

RESEARCH ARTICLE

Feasibility and usability of three consecutive nights with self-applied, home polysomnography

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Summary

In-laboratory polysomnography, the gold-standard for diagnosing sleep disorders, is resource-demanding and not conducive to multiple night evaluations. Ambulatory polysomnography, especially when self-applied, could be a viable alternative. This study aimed to assess the feasibility and reliability of self-applied polysomnography over three consecutive nights in untrained participants, assessing: technical success rate; comparing sleep diagnostic variables from single and multiple nights; and evaluating participants' subjective experience. Data were collected from 78 participants (55.1% females) invited to test a self-applicable polysomnography device for three consecutive nights at home. The technical success rate for valid sleep recordings was 82.5% out of 234 planned study nights, with 87.2% of participants obtaining at least two valid nights. Misclassification of obstructive sleep apnea severity was higher in participants with mild OSA (21.4%) compared with those with moderate-to-severe obstructive sleep apnea or no obstructive sleep apnea. Sleep efficiency and wake after sleep onset showed improvement from Night 1 to Night 3 ($p < 0.001$), and the mean polysomnography set-up time decreased significantly over this period. Participants reported moderate-to-high satisfaction with the device (System Usability Scale score 71.2 ± 12.4). The findings suggest that self-applied polysomnography is a feasible diagnostic method for untrained individuals at risk for sleep disorders, and that multiple night assessments can improve diagnostic precision for mild obstructive sleep apnea cases.

KEYWORDS

multiple night sleep study, obstructive sleep apnea, self-applied polysomnography

1 | INTRODUCTION

Sleep is an essential function for good and sustainable health, and performing objective sleep studies is essential to diagnose sleep and

breathing disorders. The diagnosis of sleep disorders generally requires an overnight assessment of sleep and breathing. Type 1 polysomnography (PSG) is the gold-standard for these overnight studies in diagnosing sleep disorders. A type 1 PSG is an in-laboratory

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procedure, which requires a sleep technologist to set up the equipment, and monitor both the safety of the patient and the signal quality of the PSG. This is typically performed over the course of 1 night (Newell et al., 2012; Stöberl et al., 2017). The main disadvantages of this technique include limited accessibility to facilities often with long waiting times, reduced availability in rural areas, and time-consuming manual work for those attending and analysing the sleep studies. Hence, the technique is associated with overall high operating costs (Korkalainen et al., 2021). Another limitation is the single-night setting, which cannot account for the first-night effect (Tamaki et al., 2005) caused by wearing the recording device and/or a new unfamiliar environment. Finally, the spontaneous night-to-night variability (Korkalainen et al., 2021; Roeder et al., 2020) of sleep may induce misclassification of sleep quality and respiration during sleep (Korkalainen et al., 2021; Newell et al., 2012). Diagnostic evaluation over several nights is likely to provide better diagnostic accuracy, and enable additional information to generate individualized diagnosis and treatment recommendations (Newell et al., 2012).

One of the most common sleep disorders is obstructive sleep apnea (OSA) characterized by sleep-related partial or complete obstruction of the upper airway (Heinzer et al., 2015; Roeder et al., 2020; Sateia, 2014; Senaratna et al., 2017). OSA is conventionally diagnosed by an overnight sleep study to quantify the apnea-hypopnea index (AHI). The AHI summarizes the number of respiratory events per hour of sleep. Normal respiration during sleep is characterized by an AHI of < 5 events per hr. The night-to-night variability in OSA severity is significant in mild to moderate AHI event frequency (Le Bon et al., 2000), which may affect the clinical diagnosis and treatment recommendation. Repeated sleep studies on the same patients could mitigate both these problems (Meyer et al., 1993; Newell et al., 2012; Stöberl et al., 2017).

To overcome the problem of limited accuracy in single-night studies and the increasing costs of multiple in-lab PSG studies, we suggest self-applied PSG at home for multiple nights that could provide a new strategy in the context of both sleep medicine and sleep research. In fact, the individual suffering from misclassification of sleep disorders, like OSA, is significant as it has a bearing on the societal costs for both under-diagnosed as well as over-diagnosed OSA (Punjabi et al., 2022; Alakörkkö et al., 2023; Kapur et al., 1999; Punjabi et al., 2020).

In the current study, we aimed to analyse the feasibility of self-applied PSG by evaluating the quantity of valid nights, the night-to-night variability of sleep parameters, and the usability and user experience with the application of the equipment in a mixed cohort of untrained participants. We hypothesized that 3 nights of self-applied PSG is feasible to perform, and provides clinical useful information to identify normal sleep versus sleep disorders.

2 | METHODS

A total of 78 participants took part in the study in two distinct phases. Phase 1 included volunteers from Reykjavik University ($n = 17$), and Phase 2 included individuals from the general population who

responded to an online survey ($n = 80$). All participants signed an informed consent form, and the study was approved by the National Bioethics Committee and the Data Protection Authority of Iceland (VSN number 21-070). From the second cohort, 16 individuals withdrew before the study started, and three participants withdrew after signing the consent form and receiving the sleep diagnostic device.

