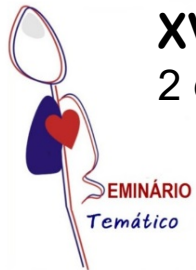


# A Utilização de Dispositivos *Wearable* e o Seu Potencial Para o Diagnóstico da Síndrome da Apneia Obstrutiva do Sono: NUKUTE



**XVI Seminário Temático em Fisiologia Clínica II**  
2 de Fevereiro de 2023



**Discentes**  
Martim Bacatelo  
Nuno Faria  
Vasco Tomás



**Regente da UC**  
Prof<sup>a</sup> Virgínia Fonseca



**Orientadora**  
Prof<sup>a</sup> Joana Belo

# TABELA DE CONTEÚDOS

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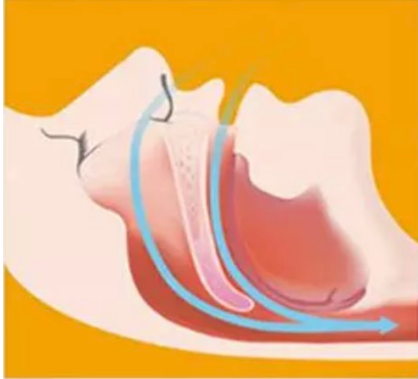
- 01 APNEIA OBSTRUTIVA DO SONO
- 02 POLISSONOGRRAFIA
- 03 DISPOSITIVOS WEARABLE NA SAOS
- 04 NUKUTE

# APNEIA OBSTRUTIVA DO SONO

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“Obstructive sleep apnea (OSA) is characterized by recurrent collapse of the pharyngeal airway during sleep, resulting in substantially reduced (hypopnea) or complete cessation (apnea) of airflow despite ongoing breathing efforts. ” (1)

*American Academy of Sleep Medicine*



Normal



Ronco



Apneia

# APNEIA OBSTRUTIVA DO SONO

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Fragmentação do sono

Desenvolvimento de HTA

Resistência à insulina

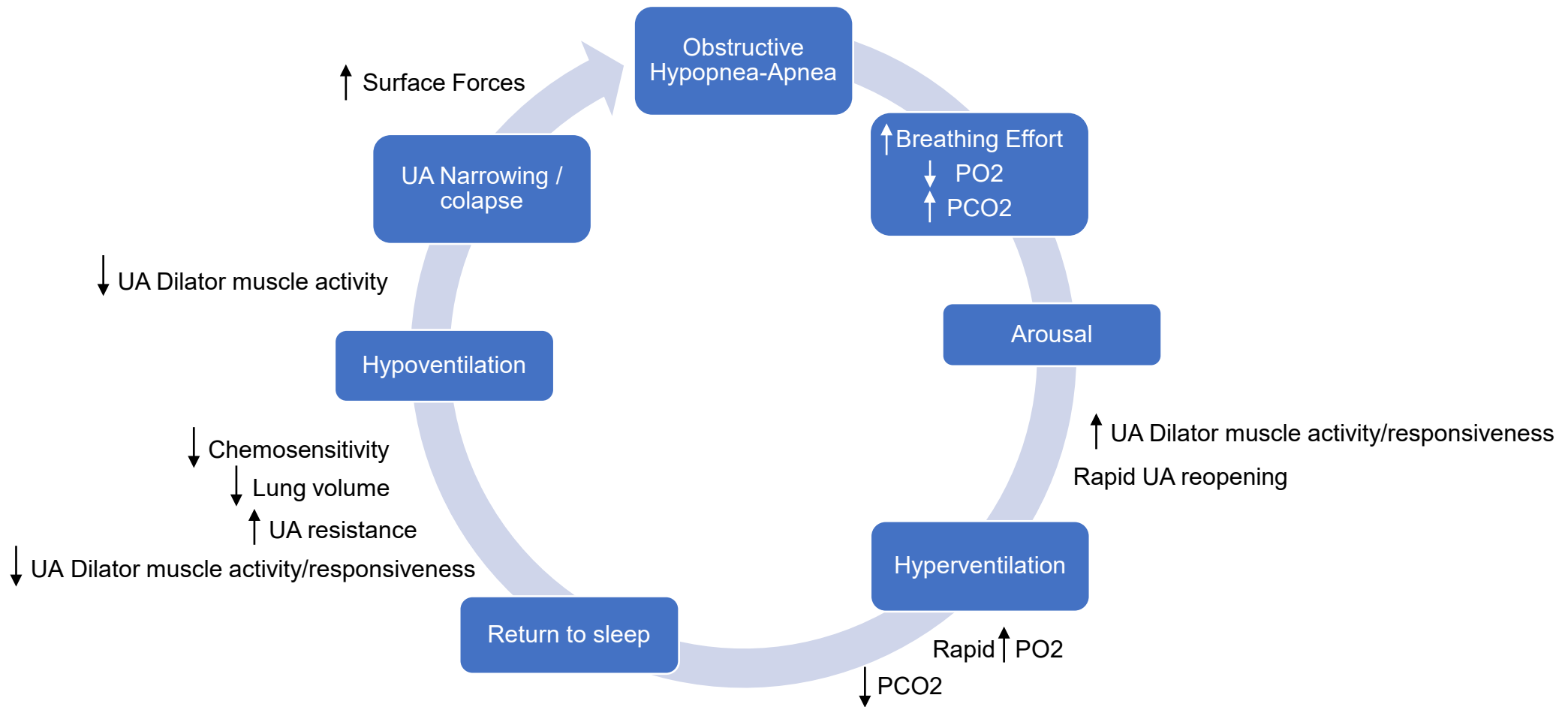
Maior risco de doença cardiovascular

Deterioração da qualidade de vida

(2)

