Feasibility of Portable Monitoring to Detect Obstructive Sleep Apnea In-home in Adolescents: A Pilot Study

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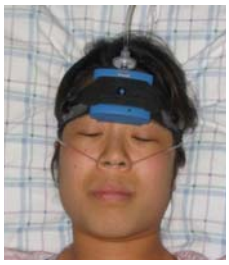
Introduction: The increasing prevalence of obstructive sleep apnea (OSA) in adolescents, due in part to the childhood obesity epidemic, will increase demand for diagnostic services. We compared detection of OSA by a portable cardiorespiratory device and concurrent lab-based polysomnography in teens with suspected OSA, followed by an assessment of the device's OSA detection accuracy in a home setting.

Methods: Thirty habitually snoring teens referred for suspected OSA [mean age 15 years (range 13-17); males=57%, minority=57%, obese=63%] were enrolled. Patients underwent a PSG concurrent with the ARES™ Unicorder (A-IL) and also wore the Unicorder for 1 or 2-nights in-home (A-IH). Portable monitoring data was lost in 2 teens due to early equipment problems. PSG-based apnea-hypopneas indices (AHI) were blindly scored using standard pediatric rules with 3% desaturation criteria for hypopnea. The ARES data were auto-scored using a stepped 3% desaturation criteria plus technical review to resolve periods with auto-detected signal quality problems.



Results: Portable monitoring data were lost in 2 patients due to early technical problems. During the concurrent session, the PSG-total sleep time and A-Lab valid recording time were 7.6 ± 1.0 and 7.6 ± 2.1 hours, respectively. For the in-home recordings, 24 of the 28 subjects wore the device for two nights, yielding mean valid recordings times of 6.6 ± 2.4 SD hours on Night-1, 6.5 ± 2.4 SD hours on Night-2 and 12.6 ± 4.2 SD hours across both nights.

The results pertaining to the quality of the Unicorder data acquired in the laboratory and at home are presented in Table 2. The percentage of excluded data reflects the difference between the total vs. valid recording times and include periods of uninterpretable data, or when the patient was upright or presumably awake. Periods with bad airflow or excluded SpO2 may have been included in the analysis based on the technician's judgment.

Table 1: Summary of Signal Quality Problem

	In-laboratory			In-home		
	% Excl. Data	% Bad Airflow	% Excl SpO2	% Exc. Data	% Bad Airflow	% Excl SpO2
Mean	5.3%	2.7%	12.0%	7.3%	8.7%	14.0%
Median	5.1%	0.0%	9.5%	6.8%	1.7%	10.7%
Std. Deviation	4.3%	4.6%	9.6%	4.6%	16.5%	8.6%
Minimum	0.0%	0.0%	1.0%	1.8%	0.0%	3.0%
Maximum	17.6%	20.0%	35.0%	20.8%	53.0%	37.4%

The relationships between the PSG vs. A-Lab and A-Home are showed correlations of 0.96 and 0.74, as presented in Figures 1.a. and 2.a. respectively. The Bland-Altman plots show little bias and relatively tight standard deviations (Figures 1.b. and 2.b.).

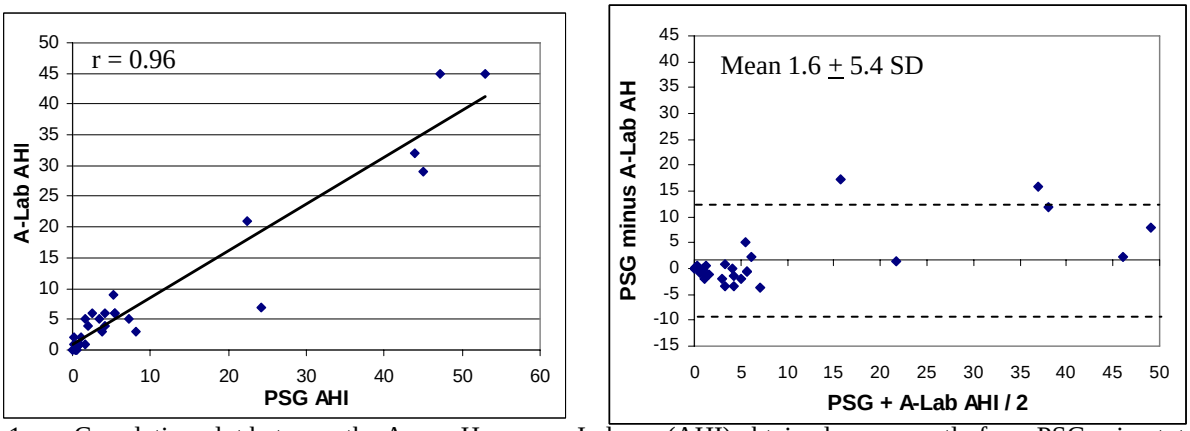


Figure 1. a. Correlation plot between the Apnea Hypopnea Indexes (AHI) obtained concurrently from PSG using total sleep time vs. a portable monitor (A-Lab) with valid recording time. b. Corresponding Bland-Altman plot of the differences in the AHIs obtained during the recording session.