2.1 | Study procedure

The participants completed an online screening questionnaire, including questions regarding their general state of health, lifestyle habits, comorbidities (e.g. heart conditions, hypothyroidism, high blood pressure, fibromyalgia, asthma, psoriatic arthritis, attention-deficit hyperactivity disorder, reflux), medications, habitual sleep habits, and subjective quality of sleep; none of these conditions was used as excluding criteria for the present study. Comorbidities were collected for demographic information and possible upcoming studies but not used in the current analysis. Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tool hosted at Reykjavik University (Harris et al., 2009; Harris et al., 2019).

In Phase 1, participants were asked to use a PSG device (A1, Nox Medical, Reykjavik, Iceland) set up as Self-Applied Somnography (SAS) for three consecutive nights (Figure 1). The device was set on auto-start, recording for 10 consecutive hours between 23:00 hours and 09:00 hours. Given the limited memory capacity of this A1 device version, participants were asked to return the device every morning to allow for download and new settings for the subsequent night.

In Phase 2, participants used a newer PSG device of the same type (A1S Nox Medical, Reykjavik, Iceland) that allowed recording of three consecutive nights of SAS without intermittent downloading. Recording times were set to 11 h between 22:30 and 09:30 (between Thursday evening and Monday morning) allowing for prolonged weekend sleep or 10 h between 22:00 and 08:00 during weekdays (Monday evening and Thursday morning). The devices automatically started and stopped recording depending on the above-mentioned time windows. For Phase 2, a mixture of healthy sleepers and sleepers reporting OSA symptoms, insomnia or restless leg syndrome symptoms were invited to participate.

2.2 | Self-applied PSG

The SAS (Figure 1) consisted of four electrodes for frontal electroencephalography (EEG), four electrodes for electrooculography, a reference electrode and a ground electrode, four electrodes for electrocardiography, and four electrodes for electromyography (EMG; two for each leg; Rusanen et al., 2024). As shown in detail in the supplemental material (Figure S1), respiration is captured by nasal cannula for airflow and two respiratory inductance plethysmography belts for respiratory movements of the thorax and abdomen. Oxygen saturation and pulse rate were measured using a finger pulse oximeter,



FIGURE 1 Self-applied polysomnography (PSG) as set in the study protocol.

whereas body position/movements and audio were recorded through an accelerometer and an integrated microphone in the hardware box, respectively.

Information related to the set-up of the PSG equipment was provided with written instructions, including figures and schemes as well as by an instruction video (lasting approximately 9 min, published on YouTube, accessible at any time and as many times as necessary via QR code or URL; Nox Medical, 2022). To test the usability of the device for self-application by the study participants, no additional instructions were provided by the research staff on how to set up the device.

2.3 | Analysis of sleep data

The scoring of the PSGs (sleep stages, arousals, breathing, etc.) was conducted according to the American Academy of Sleep Medicine (AASM) manual, Version 2.6 (Berry et al., 2017). Automatic analysis from Noxturnal version 6.2.2 was used before manual review. The

following changes to the scoring rules deviating from the AASM manual were made based on the results of a previous validation study (Rusanen et al., 2024).

- The low-pass filter setting for EEG was changed from 0.3 to 0.5 Hz.
- The peak-to-peak amplitude of the slow-wave activity was changed from 75 to 45 μ V.
- Rapid eye movement (REM) rules that refer to chin tone were invalid due to the lack of chin EMG. EMG frontalis was used to score arousals in line with the AASM scoring rules.

2.4 | Symptom assessment and evaluation of feasibility

Participants received a morning questionnaire to assess the following: their perceived quality of sleep; whether and which cables/sensors had disturbed their sleep; how long the set-up lasted; if any part loosened during the night; and if they had any allergic reactions or skin irritation.

The System Usability Scale (SUS; Brooke, 1996) and AttrakDiff (Hassenzahl et al., 2003) questionnaires were collected at baseline or at follow-up visit. SUS was used to assess device usability, while AttrakDiff was used to assess the user experience. To permit a better recall of the equipment, participants had the opportunity to re-observe the full set-up equipment on a mannequin while answering the questionnaires. In the SUS, a usability score above 68 is considered an above average positive evaluation of a product's usability (Klug, 2017; Sauro & Lewis, 2016). The combination of SUS and AttrakDiff is common practice, as usability and user experience outline different elements of feasibility (Schmitz et al., 2022). For the AttrakDiff questionnaire, the mean value of the items for each subscale was calculated as well as for each subscale. A full description of the SUS and the AttrakDiff is provided in the supplemental material.