# APNEIA OBSTRUTIVA DO SONO

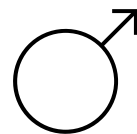
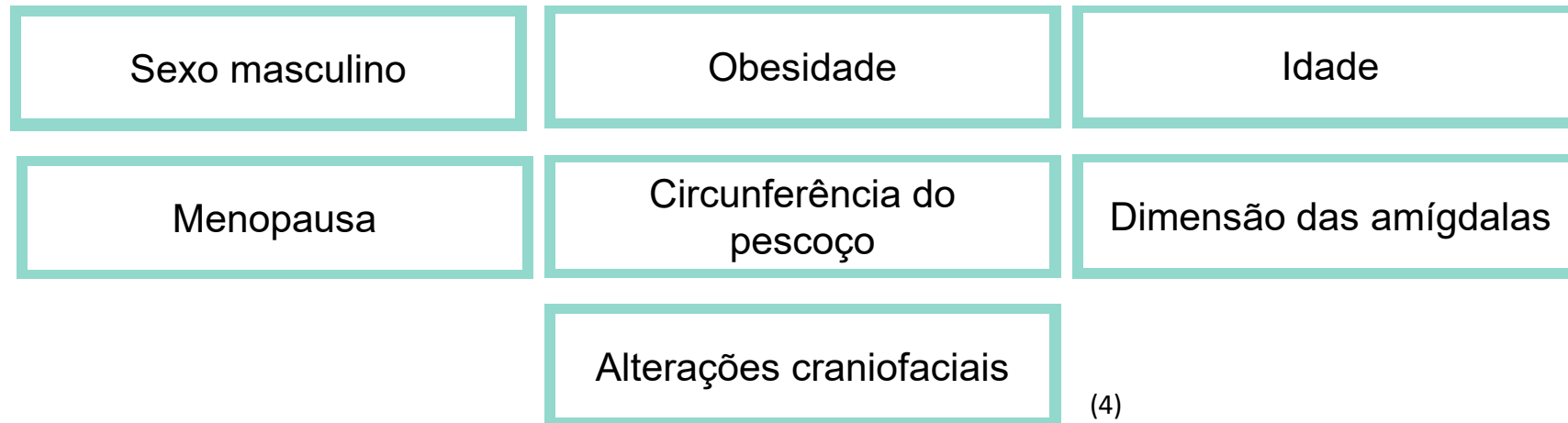
## Fisiopatologia



(3)