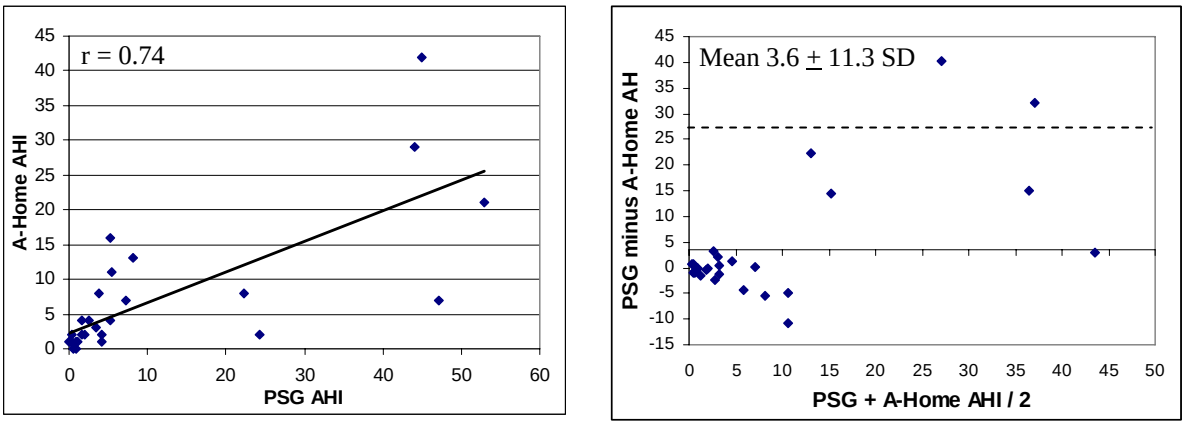


Figure 2. a. Correlation plot between the Apnea Hypopnea Indexes (AHI) obtained from PSG using total sleep time vs. in-home recordings (A-Home) with valid recording time. b. Corresponding Bland-Altman plot of the differences in the AHIs obtained during the recording sessions.

Clinical cut-off thresholds of AHI ≥2 and ≥5 were used to calculate the sensitivity, specificity and positive and negative predictive values comparing the overall PSG-AHI with the A-Lab and A-Home results. The results in Table 2 suggest fairly good concordance between the portable monitor and PSG; the PSG and A-Home agreed in 22/28 at both thresholds. Of the six that disagreed, three were clinically equivalent (PSG/A-Home: 0.4 / 2; 1.7 / 2 5.3 / 4) and two were reasonably close (PSG/A-Home: 1.6 / 4; 3.8 / 8). The one outlier with a PSG AHI of 24.3 vs. an A-home AHI of 2 had an obvious technical flaw, poor airflow quality was detected for 60% of Night 1 and over 20% of night 2; as a result of the patient failing to respond to the alarms delivered by the Unicorder. If this problem occurred during a clinical settings, the study would have been repeated.

Table 2. Comparisons between the overall AHI from PSG vs. the portable monitor

	PSG vs. A-Lab		PSG vs. A-Home	
	PSG>=2	PSG>=5	PSG>=2	PSG>=5
Sensitivity	100.0%	90.9%	94.1%	81.8%
Specificity	83.3%	76.5%	72.7%	94.1%
Neg. Predictive Value	100.0%	92.9%	88.9%	88.9%
Pos. Predictive Value	88.9%	71.4%	84.2%	90.0

Variables obtained from the ARES questionnaire and/or information obtained during the clinical consultation were evaluated for as a means to predict the PSG and A-Home AHI. The most highly correlated variables are presented in Table 3 below.

Table 3: Correlation table of clinical variables predictive of AHI

	PSG AHI	A-Home AHI		PSG AHI	A-Home AHI
BMI-Zscore	0.404	0.279	Exc. pharyngeal tissue	0.196	0.112
Snore -5 pt	0.388	0.378	Wake up Choking	0.102	0.370
Pharynx	0.377	0.472	Told stop breathing	0.098	0.348
Deviated septum	0.279	0.133	Tonsils	-0.145	-0.000
Turbinates	-0.225	-0.172	Hyponasality	-0.026	0.263

Applying the equation [*-19.522+(2.9874*BMIz)+(2.9017*Snore)+(6.9191*Pharynx)+(13.691*Deviated septum)-(2.5375*Turbinates)+(2.9818*Exc. Phar Tissue)-(0.7682*woke up choking)*], the PSG AHI was predicted. Applying a clinical cut-off > 3 events/hour to the results for the predictive equation, the sensitivity was 86.7% with a specificity of 46.2%.

Conclusions: The portable device used in this study provided similar results to PSG when worn concurrently. When used in an in-home setting, the ARES appears capable of providing information useful for a clinician to rule in- or out clinically important sleep disordered breathing in over 89% of the adolescents studied.

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