2.5 | Statistics

Descriptive data are presented as mean $\pm$ standard deviation or as distribution (percentage). For *t*-test, one-way ANOVA and repeated-measures ANOVA (used for normally distributed data while comparing the subgroup of participants with all valid nights), a *p*-value < 0.05 was considered as a statistically significant difference; same statistical significance for the non-parametric test (Kruskal–Wallis test). For categorical variables we used the chi-squared test with statistically significant difference while *p* < 0.05 . Sensitivity, specificity, positive and negative predictive value (PPV/NPV) were calculated according to the Trevethan (Alford et al., 2017) guidelines only for those individuals with three completed nights. We divided the group with the following classification: AHI < 5 for healthy participants; AHI 5–14.9 for mild OSA; and AHI ≥ 15 for moderate-to-severe OSA.

In participants with three valid nights with measurements, one-way repeated-measure ANOVA was used to test the within-participant variation.

For the calculation of diagnostic reliability, a reference AHI was calculated as the mean AHI value over 3 nights ($N = 47$ participants with three valid nights). Variations between each single night and reference value are shown using Bland-Altman plots. Further, night-to-night variability was quantified using the interclass correlation coefficient (ICC: derived using “interclass_corr” function from Pingouin statistical package for Python) as a measure of reliability, following guidelines from Koo and Li (2016). ICC has been calculated only within the group of participants that performed three valid sleep studies. In addition, we assessed the percentage of participants who changed OSA categories (no/mild/moderate-to-severe OSA) between nights. Finally, the mean value of 3 nights was compared with each single-night value. We categorized OSA severity as healthy ($AHI < 5$), mild ($AHI 5-14.9$) and moderate/severe ($AHI \geq 15$). Statistical analyses were conducted using Python 3.10.2 (Van Rossum & Drake, 2009). For AttrakDiff and SUS, the scoring was calculated according to the standard operating procedures.

3 | RESULTS

In total, data collection for 234 nights was planned (78 participants for 3 nights). Of these, we had 193 (82.5%) valid nights, 40 (17.5%) invalid nights, and 1 (0.4%) night in which the participant did not apply the device. Altogether, 60.3% of participants had three valid nights, 26.9% had two valid nights, and 12.8% had one valid night (Figure 2). Also, a total of 85.9% of participants had a successful recording on the first night, showing a 14.1% failure rate in the case of a

single-night assessment. Out of 78 participants, only one participant did not use the equipment for 1 night out of three. Anthropometric and clinical data for the study participants based on the number of valid nights of PSG are presented in Table 1. No significant differences were found between the groups in any of the anthropometric or clinical variables assessed. However, the participants with only one valid night tended to be more obese, but did not differ significantly from other study participants.

3.1 | Night-to-night variability

Sleep efficiency increased from Night 1 to Night 3 (83.2 ± 9.3 , 84.5 ± 10.7 and $89.2 \pm 8.2\%$, respectively, $p = 0.001$) in participants with three valid nights. WASO also decreased significantly throughout the 3 nights (73.0 ± 52.4 , 73.1 ± 62.2 and 40.1 ± 35.3 min, respectively, $p < 0.001$). No other significant night-to-night variability was found between the 3 nights of participants on average, including OSA severity.

Further analysis has been conducted to investigate differences between studies performed during weekdays (111 nights) and weekends (30 nights). Weekend nights were defined as: sleep studies performed in the nights between Friday and Saturday, and between Saturday and Sunday. After log transformation for non-normally distributed data, a two-way ANOVA has been performed to evaluate the effect of weekday versus weekend as well as night 1-3 differences: significant differences were observed for sleep efficiency ($p = 0.01$) and WASO ($p = 0.03$). Specifically, it was observed that sleep efficiency decreases in observations made during weekends (83.67 ± 10.83) compared with working days (87.90 ± 8.03), and WASO also increased during weekends (78.43 ± 69.41) compared with working

