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ORIGINAL ARTICLE

Predictors of Perceived Sports Performance in Female Athletes: The Role of Pelvic Floor Dysfunction and Sleep Quality

Erhan Secer[1] · Seyda Toprak Celenay[2] · Merve Keskin[3,4] · Kazim Bayram[5] · Derya Ozer Kaya[3,4]

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Abstract

Introduction and Hypothesis This study aimed to examine the relationships between perceived sports performance (PSP) and pelvic floor dysfunction (PFD) and sleep quality, and to identify whether PFD and sleep quality serve as independent predictors of PSP.

Methods A total of 95 female athletes from various competition levels (46.3% amateur, 46.3% professional, and 7.4% elite) (mean age 21.18 ± 4.51 years) were included in the study. Athletes' PSP, PFD, and sleep quality were assessed using the Perceived Performance in Sports Scale (PPSS), Pelvic Floor Distress Inventory-20 (PFDI-20) with its subscales [Pelvic Organ Prolapse Distress Inventory-6 (POPDI-6), Colorectal-Anal Distress Inventory-8 (CRADI-8), and Urinary Distress Inventory-6 (UDI-6)], and Single-Item Sleep Quality Scale (SISQS), respectively. Pearson correlation analysis was used to examine relationships between PPSS, PFDI-20, and SISQS, while multiple linear regression determined the predictive power of independent variables on PSP.

Results The PPSS total score correlated with PFDI-20 total ($r = -0.239$, $p = 0.019$) and POPDI-6 ($r = -0.384$, $p < 0.001$), while with SISQS scores ($r = 0.212$, $p = 0.039$). Psychological perception score correlated with POPDI-6 ($r = -0.399$, $p < 0.001$), PFDI-20 total ($r = -0.353$, $p < 0.001$), CRADI-8 ($r = -0.205$, $p = 0.047$), UDI-6 ($r = -0.233$, $p = 0.023$), and SISQS scores ($r = 0.261$, $p = 0.011$). Physical and tactical perception scores were linked to POPDI-6 score ($r = -0.334$, $p = 0.001$; $r = -0.326$, $p = 0.001$, respectively); tactical perception was also related to SISQS score ($r = 0.242$, $p = 0.018$). Environmental perception correlated with PFDI-20 total ($r = -0.196$, $p = 0.046$) and POPDI-6 scores ($r = -0.299$, $p = 0.003$). Significant regression models explained 7.3–17.5% of the variance, identifying POPDI-6 as the sole consistent independent predictor for overall PSP ($\beta = -0.446$, $p = 0.003$) and all subdimensions ($p < 0.05$), whereas SISQS did not emerge as a significant independent contributor in the regression models ($p > 0.05$).

Conclusions Within the limits of the examined variables, pelvic organ prolapse symptoms emerged as a significant independent predictor for specific PSP domains, though the absolute explained variance remained modest (7.3–17.5%), while sleep quality was not a significant independent predictor. Rather than practice-ready guidelines, these cross-sectional findings suggest that future prospective and interventional research is warranted to explore whether integrating pelvic health screenings into training routines can meaningfully support athletes' PSP, while carefully considering that the feasibility, confidentiality, and healthcare support for such screenings may vary across different sport participation and competition levels.

Keywords Athletic performance · Pelvic floor disorders · Regression analysis · Sports psychology · Women's health

Introduction

Perceived sports performance (PSP) serves as a primary benchmark for athletic success across all participation spectrums [1]. Governed by physiological and psychological variables, PSP is critical for long-term commitment and intrinsic motivation in young adult female athletes [2]. Crucially, this subjective performance is vulnerable to female-specific stressors; specifically, pelvic floor dysfunction (PFD) and

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compromised sleep emerge as potential factors undermining physical and psychological readiness [3].

High-impact and high-intensity athletic activities have been identified as significant risk factors for female PFD, largely due to repetitive, acute elevations in intra-abdominal pressure [4]. During jumping, running, or landing, pressure spikes can mechanically overload pelvic structures, compromising musculature integrity [5]. Beyond clinical manifestations, PFD-associated symptoms and structural loads may degrade PSP, acting as a critical deterrent for continued sport participation [3]. Furthermore, physiological strain and nocturnal symptoms (e.g., nocturia) may disrupt recovery, suggesting an interplay between pelvic health and sleep quality [6].

