C. Skłodowskiej 24a, 15-276 Białystok, Poland
kozakiewiczjulia99@gmail.com
ORCID: 0009-0002-5435-3007

Kamil Kościelecki
Voivodeship Integrated Hospital named after Jedrzej Sniadecki in Bialystok
M. C. Skłodowskiej 26, 15-278 Białystok, Poland
kamilkoscielecki99@gmail.com
ORCID: 0009-0001-5516-7540

Klaudia Mączewska
University Clinical Hospital in Bialystok
M. C. Skłodowskiej 24a, 15-276 Białystok, Poland
klaudiamacz.1994@gmail.com
ORCID: 0009-0007-3426-6666

Patrycja Długozima
University Clinical Hospital in Bialystok
M. C. Skłodowskiej 24a, 15-276 Białystok, Poland
dlugozimapatrycja97@gmail.com
ORCID: 0009-0001-4513-2256

ABSTRACT

Introduction: This review paper seeks to examine the existing knowledge on the underlying mechanisms of sleep apnea, the complexities associated with its diagnosis, and the potential of cutting-edge wearable technology to enhance its detection.

Materials and Methods: A comprehensive review of the literature was conducted using the PubMed and Google Scholar databases using the following keywords: “Sleep apnea”, “Sleep disorder”, “Smart-tech”, “Smartwatch”, “Apnea treatment”, “Apnea monitoring”.

Summary: Sleep plays a pivotal role in maintaining both physical and mental well-being. Sleep disorders can severely impair cognitive functions such as concentration and memory, while also leading to chronic fatigue and emotional instability. One of the most prevalent conditions is obstructive sleep apnea, characterized by recurrent interruptions in breathing during sleep, which, if left untreated, may result in serious health complications. Diagnosing and monitoring sleep apnea remains a challenge due to the shortage of specialized sleep laboratories. The integration of smart technology wearables has the potential to usher in a new era in the diagnosis and management of sleep apnea, along with the associated health complications.

Conclusions: Advanced sleep monitoring technologies, ranging from traditional polysomnography to modern wearables and contactless systems, enable precise assessment of sleep disorders by continuously tracking key physiological parameters. An effective system must accurately differentiate between apnea types, assess severity using the apnea-hypopnea index (AHI), and analyze factors like body position to provide tailored treatment recommendations. Extending sleep monitoring beyond single-night laboratory studies to long-term home-based tracking enhances diagnostic accuracy, optimizes treatment strategies, and improves overall sleep health.

Keywords: sleep apnea, smart-tech, sleep monitoring

Introduction

Sleep plays a crucial role in maintaining both physical and mental health, significantly impacting overall quality of life. Individuals affected by sleep disorders often experience a range of symptoms, including impaired concentration, memory difficulties, persistent fatigue, lack of energy, sluggishness, and emotional instability. Among the numerous sleep-related conditions, sleep apnea is the most prevalent. This disorder is defined by recurring interruptions in breathing throughout the sleep cycle, which can lead to serious health complications if left untreated [1].

The occurrence and frequency of sleep apnea tend to rise progressively as individuals grow older. Both the prevalence, which refers to the total number of people affected by this condition

at a given time, and the incidence, which measures the rate of new cases developing within a specific period, show a noticeable upward trend with advancing age. This increase can be attributed to several age-related physiological changes, including the weakening of airway muscles, a higher likelihood of weight gain, and alterations in respiratory control mechanisms. As a result, older adults are at a significantly greater risk of experiencing sleep apnea, making early detection and proper management especially important in this demographic [2].

Accurate diagnosis and continuous monitoring of treatment are essential aspects of managing this widespread public health concern. However, one of the major challenges in diagnosing and tracking sleep apnea treatment progress is the persistent shortage of specialized sleep laboratories. This lack of adequate medical facilities often leads to prolonged waiting times or, in some areas, a complete unavailability of necessary diagnostic services. As a result, many individuals experience significant delays in receiving proper treatment, forcing them to endure the effects of sleep apnea for extended periods. This prolonged exposure to disrupted sleep patterns can contribute to a range of serious health complications, further exacerbating the negative impact of the condition on overall well-being [2].