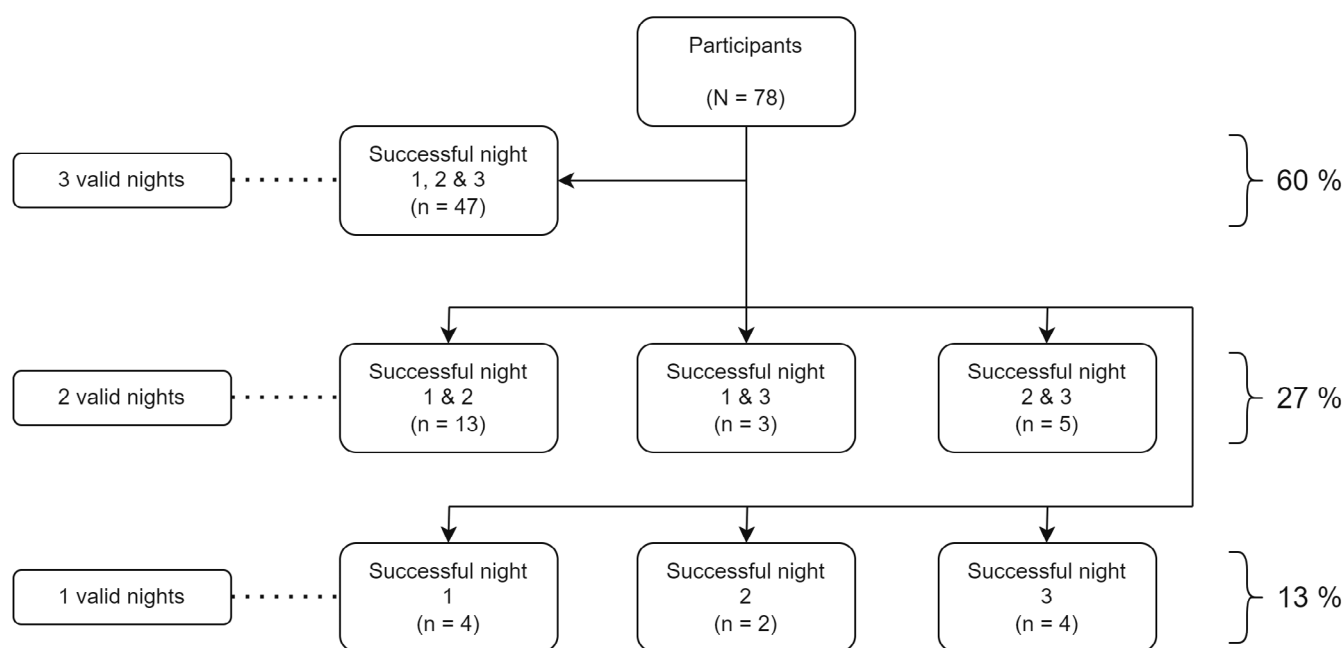


FIGURE 2 Flowchart showing number of participants for each possible permutation of valid nights.

TABLE 1 Anthropometric and clinical data.

	All participants	Participants with 3 valid nights (group 1)	Participants with 2 valid nights (group 2)	Participants with 1 valid night (group 3)	Between group difference (p-value)
N	78	47	21	10	
Age, years	43 (± 16)	42 (± 14)	43 (± 17)	51 (± 19)	0.230
Body mass index, kg m ⁻²	28.0 (± 5.0)	26.8 (± 4.6)	29.0 (± 4.2)	30.4 (± 6.6)	0.085
Female	43 (55.1%)	27 (57.4%)	11 (52.4%)	5 (50.0%)	0.965
Alcohol user	41 (52.6%)	23 (48.9%)	12 (57.1%)	6 (60.0%)	0.886
Current smoker	13 (16.7%)	5 (10.6%)	5 (23.8%)	3 (30.0%)	0.350
Regular intake of sleep aids	9 (11.5%)	5 (10.6%)	3 (14.3%)	1 (10.0%)	0.794
Known comorbidities	14 (17.9%)	9 (19.1%)	2 (9.5%)	3 (30.0%)	0.563

Shown are mean and SD for continuous as well as numbers and percentages for categorical variables. Sleep and breathing data are presented in Table 2. No differences were found in OSA severity between participants with respect to the number of valid nights. Poor sleep quality, evidenced by lower sleep efficiency ($p < 0.001$) and higher amount of wakefulness during sleep (WASO, $p < 0.001$), were more frequently identified in participants with only one valid night compared with those with three valid nights. No differences were found for sleep stage distribution, arousal indices, or OSA severity as assessed by the AHI and oxygen desaturation index (ODI).

TABLE 2 Sleep data shown are mean and SD.

	All participants	Participants with 3 valid nights (group 1)	Participants with 2 valid nights (group 2)	Participants with 1 valid night (group 3)	p-Value comparison between nights (all participants)
N	78	47	21	10	78
Sleep variables mean values (SD)					
Total sleep time (min)	382 (± 68)	388 (± 68)	365 (± 68)	369 (± 65)	0.573
Sleep efficiency	88.0* [79.0; 93.7]	89.3* [81.7; 94.3]	85.7 [74.2; 91.2]	81.7 [76.8; 87.6]	< 0.001
N1%	6.7* [6.70; 9.60]	6.6* [4.6; 9.4]	6.7* [4.8; 12.5]	7.35* [6.0; 11.2]	0.37
N2%	45.9* [40.0; 51.1]	46.7 [40.4; 52.3]	43.0 [38.5; 48.3]	46.3 [41.8; 49.0]	0.95
N3%	22.8* [16.7; 30.4]	22.1* [16.9; 28.7]	26.9 [15.9; 34.6]	22.2 [13.6; 31.9]	0.72
REM %	22.6* [17.7; 25.4]	23.10 [18.8; 25.4]	20.8 [16.4; 24.9]	4.6* [13.43; 26.6]	0.28
WASO (min)	49.5* [20.1; 87.0]	40.9* [18.0; 81.5]	62.25* [29.2; 103.3]	77.9 [44.9; 109.6]	< 0.001
Arousal index (n per hr)	12.2* [9.4; 15.4]	12.1* [9.1; 15.0]	12.4* [11.0; 15.4]	14.6* [11.8; 16.9]	0.46
OSA variables mean values (SD)					
AHI (n per hr)	5.7* [2.4; 15.3]	4.7* [2.2; 12.5]	10.15* [3.9; 19.0]	12.7 [5.2; 28.8]	0.98
ODI (n per hr)	4.7* [2.0; 13.1]	3.9* [1.8; 12.5]	9.55* [3.0; 17.1]	13.9* [4.32; 22.0]	0.96