Restorative sleep is essential for athletic recovery, yet is frequently compromised in women, often linked to cyclical hormonal fluctuations and performance-induced cognitive hyperarousal [7]. From a theoretical perspective, sleep disturbances may impair executive functioning, tactical decision-making, and stress-buffering capacities independent of somatic impairments [6]. Consequently, poor sleep architecture may independently diminish competency self-appraisals, providing a distinct rationale for sleep quality as a potential isolated predictor of subjective performance.

Despite these interactions, the independent predictive power, hierarchy, and collective impact of PFD and sleep quality on PSP remain under-explored. Current literature predominantly addresses biomechanical or hormonal influences [8, 9], leaving robust regression models that isolate PFD symptoms from wellness determinants such as sleep quality to predict subjective performance scarce. Consequently, it remains unclear whether PFD acts as a primary somatic stressor that potentially overshadows restorative sleep. Furthermore, evaluations of subjective performance constructs predominantly rely on specialized instruments such as the Perceived Performance in Sports Scale (PPSS) [10].

Therefore, this study investigated factors influencing PSP in female athletes through two main objectives: first, to examine the tentative relationships between PFD, sleep quality, and PSP; second, to determine whether PFD and sleep quality serve as independent predictors of PSP. We hypothesized that significant relationships might exist among PFD, sleep quality, and PSP, and that both PFD and sleep quality could be significant, independent predictors of PSP.

Methods

Design and Ethical Aspect of the Study

This cross-sectional study was conducted via an online survey platform in Türkiye between January and February 2026. The protocol was approved by the Manisa Celal Bayar University Health Sciences Ethics Committee (No: 20.478.486/3736) and complied with the Declaration of Helsinki. All participants provided electronic informed consent before enrollment.

Participants

The study sample was established through a systematic recruitment process based on strictly defined criteria. Participants had to be female athletes aged 18–35 years, a range selected to exclude age-related pelvic floor muscle decline and confounding menopausal changes. Additionally, ≥ 1 year of uninterrupted training in an athletic organization was required. Exclusion criteria included diagnosed neurological disorders, current pregnancy, and a history of childbirth (parous); the latter was excluded to maintain sample homogeneity regarding pelvic floor function and eliminate lifestyle-driven sleep disruptions associated with postpartum recovery. Furthermore, those with past-year urogynecological infections, prior surgeries, or incomplete surveys were excluded.

An a priori power analysis using G*Power (3.1.9.7; Exact test, bivariate normal correlation) determined that a minimum of 70 participants was required to detect significant relationships, based on a pilot study correlation ($r = -0.381$, $n = 30$) between PPSS and Pelvic Floor Distress Inventory-20 (PFDI-20) scores ($\alpha = 0.05$, $1-\beta = 0.90$). To ensure adequate statistical power and account for potential attrition, participants were recruited on the basis of the aforementioned eligibility criteria.

Procedure and Online Survey

Data for this study were collected using Google Forms, a secure online survey platform (Mountain View, California, USA). To establish a structured framework, sports clubs officially registered under national athletic federations were identified. Initial contact with club managers and team administrations via institutional email, phone, or face-to-face appointments was established to present the study protocol, objectives, and ethical clearance. Following administrative approval, the survey link was distributed to female athletes through club managers via WhatsApp to ensure engagement and accessibility.

While this convenience sampling strategy provided a pragmatic, efficient means of accessing a specialized, hard-to-reach population, it is inherently susceptible to selection bias. This distribution method relied on the active facilitation of club managers and participants' digital literacy, potentially limiting sample representativeness by undersampling athletes less active on digital platforms or within club communications.

The digital questionnaire comprised socio-demographic/sports-related characteristics and three scales: PPSS, the PFDI-20, and the Single-Item Sleep Quality Scale (SISQS). To ensure dataset integrity, all items were mandatory for submission. Technical safeguards prevented duplicate entries by restricting access via unique login credentials. To mitigate selection bias and enhance sample integrity, this controlled digital distribution ensured that only athletes meeting the recruitment criteria were reached while maintaining anonymity and data security. Nevertheless, the nonrandom nature of this recruitment strategy implies that findings should be interpreted with caution regarding generalizability to the broader female athlete population.

Perceived Performance in Sports Scale

The 25-item PPSS measures PSP across five subdimensions: physical, technical, tactical, psychological, and environmental perception [10]. Responses use a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), yielding cumulative scores from 25 to 125, with higher scores indicating greater PSP (no reverse-coded items). The instrument's validation demonstrated excellent construct validity, with factor analyses accounting for 76.52% of the total variance, and high internal consistency (Cronbach's alpha = 0.925) [10].

