

Comparative Assessment of Obstructive Sleep Apnea Using a Multisensor Smartwatch and Polysomnography

Dr. Vishal Srivastava^{1*}, Dr. Devendra Chopra^{2*}, Dr. Abhishek Gaur³, Dr. Saurvi Niranjan⁴, Dr. Abhishek Kumar Katiyar⁵, Dr. Jyoti Bajpai⁶, Dr. Suryakant⁷

¹JR 3, Department of Prosthodontics and Crown & Bridge, Saraswati Dental College and Hospital, Lucknow, Uttar Pradesh, India

²*Professor & HOD, Department of Prosthodontics and Crown & Bridge, Saraswati Dental College and Hospital, Lucknow, Uttar Pradesh, India

³Professor, Department of Prosthodontics and Crown & Bridge, Saraswati Dental College and Hospital, Lucknow, Uttar Pradesh, India

⁴Senior Lecturer, Department of Prosthodontics and Crown & Bridge, Saraswati Dental College and Hospital, Lucknow, Uttar Pradesh, India

⁵Reader, Department of Prosthodontics and Crown & Bridge, Career Post Graduate Institute of Dental Sciences & Hospital, Lucknow, Uttar Pradesh, India

⁶Assistant Professor, Department of Respiratory Medicine, King George's Medical University, Lucknow, Uttar Pradesh, India

⁷Professor & HOD, Department of Respiratory Medicine, King George's Medical University, Lucknow, Uttar Pradesh, India

***Corresponding Author:** Dr. Devendra Chopra

Professor & HOD, Department of Prosthodontics and Crown & Bridge, Saraswati Dental College and Hospital, Lucknow, Uttar Pradesh, India, Email ID: drdevendra45@gmail.com

Abstract

Aim: To assess Obstructive Sleep apnea using a multisensor smart watch and Polysomnography

Methodology: A prospective clinical study was conducted on 95 adults (18–80 years) screened using the STOP-BANG questionnaire and pulse oximetry. All eligible participants underwent overnight polysomnography (PSG) following AASM guidelines, while simultaneous SpO₂ and sleep data were recorded using a Samsung Galaxy Watch 4. ODI and AHI from PSG were compared with smartwatch-derived ODI values to assess device validity.

Results: Compared to PSG, smartwatch-derived ODI values showed slightly lower mean desaturation indices (PSG-ODI: 17.82 ± 11.05 vs. SGW4-ODI: 15.65 ± 11.03), while PSG-AHI demonstrated the highest mean severity (20.26 ± 11.89). PSG-AHI showed a strong correlation with PSG-ODI ($r = 0.88$, $p < 0.001$) and a moderate correlation with SGW4-ODI ($r = 0.59$, $p < 0.001$). Using PSG-AHI as the gold standard, PSG-ODI demonstrated higher diagnostic accuracy (88.42%) than the smartwatch (86.32%), with PSG-ODI showing sensitivity and specificity of 91.7% and 86.4%, respectively, compared with 82% and 90% for SGW4-ODI.

Conclusion: The Samsung Galaxy Watch 4 showed good agreement between its ODI values and PSG findings, supporting its usefulness as a simple, non-invasive screening tool for OSA. Its portability and accessibility make it a practical adjunct where PSG is limited, though larger studies are needed for further validation.

Keywords: Obstructive Sleep Apnea, Polysomnography, Oxygen Desaturation Index, Apnea–Hypopnea Index, Wearable Devices, Smartwatch Monitoring, Samsung Galaxy Watch 4, Sleep Screening