Note: For variables that are non-normally distributed, data are presented in the table as median and interquartile range (IQR). Sleep stages are expressed as percentage of total sleep time.

Abbreviations: AHI, apnea-hypopnea index; N1, sleep stage 1; N2, sleep stage 2; N3, sleep Stage 3; ODI, oxygen desaturation index; OSA, obstructive sleep apnea; REM, rapid eye movement sleep; WASO, wake after sleep onset.

*Non-normally distributed data.

TABLE 3 OSA severity comparing the reference AHI (mean of the 3 nights) with each night AHI.

	Reference AHI (n per hr)		
	< 5.0 (n = 24)	5.0–14.9 (n = 14)	≥ 15.0 (n = 9)
Night 1			
< 5.0	23 (95.8%)	1 (7.1%)	0
5.0–14.9	1 (4.2%)	11 (78.6%)	0
≥ 15.0	0	2 (14.3%)	9 (100%)
Night 2			
< 5.0	22 (91.7%)	2 (14.3%)	0
5.0–14.9	2 (8.3%)	11 (78.6%)	1 (11.1%)
≥ 15.0	0	1 (7.1%)	8 (88.9%)
Night 3			
< 5.0	24 (100%)	0	0
5.0–14.9	0	13 (92.9%)	1 (11.1%)
≥ 15.0	0	1 (7.1%)	8 (88.9%)

Abbreviation: AHI, apnea-hypopnea index.

days (51.42 ± 43.15). Improved sleep efficiency and decreased WASO were still found for nights 1–3, after adjusting for the week day versus weekend differences in this analysis.

3.2 | OSA severity classification

The ICC showed a very high reliability for both AHI (ICC = 0.94) and ODI (ICC = 0.95), with a reference range between 0.90 and 1.00 for excellent reliability for 1 night versus 3 nights PSG.

The agreement between a single-night AHI and reference AHI (mean of 3 nights) is shown in Table 3, and the Bland–Altman plots in Figure 3. A higher disagreement in 21.4% of individuals, both in the first and second nights, can be found in participants with mild OSA; with a single night either estimating their OSA severity as normal, or in the moderate-to-severe OSA range. This number is markedly higher than the maximum of 8.3% of the healthy participants and 11.1% of the moderate-to-severe OSA participants being misclassified by a single night.

Similar to the ICC, sensitivity and specificity for the detection of OSA (AHI cut-off 5 events per hr) were 96.7%, and 95.8%, for the first night with a PPV of 95.7% and a NPV 95.8%. Corresponding results for the second night were sensitivity 91.3%, specificity 91.7%, PPV 91.3% and NPV 91.7%. For Night 3, sensitivity, specificity, PPV and NPV were all 100%.

3.3 | Usability and user experience

The mean SUS score was 71.2 ± 12.4 , ranging between 45.0 and 97.5 ($N = 62$, 80% response rate). The mean value was above the cut-off of 68, indicating an overall positive usability evaluation. On average

for AttrakDiff subscales, perceived Pragmatic Quality was 0.51, perceived Hedonic Quality-Identification 0.45, perceived Hedonic Quality-Stimulation 0.35 and Attractiveness 0.30. The highest score was for Pragmatic Quality assessing if the participants rated the device as task oriented. The attractiveness subscale, indicating if the device is considered to be more technical or attractive for participants, had the lowest score.

Age or gender did not influence the subjective ratings of the PSG set-up for either SUS or AttrakDiff. AttrakDiff scores did not differ significantly between participants with all three or fewer valid nights, but a tendency for a lower score was found for participants with only one valid night (Figure 4).

3.4 | Set-up time and subjective sleep quality

Participants self-reported time for PSG set-up decreased significantly from Night 1 to Night 3 ($p < 0.001$; Figure 5).