Pelvic Floor Distress Inventory-20

The PFDI-20, developed by Barber et al. and validated in Turkish by Toprak Celenay et al., assessed the presence and bothersome nature of PFD symptoms [11, 12]. This 20-item instrument comprises three subscales: Pelvic Organ Prolapse Distress Inventory-6 (POPDI-6), the Urinary Distress Inventory-6 (UDI-6), and the Colorectal-Anal Distress Inventory-8 (CRADI-8). Participants first indicate symptom presence (no = 0, yes = 1); if present, distress is rated on a 4-point Likert scale (1 = not at all, 4 = quite a bit). Subscale scores are normalized (0–100), yielding a cumulative total score of 0–300, where higher scores indicate greater symptom severity and distress [12].

Single-Item Sleep Quality Scale

The SISQS, developed by Snyder et al. and validated in Turkish by Dereli and Kahraman, evaluated subjective sleep quality [13, 14]. Grounded in Visual Analog Scale (VAS) principles, this instrument rates overall sleep quality over the past 7 days on a 0–10 numerical scale, where higher scores indicate poorer sleep quality. This single-item format was selected for its practical utility and reduced respondent burden, providing a global assessment of restorative sleep patterns.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics (v25.0; IBM Corp., Armonk, NY, USA). Data normality was confirmed via the Shapiro–Wilk test, histograms, and Q-Q plots; accordingly, continuous variables were expressed as means and standard deviations (SD) and categorical data as frequencies (n) and percentages (%).

Pearson correlation analysis examined relationships among PPSS (total/subdimensions), PFDI-20 (total/subscales), and SISQS scores. Correlation coefficients (r) were interpreted as 0.00–0.10 (negligible), 0.10–0.39 (weak), 0.40–0.69 (moderate), 0.70–0.89 (strong), and 0.90–1.00 (very strong) [15].

To determine the predictive power of independent variables (PFD and sleep quality) on PSP, multiple linear regression analysis was conducted using the "Enter" method. Before performing the regression, the fundamental assumptions of the model were rigorously evaluated in accordance with the standard statistical criteria outlined by Field [16]. Multicollinearity was ruled out via variance inflation factor (VIF < 5) and tolerance (> 0.10) values. Residual independence was verified using the Durbin–Watson test (1.5–2.5), while homoscedasticity and normality were confirmed via P-P and residual scatterplots. Cook's distance (< 1.0) indicated no influential outliers. Model explanatory power and predictor contributions were evaluated using adjusted R^2, standardized beta (β), and 95% confidence intervals (CI), with significance set at $p < 0.050$.

Results

A total of 101 individuals were recruited. Following screening, six participants were excluded: two due to childbirth history and four for providing invalid or nonsensical data. Consequently, the final statistical analysis was conducted with a cohort of 95 participants ($n = 95$).

The final cohort had a mean age of 21.18 ± 4.51 years, height of 172.65 ± 8.26 cm, weight of 63.27 ± 9.75 kg, and body mass index of 21.14 ± 2.28 kg/m^2. The cohort included amateur (46.3%), professional (46.3%), and elite (7.4%) athletes, with a sports background of 9.55 ± 5.06 years and weekly training of 11.28 ± 5.99 h. Participants predominantly engaged in team sports, mainly volleyball (55.8%) and handball (20.0%), followed by football, basketball, fitness, dance, swimming, badminton, gymnastics, and tennis, with 54.7% competing at the senior level. Detailed baseline characteristics are presented in Table 1.

Regarding clinical presentation, 29.5% ($n = 28$) of the athletes were symptomatic (≥ 1 symptom on PFDI-20) and 70.5% ($n = 67$) asymptomatic. The cohort mean SISQS score was 6.25 ± 1.76, indicating moderate-to-poor sleep quality.

Table 1 The socio-demographic and sport-related characteristics of female athletes