Background

High-quality sleep plays a vital role in maintaining physical, mental, and emotional well-being. Chattu et al.,(2018) described insufficient or disturbed sleep as a growing global public health concern associated with reduced productivity, poor quality of life, and increased morbidity¹. Malik et al.,(2014) further demonstrated that sleep disturbances significantly heighten the risk of suicidal behavior among individuals with psychiatric disorders², emphasizing

the broader mental health implications of poor sleep. Obstructive Sleep Apnea (OSA), one of the most prevalent sleep disorders, is characterized by repetitive upper airway obstruction during sleep. Park, Ramar, and Olson reported that reduced pharyngeal muscle tone leads to apnea and hypopnea events, accompanied by oxygen desaturation and arousals³. Screening tools remain essential for early detection; Sharma et al.,(2017) confirmed the effectiveness of the STOP-BANG questionnaire in

identifying individuals at elevated risk⁴. In India, Suri et al. highlighted a significant prevalence of OSA among adults, reflecting its underdiagnosis in the population⁵. Globally, Senaratna et al.,(2017) estimated adult OSA prevalence between 9% and 38%¹⁴. While polysomnography (PSG) is the gold standard for diagnosis, its high cost, limited accessibility, and need for specialized laboratory settings pose challenges³. To address these limitations, Romem et al.,(2013) demonstrated that photoplethysmography (PPG) signals obtained from pulse oximetry effectively detect respiratory disturbances⁶. The FDA has also established rigorous accuracy standards for pulse oximeters, supporting their clinical reliability⁷. Watson emphasized that improving access to diagnostic and therapeutic OSA services can reduce long-term healthcare expenditures⁸. Advancement in wearable technologies has further expanded sleep monitoring options. Early actigraphy work by Sadeh et al.,(1995) validated the usefulness of movement-based sleep assessment⁹. More recent studies by Rashid et al.,(2021) and Rosa et al.,(2021) showed that the Oxygen Desaturation Index (ODI) strongly correlates with PSG-based OSA severity^{10,11}. Wali et al.,(2020) confirmed the reliability of oxygen saturation indices¹², while Kainulainen et al.,(2019) demonstrated that desaturation severity may reflect daytime symptoms better than AHI¹³. Recent evaluations by Kim et al.,(2022) and Jung et al.,(2022) support the diagnostic potential of PPG-based smartwatches for OSA detection^{15,16}.

Methodology

The study was approved by the Institutional Research and Development Committee (SDC/IRDC/2022/MDS/17) and Human Ethics Committee (SDC&H/IHEC/2022/MDS/17). Ninety-five consenting participants completed a questionnaire with assistance when required. The sleep study employed 3M Micropore tape, Otica nasal cannula, Littmann 3M electrodes, and the SOMNO SCREEN PLUS system (SOMNO Medics GmbH, Germany) with respiratory effort belts. A SAMSUNG GALAXY WATCH 4 (model SM-R870N) with Bioelectrical Impedance and multiple sensors was also used. Equipment selection was free from commercial bias.

Participants aged 18–80 years with OSA symptoms, STOP-BANG score >3, and pulse oximetry <96% were included, while those with chronic systemic diseases, parasomnias, pregnancy/lactation, or drug abuse were excluded. Screening was performed using the STOP-BANG questionnaire in the Department of Respiratory Medicine. The Samsung Galaxy Watch 4 (model SM-R870N) (Fig. 1) was selected for its multi-sensor capability, including Bioelectrical Impedance, PPG, and accelerometer modules, enabling real-time SpO₂ (Fig. 2) and sleep monitoring via the Samsung Health app. Participants underwent overnight polysomnography (PSG) following AASM guidelines, using nasal cannulae (Fig. 3B), effort belts, and standard electrodes. After PSG, smartwatch and PSG data were compared. The Oxygen Desaturation Index (ODI) was calculated as the number of ≥3% desaturation events per hour of sleep. ODI and Apnea-Hypopnea Index (AHI) from PSG were tabulated and correlated with ODI values obtained from the smartwatch for validation. (Fig. 4)

