



2019台灣胸腔暨重症加護醫學會

2019 Taiwan Society of Pulmonary and Critical Care Medicine

實驗室睡眠多項生理檢查相較於
居家穿戴式裝置檢測高估阻塞型
睡眠呼吸中止症嚴重度的探討性研究

Overestimation in severity of obstructive sleep apnea (OSA) of in-lab polysomnography (PSG) comparing to home-based sleep testing by the wearable device

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貼心貼 心電圖分析系統 (RootiCare System)



- **Electocardiogram (ECG) – one lead**
 - Arrhythmia (Af)
 - Heart rate variability (HRV)
 - EDR (ECG derived respiration)
 - Autonomic arousal index (AAI)
- **Accelerometer**
 - Physical activity
 - Sleep position
 - Respiratory pattern, cough (sleep)
- **Respiratory muscle impedance**
 - Respiratory pattern, cough
 - Breathing work/airflow
- **Skin temperature**
 - Autonomic nerve system
 - Inflammation

Study Design & Demographic data

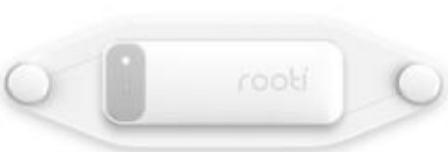
Variables	Total n=125	In-Lab Polysomnography		
		AHI<15 n=33	15≤AHI<30 n=32	AHI≥30 n=60
Age	44.4±12.3	42.0±11.0	45.5±12.3	45.1±12.9
M/F	96/29	22/11	24/8	50/10
BMI	26.8±4.4	24.4±2.9	25.4±3.7	28.8±4.5
Neck circumference	38.5±3.5	37.0±2.5	37.6±3.6	39.9±3.4
Mean SpO₂ (%)	93.9±4.0	96.6±1.1	95.9±1.2	91.4±4.4
Lowest SpO₂ (%)	81.3±10.0	89.3±5.8	84.0±5.6	75.5±10.2
ODI	24.9±25.7	3.3±3.9	9.0±7.9	45.3±23.0
AHI	33.9±24.2	8.4±3.7	21.8±4.7	54.4±18.4
CVHRI	22.1±19.5	10.3±8.1	11.9±8.4	34.1±21.2
CEI	12.6±10.7	5.5±4.5	9.2±4.4	18.3±12.3
Rx index (CVHRI+CEI)	28.3±20.1	14.2±8.6	18.5±7.9	41.2±21.1
Supine (%)	74.6±24.1	72.5±27.0	77.6±21.1	74.1±24.1

Clinically compatible
with OSA patients

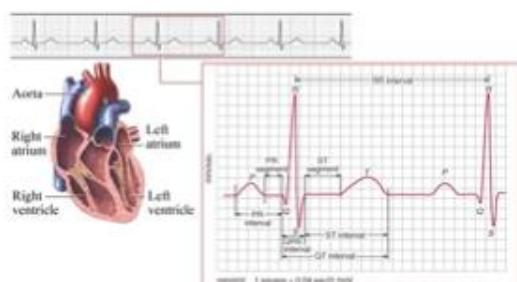
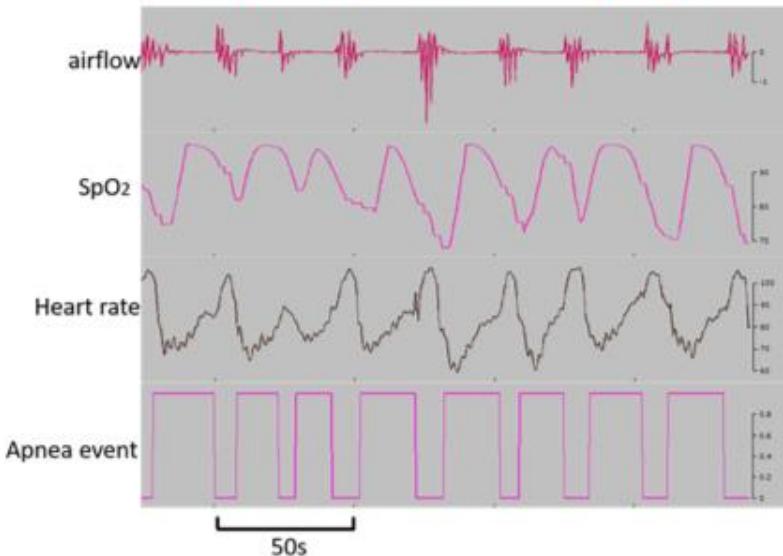
In-lab
Polysomnography
+
Rooti Rx