Characteristics	Statistics Mean ± SD
Age, years	21.18 ± 4.51
Height, cm	172.65 ± 8.26
Weight, kg	63.27 ± 9.75
Body mass index, kg/m^2	21.14 ± 2.28
Duration of sports participation, years	9.55 ± 5.06
Weekly training duration, h/week	11.28 ± 5.99
Age at menarche, years	13.03 ± 1.52
SISQS score	6.25 ± 1.76
	n (%)
Pelvic floor dysfunction status	
Symptomatic athletes (at least 1 symptom on PFDI-20)	28 (29.5)
Asymptomatic athletes	67 (70.5)
Sports branch	
Volleyball	53 (55.8)
Handball	19 (20.0)
Basketball	5 (5.3)
Football	7 (7.4)
Dance	2 (2.1)
Fitness	5 (5.3)
Gymnastics	1 (1.1)
Swimming	2 (2.1)
Badminton	2 (2.1)
Tennis	1 (1.1)
Competition level	
Amateur	44 (46.3)
Professional	44 (46.3)
Elite	7 (7.4)
Team level	
Junior team	43 (45.3)
Senior team	52 (54.7)
Chronic medical condition	
Yes	4 (4.2)
No	91 (95.8)
Surgical history (abdominal/urogenital)	
Yes	2 (2.1)
No	93 (97.9)
Regular medication use	
Yes	5 (5.3)
No	90 (94.7)
Menstrual cycle	
Regular	80 (84.2)
Irregular	15 (15.8)
Smoking status	
Never smoked	64 (67.4)
Former smoker	5 (5.3)
Current smoker	26 (27.4)
Alcohol consumption	
Never	38 (40.0)
Rare (social drinker)	53 (55.8)
Regular weekly use	4 (4.2)

Table 1 (continued)

SD Standard deviation; *cm* centimeter; *kg* kilogram; kg/m^2: kilograms per square meter; *SISQS* Single-Item Sleep Quality Scale; PFDI-20: Pelvic Floor Distress Inventory-20

Competition levels were defined on the basis of national/international athletic standing: Amateur: Athletes participating in local, noncommercial leagues; Professional: Full-time or part-time contracted athletes competing in national professional leagues; Elite: Athletes currently representing national teams or competing at international levels. Team levels were classified as: Junior team: Age-restricted youth categories (e.g., U19, U21) governed by sports federations; Senior team: Premium, non-age-restricted top-tier competition level within national league structures

As detailed in Table 1, most reported no chronic conditions (95.8%, $n = 91$), surgical history (97.9%, $n = 93$), or regular medication use (94.7%, $n = 90$). Mean age at menarche was 13.03 ± 1.52 years, with 84.2% ($n = 80$) reporting regular and 15.8% ($n = 15$) irregular menstrual cycles. Lifestyle analysis showed 67.4% ($n = 64$) never smoked, 27.4% ($n = 26$) currently smoked, and 5.3% ($n = 5$) formerly smoked. Alcohol consumption was rare/social (55.8%, $n = 53$), never (40.0%, $n = 38$), or regular weekly (4.2%, $n = 4$).

Table 2 presents the correlations between PPSS, PFDI-20, and SISQS. The PPSS total score correlated weakly with PFDI-20 total ($r = -0.239$, $p = 0.019$), POPDI-6 ($r = -0.384$, $p < 0.001$), and SISQS ($r = 0.212$, $p = 0.039$). Psychological perception showed the most consistent associations, correlating moderately with POPDI-6 ($r = -0.399$, $p < 0.001$) and weakly with PFDI-20 total ($r = -0.353$, $p < 0.001$), CRADI-8 ($r = -0.205$, $p = 0.047$), UDI-6 ($r = -0.233$, $p = 0.023$), and SISQS ($r = 0.261$, $p = 0.011$). Physical and tactical perception correlated weakly only with POPDI-6 ($r = -0.334$, $p = 0.001$; $r = -0.326$, $p = 0.001$, respectively); tactical perception also linked positively to SISQS ($r = 0.242$, $p = 0.018$). Environmental perception yielded weak negative correlations with PFDI-20 total ($r = -0.196$, $p = 0.046$) and POPDI-6 ($r = -0.299$, $p = 0.003$). Technical perception demonstrated no significant correlations across any variables ($p > 0.050$).

Table 3 presents the multiple linear regression results for predicting the PPSS total score. The model was significant ($F = 6.052$, $p < 0.001$), with an adjusted R^2 of 0.137, explaining 13.7% of the variance. Among the predictors, only the POPDI-6 subscale score emerged as a significant independent predictor ($\beta = -0.446$, $t = -3.022$, $p = 0.003$), displaying a negative relationship with the outcome. Conversely, the PFDI-20 total score ($\beta = -0.125$, $p = 0.389$) and SISQS scores ($\beta = 0.100$, $p = 0.312$) were not significant contributors.

