Technoleg Iechyd Cymru
Health Technology Wales

Topic Exploration Report [1]

Finger-worn sensors to diagnose and monitor sleep-disordered breathing in children and adults

What is a Topic Exploration Report?

Topic Exploration Reports are not health technology assessments. These reports provide a high-level briefing on new topics submitted to Health Technology Wales and are not based on exhaustive or systematic literature searches. Instead, they rely on a focussed scan of key resources.

What evidence is used in a Topic Exploration Report?

Priority is given to summarising the most relevant or useful evidence, rather than covering all possible evidence. Information reported is typically based on abstracts and study authors' own conclusions, rather than detailed scrutiny of full texts.

What are the aims of a Topic Exploration Report?

Topic Exploration Reports offer an overview of the available evidence on a topic and aim to highlight any uncertainties or gaps in the evidence. These reports outline the quantity and type of evidence found, but no critical appraisal or formal evidence synthesis is conducted.

How should a Topic Exploration Report be used?

Topic Exploration Reports can be used to indicate what evidence may be available for a topic, and do not provide definitive guidance on how a technology should be used. The evidence presented within the reports should be interpreted with caution.

[1] Cyfieithu dogfennau HTW wedi'u cyhoeddi o'r Saesneg i'r Gymraeg
Translation of published technical HTW documents from English into Welsh

Topic exploration report number	TER658
Topic	Finger-worn sensors to diagnose and monitor sleep-disordered breathing in children and adults.
Summary of findings	The most common cause of sleep-disordered breathing is obstructive sleep apnoea/hypopnoea syndrome (OSAHS). OSAHS is diagnosed by sleep studies using hospital-based polysomnography, home respiratory polygraphy or home oximetry. Finger-worn sensors that measure physiological processes and communicate wirelessly with Smartphones or tablets for analysis, have been developed for use at home. They are easier to use and less obtrusive than home polygraphy. We identified one health technology assessment that considered six wearable home-testing devices for OSAHS, only one of which was finger-worn, one systematic review and meta-analysis of studies examining a second finger-worn device, and one primary study using a third finger-worn device. All devices used photoplethysmography to measure physiological processes and all studies reported on diagnostic accuracy. Sensitivities of around 80% to 100% were reported, although one device reported pooled sensitivity of 66% for severe OSAHS. Specificities were more variable, from around 25% to 100%. A cost-effectiveness analysis was developed for the health technology assessment. Five wearable devices, including the finger-worn device, were reported as being cost-effective alternatives to home oximetry and home respiratory polygraphy.

Introduction and aims

Sleep-disordered breathing or sleep-related breathing disorders are terms used for a range of conditions that cause abnormal breathing during sleep, including obstructive sleep apnoea/hypopnoea syndrome (OSAHS), central sleep apnoea syndromes and sleep-related hypoventilation disorders. The most common is OSAHS where the airway becomes temporarily obstructed by the soft tissue in the neck, restricting or completely halting breathing. This results in partial awakening which reopens the airway and restarts breathing. People with OSAHS can experience hundreds of episodes during a single night, leading to poor quality sleep and daytime fatigue. In addition, each episode produces an increase in blood pressure, which causes chronic hypertension increasing risk of cardiovascular disease.

The reference standard for diagnoses of sleep-disordered breathing is hospital-based polysomnography which is a comprehensive sleep study that measures brain activity via electroencephalograph (EEG), eye movements, muscle tone, heart rate, breathing and oxygen saturation. Where symptoms suggest OSAHS, diagnosis can be obtained through a home respiratory polygraphy test which measures breathing, heart rate and oxygen saturation during sleep. If availability of home respiratory polygraphy is limited, the National Institute for Health and Care Excellence (NICE) (2021) recommends that overnight home oximetry, to check oxygen saturation alone, can be considered, although this may not accurately diagnose OSAHS in people with heart failure or chronic lung disease. Usually, people need to visit the sleep clinic to obtain the necessary equipment for the tests.

Wearable devices to diagnose sleep-disordered breathing have also been developed. These devices involve wearing one or two small sensors that capture physiological processes. Typically, device-specific firmware is used to process the data before sending it wirelessly to a smartphone or tablet, or to a cloud-based server for further processing. Systems may use algorithms developed using machine learning techniques. Local and/or cloud-based records may be created for ongoing monitoring. These devices can be sent through the post, are more comfortable to wear, easier to use and potentially more accurate than systems for home respiratory polygraphy or home oximetry, since they are less disruptive to normal sleep (NICE 2024).