4 | DISCUSSION

Our study demonstrated that self-applied PSG in participants, not previously exposed to a sleep study, was feasible to perform for the majority of participants, as 87% of them were able to collect multiple (at least two) nights and all of them managed to perform at least one successful diagnostic night with PSG. All participants who attempted to set up the equipment had at least one valid night for clinical evaluation and diagnosis. The multiple-night setting identified mild OSA as an important target for multiple nights to avoid more than 20% misclassification of OSA severity during a single-night diagnostic recording. Furthermore, sleep quality, exemplified for measures of sleep continuity (sleep efficiency and WASO), improved significantly between nights, showing that multiple-night recordings will provide a better diagnostic precision for habitual sleep assessment. Finally, the technology was perceived as adequate, easy-to-use and user-friendly by most participants.

Simplified self-applied home sleep apnea testing (HSAT) without EEG has been used for decades. HSAT for suspected OSA is a clinical routine in many countries, and its usage continues to increase in Europe and elsewhere. The use of HSAT without EEG has been described as time and resource saving, increasing the availability of sleep services and the reasonable precision for the diagnosis of moderate-to-severe OSA in the majority of patients; in particular, in the absence of more significant cardiometabolic comorbidities. However, diagnostic accuracy with HSAT without EEG is low, compared with PSG (Escourrou et al., 2015). The reason for this is two-fold: (1) hypopneas linked to an arousal without oxygen desaturation are only identified by PSG; (2) PSGs provide the total sleep time and not the recording time as the nominator for the AHI (Escourrou et al., 2015). Thereby, HSAT underestimates the true AHI significantly during nights with low sleep efficacy. So, HSAT without EEG has significant limitations besides the cost saving and

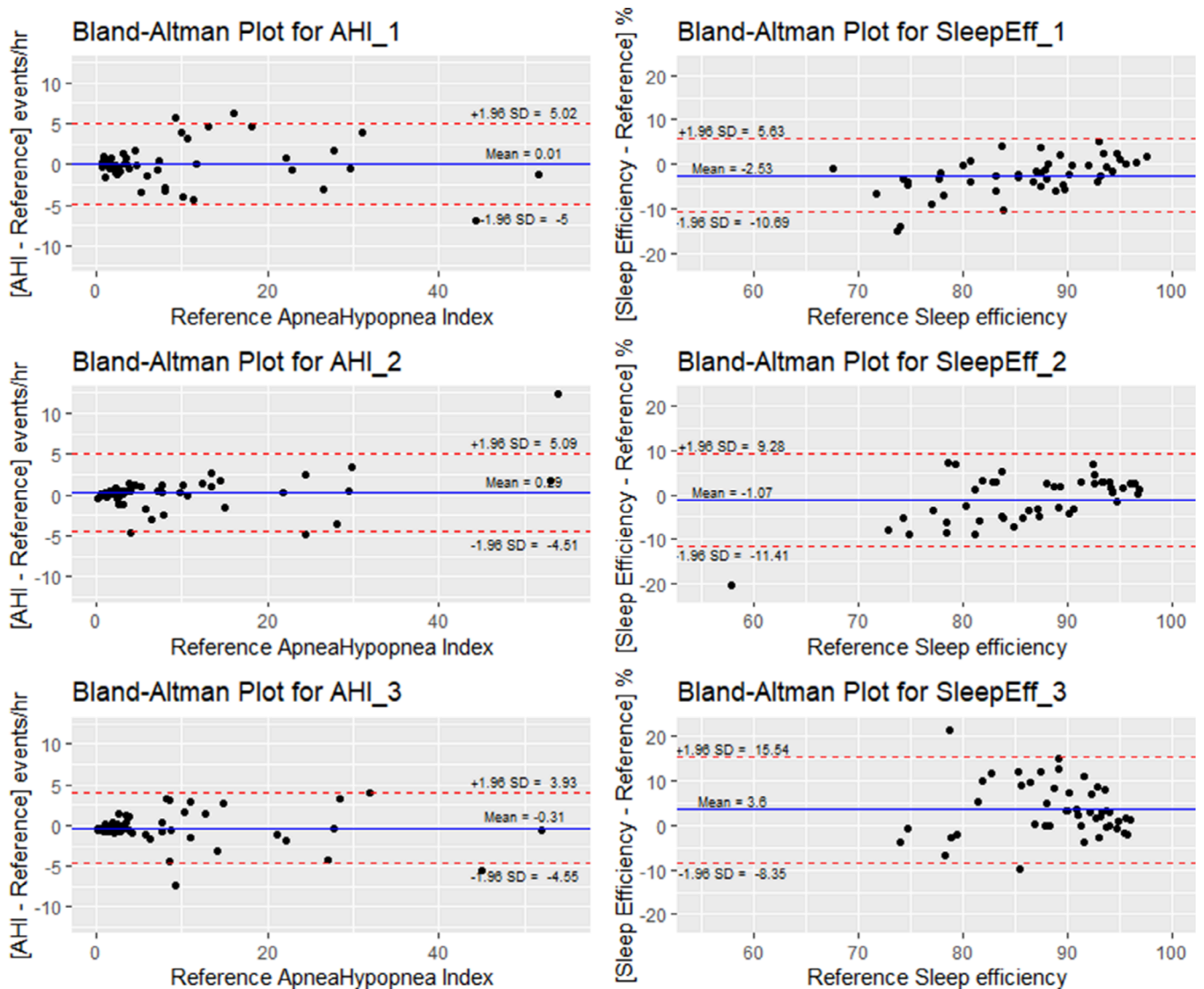
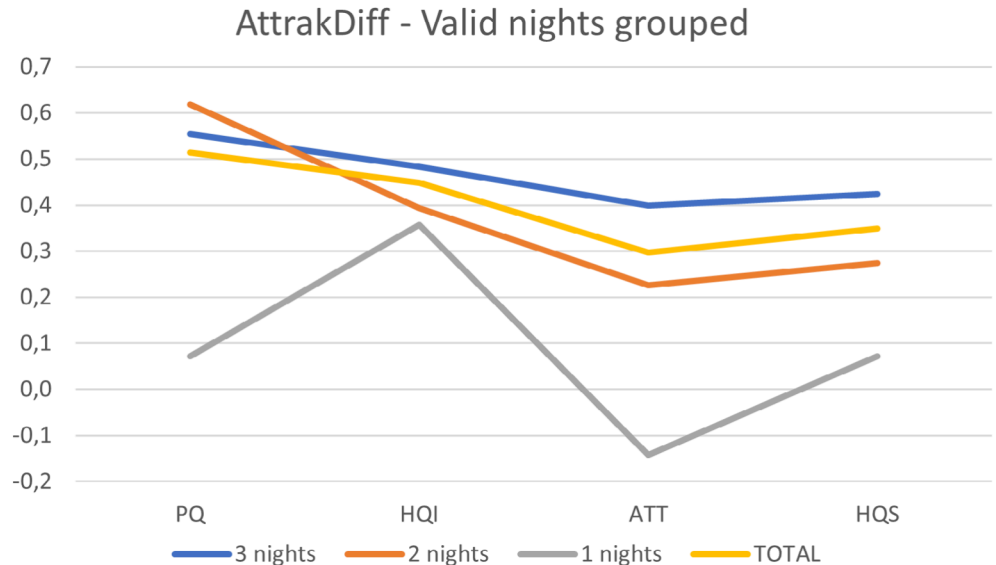