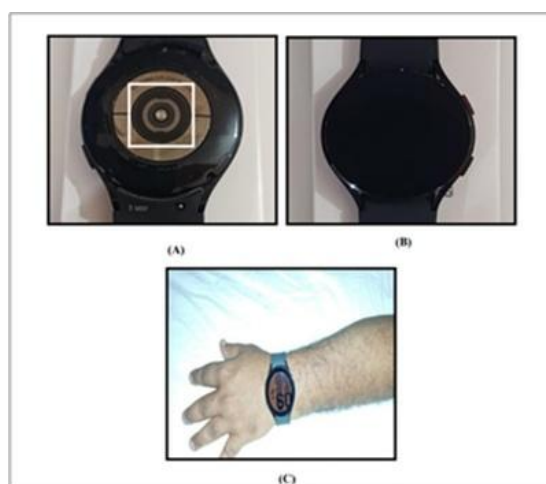


Figure 1: Galaxy Watch 4(GW4) used in this study

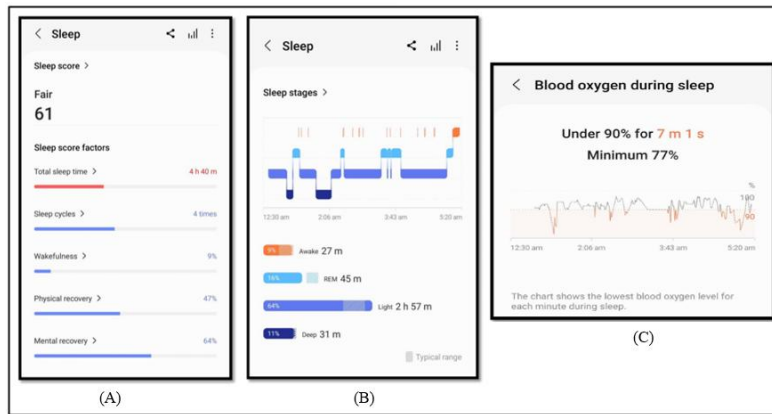


Figure 2: 2A) Sleep Parameters after all night sleep on Samsung sleep application measured by SGW4.,2B) Sleep stages measured after all night sleep on Samsung sleep application measured.,2C) Screenshot of desaturated oxygen levels throughout the the sleep with drop of oxygen level recorder per second.

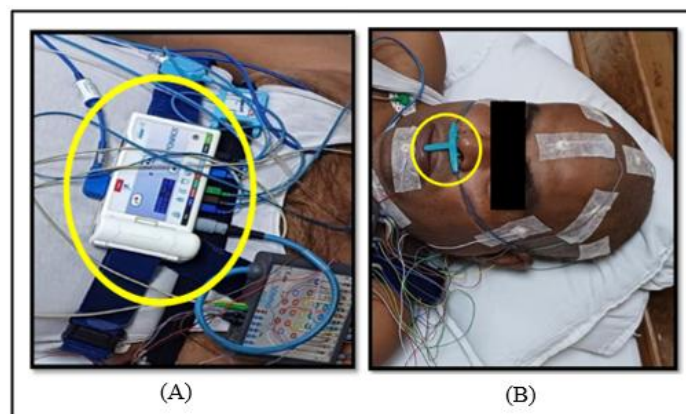


Figure 3: 3A) Control unit [encircled] placed on the abdominal region having no direct contact with skin.,3B) Nasal cannula [encircled] attached to the nostrils.