Stand-alone finger-worn devices, such as sleep rings or fingertip devices, may be particularly easy to use since there is no need to attach sensors to the body and no wires to catch on anything during sleep. One such device is SleepImage (SleepImage, USA), a UKCA marked Class IIa medical device which has been evaluated in the UK at the University Hospitals of Liverpool and at the Royal Brompton Hospital (the latter for managing motor neurone disease). In addition, the device will be used at Hywel Dda University Health Board to explore sex-specific changes in sleep, with the aim of improving clinical pathways for sleep disordered breathing for women during the menstrual cycle and menopause. Either a sleep ring, or a fingertip device, can be used to record heart rate, breathing patterns and oxygen saturation during sleep using an optical monitoring technique called photoplethysmography (PPG) The signals are automatically uploaded via a mobile app to a dashboard and analysed by the SleepImage system using a proprietary method called Cardiopulmonary Coupling (CPC) to measure sleep quality, assess sleep disorders and diagnose sleep-disordered breathing. SleepImage is widely used in clinical research studies that involve measurements of sleep. Two similar finger-worn devices that can diagnose OSAHS were identified. NightOwl (Resmed) is worn on the index finger and uses PPG and accelerometery to record physiological processes. It is CE marked but it is not known if it is in use in the UK. The Belun Ring (Belun technology, Hong Kong) is a sleep-ring device which has US Food and Drug Administration (FDA) approval but does not appear to have a UKCA or CE mark. Other commercial health tracking rings are available but are not approved by the FDA for diagnosis of OSAHS.

Introduction and aims

Health Technology Wales researchers searched for evidence on the clinical and cost effectiveness of finger-worn sensors to diagnose and monitor sleep-disordered breathing in children and adults.

Evidence overview

Health technology assessment

We did not identify any health technology assessments specific to finger-worn devices for sleep-disordered breathing, but NICE has published related HealthTech guidance (HTG735) on home-testing devices for diagnosing OSAHS (NICE 2024). Six wearable home-testing devices were examined and four were recommended as an alternative to home polygraphy or home oximetry in people aged 16 years and older. More research was needed for people below the age of 16. Two devices used a wireless sensor attached to the chin or neck to measure jaw movement or sounds generated from physiological processes. Two devices, which were related to each other, used a wrist strap with wired finger sensor to measure peripheral vascular tone using PPG. Diagnostic accuracy for a finger-worn device (NightOwl) was also examined, based on three studies, and found to be acceptable but the device was not recommended since it had not gained a CE mark at the time of the review. The recommendations comment that devices that use light-based technology may not be as effective in people with black or brown skin, but there was no subgroup analysis by skin colour available.

The recommendations were based on evidence from a systematic review and economic analysis conducted by Peters et al. (2025). Searches were conducted up to September 2023. Overall, sensitivity was reported as generally between 80% and 100% but specificity was more variable, being between 25% and 100%. Most of the validation tests were conducted in hospital rather than in the home setting, but experts consulted by NICE considered that diagnostic accuracy estimates from studies in hospital would be comparable to studies conducted at home.

Secondary evidence

We identified an additional systematic review that evaluated the diagnostic accuracy of the Belun Ring Platform for OSAHS compared with polysomnography (Bhatia et al. 2025). Searches were conducted up to July 2025. Four prospective studies that included 339 participants were identified. For severe OSAHS, pooled sensitivity was 66% (95% confidence interval [CI]: 40% to 85%), and pooled specificity was 95% (95% CI: 91% to 97%). For moderate to severe OSAHS, pooled sensitivity was 92% (95% CI: 86% to 96%) and pooled specificity was 81% (95% CI: 73% to 87%). For mild OSAHS, pooled sensitivity was 97% (95% CI: 91% to 99%), but pooled specificity was only 18% (95% CI: 5% to 50%). The review concluded that the device shows good diagnostic accuracy for moderate to severe OSAHS.

Primary evidence

We identified one additional primary study which evaluated the diagnostic accuracy of the SleepImage Ring for OSAHS compared with polysomnography (Lu et al. 2023). Thirty-nine participants were included. A strong correlation ($r=0.89$, $p<0.001$) was observed between the SleepImage Ring and the apnoea-hypopnea index (AHI). For severe OSAHS sensitivity was 88% (95% CI: 73% to 100%) and specificity was 91% (95% CI: 79% to 100%). For moderate to severe OSAHS sensitivity was 87% (95% CI: 73% to 100%) and specificity was 69% (95% CI: 46% to 91%) and for mild OSAHS, sensitivity and specificity were 100% (95% CI: 100% to 100%).