# APNEIA OBSTRUTIVA DO SONO

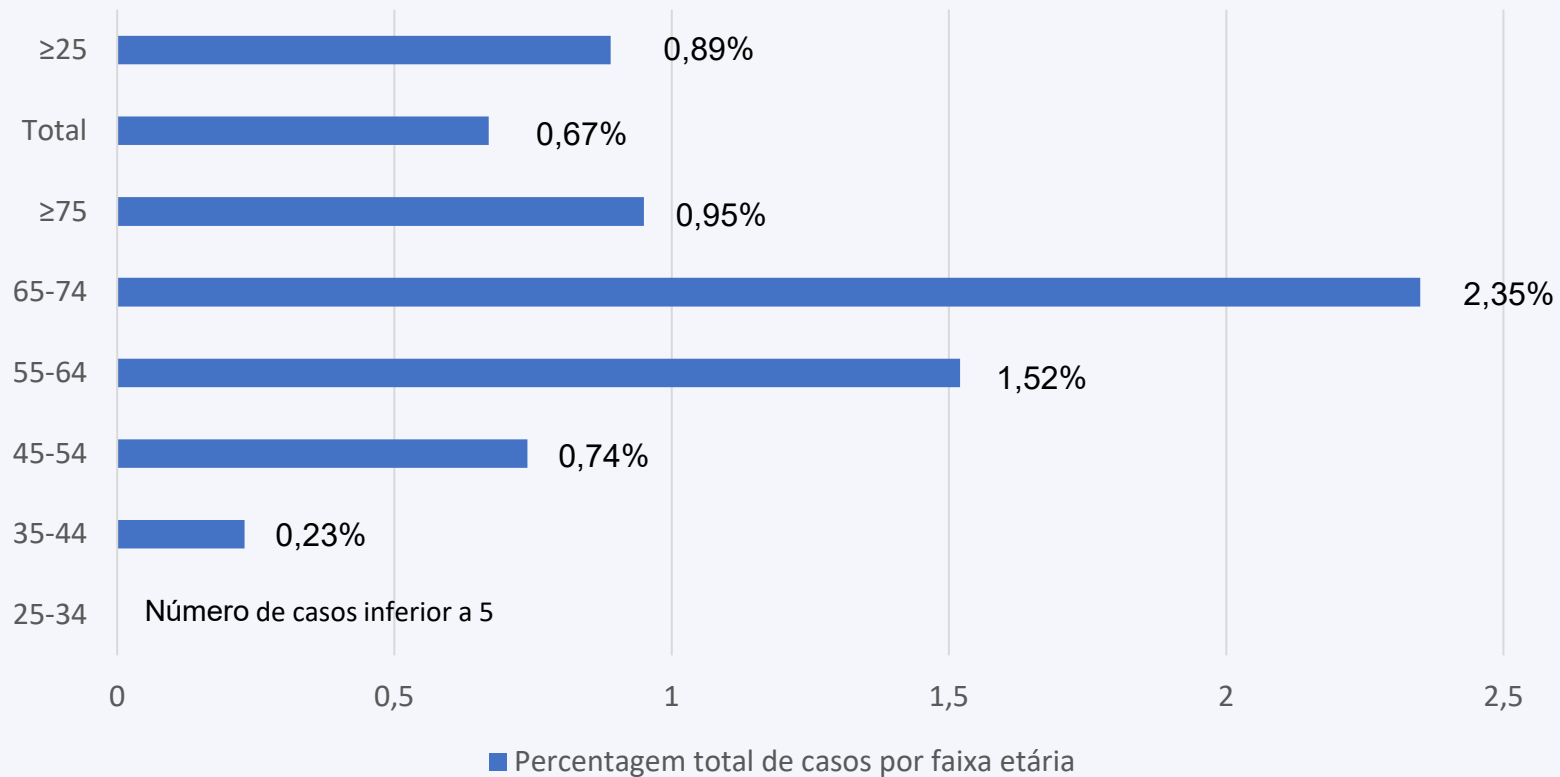
## Fatores de risco



# APNEIA OBSTRUTIVA DO SONO

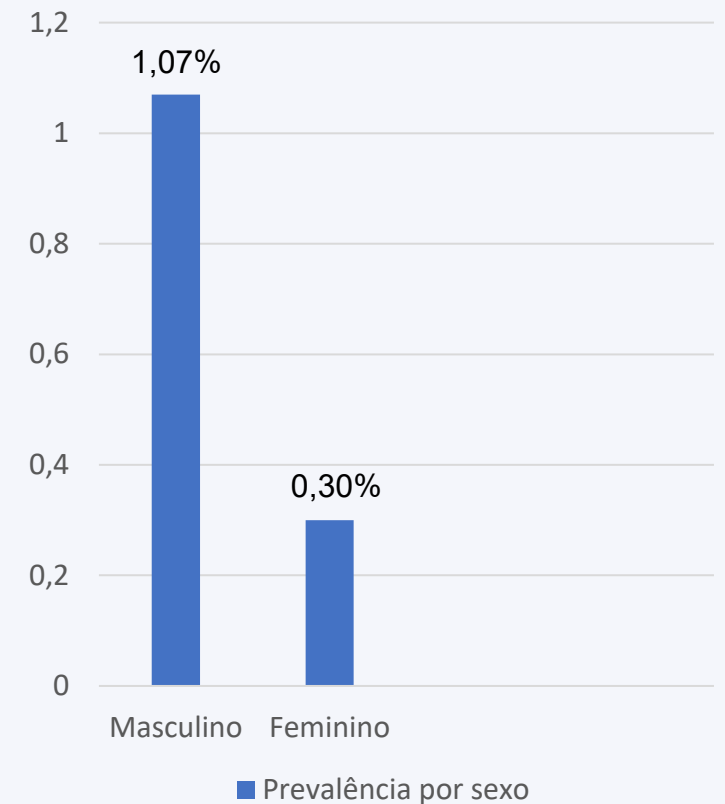
## Prevalência

Prevalência da SAOS por faixa etária



(5)

Prevalência por sexo



(5)

# APNEIA OBSTRUTIVA DO SONO

## Diagnóstico

### A – Pelo menos 1 critério

Sintomas derivados da má qualidade do sono;

Sensação de asfixia/engasgamento;

Testemunhos;

Diagnóstico de HTA, FA, Diabetes tipo 2, alterações de humor, perturbações cognitivas, doença coronária e insuficiência cardíaca congestiva;

B - 5 ou mais eventos de Apneia e/ou Hipopneia por hora (obstrutivos)

C - 15 ou mais eventos de Apneia e/ou Hipopneia por hora (obstrutivos)

A + B

C

(1)

# POLISSONOGRRAFIA

## Índice de Apneia/Hipopneia

<b>&lt; 5 eventos / hora</b>	<b>5 - 15 eventos / hora</b>
Sem Apneia	Grau Ligeiro
<b>15 - 30 eventos / hora</b>	<b>&gt; 30 eventos / hora</b>
Grau Moderado	Grau Grave

(6)



# POLISSONOGRRAFIA

## Gold Standart

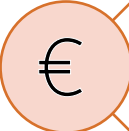

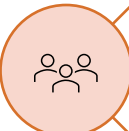


Level	Designation	Description
I	<b>Attended laboratory polysomnography</b>	Conducted in a sleep laboratory Includes recording of EEG, EOG, EMG-SM, airflow, respiratory effort, ECG, SaO2, EMG-AT Technologists in attendance
II	<b>Unattended polysomnography</b>	Usually conducted in the patient's home but sometimes recorded in a hospital bedroom or care unit Includes recording of EEG, EOG, EMG-SM, airflow, respiratory effort, ECG, SaO2, EMG-AT No technologists in attendance
III	<b>Unattended cardiopulmonary recording</b>	Usually conducted in the patient's home but sometimes recorded in a hospital bedroom or care unit Usually four or more channels, including airflow, respiratory effort, ECG, SaO2, and/or snoring sounds No technologists in attendance
IV	<b>Unattended single-or-dual-channel recording</b>	Usually conducted in the patient's home but sometimes recorded in a hospital bedroom or care unit Usually records one or two channels, typically ECG and SaO2 No technologists in attendance

(7)

