Night-to-night variability in Apnoea-Hypopnoea Index: Implications for Obstructive Sleep Apnoea diagnosis

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Background

Obstructive Sleep Apnoea

Obstructive Sleep Apnoea (OSA) is estimated to affect 1 billion people worldwide yet remains underdiagnosed. The Apnoea-Hypopnoea Index (AHI) is the gold standard for OSA diagnosis; however, it is typically derived from polysomnography (PSG) or home sleep studies (HSS) carried out over a single night. Night-to-night variability (NNV) in AHI poses challenges for accurate diagnosis, particularly in patients with milder disease.

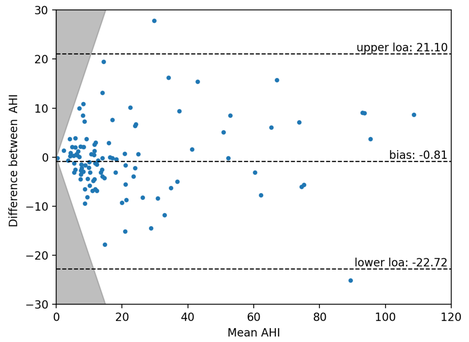
Data Collection

One hundred and six participants were monitored for two consecutive nights (using a SOMNOtouch RESP HSS device). AHI was calculated according to AASM guidelines (2012) by a certified sleep technologist. Participants included 67 males and 39 females with no diagnosis of OSA. Mean age was 44.6yr, mean BMI was 31

HSS	<5 night 2	5–15 night 2	15–30 night 2	30 + night 2
<5 night 1	5(4.7%)	4(3.8%)	0	0
5–15 night 1	8(7.5%)	35(33%)	8(7.5%)	0
15–30 night 1	1(0.9%)	3(2.8%)	15(14.2%)	5(4.7%)
30 + night 1	0	0	2(1.9%)	20(18.9%)

Analysis

A Bland-Altman analysis was used to quantify the repeatability of the single night recordings. This showed a small negative bias of -0.8 (95% CI: -2.96 to 1.34) suggesting no first night effect, but wide limits of agreement (-22.7 to 21.1).



Not only did this reveal poor repeatability, but the change in AHI between consecutive nights resulted in a change in OSA severity categorisation in 33% of participants, in some cases jumping 2 categories

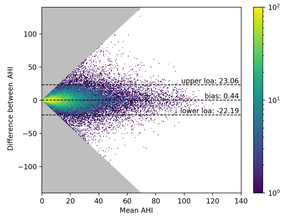
Multi-night recordings are currently often impractical, but single night recordings can result in significant under or over estimations of the long-term AHI

[1] H. E. Romero, N. Ma, G. J. Brown and E. A. Hill, “Acoustic Screening for Obstructive Sleep Apnea in Home Environments Based on Deep Neural Networks”, in IEEE Journal of Biomedical and Health Informatics, vol. 26, no. 7, pp. 2941-2950, July 2022.

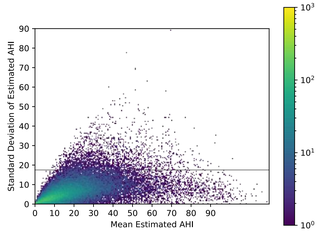
Alternative approaches

Acoustic Analysis

This data was originally collected with the intention of training a convolutional neural network (CNN) to estimate AHI from acoustic information alone [1]. This has been deployed in the mobile phone app “SoundSleep” which currently has over 52 000 users who have made 2 or more recordings. A repeat analysis for the first 2 nights of recordings of these users also shows large limits of agreement, however, with over 15 000 users having 10 or more nights, more robust statistics become available



Bland-Altman analysis from 2 nights



Statistics of multi-night recordings

App	<5 night 2	5–15 night 2	15–30 night 2	30 + night 2
<5 night 1	4357(8.3%)	2404(4.6%)	438(0.8%)	237(0.5%)
5–15 night 1	2452(4.7%)	11638(22.2%)	3935(7.5%)	582(1.1%)
15–30 night 1	509(1.0%)	4256(8.1%)	7887(15.0%)	2427(4.6%)
30 + night 1	248(0.5%)	786(1.5%)	2691(5.1%)	7649(14.6%)

Conclusion

Single night recordings of AHI likely miss-categorise the level of OSA severity. Multi-night recordings are currently impractical using the standard techniques, however novel machine learning approaches may allow more accurate assessment of long-term AHI via acoustic information collected over longer periods of time.