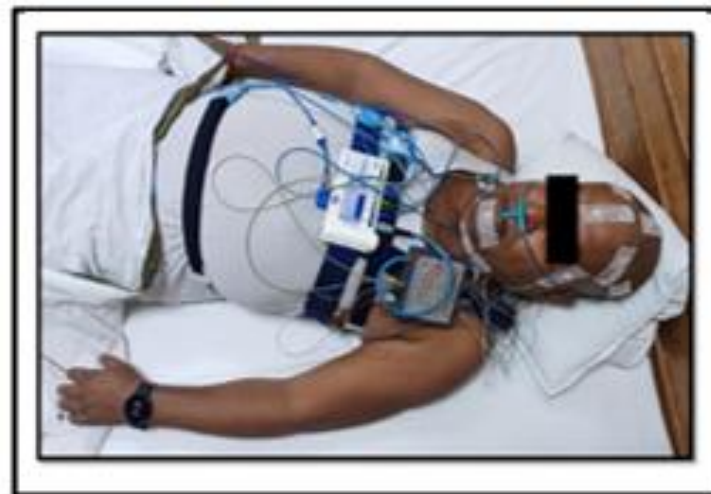


Figure 4: Patient having all the sensors secured and SGW4 worn on left wrist

Results

All 95 participants successfully completed the study without technical or procedural difficulties. Analysis of baseline sleep parameters revealed distinct variations between Apnea-Hypopnea Index (PSG AHI), Oxygen Desaturation Index obtained from polysomnography (PSG ODI), and Oxygen Desaturation Index measured using the Samsung Galaxy Watch 4 (SGW4 ODI). As shown in Table 1,

PSG AHI demonstrated the highest mean value (20.26 ± 11.89), followed by PSG ODI (17.82 ± 11.04), whereas SGW4 ODI exhibited a lower mean (15.65 ± 11.02). These findings indicate a systematic reduction in desaturation event detection from PSG AHI to smartwatch-derived ODI. Correlation analyses were performed to assess the strength of association between PSG parameters and smartwatch readings. A strong positive correlation was observed

between PSG AHI and PSG ODI, with a Pearson correlation coefficient of $r = 0.88$ ($p < 0.001$), indicating high linear agreement between apnea-hypopnea events and oxygen desaturation events detected during PSG (Table 2). In contrast, the correlation between PSG AHI and SGW4 ODI was moderate but statistically significant, with $r = 0.59$ ($p < 0.001$), suggesting that while the Galaxy Watch 4 follows the trend of apnea severity, its desaturation detection is less sensitive than PSG (Table 3). Diagnostic performance measures were calculated using PSG AHI as the gold standard. As shown in Table 4, PSG ODI demonstrated excellent diagnostic characteristics, with a sensitivity of 91.7%, specificity

of 86.4%, PPV of 80.49%, and NPV of 94.44%, achieving an overall diagnostic accuracy of 88.42%. The SGW4 ODI also showed strong diagnostic potential, with a sensitivity of 82% and specificity of 90%. Despite slightly lower sensitivity compared to PSG ODI, its PPV (88.10%) and NPV (84.91%) remained high, resulting in an overall diagnostic accuracy of 86.32%. These findings collectively indicate that while PSG ODI remains more precise in detecting desaturation-related respiratory events, the Samsung Galaxy Watch 4 provides a reasonably accurate and clinically valuable estimation of nocturnal ODI, supporting its potential role as a portable screening tool for obstructive sleep apnea.

Table 1: Mean Differences between PSG AHI, PSG ODI, SGW4 ODI

	N	Minimum	Maximum	Mean	Std. Deviation
PSG AHI	95	1.20	39.80	20.2600	11.8995
PSG ODI	95	1.00	41.20	17.8274	11.0497
SGW4 ODI	95	1.00	82.00	15.6547	11.02817

[Table 1] Shows variation of PSG AHI, PSG ODI and SGW4 ODI in sleep where PSG AHI had the greatest mean (20.26) which, when compared to PSG ODI (17.82) followed by SGW4 ODI having a mean of (15.65).

Table 2: Correlation between PSG AHI and PSG ODI

		PSG AHI	PSG ODI
PSG AHI	Pearson Correlation	1	.881
	Sig. (2-tailed)		.000
	N	95	95
PSG ODI	Pearson Correlation	.881	1
	Sig. (2-tailed)	.000	
	N	95	95

[Table 2] Depicts the correlation between PSG AHI and PSG ODI. The test indicates a significant difference between the two groups. Pearson correlation value of 0.88 shows a strong linear correlation between PSG AHI and PSG ODI.