Home-based
Rooti Rx
For 3 days

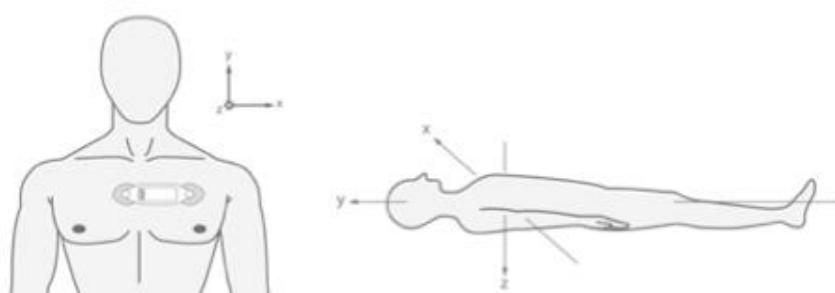
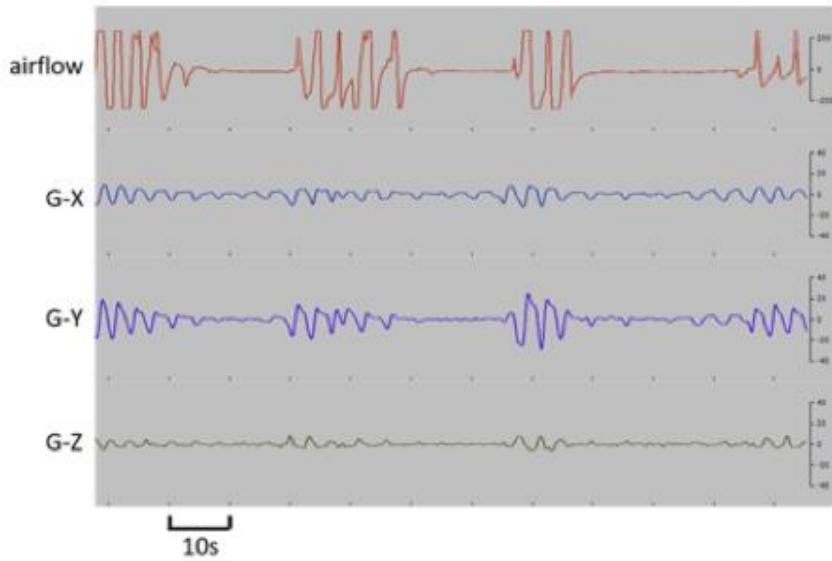
穿戴式裝置：Rooti Rx



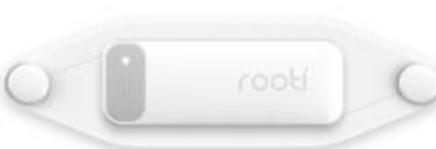
**CVHR: Cyclic Variation of Heart Rate:
Respiratory Arousal Index (RAI)**



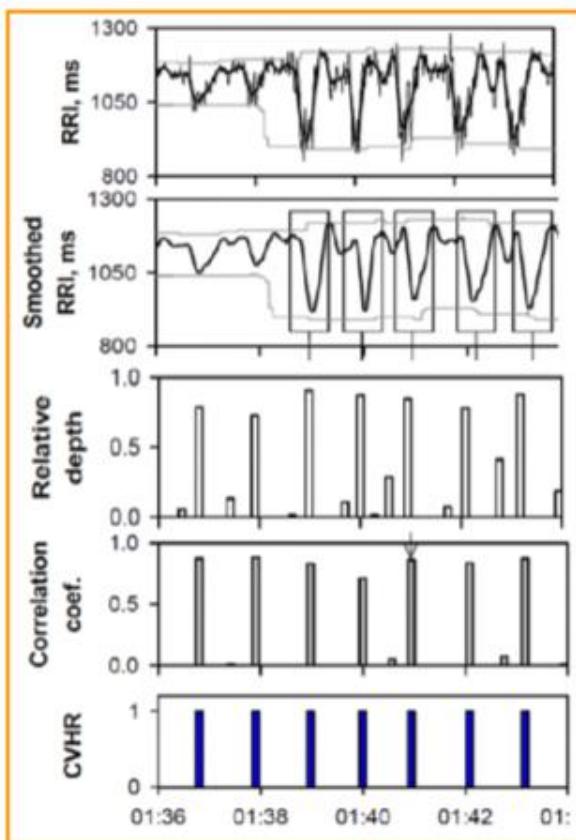
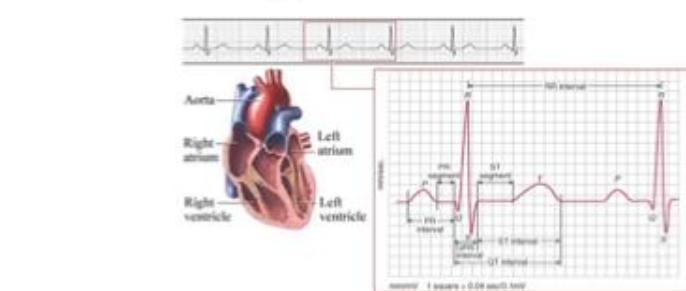
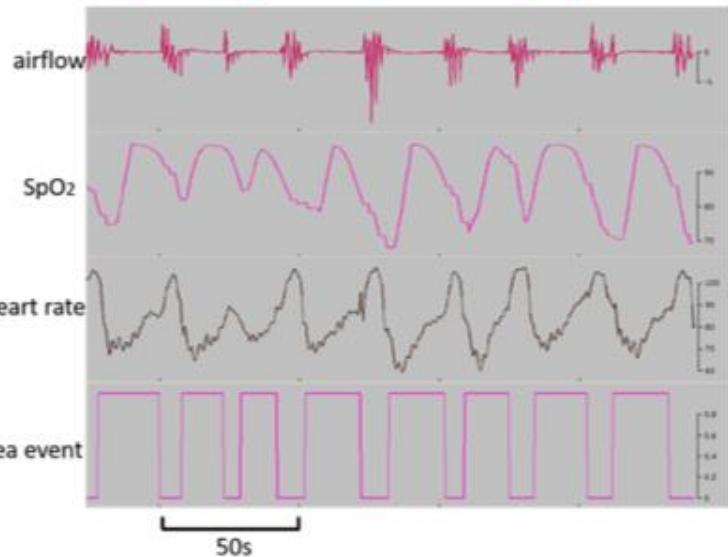
G-sensor: Chest effort detected by movement