FIGURE 3 Bland-Altman plots of AHI (left) and Sleep Efficiency (right) for three consecutive nights of sleep study. AHI, apnea-hypopnea index.

FIGURE 4 AttrakDiff subscales scores for participants based on their number of valid polysomnography (PSG) nights. ATT, attractiveness; HQI, perceived hedonic quality-identification; HQS, perceived hedonic quality-stimulation; PQ, perceived pragmatic quality.



Self-applied somnography: time to setup

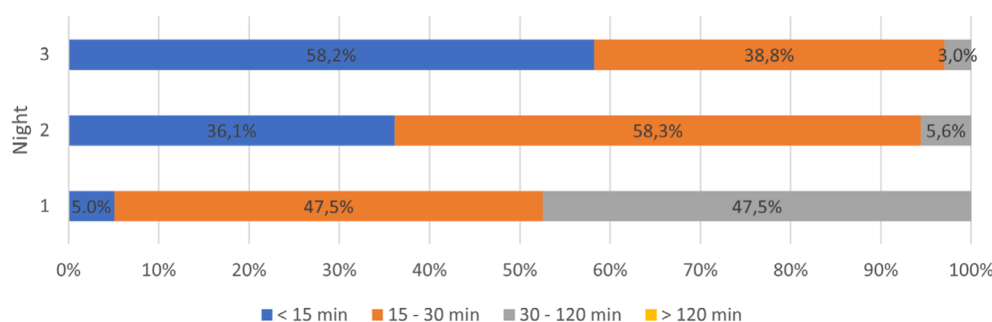


FIGURE 5 Time to set up the self-applied polysomnography (PSG).

the increased availability, especially for patients with mild-to-moderate OSA.

Other sleep disorders that require PSG assessment may also benefit from self-applied PSG. These include, for example, hypersomnias, sleep-related arousal disorders, motor disorders and treatment-resistant insomnia (Riemann et al., 2023). Currently, PSG availability is limited and waiting lists are very long in many clinical settings in Europe and worldwide. Therefore, previous clinical and research studies have used ambulatory PSG settings already in the 1990s, but the clinical feasibility and patient acceptance was generally low due to high labour costs for the sleep centre personnel and the high demand for technical skills by the patients at that time. Newer studies show more promising results for ambulatory PSGs. Punjabi et al. (2020) showed that self-applied PSG for 1 night had a reasonable feasibility and study data quality. Technical failure rate was 15.9% for the first attempt of self-application. This is similar to the results of the current study (14.9% for Night 1). However, in the Punjabi et al. study, significant staff time was used to explain the self-applied PSG hook up as well as any troubleshooting during the study night. In our study, we had a similar failure rate despite not performing these labour-intensive steps. Importantly, the technical failure rate of our study is consistent when compared with reported data from previous studies where home PSG was set-up by clinical personnel and resulted in a 4%–20% (Bruyneel & Ninane, 2014; Zancanella et al., 2022) failure rate. Thereby, our setting is more cost-efficient due to the self-application of the PSG equipment.

