Research Square

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Assessing the relationship of RDW changes with the severity of obstructive sleep apnea syndrome

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Abstract

Background

Obstructive sleep apnea syndrome is a prevalent sleep-related breathing disorder with systemic cardiovascular and hematologic consequences. Red cell distribution width and platelet distribution width, routinely reported indices in complete blood counts, have been proposed as potential markers of OSAS severity.

Methods

In this cross-sectional study, adults diagnosed with OSAS by overnight polysomnography at Rasoul Akram Hospital, Tehran (October 2020–October 2025) were enrolled. Demographic data and body mass index were recorded, and morning venous blood samples were obtained for complete blood count, including RDW and PDW. Patients were categorized into mild (AHI 5–<15), moderate (AHI 15–<30), and severe (AHI ≥ 30) OSAS groups. Potential confounders known to affect RDW and platelet indices were rigorously excluded.

Results

A total of 115 patients were included (55.7% male, mean age 43.08 ± 12.20 years, mean BMI 32.86 ± 8.02 kg/m²). OSAS severity distribution was 30.4% mild, 30.4% moderate, and 39.1% severe; mean AHI was 38.34 ± 33.44 (range 5–159). BMI was significantly higher in severe OSAS (73.3% with BMI ≥ 30) compared with moderate (54.3%) and mild (45.7%) OSAS (P = 0.035). Mean RDW (13.52 ± 1.30%) and PDW (12.16 ± 1.89 fL) did not differ significantly across OSAS severity categories (both P > 0.4), and stratification by BMI (< 30 vs ≥ 30) similarly showed no significant association between RDW or PDW and OSAS severity (P > 0.3 in all comparisons).

Conclusion

In this Iranian cohort with carefully selected patients free of major hematologic and systemic confounders, RDW and PDW were not associated with OSAS severity or BMI, in contrast to several previous reports suggesting a positive relationship between RDW, PDW, and OSAS severity. Larger multicenter studies and longitudinal designs are warranted to clarify the utility of RDW and PDW as biomarkers in OSAS in different populations.

Introduction

Sleep is a fundamental biological process required for energy conservation, tissue repair, immune regulation, and neurocognitive functioning [1]. Healthy sleep can be characterized along multiple

dimensions, including regularity, satisfaction, daytime alertness, timing, efficiency, and duration. Disturbances that disrupt these dimensions are classified as sleep disorders [2].

Obstructive sleep apnea syndrome (OSAS) is among the most common primary sleep disorders and is characterized by recurrent episodes of partial or complete upper airway obstruction during sleep, leading to intermittent hypoxia, sleep fragmentation, and excessive daytime sleepiness [3]. Polysomnography (PSG) remains the standard diagnostic tool, providing quantification of apnea, hypopnea, and respiratory effort-related arousals (RERAs) [4]. Apnea is defined as a ≥ 90% reduction in airflow for at least 10 seconds, while hypopnea is defined as a ≥ 30% reduction in airflow for ≥ 10 seconds, accompanied by ≥ 3% oxygen desaturation or an arousal. The apnea–hypopnea index (AHI), calculated as the number of apnea and hypopnea events per hour of sleep, is used to define OSAS severity: AHI < 5 is normal, 5–<15 mild, 15–<30 moderate, and ≥ 30 severe [4].

Beyond fragmented sleep and daytime somnolence, OSAS has far-reaching systemic consequences, including neurocognitive impairment, mood disturbance, increased cardiovascular risk, metabolic dysregulation, and a possible association with malignancy [5, 6]. Previous studies have shown that OSAS can influence hematologic parameters, such as hematocrit and whole blood viscosity, and may be associated with increased platelet activation [7].

RDW quantifies variability in red blood cell size, whereas PDW reflects heterogeneity in platelet size, both of which may increase in states of ineffective erythropoiesis, chronic inflammation, and enhanced platelet activation [8, 9]. Several studies have reported that RDW is higher in patients with OSAS and may correlate with AHI and other sleep-disordered breathing indices, and that PDW or other platelet indices may be elevated in severe OSAS [10, 11, 12]. However, these associations are not uniform across all populations and may be confounded by comorbid cardiovascular and metabolic conditions [13].

The present study aimed to investigate the relationship between RDW, PDW, and OSAS severity in an Iranian cohort, while rigorously excluding common comorbidities and conditions known to affect these hematologic indices.

Methods

Study design and population

This cross-sectional study included consecutive patients aged ≥ 18 years who were referred to the sleep clinic of Rasoul Akram Hospital, Tehran, and diagnosed with OSAS by full-night attended polysomnography between October 2020 and October 2025. All participants provided informed consent prior to enrollment.

Demographic data (age, sex) and anthropometric parameters (weight, height, BMI) were recorded at the time of polysomnography. OSAS severity was classified according to AHI into mild (5–<15), moderate (15–<30), and severe (≥ 30) groups.

Exclusion criteria

To minimize confounding, we excluded patients with conditions known to alter RDW or platelet indices, including liver disease, kidney disease, established heart disease, diabetes mellitus, hypertension, prior anemia or hematologic disorders, blood transfusion within the previous three months, pregnancy, alcohol use, current smoking or smoking within the last three months, and use of iron or multivitamin supplements.