穿戴式裝置 : Rooti Rx



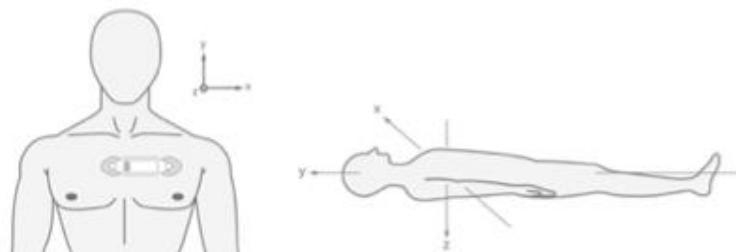
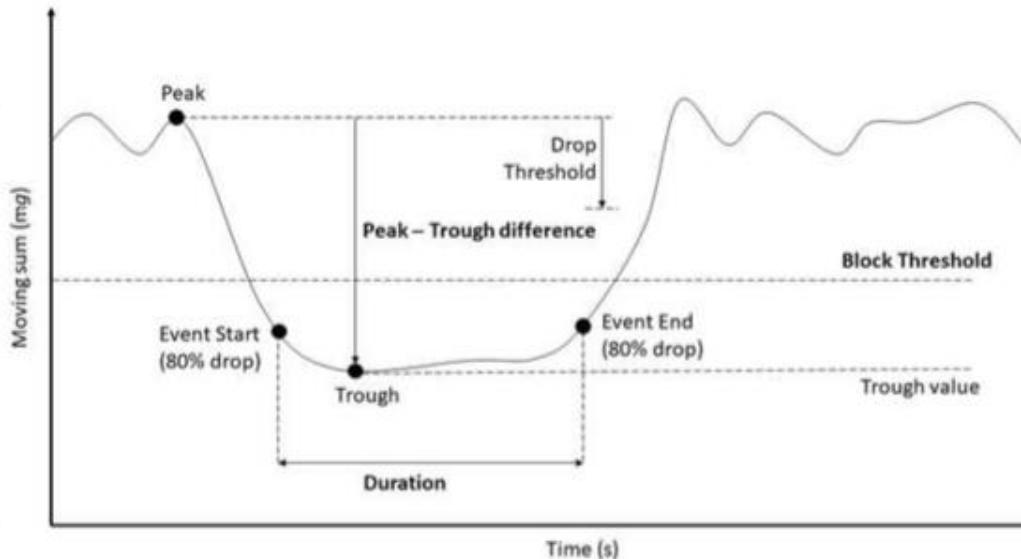
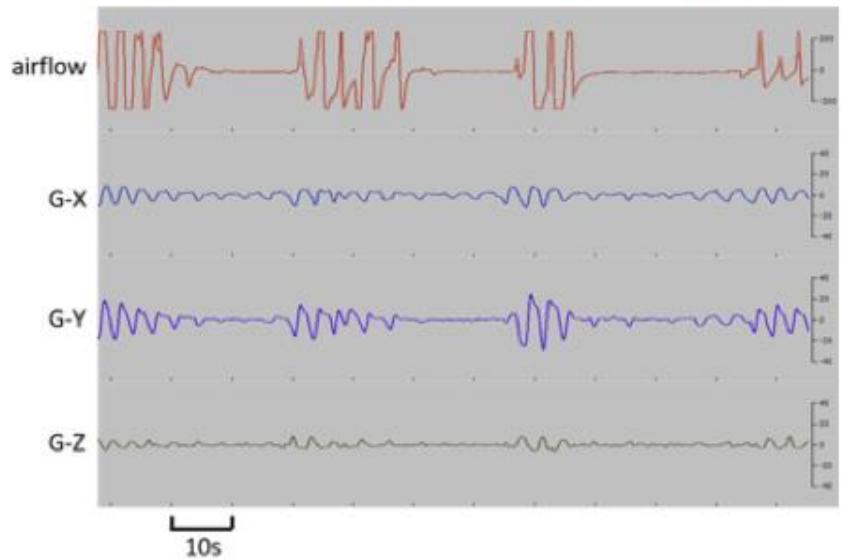
CVHR: Cyclic Variation of Heart Rate: Respiratory Arousal Index (RAI)



穿戴式裝置 : Rooti Rx



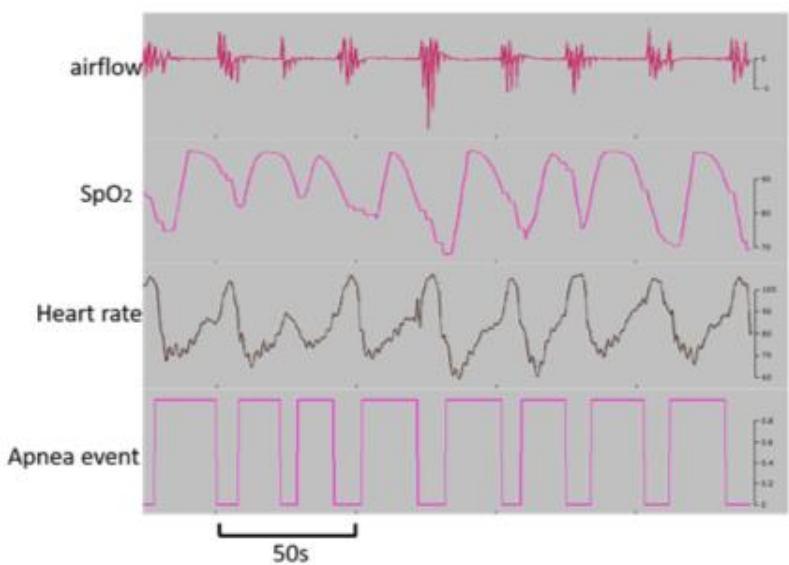
G-sensor: Chest effort detected by movement