# POLISSONOGRRAFIA

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## Limitações

-  Dispendioso
  -  Acessibilidade limitada
  -  Seleção criteriosa de doentes
  -  Número elevado de exames inconclusivos por erros técnicos
  -  Avaliação e preparação do exame demorada
- (7,8)

[7] Resende Gonçalves DA. Descrição de parâmetros polissonográficos relacionados à insônia e à fragmentação do sono em pacientes com diagnósticos de condições otorrinolaringológicas que causam obstrução nasal [Internet]. Brasília - DF. [Brasília]: Universidade de Brasília; 2016 [cited 2023 Jan 29]. Available from: <https://core.ac.uk/download/pdf/94140859.pdf>

[8] Medicine PMTF of the AA of S. Clinical Guidelines for the Use of Unattended Portable Monitors in the Diagnosis of Obstructive Sleep Apnea in Adult Patients. Journal of Clinical Sleep Medicine [Internet]. 2007 Dec 15 [cited 2023 Jan 31];03(07):737–47. Available from: <https://jcs.m.aasm.org/doi/10.5664/jcs.m.27032>

# DISPOSITIVOS WEARABLE NA SAOS



(9)



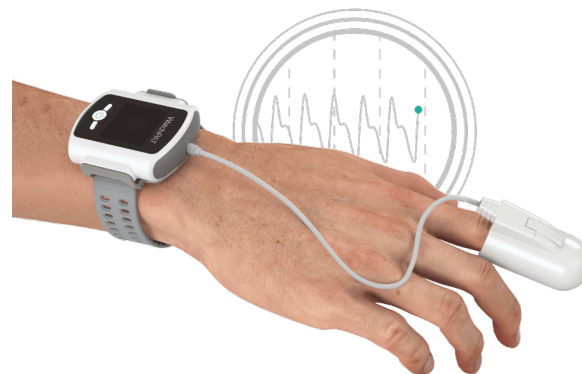
(10)



(13)



(12)



(11)

[1] Berry R, Quan S, Abreu A, Bibbs M. The AASM Manual for the Scoring of Sleep and Associated Events [Internet]. 2014. Available from: [www.aasm.org](http://www.aasm.org).  
[9] Apple Watch Series 8 - Apple (PT) [Internet]. 2022 [cited 2023 Jan 31]. Available from: <https://www.apple.com/pt/apple-watch-series-8/>  
[10] Oura Ring. Smart Ring for Fitness, Stress, Sleep & Health. [Internet]. 2023 [cited 2023 Jan 31]. Available from: <https://ouraring.com/>  
[11] WatchPAT® Home Sleep Test (HST/HSAT) Sleep Apnea Device | Itamar Medical Ltd. [Internet]. 2023 [cited 2023 Jan 31]. Available from: <https://www.itamar-medical.com/>  
[12] HSAT at-home sleep testing: ApneaTrak Type 3 sleep studies [Internet]. 2023 [cited 2023 Jan 31]. Available from: <https://www.cadwell.com/hsat/>  
[13] Remote screening diagnostics of sleep apnea - Nukute [Internet]. 2022 [cited 2023 Jan 29]. Available from: <https://nukute.com/>

# NUKUTE

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Monitorização de padrões respiratórios durante o sono

Fornecimento de *feedbacks* e recomendações personalizadas

Monitorização do ritmo cardíaco

Monitorização da pressão arterial

(13)

