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Ventilation and Effort Monitoring in OSA via Non-Contact Bed Sensing

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Study objectives To develop a novel non-contact approach to assess ventilation and inspiratory effort for comprehensive multi-night assessment of obstructive sleep apnoea (OSA).

Methods Thirteen patients with OSA underwent in-laboratory physiological sleep studies with full polysomnography, calibrated airflow and oesophageal pressure to assess ventilation and inspiratory effort. Simultaneous non-contact mattress-based cardiorespiratory ballistographic signals were also recorded, followed by ≥1-week of in-home mattress-sensor recordings. A pretrained 100-million parameter hybrid CNN Transformer was used to covert raw non-contact signals into estimated ventilation and inspiratory effort. Model performance was evaluated using leave-one-out cross-validation at both epoch and respiratory event levels, before final training for home deployment and evaluation of normalised mean [95% CI] absolute error (nMAE) evaluation.

Results nMAE for ventilation was 11.9 [10.4–13.5]%, and for inspiratory effort was 11.8 [10.6–13.1]%. Moderate correlations were observed between estimated and reference signals, with Pearson correlations of 0.50 [0.43–0.58] for ventilation and 0.53 [0.42–0.65] for inspiratory effort. Near-miss accuracy within 5% was 56% for ventilation and 54% for inspiratory effort, increasing to 73% and 74% within 10%. Following the lab study, 12 of 13 participants completed multi-night home evaluations. Ventilation showed higher night-to-night variability (42 [30–54]%) than inspiratory effort (13 [10–17]%).

Conclusions This study demonstrates, for the first time, the feasibility of comprehensive multi-night in-lab and in-home assessment of ventilation and inspiratory effort beyond conventional OSA severity metrics. This approach enables multi-night evaluations of ventilation and inspiratory effort and thus mechanistic insights into OSA not possible with PSG alone.

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