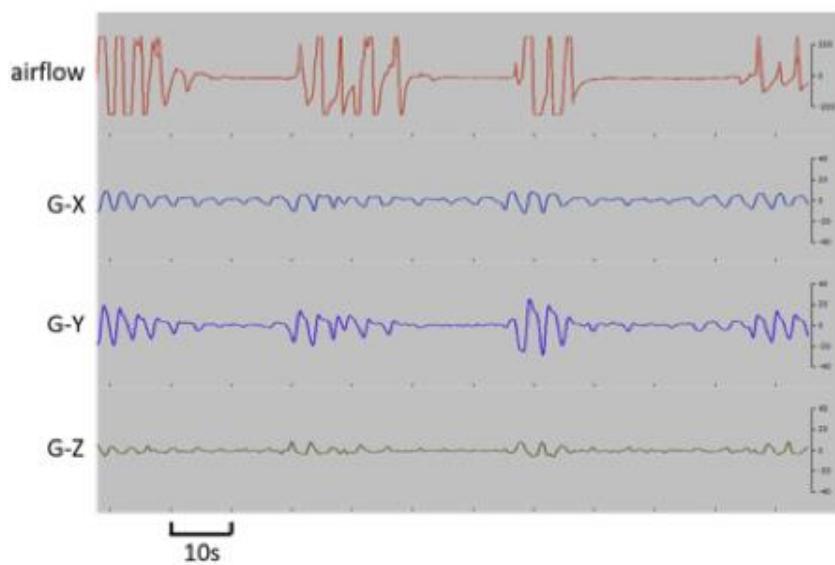
1. Peak-trough difference should > Drop threshold
2. The trough value should be lower than Block threshold
3. The duration of each event (end point - start point) > 10sec

穿戴式裝置：Rooti Rx

**CVHR: Cyclic Variation of Heart Rate:
Respiratory Arousal Index (RAI)**



G-sensor: Chest effort detected by movement



穿戴式裝置：Rooti Rx

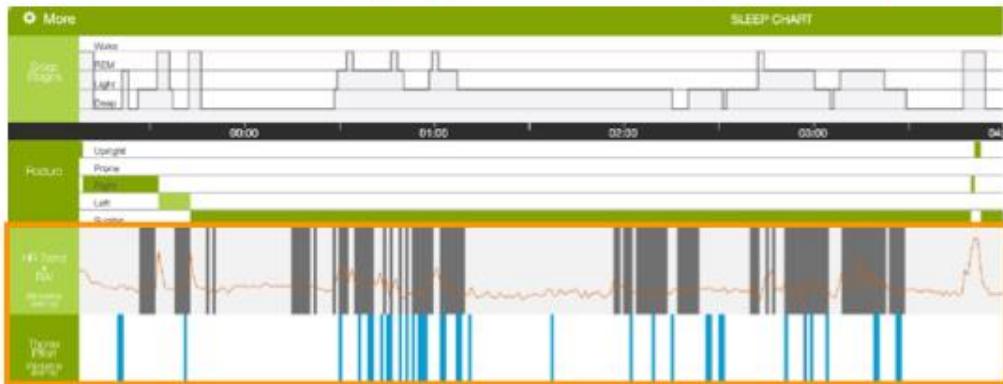
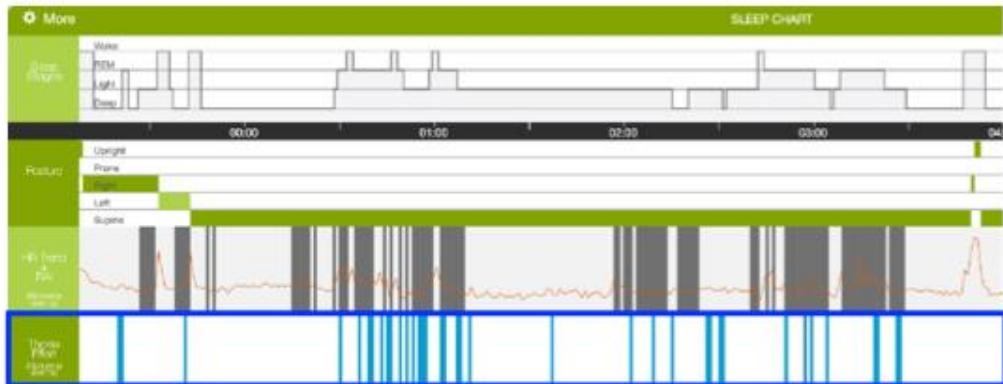
**CVHR: Cyclic Variation of Heart Rate:
Respiratory Arousal Index (RAI)**



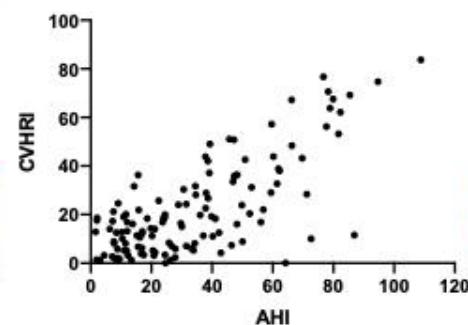
G-sensor: Chest effort detected by movement