Laboratory measurements

Following overnight polysomnography, a fasting morning venous blood sample was obtained from each patient for complete blood count analysis. RDW was reported as a percentage, reflecting variability in red blood cell volume, with a typical reference range of 11.5–14.5%. PDW was reported as an index of platelet size distribution, with laboratory-specific reference ranges.

Statistical analysis

Data analysis was performed using SPSS version 24. Quantitative variables were expressed as mean ± standard deviation (SD), and categorical variables as counts and percentages. Normality of continuous variables was assessed with the Kolmogorov–Smirnov test. Between-group comparisons of quantitative variables (RDW, PDW, age, BMI) across OSAS severity categories were performed using one-way ANOVA. A P value < 0.05 was considered statistically significant.

Results

Baseline characteristics

The study included 115 patients, of whom 64 (55.7%) were male and 51 (44.3%) were female. Mean age was 43.08 ± 12.20 years (range 18–84). Mean BMI was 32.86 ± 8.02 kg/m², ranging from 19 to 61, with 47 (40.9%) patients having BMI < 30 and 68 (59.1%) classified as obese (BMI ≥ 30).

Regarding OSAS severity, 35 (30.4%) patients had mild OSAS (AHI 5–<15), 35 (30.4%) had moderate OSAS (AHI 15–<30), and 45 (39.1%) had severe OSAS (AHI ≥ 30). Mean AHI was 38.34 ± 33.44 events/hour (range 5–159).

There was no significant difference in mean age or sex distribution among the mild, moderate, and severe OSAS groups (P = 0.267 for age; P = 0.305 for sex), indicating that age and sex were balanced across severity strata. BMI, however, was significantly higher in patients with severe OSAS (P = 0.035). Specifically, 73.3% of severe OSAS patients had BMI ≥ 30 compared with 54.3% of moderate and 45.7% of mild OSAS patients (Table 1).

Table 1
Demographic characteristics in patients with different severities of OSA

		OSA Severity			P.value
		Mild (5 < AHI < 15) N(%)	Moderate (15 < AHI < 30) N(%)	Severe (30 < AHI) N(%)	
Age(year) mean ± SD		40.48 ± 12.35	43.28 ± 13.50	44.95 ± 10.87	0.267
Gender	Male	17(48.6)	18(51.4)	29(64.4)	0.305
	Female	18(51.4)	17(48.6)	16(35.6)	
BMI	< 30	19(54.3)	16(45.7)	12(26.7)	0.035
	≥ 30	16(45.7)	19(54.3)	33(73.3)	

RDW and PDW across OSAS severity

Overall mean RDW was 13.52 ± 1.30% (range 11.2–20.50), and mean PDW was 12.16 ± 1.89 (range 8.4–17). When stratified by OSAS severity, RDW values were 13.70 ± 1.38% in severe, 13.38 ± 0.93% in moderate, and 13.44 ± 1.51% in mild OSAS (P = 0.506). PDW values were 11.99 ± 1.85 in severe, 12.51 ± 1.87 in moderate, and 12.01 ± 1.95 in mild OSAS (P = 0.417). Thus, neither RDW nor PDW showed a statistically significant trend across OSAS severity categories (Table 2).

Table 2
Relationship between RDW and PDW with OSA severity in patients

	OSA Severity			P.value
	Mild (5 < AHI < 15) Mean ± SD	Moderate (15 < AHI < 30) Mean ± SD	Severe (30 < AHI) Mean ± SD	
RDW	13.44 ± 1.51	13.38 ± 0.93	13.70 ± 1.38	0.506
PDW	12.01 ± 1.95	12.51 ± 1.87	11.99 ± 1.85	0.417

RDW and PDW stratified by BMI

We further examined whether BMI modified the relationship between RDW, PDW, and OSAS severity by stratifying patients into BMI < 30 and BMI ≥ 30. Among patients with BMI < 30, RDW values were 13.28 ± 1.00% (severe), 13.26 ± 0.85% (moderate), and 12.91 ± 0.81% (mild OSAS), with P = 0.398, and PDW values were 11.90 ± 2.29, 12.21 ± 1.89, and 11.71 ± 1.82, respectively (P = 0.755).

In the BMI ≥ 30 group, RDW values were 13.85 ± 1.47% (severe), 13.47 ± 1.00% (moderate), and 14.06 ± 1.90% (mild OSAS), with P = 0.492, and PDW values were 12.03 ± 1.70, 12.76 ± 1.87, and 12.38 ± 2.11, respectively (P = 0.385). Again, no significant association between OSAS severity and RDW or PDW was observed within either BMI stratum (Table 3).