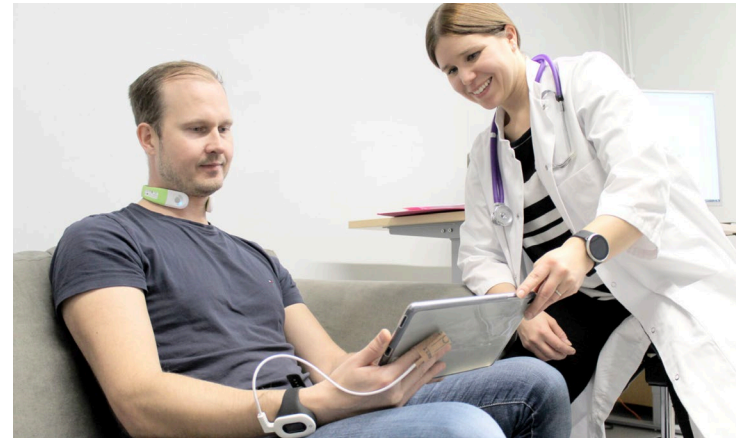
# NUKUTE

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Colar cervical



Oxímetro



*Tablet com a App NUKUTE*



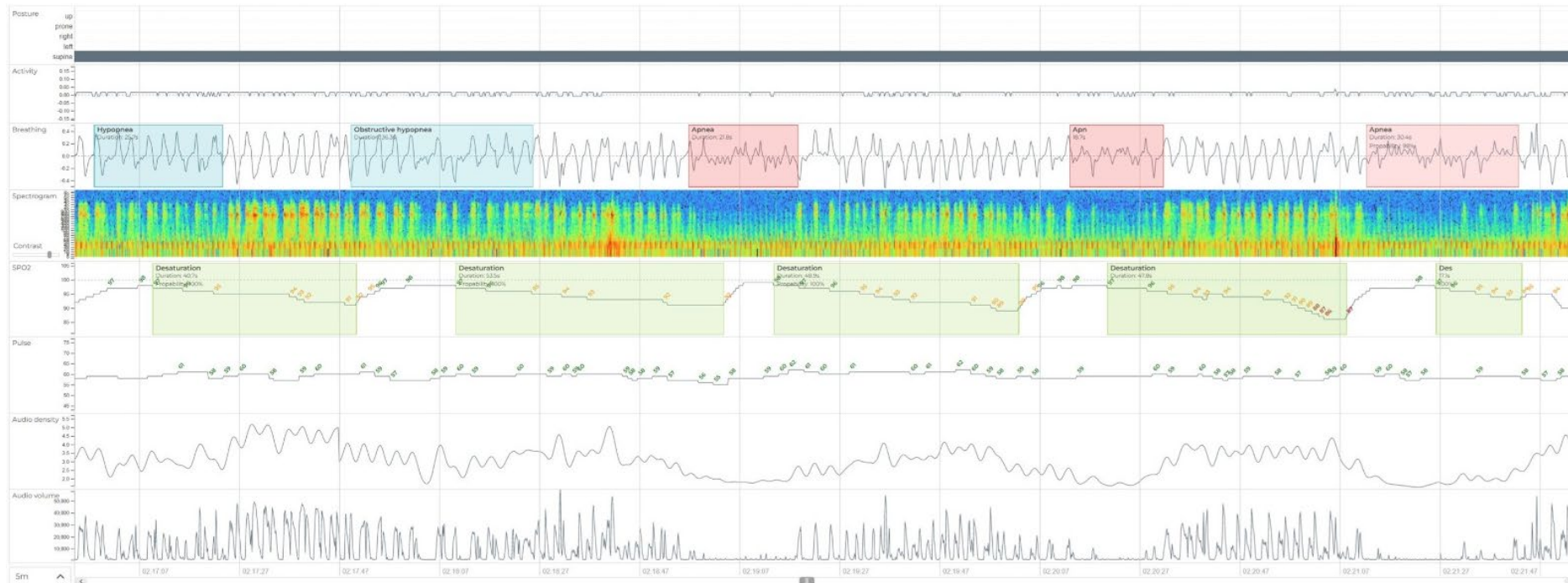
(13)

# NUKUTE

Sensor Piezoelétrico

Sons traqueais

Resultados na App



(13,14)

[13] Remote screening diagnostics of sleep apnea - Nukute [Internet]. 2022 [cited 2023 Jan 29]. Available from: <https://nukute.com/>  
[14] Mäkinen N, Hannila E, Pisilä AP, Starck T, Huuskonen U, Kallio M, et al. System validation study for novel wearable sleep apnea screening device. World Sleep Congress [Internet]. 2022 [cited 2023 Jan 29]; Available from: <https://nukute.com/wp-content/uploads/2022/05/World-Sleep-2022-oral-abstract.pdf>

# NUKUTE

## Resultados

AHI cut-off	Automatic		Manual	
	Accuracy	Cohen's $\kappa$	Accuracy	Cohen's $\kappa$
$\geq 5$ events/h	88%	0.76	93%	0.85
$\geq 15$ events/h	93%	0.80	93%	0.80
$\geq 30$ events/h	95%	0.72	98%	0.88

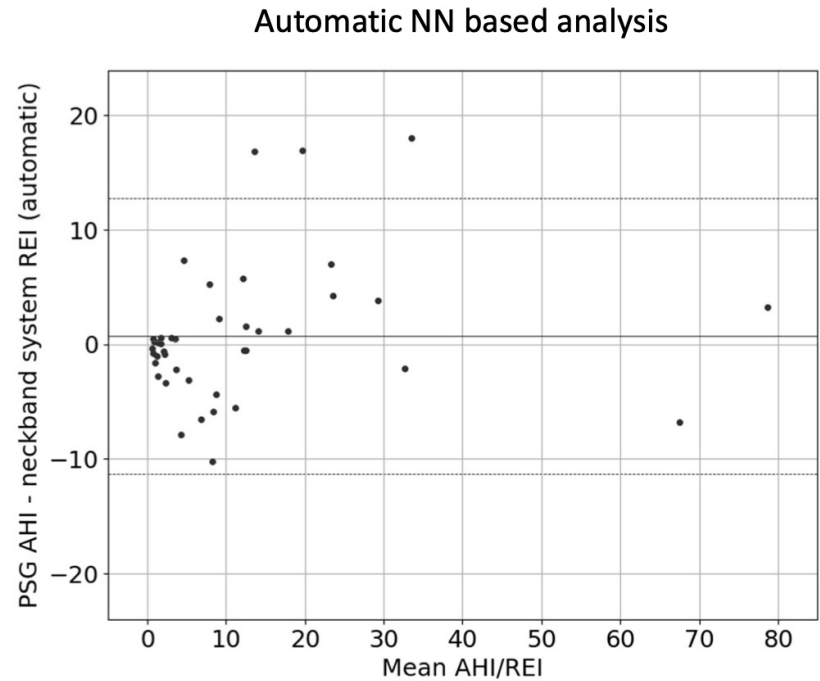
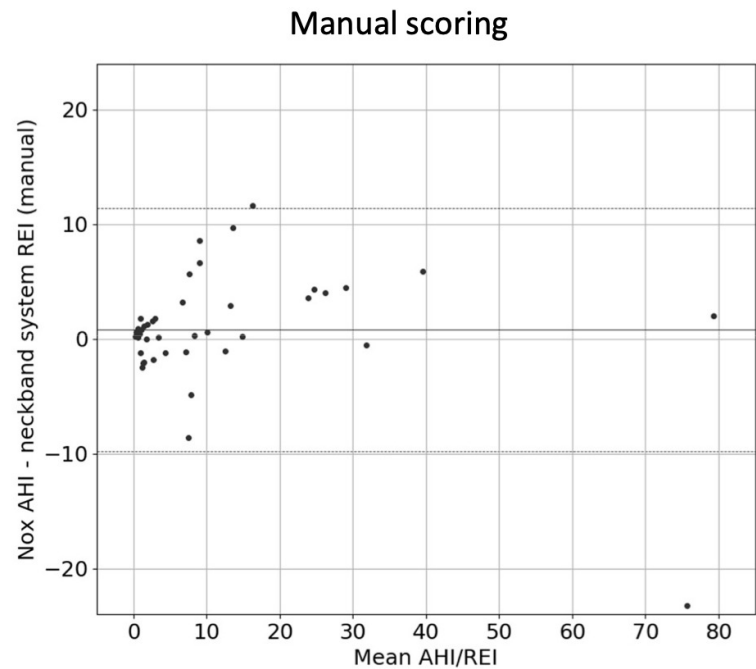
(15)