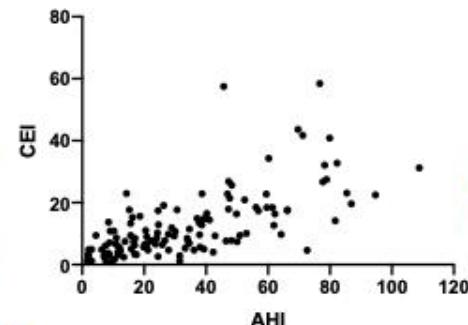
穿戴式裝置：Rooti Rx



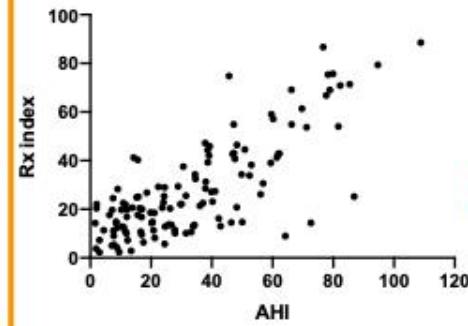
Correlation of CVHRI & AHI



Correlation of CEI & AHI



Correlation of Rx index & AHI



Study Design & Demographic data

		In-Lab Polysomnography			Home-based Rooti Rx (Rx index)		
Variables	Total n=125	AHI<15 n=33	15≤AHI<30 n=32	AHI≥30 n=60	<15 n=55	15 to <30 n=47	≥30 n=23
Age	44.4±12.3	42.0±11.0	45.5±12.3	45.1±12.9	43.4±11.5	45.3±12.7	45.0±13.4
M/F	96/29	22/11	24/8	50/10	38/17	40/7	18/5
BMI	26.8±4.4	24.4±2.9	25.4±3.7	28.8±4.5	26.5±4.8	26.0±2.9	28.9±5.2
Neck circumference	38.5±3.5	37.0±2.5	37.6±3.6	39.9±3.4	38.1±3.3	38.3±2.9	40.1±4.6
Mean SpO₂ (%)	93.9±4.0	96.6±1.1	95.9±1.2	91.4±4.4	95.2±2.5	94.9±2.5	89.0±5.3
Lowest SpO₂ (%)	81.3±10.0	89.3±5.8	84.0±5.6	75.5±10.2	85.1±7.7	81.8±9.1	71.3±10.5
ODI	24.9±25.7	3.3±3.9	9.0±7.9	45.3±23.0	14.1±18.4	22.7±21.8	55.2±25.3
AHI	33.9±24.2	8.4±3.7	21.8±4.7	54.4±18.4	23.2±17.4	33.5±20.6	60.4±25.3
CVHRI	22.1±19.5	10.3±8.1	11.9±8.4	34.1±21.2	4.7±3.3	14.7±5.6	39.8±16.3
CEI	12.6±10.7	5.5±4.5	9.2±4.4	18.3±12.3	4.7±2.3	9.8±6.1	20.7±9.8
Rx index (CVHRI+CEI)	28.3±20.1	14.2±8.6	18.5±7.9	41.2±21.1	10.1±2.9	20.8±3.9	46.8±16.1
Supine (%)	74.6±24.1	72.5±27.0	77.6±21.1	74.1±24.1	54.6±18.8	50.7±20.8	54.0±23.0