Table 3
Relationship between RDW and PDW with OSA severity in patients by body mass index

		OSA Severity			P.value
		Mild (5 < AHI < 15) Mean ± SD	Moderate (15 < AHI < 30) Mean ± SD	Severe (30 < AHI) Mean ± SD	
BMI < 30	RDW	12.91 ± 0.81	13.26 ± 0.85	13.28 ± 1.0	0.398
	PDW	11.71 ± 1.82	12.21 ± 1.89	11.90 ± 2.29	0.755
BMI > 30	RDW	14.06 ± 1.90	13.47 ± 1.0	13.85 ± 1.47	0.492
	PDW	12.38 ± 2.11	12.76 ± 1.87	12.03 ± 1.70	0.385

Discussion

This study demonstrates a positive association between BMI and OSAS severity, consistent with the established role of obesity as a major risk factor for OSAS [5, 6]. In contrast, RDW and PDW did not show significant variation across OSAS severity categories, regardless of BMI stratification, suggesting limited utility of these indices as severity markers in this carefully selected Iranian population [11]. Several prior studies have reported a positive relationship between RDW and OSAS severity. Sökücü et al. found that RDW at presentation correlated with AHI in patients evaluated for OSAS, even in non-anemic individuals [12]. Yousef and Alkhiary similarly reported that RDW and hematocrit values were related to OSAS severity [10]. Subías et al. observed higher RDW values in patients with OSAS than in healthy subjects and an independent positive association between AHI and RDW [11]. Meta-analytic data suggest that RDW may be higher in OSAS compared with non-OSAS controls and may be linked to cardiovascular events in this population [14]. Regarding platelet indices, Bülbül et al. have shown increased PDW and mean platelet volume in OSAS, particularly in severe disease, supporting a role for platelet activation in OSAS-related cardiovascular risk [9]. However, some studies, including those focusing on comorbidity-free OSAS cohorts, have reported inconsistent or modest associations, implying that comorbid disease burden may partly drive these changes [13]. In contrast to these reports, the present study did not find significant differences in RDW or PDW across OSAS severity groups. Several factors may explain this discrepancy: Rigorous exclusion of comorbid conditions (cardiovascular disease, diabetes, hypertension, chronic kidney or liver disease, anemia, smoking, alcohol use, and micronutrient supplementation) may have removed a substantial portion of the systemic inflammatory and oxidative stress burden that

influences RDW and platelet indices in other cohorts [8, 14, 15]. The cross-sectional design with single time-point measurement may not capture dynamic changes in RDW and PDW related to disease progression or treatment [2]. Genetic, dietary, and environmental differences between Iranian populations and those studied elsewhere may modulate hematologic responses to intermittent hypoxia and sleep fragmentation [11].

Our findings suggest that, in a relatively "clean" OSAS population without major confounding comorbidities, RDW and PDW may have limited value as surrogate markers of OSAS severity. From a practical standpoint, clinicians should be cautious about relying solely on RDW or PDW to infer OSAS severity and should continue to use polysomnography-based indices in conjunction with clinical assessment [4]. Nevertheless, RDW and PDW may still provide prognostic information in OSAS patients with significant cardiovascular or metabolic comorbidity, as suggested by prior studies linking RDW to cardiovascular events and mortality [14, 15].

Strengths and limitations

A key strength of this study is the rigorous exclusion of multiple potential confounders that can independently alter RDW and PDW, thereby isolating the relationship between these indices and OSAS. Additionally, the use of standardized polysomnography and well-defined AHI-based severity categories supports internal validity [4].

Limitations include the single-center design, modest sample size, and cross-sectional nature, which preclude evaluation of longitudinal changes and treatment effects (for example, changes in RDW or PDW with continuous positive airway pressure therapy). The lack of a healthy control group without OSAS also limits direct comparison of RDW and PDW between OSAS and non-OSAS populations. Finally, we did not measure other inflammatory or oxidative stress markers that might have contextualized RDW and PDW findings [14].

Conclusion

In this cross-sectional Iranian cohort of 115 adults with OSAS, BMI was positively associated with disease severity, whereas RDW and PDW were not significantly related to AHI-based OSAS severity categories or to BMI strata. These results differ from several earlier studies that reported higher RDW and PDW in more severe OSAS [10,12] and underscore the importance of population characteristics and comorbidity profiles when interpreting hematologic indices as potential biomarkers in OSAS. Larger, multicenter, and longitudinal studies, ideally including healthy controls and more comprehensive inflammatory profiling, are needed to clarify the role of RDW and PDW in OSAS risk stratification and prognosis [6,13].

Declarations

Human Ethics and Consent to Participate declarations

This study was carried out in accordance with the ethical principles of the Declaration of Helsinki (2013). The research protocol was approved by the Ethics Committee of Iran University of Medical Sciences (approval code: IR.IUMS.FMD.REC.1401.328). Written informed consent for publication of clinical details and clinical images was obtained from the patient.

Consent for publication

Not applicable.

Availability of data and materials

The data sets used during the current study are available from the corresponding author (E.H) on reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Author Contributions

- O.A: Conceptualization, study design, data acquisition, investigation, and manuscript revision.
- M.Gh: Conceptualization, study supervision, methodology, and critical revision of the manuscript for important intellectual content.
- S.J: Data curation, formal analysis, statistical analysis, and interpretation of results.
- S.S: Methodology, data acquisition, project administration, drafting of the original manuscript.
- E.H: Data acquisition, investigation, writing – review and editing.

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