Tabela de precisão de diagnóstico manual e automático



# NUKUTE

## Resultados



(14)



[14] Mäkinen N, Hannila E, Pisilä AP, Starck T, Huuskonen U, Kallio M, et al. System validation study for novel wearable sleep apnea screening device. World Sleep Congress [Internet]. 2022 [cited 2023 Jan 29]; Available from: <https://nukute.com/wp-content/uploads/2022/05/World-Sleep-2022-oral-abstract.pdf>

# NUKUTE

## Resultados

IA/H, Eventos/hora	Sensibilidade	Especificidade	VPP	VPN
$\geq 5$	1.00	1.00	1.00	1.00
$\geq 15$	0.83	0.96	0.94	0.90
$\geq 30$	1.00	1.00	1.00	1.00

Sensibilidade, Especificidade, Valor Preditivo Positivo (VPP) e Valor Preditivo Negativo (VPN)



# NUKUTE

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## Vantagens

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Fácil utilização

---

Maior comodidade

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Monitorização à distância

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## Limitações

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Capacidades limitadas

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Política de privacidade

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Bateria

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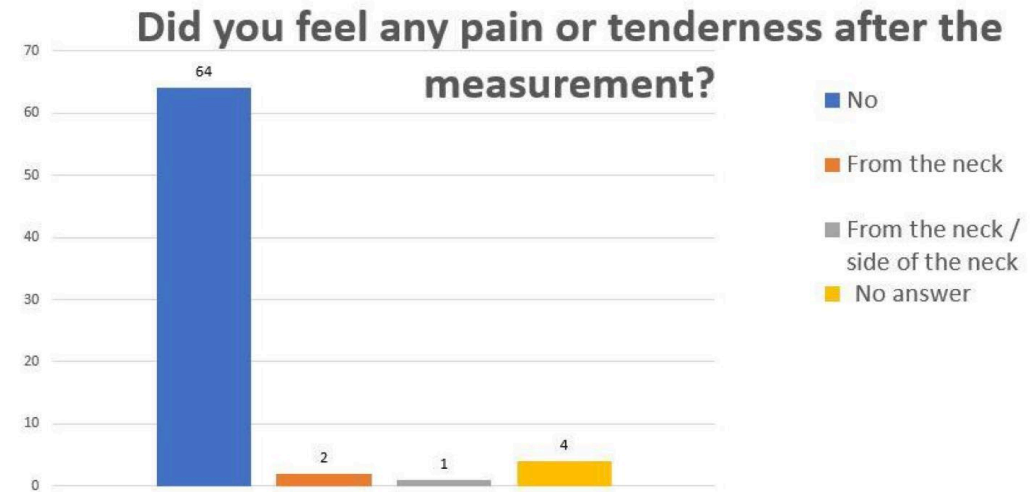
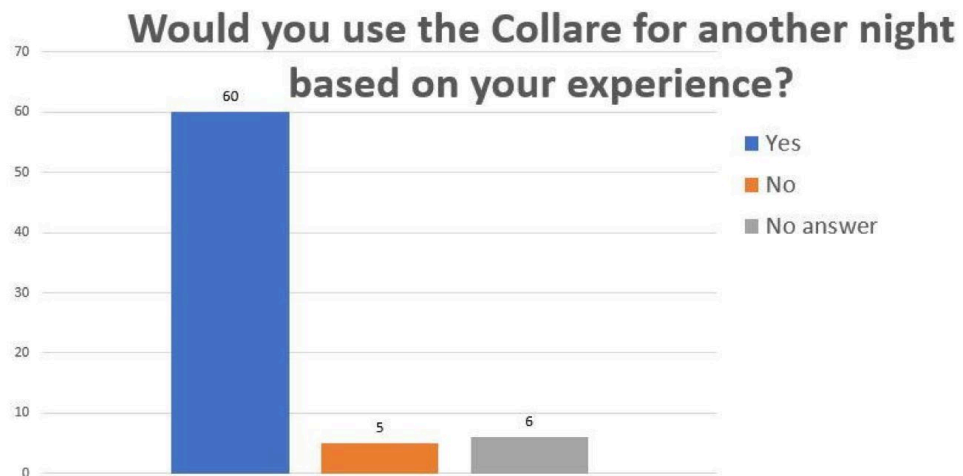
Subvalorização de índices/hora

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(13)