Table 3: Correlation between PSG AHI and SGW4

		PSG AHI	PSG ODI
PSG AHI	Pearson Correlation	1	.593
	Sig. (2-tailed)		.000
	N	95	95
SGW4 ODI	Pearson Correlation	.593	1
	Sig. (2-tailed)	.000	
	N	95	95

[Table 3] Depicts the correlation between PSG AHI and SGW4. The test indicates a significant difference between the 2 groups. Pearson correlation value of 0.59 shows a moderate correlation between PSG AHI and SGW4.

Table 4: Values for Sensitivity, Specificity, PPV and NPV for PSG ODI and SGW4 ODI

GOLD STANDARD	Sensitivity %	Specificity %	PPV %	NPV %	Diagnostic Accuracy %
PSG AHI					
PSG ODI	91.7	86.4	80.49	94.44	88.42
SGW4 ODI	82.0	90.0	88.10	84.91	86.32

Interpretation:

PSG ODI showed a strong correlation with PSG AHI, indicating high reliability in identifying both positive and negative cases of sleep-disordered breathing. Although SGW4 ODI demonstrated only moderate correlation, its good specificity supports its

usefulness as a supportive screening tool. Overall, PSG remains the definitive diagnostic method.

Discussion

Given the high prevalence of Obstructive Sleep Apnea (OSA) and the barriers to its diagnosis, there is a growing need for alternative diagnostic tools.

This study aimed to evaluate the Samsung Galaxy Watch 4 (SGW4) as a potential screening device for OSA, addressing the limitations of traditional polysomnography (PSG). Ninety-five participants (aged 18–80 years) underwent simultaneous overnight monitoring with SGW4 and PSG, the latter serving as the diagnostic gold standard based on Apnea–Hypopnea Index (AHI). SGW4 utilizes multiple sensors—including PPG, accelerometer, barometer, gyroscope, and geomagnetic sensors—to assess sleep parameters. The key parameter analyzed was the Oxygen Desaturation Index (ODI), representing the frequency of $\geq 3\%$ drops in SpO₂ per hour of sleep. PPG signals reflect cardiac and respiratory variations and have previously demonstrated good concordance with PSG-based measures of OSA (Romem et al., 2014)⁶. Accelerometer and gyroscopic data enhance the accuracy of sleep–wake and movement detection, improving actigraphy performance (Sadeh et al., 1995)⁹. Consistent with previous findings (Rashid et al., 2021; Rosa et al., 2021; Wali, 2020; Kainulainen, 2019),^{10–13} the current study demonstrated a strong correlation between SGW4-derived ODI and PSG-derived AHI ($r \approx 0.8$, $p \leq 0.05$), with a sensitivity of 91.7%, specificity of 86.4%, positive predictive value of 80.5%, and negative predictive value of 94.4%. These results closely align with the diagnostic accuracies reported in smartwatch-based studies (Kim et al., 2002; Jung et al., 2022)^{15,16}. Considering that an AHI ≥ 5 events/hour is the diagnostic threshold for OSA, the SGW4 shows strong potential as a reliable, accessible, and user-friendly screening tool. While PSG remains the gold standard, wearable multi-sensor technology such as the SGW4 may help overcome logistical and financial barriers, facilitating earlier detection and management of OSA in broader populations.

Conclusion:

The findings of this study indicate that the Samsung Galaxy Watch 4 (SGW4) demonstrates promising accuracy in estimating the Oxygen Desaturation Index when compared with polysomnography, the diagnostic gold standard for Obstructive Sleep Apnea. Although not a replacement for PSG, SGW4 offers a practical, accessible, and non-invasive screening option. Its integration into routine preliminary assessment may facilitate earlier detection of OSA, warranting further large-scale validation.

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Conflict Of Interest:

The authors report no conflict of interest.

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