Economic evidence

Evidence overview

A cost-effectiveness analysis was developed for NICE HealthTech guidance HTG735. Five wearable devices, including the finger-worn device, were reported as being cost-effective alternatives to home oximetry and home respiratory polygraphy. There was some data that suggested that wearable home-testing devices may reduce staff time and had the potential to reduce wait times for sleep studies.

Ongoing studies

The Scottish Health Technologies Group (SHTG) is conducting a health technology assessment evaluating the clinical and cost-effectiveness of wearable home-testing devices for the diagnosis of OSAHS compared with home respiratory polygraphy systems. The assessment is not exclusive to finger-worn devices. SHTG aims to publish the report in July 2026.

Areas of uncertainty

- Diagnostic accuracy of finger-worn devices for diagnosing sleep-disordered breathing in children.
- Whether devices based on optical monitoring show good diagnostic accuracy in people with black or brown skin.
- Patient experiences with the devices.
- The impact on clinical outcomes from using the devices for diagnosis and monitoring.
- The topic proposer has highlighted that underdiagnosis of sleep apnoea is a known issue for women and suggested that devices that facilitate easy multi-night testing may provide a solution.

Literature search results

Health technology assessments and guidance
NICE. (2021). Obstructive sleep apnoea/hypopnoea syndrome and obesity hypoventilation syndrome in over 16s. NICE guideline [NG202]. National Institute for Health and Care Excellence. Available at: https://www.nice.org.uk/guidance/ng202 [Accessed 21 April 2026]. NICE. (2024). Home-testing devices for diagnosing obstructive sleep apnoea hypopnoea syndrome. HealthTech guidance [HTG735]. National Institute for Health and Care Excellence. Available at: https://www.nice.org.uk/guidance/htg735 [Accessed 21 April 2026].
Evidence reviews and economic evaluations
Bhatia O, Madan K, Tiwari P, et al. (2025). Utility of Belun Ring platform for the diagnosis of obstructive sleep apnea: a systematic review and meta-analysis. Sleep Breath. 29(6): 363. doi: https://doi.org/10.1007/s11325-025-03548-0 Peters J, Shepherd J, Maund E, Grigore B, Woods L, Lord J, Scott DA and Hyde C (2025) Home-testing devices for diagnosing obstructive sleep apnoea hypopnoea syndrome: a systematic review and economic evaluation. Health Technology Assessment. doi: https://doi.org/10.3310/GJJS3014 Abstract only available from https://eprints.soton.ac.uk/508319/ [Accessed 27 April 2026].
Individual studies
Lu M, Brenzinger L, Rosenblum L, et al. (2023). Comparative study of the SleepImage ring device and polysomnography for diagnosing obstructive sleep apnea. Biomed Eng Lett. 13(3): 343-52. doi: https://doi.org/10.1007/s13534-023-00304-9
Ongoing research
SHGT (2026) Wearable home-testing devices for diagnosing obstructive sleep apnoea syndrome (OSAHS). Available at: https://shtg.scot/our-advice/wearable-home-testing-devices-for-diagnosing-obstructive-sleep-apnoea-syndrome-osahs/ [Accessed 21 April 2026].

Date of search	April 2026
Concepts used	Sleep; sleep apnoea; sleep disordered breathing; SleepImage; NightOwl; Belun; sleep ring; finger-worn; photoplethysmography

Proposed research question and evidence selection criteria (if selected)

Proposed Research question	**What is the clinical and cost effectiveness of finger-worn sensors for the diagnosis and monitoring of sleep-disordered breathing in children and adults**

	Inclusion criteria	Exclusion criteria
Population	People with suspected or confirmed sleep disordered breathing	
Intervention	Finger-worn home testing devices for the diagnosis of OSAHS	
Comparison/ Comparators	Home respiratory polygraphy systems	
Outcome measures	Diagnostic accuracy (including diagnostic accuracy in people with black or brown skin). Impact on treatment decisions Patient reported outcomes such as ease of use. Health related QoL Resource use Economic outcomes	

Proposed speciality	**Respiratory system**