# NUKUTE

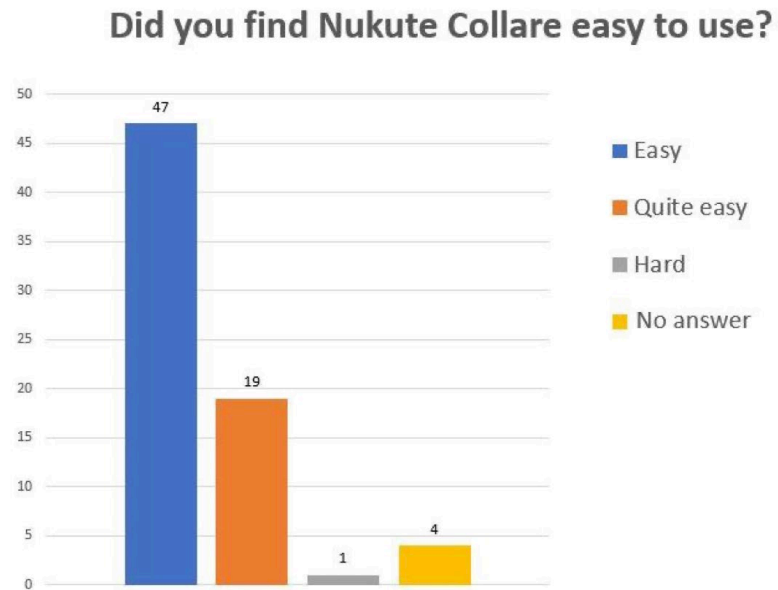
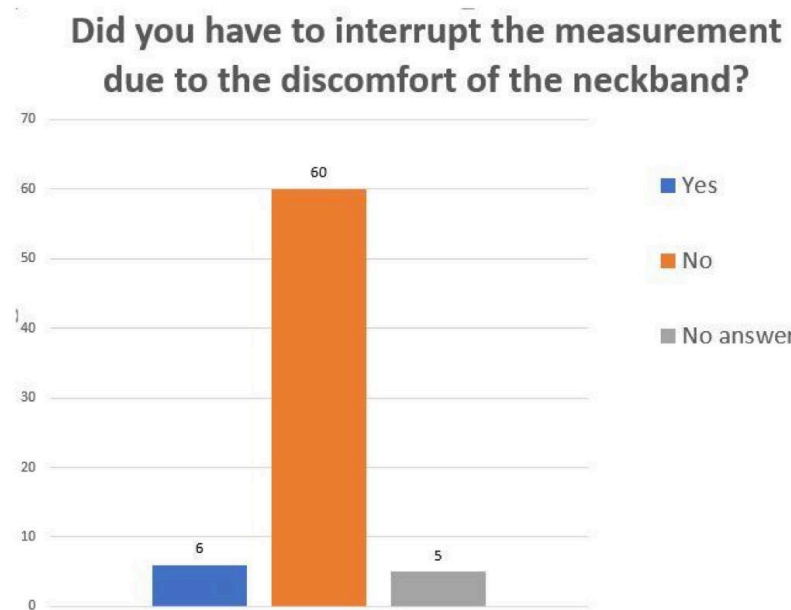
## Opinião dos utilizadores



(16)

# NUKUTE

## Opinião dos utilizadores



(16)

# POLISSONOGRAFIA VS NUKUTE

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## Polissonografia



(17)

## Nukute



(13)

## THE CITY OF OULU OUTSOURCES SLEEP APNEA SCREENING TO NUKUTE

The City of Oulu has selected the medtech company, **Nukute**, as the sole provider of a solution for sleep apnea screening.

Nukute's service solution, powered by Nukute's own CE-marked medical device innovation, facilitates a healthcare process that leads to a reduced need for specialised health care. The cost-effectiveness the device and solution provide unequivocally helped seal the deal with the City of Oulu.

The decision was made in collaboration with the previous service provider, the University Hospital of Oulu (OYS). The agreement highlights the importance of shifting the screening diagnostics of sleep apnea to a primary healthcare provider, away from specialised clinic duty. In Oulu, there are already over 500 people within the public healthcare system referred to home sleep apnea testing (HSAT) by the City's general practitioners. OYS will now transfer these patients to Nukute. Nukute's healthcare unit is located in Rehapolis 1, right beside the Oulu University Hospital and at the heart of Oulu's healthcare district.

*'First and foremost we need to speed up the screening and diagnostic processes of sleep apnea. The City of Oulu has a strong track record of participating in the development and deployment of new technology. We hope our cooperation with Nukute will be a stepping stone for the Nukute technology becoming widespread throughout the world,' stated the City of Oulu's Deputy Chief Physician, **Artturi Vuotila**.*

*'For us at Nukute, for our technology and medical approach to sleep apnea screening, this is nothing less than a pivotal project to be handled with the utmost sense of priority. To follow in the Oulu University Hospital's footsteps is not a minor task for a healthtech start-up. That being said, we sincerely thank the City of Oulu for the trust they have placed in us. Our goal is to have this become an industry benchmark from which we'll drive a success story in the global medical technology business,' commented **Pekka T. Saavalainen**, the CEO (interim) of Nukute.*

Sleep apnea can be described as a new first-world endemic that is suffered by 936 million people around the world. (Estimation of the global prevalence and burden of obstructive sleep apnoea: a literature-based analysis; The Lancet Respiratory Medicine, Volume 7 Issue 8, August 2019)