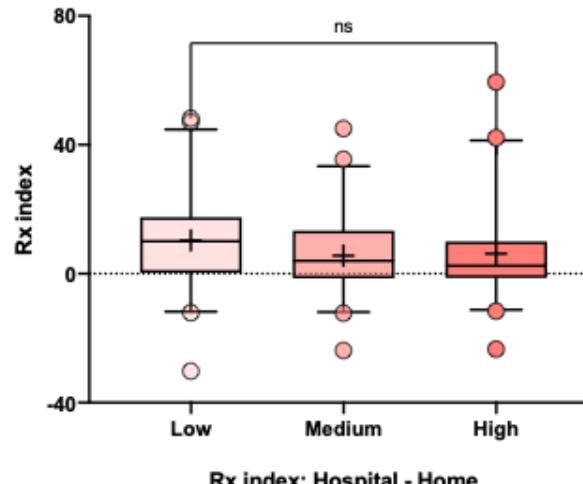
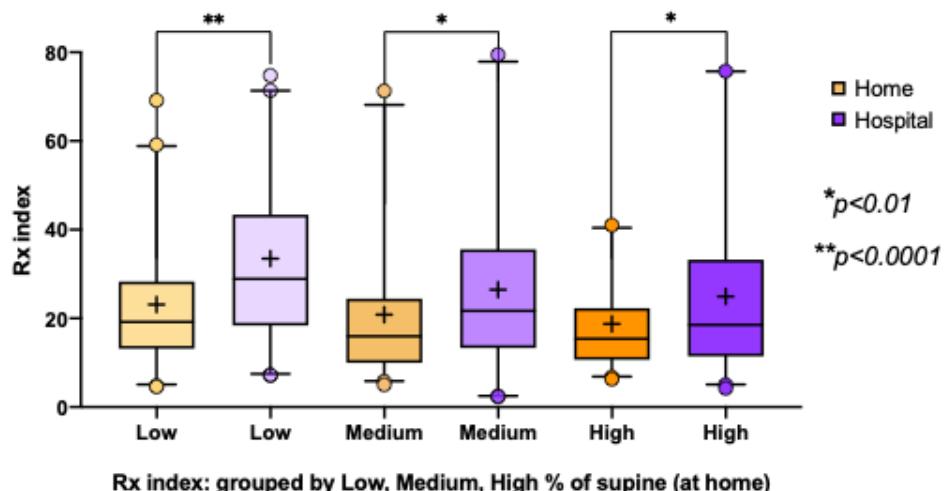
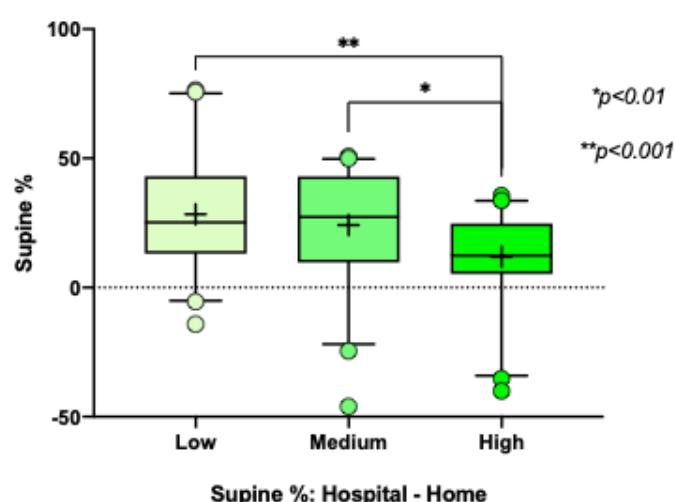
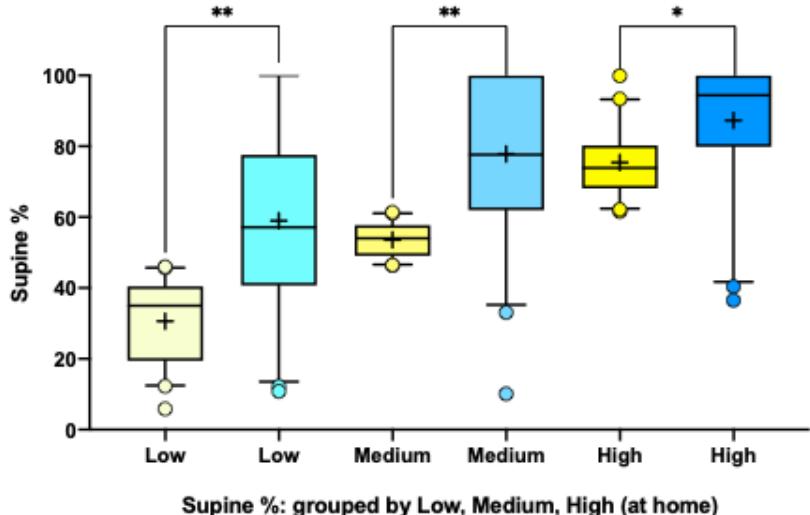
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Variables	Total n=125	In-Lab Polysomnography			Home-based Rooti Rx (Rx index)		
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Age	44.4±12.3	42.0±11.0	45.5±12.3	45.1±12.9	43.4±11.5	45.3±12.7	45.0±13.4
M/F	96/29	22/11	24/8	50/10	38/17	40/7	18/5
BMI	26.8±4.4	24.4±2.9	In-Lab PSG: Severity increased?				28.9±5.2
Neck circumference	38.5±3.5	37.0±2.5	37.6±3.6	39.9±3.4	38.1±3.3	38.3±2.9	40.1±4.6
Mean SpO₂ (%)	93.9±4.0	96.6±1.1	95.9±1.2	91.4±4.4	95.2±2.5	94.9±2.5	89.0±5.3
Lowest SpO₂ (%)	81.3±10.0	89.3±5.8	84.0±5.6	75.5±10.2	85.1±7.7	81.8±9.1	71.3±10.5
ODI	24.9±25.7	3.3±3.9	9.0±7.9	45.3±23.0	14.1±18.4	22.7±21.8	55.2±25.3
AHI	33.9±24.2	8.4±3.7	21.8±4.7	54.4±18.4	23.2±17.4	33.5±20.6	60.4±25.3
CVHRI	22.1±19.5	10.3±8.1	11.9±8.4	34.1±21.2	4.7±3.3	14.7±5.6	39.8±16.3
CEI	12.6±10.7	5.5±4.5	9.2±4.4	18.3±12.3	4.7±2.3	9.8±6.1	20.7±9.8
Rx index (CVHRI+CEI)	28.3±20.1	14.2±8.6	18.5±7.9	41.2±21.1	10.1±2.9	20.8±3.9	46.8±16.1
Supine (%)	74.6±24.1	72.5±27.0	77.6±21.1	74.1±24.1	54.6±18.8	50.7±20.8	54.0±23.0

居家穿戴裝置與醫院檢查之比較

居家穿戴裝置睡眠平躺比例(supine%)分組比對

42 → 46% ← 42 → 61.5% ← 41

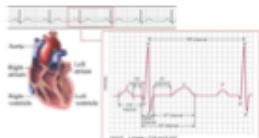
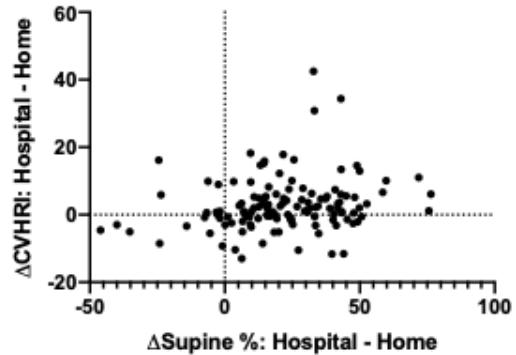


居家穿戴裝置與醫院檢查之比較

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1969 - 2019

醫院與居家平躺睡姿差異與嚴重度差異的相關性分析

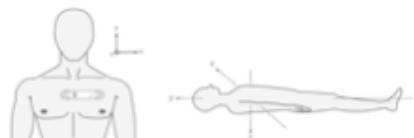
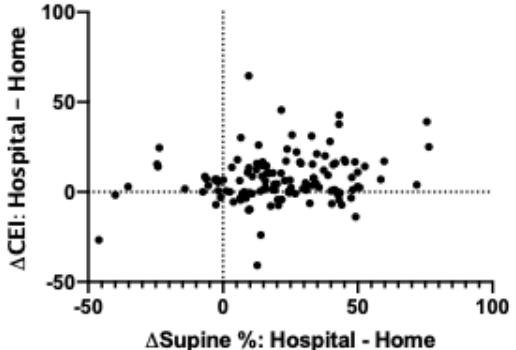
Correlation of Δ Supine% vs Δ CVHRI