Sleep apnea

Sleep apnea is a common sleep disorder characterized by repeated and temporary interruptions in breathing throughout the sleep cycle. The gold standard for diagnosing this condition is polysomnography (PSG), a comprehensive sleep study conducted in a clinical setting. Despite its effectiveness, PSG comes with several drawbacks — it is costly, time-intensive, and requires patients to visit specialized sleep clinics. The procedure involves the use of professionally installed wearable sensors to monitor physiological parameters, which adds to its complexity. Additionally, the high demand for these tests results in long waiting lists, further delaying diagnosis and treatment. Given these challenges, the integration of wearable smart technology into everyday life presents a promising alternative. These advanced devices have the potential to provide continuous sleep monitoring in a more accessible, cost-effective, and convenient manner, helping to bridge the gap in sleep apnea detection and management [3].

Obstructive sleep apnea (OSA) is a highly prevalent sleep disorder, affecting an estimated 425 million adults worldwide who exhibit an apnea-hypopnea index (AHI) of 15 or more events per hour. Despite its widespread occurrence, OSA remains significantly underdiagnosed, leaving many individuals unaware of their condition and at risk for serious health complications. Sleep-disordered breathing (SDB) encompasses a range of abnormal respiratory patterns during sleep, which may involve repeated pauses in breathing, shallow or insufficient ventilation, and

disrupted airflow. Among the most recognized forms of SDB are obstructive sleep apnea (OSA) and upper airway resistance syndrome (UARS). OSA may manifest with or without noticeable symptoms; however, when symptomatic, it is often associated with profound neurocognitive and cardiovascular consequences, which can develop as a direct result of prolonged untreated sleep disturbances. Individuals suffering from OSA frequently experience fragmented sleep, excessive daytime fatigue, impaired cognitive function, and a significantly diminished quality of life. If left unmanaged, the condition can contribute to severe long-term health effects, further emphasizing the importance of timely diagnosis and appropriate intervention [4].

Diagnostic methods

A diagnosis of sleep apnea requires sleep testing, which can be performed either using polysomnography (PSG) or with home sleep apnea testing (HSAT). Polysomnography is regarded as the gold standard for evaluating sleep apnea [5]. PSG records various physiological parameters, including neurophysiologic and cardiopulmonary data over several sleep stages, wakefulness, and sleep-wake transitions. The American Academy of Sleep Medicine (AASM) advises that a minimum of 6 hours of continuous overnight recording be conducted during sleep studies. The test can be adapted to the patient's clinical history to evaluate the necessity for supplemental oxygen and positive airway pressure titration, detect high carbon dioxide levels (hypercapnia or hypoventilation) from shallow breathing, and track seizures or parasomnias [6, 7]. There are four types of sleep studies based on the number of physiological variables recorded:

Level I: Standard PSG with EEG (electroencephalography), EOG (electrooculography), chin EMG (electromyography), ECG (electrocardiography), airflow, respiratory effort, oxygen saturation, and limb EMG, with constant technician supervision.

Level II: Portable PSG, similar to Level I, but with a heart rate monitor replacing the ECG and no technician supervision.

Level III: Modified sleep apnea testing, focusing on ventilation, heart rate or ECG, and oxygen saturation, with minimal technician involvement.

Level IV: Continuous monitoring of a single or dual parameter, typically oxygen saturation, using simple devices.

The report provides the count of apnea and hypopnea. Apnea occurs when airflow drops to less than 10% of the baseline for more than 10 seconds. It is classified as obstructive if there is respiratory effort, or central if there is no respiratory effort. Hypopnea is when airflow decreases to less than 30% of the baseline for more than 10 seconds, accompanied by a 4% drop in oxygen

saturation. The Apnea-Hypopnea Index (AHI) is a measure used to assess the severity of sleep apnea by calculating these events per hour of sleep. An AHI under 5 per hour is considered normal, between 5 and 15 indicates mild apnea, 15 to 30 suggests moderate severity, and an AHI over 30 is categorized as severe sleep apnea [8].