Table 4 presents the multiple linear regression results for predicting the PPSS subdimension scores. For the physical perception subdimension, the model was significant ($F = 12.234$, $p = 0.001$), with an adjusted R^2 of 0.107,

Table 2 The relationship between the PPSS (total and subdimension scores) and the PFDI-20 (total and subscale scores), and the SISQS total score

PPSS		PFDI-20				SISQS
		PFDI-20 total score	POPDI-6 subscale score	CRADI-8 subscale score	UDI-6 subscale score	SISQS total score
PPSS total score	*r*	**−0.239***	**−0.384***	−0.063	−0.138	**0.212***
	p	**0.019**	**< 0.001**	0.542	0.181	**0.039**
Physical perception subdimension score	*r*	−0.152	**−0.334***	−0.005	−0.048	0.133
	p	0.141	**0.001**	0.961	0.643	0.198
Technical perception subdimension score	*r*	−0.014	−0.139	−0.135	−0.055	0.093
	p	0.893	0.180	0.192	0.596	0.370
Tactical perception subdimension score	*r*	−0.151	**−0.326***	−0.014	−0.076	**0.242***
	p	0.144	**0.001**	0.892	0.462	**0.018**
Psychological perception subdimension score	*r*	**−0.353***	**−0.399***	**−0.205***	**−0.233***	**0.261***
	p	**< 0.001**	**< 0.001**	**0.047**	**0.023**	**0.011**
Environmental perception subdimension score	*r*	**−0.196***	**−0.299***	−0.092	−0.085	0.084
	p	**0.046**	**0.003**	0.376	0.411	0.418

PPSS Perceived Performance in Sports Scale; *PFDI-20* Pelvic Floor Distress Inventory-20; *POPDI-6* Pelvic Organ Prolapse Distress Inventory-6; *CRADI-8* Colorectal Anal Distress Inventory-8; *UDI-6* Urinary Distress Inventory-6; *SISQS* Single-Item Sleep Quality Scale; *r* Pearson correlation coefficient

Bold values represent statistically significant correlations at $p < 0.050$

[*] $p < 0.050$

Table 3 Multiple linear regression analysis results for predicting the PPSS total score

	Unstandardized coefficients (B)	Coefficient standard error	95% confidence interval (lower, upper)	Standardized Coefficient beta (β)	*t*	*p* value	Tolerance	VIF
PFDI-20 total	−0.071	0.082	(−0.232, 0.090)	−0.125	−0.866	0.389	0.430	2.326
POPDI-6 subscale	−0.698	0.231	(−1.151, −0.245)	−0.446	−3.022	**0.003**	0.407	2.457
SISQS total	0.648	0.638	(−0.602, 1.898)	0.100	1.016	0.312	0.912	1.096
Model summary: $R = 0.406$; $R^2 = 0.147$; adjusted $R^2 = 0.137$; $F = 6.052$; $p < 0.001$								

PPSS Perceived Performance in Sports Scale; *PFDI-20* Pelvic Floor Distress Inventory-20; *POPDI-6* Pelvic Organ Prolapse Distress Inventory-6; *SISQS* Single-Item Sleep Quality Scale; *VIF* Variance Inflation Factor

Statistically significant *p* values ($p < 0.050$) are highlighted in bold

explaining 10.7% of the variance. Among the variables, the POPDI-6 subscale score emerged as a significant independent predictor ($\beta = -0.341$, $t = -3.472$, $p = 0.001$), displaying a negative relationship with the outcome.

For the tactical perception subdimension, the model was significant ($F = 6.945$, $p = 0.001$), with an adjusted R^2 of 0.110, explaining 11% of the variance. Among the variables, only the POPDI-6 subscale score emerged as a significant independent predictor ($\beta = -0.280$, $t = -2.788$, $p = 0.007$), displaying a negative relationship with the outcome. Conversely, the SISQS total score ($\beta = 0.155$, $p = 0.124$) was not a significant contributor.

For the psychological perception subdimension, the model was significant ($F = 6.042$, $p < 0.001$), with an adjusted R^2 of 0.175, explaining 17.5% of the variance. Among the variables, only the POPDI-6 subscale score emerged as a significant independent predictor ($\beta = -0.364$, $t = -3.102$, $p = 0.002$), displaying a negative relationship with the outcome. Conversely, CRADI-8 ($\beta = -0.106$, $p = 0.369$), UDI-6 ($\beta = -0.176$, $p = 0.085$), and SISQS scores ($\beta = 0.171$, $p = 0.078$) were not significant contributors.

For the environmental perception subdimension, the model was significant ($F = 4.811$, $p = 0.010$), with an adjusted R^2 of 0.073, explaining 7.3% of the variance. Among the variables, only the POPDI-6 subscale score emerged as a significant independent predictor ($\beta = -0.360$, $t = -2.408$, $p = 0.018$), displaying a negative relationship with the outcome. Conversely, the PFDI-20 total score ($\beta = -0.085$, $p = 0.576$) was not a significant contributor. All scatterplots representing the regression models are presented in Fig. 1.