Pearson correlation
95% CI: 0.02829 to 0.3655

$r = 0.2029$, $R^2 = 0.04117$
 $P = 0.0233$

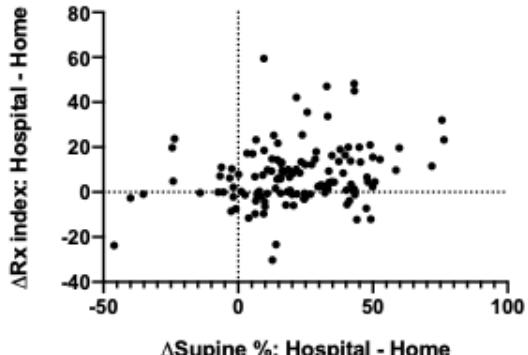
Correlation of Δ Supine% vs Δ CEI



Pearson correlation
95% CI: 0.02866 to 0.3658

$r = 0.2032$, $R^2 = 0.04131$
 $P = 0.0230$

Correlation of Δ Supine% vs Δ Rx index



Pearson correlation
95% CI: 0.07302 to 0.4037

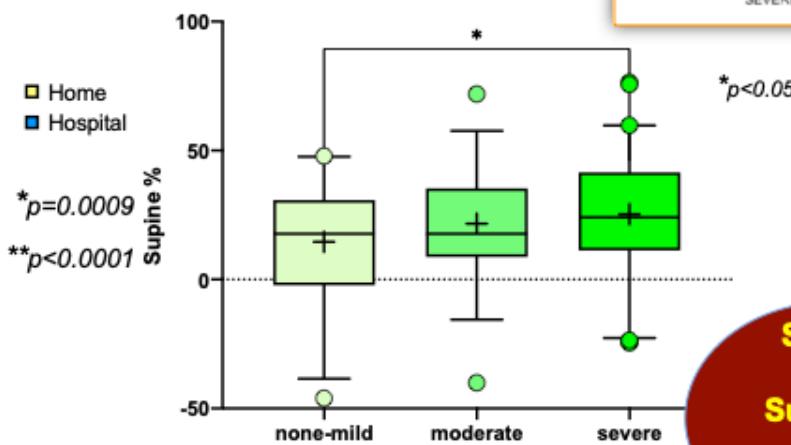
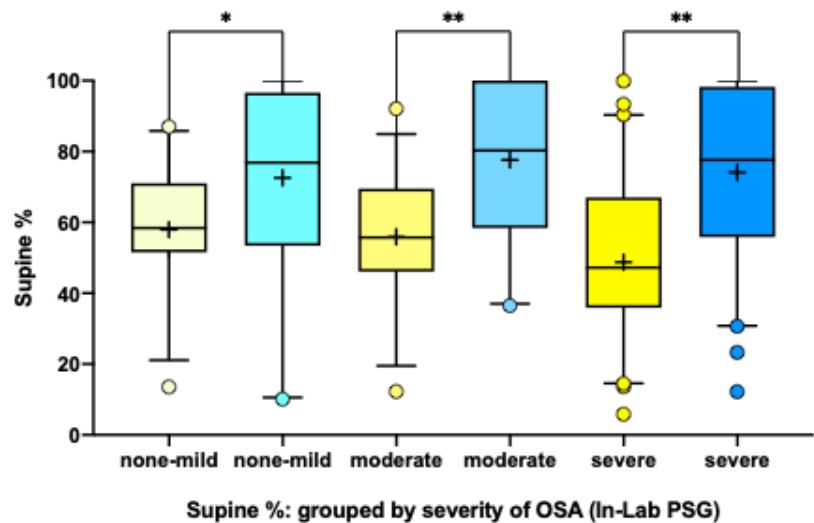
$r = 0.2455$, $R^2 = 0.06026$
 $P = 0.0058$

居家穿戴裝置與醫院檢查之比較

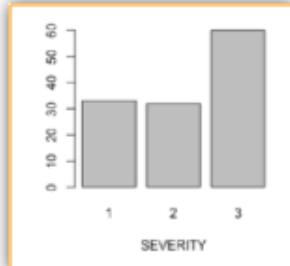
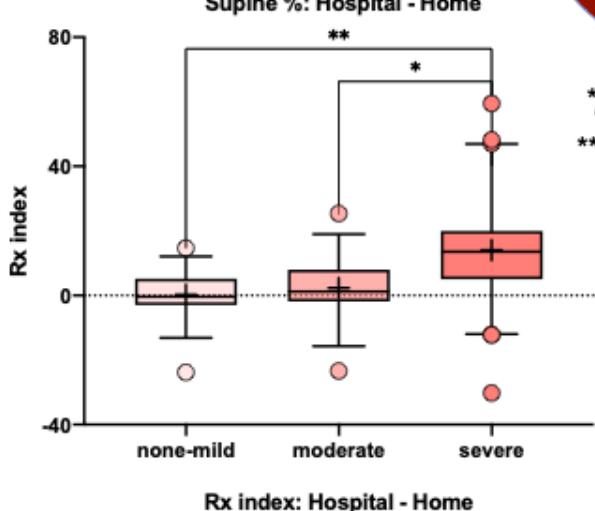
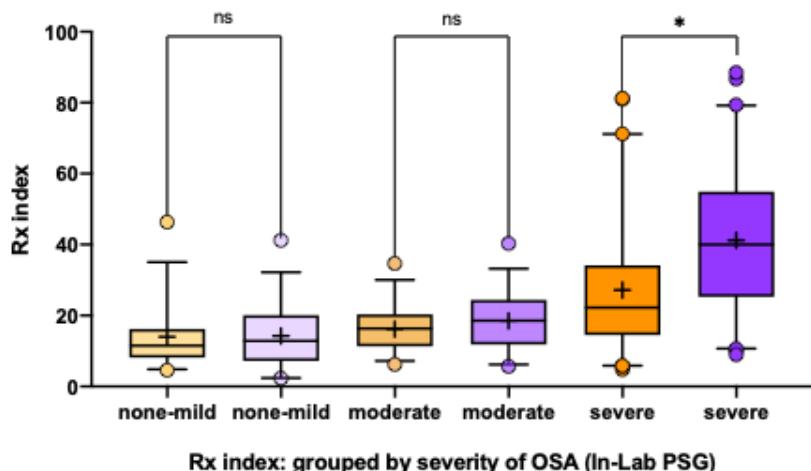
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1969 - 2019