# Referências Bibliográficas

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1. Berry R, Quan S, Abreu A, Bibbs M. The AASM Manual for the Scoring of Sleep and Associated Events [Internet]. 2014. Available from: [www.aasm.org](http://www.aasm.org).
2. Alves da Silva G, Hauelsen Sander H, Luiz Eckeli A, Maria França Fernandes R, Barbosa Coelho E, Nobre F. Conceitos básicos sobre síndrome da apneia obstrutiva do sono Basic concepts about obstructive sleep apnea. Rev Bras Hipertens [Internet]. 2009 [cited 2023 Jan 29];16(3):150–7. Available from: <http://departamentos.cardiol.br/dha/revista/16-3/05-conceitos.pdf>
3. Eckert DJ, Malhotra A. Pathophysiology of Adult Obstructive Sleep Apnea. Proc Am Thorac Soc [Internet]. 2008 Feb 2 [cited 2023 Jan 31];5(2):144. Available from: [/pmc/articles/PMC2628457/](https://pubmed.ncbi.nlm.nih.gov/16228457/)
4. Spicuzza L, Caruso D, di Maria G. Obstructive sleep apnoea syndrome and its management. 2015 [cited 2023 Jan 31]; Available from: <http://taj.sagepub.com>
5. Síndrome de Apneia Obstrutiva do Sono: Epidemiologia, Diagnóstico e Tratamento. Um Estudo da Rede Médicos-Sentinela - INSA [Internet]. Instituto Nacional de Saúde Ricardo Jorge. 2014 [cited 2023 Jan 31]. Available from: <https://www.insa.min-saude.pt/sindrome-de-apneia-obstrutiva-do-sono-epidemiologia-diagnostico-e-tratamento-um-estudo-da-rede-medicos-sentinela/>
6. da Cunha Daltro CH, Fontes FHDO, Santos-Jesus R, Gregorio PB, Araújo LMB. Síndrome da apnéia e hipopnéia obstrutiva do sono: associação com obesidade, gênero e idade. Arquivos Brasileiros de Endocrinologia & Metabologia [Internet]. 2006 [cited 2023 Jan 29];50(1):74–81. Available from: <http://www.scielo.br/j/abem/a/XYPw6cTJynmx4fc447cCY4r/?lang=pt>
7. Resende Gonçalves DA. Descrição de parâmetros polissonográficos relacionados à insônia e à fragmentação do sono em pacientes com diagnósticos de condições otorrinolaringológicas que causam obstrução nasal [Internet]. Brasília - DF. [Brasília]: Universidade de Brasília; 2016 [cited 2023 Jan 29]. Available from: <https://core.ac.uk/download/pdf/94140859.pdf>
8. Medicine PMTF of the AA of S. Clinical Guidelines for the Use of Unattended Portable Monitors in the Diagnosis of Obstructive Sleep Apnea in Adult Patients. Journal of Clinical Sleep Medicine [Internet]. 2007 Dec 15 [cited 2023 Jan 31];03(07):737–47. Available from: <https://jcs.m.aasm.org/doi/10.5664/jcs.m.27032>
9. Apple Watch Series 8 - Apple (PT) [Internet]. 2022 [cited 2023 Jan 31]. Available from: <https://www.apple.com/pt/apple-watch-series-8/>
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11. WatchPAT® Home Sleep Test (HST/HSAT) Sleep Apnea Device | Itamar Medical Ltd. [Internet]. 2023 [cited 2023 Jan 31]. Available from: <https://www.itamar-medical.com/>
12. HSAT at-home sleep testing: ApneaTrak Type 3 sleep studies [Internet]. 2023 [cited 2023 Jan 31]. Available from: <https://www.cadwell.com/hsat/>
13. Remote screening diagnostics of sleep apnea - Nukute [Internet]. 2022 [cited 2023 Jan 29]. Available from: <https://nukute.com/>
14. Mäkinen N, Hannila E, Pisilä AP, Starck T, Huuskonen U, Kallio M, et al. System validation study for novel wearable sleep apnea screening device. World Sleep Congress [Internet]. 2022 [cited 2023 Jan 29]; Available from: <https://nukute.com/wp-content/uploads/2022/05/World-Sleep-2022-oral-abstract.pdf>
15. Mäkinen N, Hannila E, Pisilä AP, Starck T, Huuskonen U, Kallio M, et al. Novel wearable technology to screen for sleep apnea: Method validation [Internet]. 2022 [cited 2023 Jan 29]. Available from: <https://nukute.com/wp-content/uploads/2022/04/Nukute-Scientific-Poster-World-Sleep-2022-Rome-2022-03-15-1.0-JR.pdf>
16. Mäkinen N, Hannila E, Pisilä AP, Starck T, Huuskonen U, Kallio M, et al. Clinical Study: Evaluating the usability and clinical performance of the NUKUTE COLLARE system. 2022 [cited 2023 Jan 29]; Available from: [https://nukute.com/wp-content/uploads/2021/05/CLINICAL\\_STUDY\\_2021\\_10\\_05\\_2021-1.pdf](https://nukute.com/wp-content/uploads/2021/05/CLINICAL_STUDY_2021_10_05_2021-1.pdf)
17. Level 3 Sleep Apnea test - Book Online at Oxygen Times [Internet]. 2023 [cited 2023 Jan 31]. Available from: <https://www.oxygentimes.com/sleep-test/sleep-test-level-3>
18. The City of Oulu outsources sleep apnea screening to Nukute - OuluHealth [Internet]. 2022 [cited 2023 Jan 31]. Available from: <https://ouluhealth.fi/the-city-of-oulu-outsources-sleep-apnea-screening-to-nukute/>