The placement of electrodes and sensors is crucial in sleep studies, as poor application can compromise data quality and require time-consuming troubleshooting. Moreover, standard PSG is costly and inconvenient for patients who must travel to a center, leading some to argue that less comprehensive procedures may be sufficient for diagnosing sleep-disordered breathing, particularly obstructive sleep apnea (OSA). As a result, portable devices for home testing have been developed, often requiring no technician supervision. These devices range from simple overnight oximetry to more advanced systems with the same leads as standard PSG. Studies comparing portable and standard PSG have shown similar outcomes when used by trained specialists and properly educated patients. According to the AASM, portable devices should record airflow, respiratory effort, and oxygen saturation, with the most accurate signals obtained from thermistors, nasal pressure sensors, and respiratory inductance plethysmography [6]. Unfortunately, it has been shown that HSAT is not always as accurate as PSG. The analysis reveals a 21% discrepancy in the diagnostic accuracy of HSAT, with a misdiagnosis rate of 41% when using the latest AASM scoring rules. Future research should establish reliable parameters to assess HSAT performance and its comparison to PSG [9].

In the diagnosis of obstructive sleep apnoea, various questionnaires serve as valuable tools. The Epworth Sleepiness Scale (ESS) was initially created to assess general daytime sleepiness rather than specifically diagnosing sleep apnoea. It consists of eight self-rated questions, each scored from 0 to 3. A score greater than 10 suggests significant daytime sleepiness. The Berlin Questionnaire (BQ), developed to identify sleep apnea risk factors, includes 10 questions across three categories: snoring, daytime sleepiness or fatigue, and obesity or hypertension. Patients with frequent symptoms (more than 3–4 times a week) in at least two of these categories are considered at high risk for sleep apnea. The STOP questionnaire includes four yes/no questions about loud snoring, tiredness, observed apnoea, and high blood pressure. A score of ≥2 indicates an intermediate risk of OSA. The STOP-Bang questionnaire adds BMI (≥35 kg/m²), age (≥50 years), neck circumference (≥40 cm) and sex (male). A score of ≥3 suggests an intermediate risk of OSA [10].

Use of smart-tech in diagnostics

Traditionally, diagnosing sleep-disordered breathing has been dependent on two primary methods: polysomnography (PSG) conducted in a clinical sleep laboratory and home sleep apnea testing (HSAT) performed in a more familiar environment. While both approaches are widely used, they come with inherent limitations, such as high costs, logistical challenges, and restricted accessibility [11]. In recent years, however, there has been a remarkable surge in the development of cutting-edge sleep-monitoring technologies. These advancements have significantly transformed the landscape of sleep medicine by enabling the collection of sleep physiology data outside of specialized sleep centers. Furthermore, these modern solutions facilitate long-term monitoring, allowing for the assessment of sleep patterns over extended periods rather than a single night. Additionally, they contribute to large-scale, population-based research, making it possible to analyze sleep disorders on a broader scale and improve early detection and intervention strategies [12].

How does it work?

Heart rate sensor

The Polar H10, utilizing a chest strap, is a commercially available device, used to measure heart rate. The data acquisition process is simple, with heart rate signals being captured in real time. The sensor transmits data via low-power Bluetooth to an Android smartphone, ensuring continuous real-time monitoring while maintaining energy efficiency [2].

It is a wearable sensor, designed to be attached directly to a person's body. Ensuring practicality and usability, it is easy to set up and operate, cost-effective, comfortable for prolonged wear, and equipped with a long-lasting battery. The sensor features an intuitive user interface, accessible via a mobile application or computer program, and requires minimal technical knowledge for users to interpret and utilize the collected data effectively [2].