The main strengths of this study include the population studied with a wide distribution in terms of age, gender and body mass index, as well as the inclusion of healthy sleepers and sleepers with symptoms of OSA, insomnia and restless legs syndrome. Moreover, we excluded the inter-scorer variability by having one well-trained, sleep-scoring expert for the entire dataset. Another important aspect in our study is the systematic evaluation of acceptance of the new sleep diagnostic technology by the participants. We used well-established tools for the evaluation of this important aspect (SUS and AttrakDiff), and those showed general positive feedback for both the aspects. We also identified no specific gender- or age-related difference in the participant feedback about the technical experience with the device. Despite the limited number of participants studied, our data indicate that self-applied PSG over several nights may be suitable for a broad

range of participants in the future, both in clinical care and in research.

Several study limitations also need to be addressed. First, the Phase 1 recruitment consisted of university volunteers, and Phase 2 by interested volunteers with and without sleep complaints. It remains unknown if this procedure might have entered a bias in our data as the participants were not fully representative of a typical sleep clinical cohort. The second weakness is the limited number of participants in this study, which offered limited statistical power for subgroup analysis. Indeed, our study did not allow properly to adjust the data for demographical or lifestyle data such as the proportion of active smokers for each subgroup. Another limitation includes the lack of data for intra-scorer variability in sleep studies analysis.

Future studies need to evaluate the use of self-applied PSG over several nights in the setting of a representative clinical cohort of patients with suspected OSA and other sleep disorders, preferably in multi-centric settings involving patients from different countries, languages and socio-economic backgrounds.

5 | CONCLUSION

In conclusion, our study results show that the highest diagnostic standards in sleep medicine (PSG) are conceptually ready to move from hospital-based sleep centres into patient homes, as the majority of previously untrained participants can easily and safely use home PSGs. This pathway using self-applied technology for overnight EEG recordings allows data collection with a low failure rate similar to studies requiring intervention with trained personnel. Thereby, diagnostic accuracy can be increased in multiple-night assessments, and future evaluations need to analyse if this new approach significantly reduces costs.

AUTHOR CONTRIBUTIONS

Dimitri Ferretti: Investigation; writing – original draft; writing – review and editing; formal analysis; visualization. **Anna S. Islind:** Software; data curation; resources; writing – review and editing; conceptualization; funding acquisition. **Kristín A. Ólafsdóttir:** Investigation; validation; writing – review and editing; data curation; funding acquisition. **Sigríður Sigurdardóttir:** Writing – review and

editing; data curation; investigation; validation. **Kamilla R. Jóhannsdóttir:** Visualization; writing – review and editing; supervision. **Jan Hedner:** Supervision; writing – review and editing; funding acquisition. **Ludger Grote:** Writing – review and editing; supervision; visualization; funding acquisition. **Erna Sif Arnardóttir:** Writing – original draft; writing – review and editing; funding acquisition; conceptualization; methodology; project administration; supervision; resources; visualization; investigation.

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CONFLICT OF INTEREST STATEMENT

Dimitri Ferretti, Anna Sigríður Islind, Kristín Anna Ólafsdóttir, Sigríður Sigurðardóttir and Kamilla Rún Jóhannsdóttir declare no conflict of interest. Ludger Grote declares no conflict of interest directly linked to the content of the current study. Outside the current work, Ludger Grote has received personal fees for lecturing for Astra Zeneca, Lundbeck, and Resmed. Ludger Grote provided scientific advice to Onera (sleep diagnostic equipment). Ludger Grote is co-owner of a licensed patent to Desitin (pharmacological treatment of sleep apnea). Jan Hedner reports fees for lectures from Somnomed and Desitin outside the current study. Erna Sif Arnardóttir reports honoraria from Nox Medical, ResMed, Jazz Pharmaceuticals, Linde Healthcare, Wink Sleep, Apnimed and Vistor, and she is a member of the Philips Medical Advisory Board, all unrelated to the contents of the paper.

DATA AVAILABILITY STATEMENT

The data includes sensitive medical information and therefore is not made publicly available.

PATIENT CONSENT STATEMENT

All participants signed an informed consent form, and the study was approved by the National Bioethics Committee and the Data Protection Authority of Iceland (VSN number 21-070).

PERMISSION TO REPRODUCE MATERIAL FROM OTHER SOURCES

Material presented in the main text is original.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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