Table 4 Multiple linear regression analysis results for predicting the PPSS subdimension scores

	Unstandardized coefficients (B)	Coefficient standard error	95% confidence interval (lower– upper)	Standardized Coefficient beta (β)	*t*	*p* value	Tolerance	VIF
Physical perception subdimension score								
POPDI-6 subscale	−0.143	0.041	(−0.223, −0.063)	−0.341	−3.472	**0.001**	1.000	1.000
Model summary: $R=0.341$; $R^2=0.116$; adjusted $R^2=0.107$; $F=12.234$; $p=0.001$								
Tactical perception subdimension score								
POPDI-6 subscale	−0.096	0.035	(−0.165, −0.027)	−0.280	−2.788	**0.007**	0.915	1.093
SISQS total	0.219	0.141	(−0.057, 0.495)	0.155	1.553	0.124	0.915	1.093
Model summary: $R=0.358$; $R^2=0.106$; adjusted $R^2=0.110$; $F=6.945$; $p=0.001$								
Psychological perception subdimension score								
POPDI-6 subscale	−0.200	0.064	(−0.325, −0.075)	−0.364	−3.102	**0.002**	0.615	1.626
CRADI-8 subscale	−0.047	0.052	(−0.149, 0.055)	−0.106	−0.904	0.369	0.594	1.684
UDI-6 subscale	−0.074	0.043	(−0.158, 0.010)	−0.176	−1.741	0.085	0.833	1.200
SISQS total	0.392	0.220	(−0.039, 0.823)	0.171	1.782	0.078	0.903	1.107
Model summary: $R=0.457$; $R^2=0.159$; adjusted $R^2=0.175$; $F=6.042$; $p<0.001$								
Environmental perception subdimension score								
PFDI-20 total	−0.010	0.016	(−0.041, 0.021)	−0.085	−0.562	0.576	0.431	2.320
POPDI-6 subscale	−0.112	0.046	(−0.202, −0.022)	−0.360	−2.408	**0.018**	0.431	2.320
Model summary: $R=0.304$; $R^2=0.089$; adjusted $R^2=0.073$; $F=4.811$; $p=0.010$								

PPSS Perceived Performance in Sports Scale; *PFDI-20* Pelvic Floor Distress Inventory-20; *POPDI-6* Pelvic Organ Prolapse Distress Inventory-6; *CRADI-8* Colorectal Anal Distress Inventory-8; *UDI-6* Urinary Distress Inventory-6; *SISQS* Single-Item Sleep Quality Scale; *VIF* Variance inflation factor

Statistically significant *p* values ($p<0.050$) are highlighted in bold

Discussion

The main findings of this study demonstrated that PSP levels in female athletes are associated with both PFD and sleep quality. Further analysis indicated that pelvic organ prolapse symptoms, in particular, serve as a significant independent predictor of PSP within this population.

Regarding clinical profile, 29.5% of athletes reported ≥ 1 PFD symptom, and baseline sleep quality was moderate-to-poor (mean SISQS 6.25 ± 1.76). This 29.5% prevalence aligns with the 20–45% global spectrum reported by Alqhatani et al. for young women in high-impact activities [17], yet exceeds rates in sedentary cohorts. Crucially, 55.8% of our sample consisted of volleyball players. As corroborated by Pawlik et al., chronic, high-velocity vertical jumping and repetitive landing induce severe elevations in intra-abdominal pressure, placing a heavy cumulative mechanical burden on the pelvic floor musculature [5]. Consequently, the observed pelvic floor symptoms, particularly structural heaviness and prolapse, may be driven by these repetitive jumping loads. Because our cohort features few athletes from low-impact, non-jumping disciplines, generalizability warrants caution; these somatic barriers may uniquely represent high-impact, jump-dominant sports rather than the broader female athletic community.

While athletic performance is a multidimensional construct, this study elucidated the relationship between PFD and PSP to address a focused literature gap. Our findings suggest that higher PFD levels, particularly pelvic organ prolapse symptoms, are significantly associated with lower PSP. This aligns with the "paradoxical" nature of high-impact sports, where mechanical loads and repetitive intra-abdominal pressure inherent in elite disciplines potentially exacerbate PFD symptoms [8]. These results imply that such symptoms are not merely clinical complaints but may constitute a tangible somatic barrier to optimal athletic success.