The device is user-friendly, requiring no specialized knowledge or technical expertise to operate. Its lightweight design ensures comfort, making it suitable for extended periods of wear without causing discomfort or inconvenience to the user. Additionally, there are no restrictions on the duration of monitoring, allowing for continuous and uninterrupted observation over an extended timeframe. This makes it particularly advantageous for long-term data collection, enabling more comprehensive analysis of physiological parameters without the limitations often associated with traditional monitoring methods [2].

Oxygen saturation

The international standard ISO 80601-2-61 establishes the guidelines for evaluating the accuracy of oxygen saturation (SpO_2) measurements obtained through pulse oximeters [13]. Compliance with this standard involves several critical requirements, one of which is the controlled induction of short-term hypoxemia in test participants. This process enables researchers to assess the reliability of SpO_2 readings across various levels of oxygenation. The standard permits validation through both invasive and non-invasive methods, ensuring comprehensive accuracy assessment. A key criterion outlined in ISO 80601-2-61 is that the pulse oximeter's accuracy, quantified as the root-mean-square difference (Arms), must not exceed 4.0% when measuring SpO_2 within the range of 70% to 100%, as compared to a reference measurement system. Adherence to this standard is essential in determining whether a pulse oximetry device meets the necessary precision requirements for clinical and consumer use [14].

Apple conducted a study to evaluate the development of its SpO_2 measurement application for the Apple Watch, ensuring compliance with established standards by using invasive measurements as the reference. The findings revealed only minor discrepancies between SpO_2 readings obtained from the smartwatch and those from the gold standard measurement method. Furthermore, the study demonstrated that the smartwatch exhibited a high level of accuracy in identifying hypoxemia, highlighting its potential as a reliable tool for monitoring blood oxygen levels [14].

Accelerometer

The accelerometer plays a crucial role in distinguishing between obstructive sleep apnea (OSA) and central sleep apnea (CSA) by leveraging its high sensitivity to thoraco-abdominal movements. This capability is essential because OSA is characterized by persistent respiratory effort despite airway obstruction, whereas CSA involves a lack of respiratory effort due to a failure in neural respiratory drive. By accurately detecting and analyzing thoracic and abdominal motion patterns, the accelerometer can effectively differentiate between these two types of apnea, enabling a more precise classification of sleep-disordered breathing events. This distinction is particularly valuable in clinical and at-home monitoring settings, as it aids in determining the appropriate treatment approach for individuals affected by sleep apnea [11].

Detecting apnea with smart-tech

Smartbands

Wearable devices like smartbands use accelerometers and photoplethysmography (PPG), which monitor physiological and movement patterns during sleep. Accelerometry is a technology that detects body movement along multiple axes, specifically the x, y and z axes. PPG is a non-invasive technique that uses light to detect variations in blood volume, providing real-time measurements of key physiological parameters such as heart rate, oxygen saturation and blood circulation. Combining accelerometers with PPG sensors in wearable devices offers a more accurate sleep assessment. These sensors are low-cost, noninvasive, and offer continuous real-time data [15].

A study conducted at the outpatient sleep clinic of University Hospital HLA Moncloa in Madrid, Spain, utilized two Fitbit models: the Fitbit Charge 2 (2016) and the Fitbit Alta HR (2017). Inclusion criteria included being over 18 years old, having diagnosed OSA or sleep apnea symptoms. Assignment of the devices to participants was done randomly by engineers prior to meeting the participants. Participants wore a Fitbit sleep tracking device on their wrist while undergoing the PSG. Both devices are equipped with a three-axis accelerometer and a heart-rate monitor, operating on similar systems to provide comparable results under the same conditions. The use of these two measurement methods together significantly enhances accuracy. Fitbit devices can track four sleep stages: awake, light sleep, deep sleep, and REM sleep. Light sleep is considered the first stage, followed by deep sleep and REM. When the Fitbit was unable to capture all four stages, it simplified the data into three categories: awake, asleep, and an intermediate restless stage. Data were recorded using 30-second epochs, with both PSG and Fitbit devices starting simultaneously. The Fitbit app synced with a smartphone to collect data. The results of the study showed that the sensitivity was 87.81%, while the specificity was 43.85%. In patients diagnosed with obstructive sleep apnea (OSA), the sensitivity of the devices was 87.61%, and the specificity was 44.77%. While these devices showed a high ability to detect cases of OSA, their capacity to correctly distinguish between affected and healthy individuals was limited. One of the drawbacks of the Fitbit devices was that they overestimated total sleep time (TST) by an average of 59.78 minutes. Meanwhile, they underestimated wake after sleep onset (WASO) by 36.14 minutes and sleep onset latency (SOL) by 23.22 minutes [16].

