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# Deep Learning Via Non-Contact Bed-Sensors for Comprehensive Multi-Night Sleep-Breathing Assessment

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### Study objectives

To develop and validate an unobtrusive scalable device-analytics framework for multi-night monitoring of sleep-disordered breathing for improved diagnosis and management of obstructive sleep apnoea (OSA).

### Methods

Mattress ballistocardiographic respiratory and body-motion signals were combined with a hybrid CNN-Transformer model for multitask inference of respiratory events, sleep/wake stage, and arousals. Simultaneous mattress-sensor and polysomnography (PSG) recordings from 126 participants were split into training/initial validation (n=98) and final validation (n=28). Algorithms were trained and evaluated against expert-scored PSG at patient, event, and epoch levels using receiver operating characteristic (ROC) and Bland-Altman analyses.

### Results

Algorithm-estimated total sleep time for apnoea hypopnea index (AHI) derivation showed no significant bias versus PSG (mean [95% CI] 31 [-25 to 45] min). In the independent validation set, algorithm-derived AHI was strongly correlated with PSG-derived AHI (r=0.94; [0.87 to 0.97]) and showed high agreement, with no significant bias (0.8 [-2.8 to 4.3]/h), mean absolute error 7.3 [0.5 to 9.9/h], and Bland-Altman limits of agreement -17.6 to 19.1/h. Patient-level performance was high at clinical thresholds, with ROC AUC 0.94 for mild OSA (AHI ≥5/h) and 1.00 for severe OSA (AHI ≥30/h). Epoch-level performance remained robust across respiratory event detection and sleep classification. Arousal discrimination was also strong (ROC AUC 0.92 respiratory arousals; 0.82 non-respiratory arousals).

### Conclusions

A non-contact mattress sensor plus deep learning framework supports sleep and breathing event classification for multi-night OSA screening. Strong agreement with PSG-derived AHI and robust event- and arousal-level detection support unobtrusive, scalable multi-night home sleep assessment.