A pivotal contribution of this study is utilizing multiple linear regression to establish a hierarchy among predictors. While most research identifies associations between general symptom severity and quality of life [18, 19], our models establish pelvic organ prolapse symptoms as the dominant independent predictor of PSP, explaining 13.7% of the overall variance. The remaining unexplained variance likely relates to unmeasured factors such as psychological resilience, nutrition, or training load. Nevertheless, specific sensations of "heaviness" or "structural instability" may carry greater weight in an athlete's self-assessment than broader issues, aligning with Donnelly et al., who noted that prolapse symptoms associate with altered biomechanics and diminished perceived support [20].

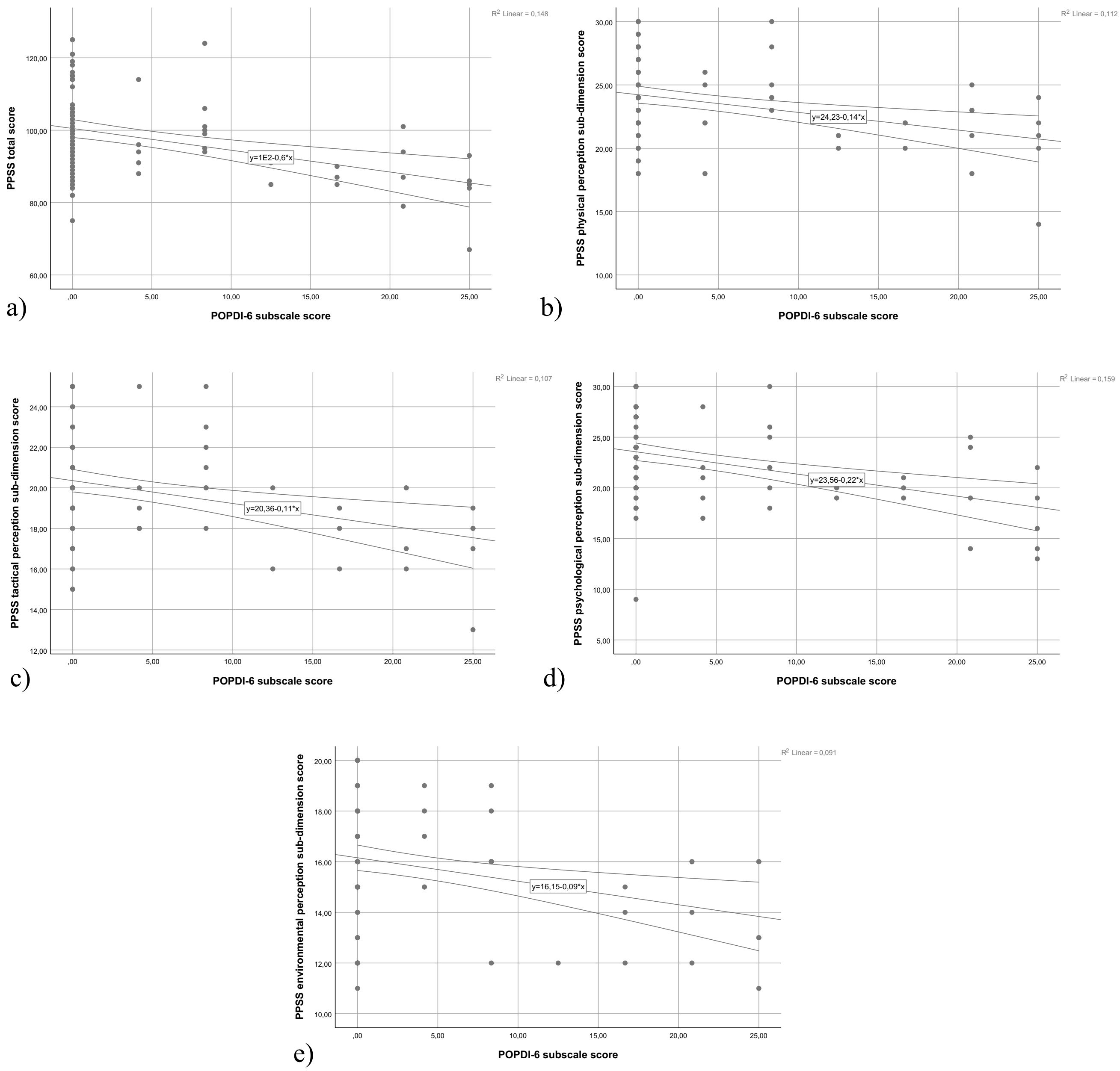

Fig. 1 Scatter plots illustrating the negative linear relationship between Pelvic Organ Prolapse Distress Inventory-6 (POPDI-6) subscale scores and (**a**) Perceived Performance in Sports Scale (PPSS) total scores, (**b**) PPSS physical perception, (**c**) PPSS tactical perception, (**d**) PPSS psychological perception, and (**e**) PPSS environmental perception subdimension scores