Wearable respiration belt

The Airgo™ belt is a wearable CE Class IIa-certified medical device. It contains a silver band that changes resistance in response to the belt's length adjustments, enabling it to track changes in thoracic circumference during breathing. Positioned around the lower thorax, near the

floating ribs, it provides both respiratory effort and volumetric data from a single location [17]. The device uses a patented algorithm to calculate tidal volume and respiratory rate by identifying the minimum and maximum of each breathing cycle. The algorithm converts each breath into a vector characterized by a specific length (representing tidal volume), a baseline (indicating the functional residual capacity at that moment), and a shape, which is linked to the openness of the upper airways. It also detects upper airway obstructions by analyzing changes in the thoracic cage's movement and the vector's shape. Obstructive events are recognized by a reduction in minute ventilation, accompanied by changes in the morphology of the vectors. These alterations are caused by paradoxical movements of the thoracic cage, which occur when the upper airway becomes obstructed, leading to irregular breathing patterns [18]. In one of the studies, the device showed a sensitivity of 55.6%. By simultaneously measuring SpO2, the overall sensitivity increased to 66.7% and the number of false positives decreased by almost 50%. Sensitivity for obstructive sleep apnea events was 55%, and when SpO2 was also measured, it increased to 68% [17].

Hybrid acoustic smartphone app technology

Recently, a novel hybrid machine learning software development kit, using both active sonar and passive acoustic analysis, was developed. The breathing patterns can be monitored through a smartphone using the "Firefly" app technology platform. This innovative system leverages advanced digital signal processing (DSP) and artificial intelligence (AI) algorithms to accurately detect various sleep stages, track respiration rate, identify snoring and monitor patterns associated with obstructive sleep apnea. Simply placing the smartphone near the subject, such as on a bedside table, during sleep is all that's required. The hybrid processing method combines two key techniques: detection of passive breath sounds, including pauses that may indicate apnea or hypopnea, and active sonar technology, which tracks the movement of the individual as they breathe and shift positions. Once the recording session ends, the phone processes the data and generates results, including an estimated AHI, reflecting the average significant breathing interruptions per hour, and a classification indicating if the interruptions are ≥15 events per hour (high OSA risk) or <15 per hour (low risk). In one study, the Firefly app demonstrated a sensitivity of 88.3% and a specificity of 80.0% in detecting OSA episodes at a clinical AHI threshold of ≥15 events per hour [4].

ECG chest belt

Patients with sleep apnea often exhibit cyclic fluctuations in heart rate, which result in corresponding characteristic changes in the ECG amplitude or morphology. Although most

guidelines typically advocate for multi-sensor approaches in specific patient groups, various algorithms have been created to detect sleep apnea using only electrocardiogram (ECG). The portable ECG chest belt includes porous textile ECG electrodes and a humidification unit, allowing for continuous multi-night ECG signal monitoring. Additionally, it includes a water-filled wetting pad that releases about 3 g of water daily through evaporation to enhance signal conduction. The device can be easily worn by patients themselves in an unsupervised environment. The accuracy of sleep apnea severity classification using the ECG belt was comparable to that of the patched ECG system. While the ECG belt demonstrated an accuracy of 72%, with sensitivity at 70% and specificity at 74%, the patched ECG system achieved an accuracy of 74%, with a higher sensitivity of 88%, but a lower specificity of 61% [19, 20].