根據睡眠呼吸中止症**嚴重度**分組比對

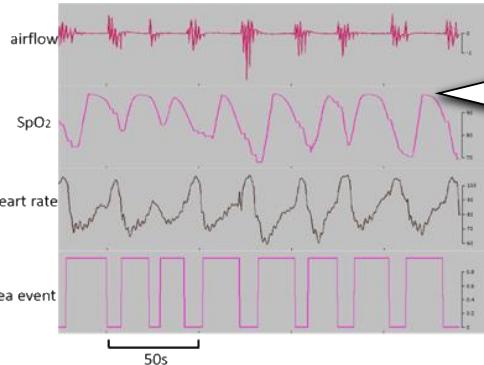
33 → **AHI=15** ← 32 → **AHI=30** ← 60



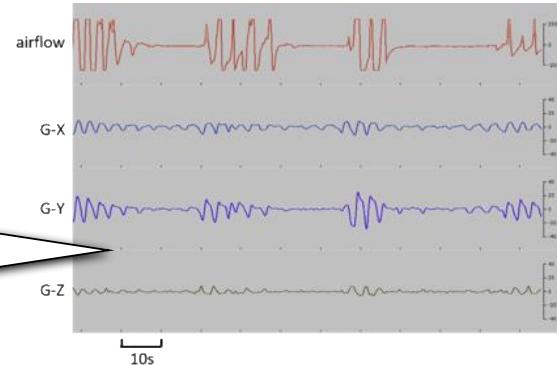
Severe OSA:
Supine ↑
Overestimated Severity



穿戴式裝置精準度vs睡姿效應

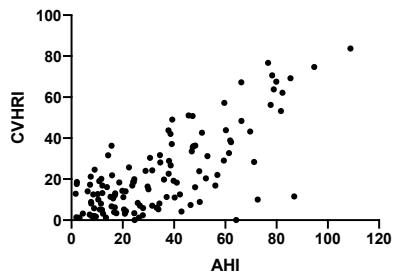


**CVHR: Cyclic Variation of Heart Rate:
Respiratory Arousal Index (RAI)**

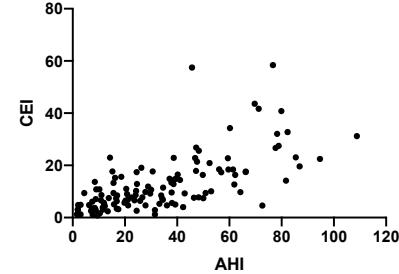


**G-sensor: Chest effort
detected by movement**

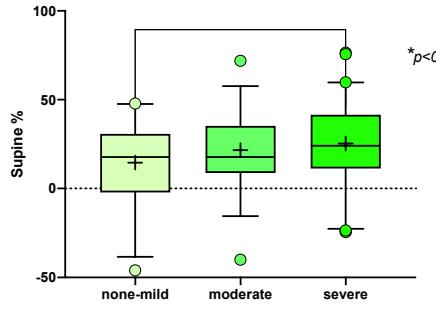
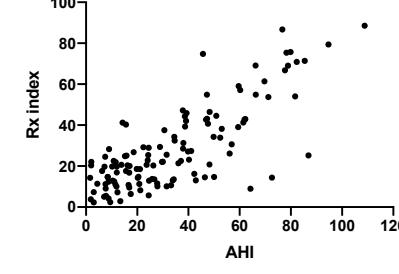
Only CVHR: $r = 0.7433, P < 0.0001$



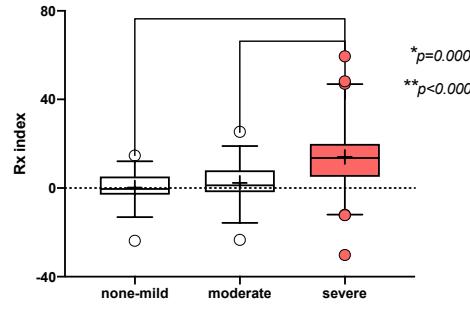
CVHR + CEI: $r = 0.7826, P < 0.0001$



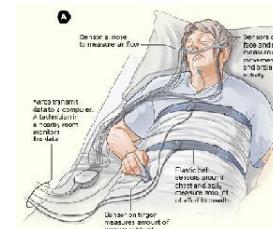
Only CEI: $r = 0.6724, P < 0.0001$



平躺比例增加



嚴重度增加



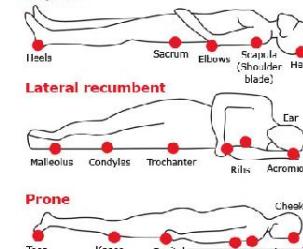
平躺為主 supine

**首次由穿戴式裝置證明：
醫院 vs 居家 檢測之睡姿不同
足以影響睡眠呼吸中止嚴重度**

**醫院端平躺
百分比較高
嚴重度增加**

**高估
低估**

**醫院端環境改變
警覺度增加
上呼吸道較不放鬆**



居家：自由翻身