Smart pillow

A smartphone-based automated adjustable pillow system has been developed to facilitate both the detection and treatment of sleep apnea. This innovative system utilizes a blood oxygen sensor to identify sleep apnea events in real time. When a disruption in breathing is detected, the pillow's height and shape are automatically modified to help restore normal breathing patterns. Additionally, once the adjustment is made, the sensor continues to monitor blood oxygen levels to assess the effectiveness of the modification and refine the adjustment process accordingly. This creates a real-time feedback control system, allowing for continuous optimization of the pillow's positioning [1].

Compared to traditional diagnostic or therapeutic devices for sleep apnea, this system offers several advantages — it is noninvasive, cost-effective, and highly portable, making it suitable for both home use and travel. This real-time sleep apnea detection and classification algorithm is designed to determine whether an adjustment to the pillow is necessary. Additionally, a feedback-based pillow adjustment algorithm has been developed, which dictates the optimal timing, method, and evaluation criteria for modifying the pillow's position to enhance its effectiveness in mitigating sleep apnea events. The experiment using the smart pillow was conducted on 40 patients, demonstrating that the duration and number of sleep apnea events were reduced significantly, by more than 50% [1].

MORFEA

MORFEA is a non-intrusive, wireless wearable device designed for at-home pre-screening of sleep-related breathing disorders (SRBD). MORFEA demonstrates promising capabilities in detecting apnea episodes, monitoring thoraco-abdominal movements linked to obstructive sleep apnea (OSA), assessing SRBD severity, and identifying both the patient and head position

during sleep. The device is designed for comfortable placement on the nasal septum, ensuring ease of use without causing discomfort [5].

MORFEA integrates photoplethysmography (PPG)—an optical technique that employs red and infrared light sources to measure arterial blood volume fluctuations—alongside a tri-axis accelerometer based on MicroElectroMechanical Systems (MEMS) technology for movement analysis. The device operates in real-time, continuously recording and transmitting data via Bluetooth Low Energy to an external processing unit, where information can be monitored as it is acquired [5].

A key advantage of MORFEA's nasal septum positioning is its enhanced PPG sensitivity to airflow modulation, while simultaneously providing highly accurate accelerometer readings of thoraco-abdominal movements. To maximize its diagnostic potential, dedicated algorithms were developed for apnea detection (based on PPG signals), apnea classification (using PPG and inertial signal fusion), and body position identification (through inertial signal analysis) [5].

Belun ring

The Belun Ring - officially known as the Belun Sleep System BLS-100, developed by Belun Technology Company Limited in Hong Kong - is a wearable sleep monitoring system powered by deep learning (DL) algorithms. This device was recently granted Class II clearance by the U.S. Food and Drug Administration (FDA) as a home sleep testing tool for diagnosing moderate to severe obstructive sleep apnea (OSA) and for sleep stage classification [12].

At the core of this system is the Belun Ring sensor, a reflectance pulse oximeter classified as an FDA Class II medical device. This advanced wearable uses non-invasive optical technology to measure blood oxygen saturation (SpO_2) and other key physiological parameters during sleep. The device is equipped with a first-generation artificial intelligence algorithm (BSP1), which has demonstrated high overall accuracy in detecting and classifying moderate to severe OSA. By leveraging deep learning-based data processing, the Belun Ring provides an effective, accessible, and clinically validated alternative to traditional sleep studies, making it a valuable tool for both medical professionals and individuals seeking at-home sleep assessment [12].

Concerns while using smart-tech in diagnostics

The interpretation of data from wearable devices can vary considerably due to differences in the algorithms used, and these devices often encounter issues related to accuracy and precision. As a result, some studies have raised concerns about their reliability and effectiveness for clinical use, suggesting that they do not yet meet the necessary psychometric standards. The

American Academy of Sleep Medicine (AASM) emphasized the importance of validating these devices thoroughly before they can be considered appropriate for use in clinical practice. The AASM advocates for more rigorous testing to ensure that these devices provide accurate and reliable data for medical decision-making [16].

Devices using accelerometers may overestimate sleep by misclassifying wake periods, for example lying down while reading, or underestimate it by mistaking sleep movements for awakenings. They also struggle to differentiate non-REM stages or subtle sleep changes. Moreover, photoplethysmography readings may be influenced by motion, skin factors and environmental conditions like light and temperature [15].

Respiration belts do not measure oxygen saturation, so this is merely a screening tool and cannot accurately determine the patient's overall risk level, as it does not provide information about the severity of desaturations [18]. In the case of portable ECG devices, obtaining high-quality measurements comparable to clinical conditions can be challenging due to the more frequent occurrence of artifacts, resulting from the absence of gel electrodes [20].

Conclusions

Numerous technologies offer potential benefits for sleep monitoring, each contributing to a more accurate and comprehensive assessment of sleep patterns and disorders. These technologies range from traditional polysomnography used in sleep laboratories to modern wearable devices and contactless monitoring systems. One of the key advantages of these technologies, especially modern solutions, is their ability to provide continuous and detailed tracking of various physiological parameters, such as breathing patterns, heart rate, oxygen levels and body movements.

A comprehensive sleep monitoring system should be capable of detecting any type of apnea and determining its timing. This ensures that different forms of sleep apnea, including obstructive, central, and mixed types, can be accurately identified and analyzed. By pinpointing when each apnea event occurs, specialists can better understand the patient's sleep disturbances and their patterns over time.

Moreover, an effective system must be able to detect chest respiratory efforts. This capability is crucial for differentiating between obstructive and central sleep apnea. By distinguishing these types, healthcare professionals can provide more targeted treatments.

Another essential function of sleep monitoring is grading sleep-related breathing disorders (SRBD) using the apnea-hypopnea index (AHI). The AHI is a key parameter that quantifies the severity of sleep apnea by calculating the number of apnea and hypopnea events per hour of

sleep. This classification helps doctors determine the appropriate intervention, whether lifestyle changes, CPAP therapy, or other medical treatments.

In addition to apnea detection, an advanced sleep monitoring system should also identify the patient's body position during sleep. This information is particularly valuable because certain sleeping positions can exacerbate apnea symptoms. For example, some individuals experience more severe apnea episodes when sleeping on their back due to airway collapse, whereas side sleeping might reduce their frequency and severity. Understanding these patterns allows for personalized recommendations that improve sleep quality.

Furthermore, the system should be designed to accommodate a wide range of users. Sleep disorders affect people of all ages and body types, so the technology must be adaptable and comfortable for different individuals. Ensuring ease of use and accessibility can lead to broader adoption and more consistent monitoring.

Extending the observation duration through a sleep apnea detection service can enhance both diagnosis and treatment monitoring. Traditional sleep studies conducted in laboratories provide only a single-night snapshot of a patient's condition. However, prolonged monitoring at home can offer more comprehensive insights into sleep patterns over multiple nights, leading to a more accurate assessment and better treatment adjustments.

Overall, sleep monitoring plays a critical role in diagnosing and managing sleep apnea. By incorporating advanced detection techniques and continuous observation, healthcare providers can improve patient outcomes, offering more precise diagnoses and tailored treatments. Various sleep monitoring technologies offer a range of benefits, from accurate diagnosis and personalized treatment to long-term health tracking and improved accessibility. As these innovations continue to evolve, they hold great promise for enhancing sleep health and overall well-being.

Disclosure

Author's contribution

Conceptualization: Aleksandra Głowacka

Methodology: Paulina Grzeszczuk

Formal analysis: Patrycja Długozima, Iwona Skorulska

Investigation: Klaudia Mączewska, Julia Kozakiewicz, Kamil Kościelecki

Writing-rough preparation: Aleksandra Głowacka, Paulina Grzeszczuk, Agnieszka Kalisz

Writing-review and editing: Patrycja Długozima, Iwona Skorulska, Weronika Grywińska

Supervision: Marta Ignatiuk-Chilkiewicz

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