Our psychological perception subdimension was highly sensitive to pelvic floor health, showing consistent negative correlations across all distress subscales. In the corresponding regression model (17.5% variance explained), pelvic organ prolapse symptoms remained the sole independent predictor of decreased mental readiness, even after controlling for urinary, bowel, and sleep factors. This highlights that PFD relates not only to physical limitations but also to an athlete's mental confidence. This link with altered mental appraisal aligns with Swake and Young [19] and Stickley and McDowell [21] regarding increased stress and decreased self-confidence in athletes. Furthermore, the symptom-related anxiety described by Donnelly et al. [20] and Dakic et al. [22] may couple with this relationship, where somatic distress distraction potentially reduces the psychological readiness required for competitive execution.

Crucially, sleep quality's failure to emerge as a significant independent predictor contradicts our initial hypothesis, representing a baseline deviation rather than a mediation artifact. When modeled alongside PFD, sleep quality lacked independent contribution to PPSS total or subdimension scores. For instance, in the psychological (17.5% variance) and tactical (11% variance) models, sleep quality lost statistical significance once pelvic organ prolapse symptoms were introduced, highlighting a clear predictor hierarchy. While Lim et al. [23] and Gu et al. [24] established positive sleep-health associations in isolation, our results suggest sleep's salience becomes secondary when acute physical stressors, such as the mechanical burden of prolapse, are concurrently evaluated.

This pattern matches other multi-variable predictive sports models. For example, Brandt et al. found that while sleep correlates with performance, mood states dominate during competition [25]. Similarly, Long et al. demonstrated that sleep characteristics predict perceived exertion as a baseline for perceiving "strain" rather than directly predicting success [26]. Ultimately, our findings suggest sleep functions as a supportive background factor rather than a primary contributor amid structural physiological burdens.

Regarding our secondary focus, initial correlations indicated sleep quality positively associates with total PSP and its psychological and tactical subdimensions. However, being weak and near-threshold, these bivariate associations warrant caution as strictly exploratory baseline characteristics rather than stable trajectories. While Hamlin et al. emphasized sleep parameters are linked to health and perceived training quality [27], our near-threshold results offer only tentative support amid PFD. Similarly, the sensitivity of cognitive-heavy domains in preliminary correlations mirrors Fitton et al. [28] regarding sleep-induced altered mental appraisals; however, owing to statistical weakness, these parallelisms remain purely hypothetical.

Within this context, an unexpected positive correlation occurred between SISQS and PPSS scores. Because higher SISQS scores indicate poorer sleep, this linear relationship tentatively suggests diminished sleep quality paradoxically co-occurs with superior perceived performance, warranting cautious interpretation regarding self-report psychometric dissociation. As noted by Saw et al., subjective dimensions such as sleep quality and readiness do not always covary predictably [29]. In highly motivated athletes, psychological decoupling may occur, where perceived sleep disruption does not automatically impair subjective appraisals of capability [29]. Rather than biological synergy, this correlation underscores the nonlinear complexity of athletic self-appraisals, necessitating future objective, longitudinal designs.

The baseline mechanical burden of prolapse appears to overshadow other wellness factors, though whether this involves an underlying mediation pathway remains open. This establishes a provisional hypothesis for future longitudinal research to explicitly test sleep quality mediation rather than assuming direct mechanistic links from cross-sectional data. This finding addresses the literature gap identified by Canosa-Carro et al., suggesting PFD acts as a primary somatic stressor disrupting traditional performance predictor hierarchies [9]. Furthermore, regarding tactical and physical perceptions, pelvic organ prolapse distress emerged as the sole significant independent negative predictor, suggesting internal mechanical instability undermines confidence during strategic and physical execution.

In contrast to other subdimensions, the technical perception subscale of the PPSS showed no significant associations with PFD symptoms or sleep quality. This dissociation suggests that while somatic variables, such as the perceived mechanical instability of prolapse and variations in sleep quality, coincide with physical, tactical, and psychological performance perceptions, an athlete's subjective evaluation of technical execution remains robust. Consequently, these relationships appear specific to performance domains involving immediate structural load-bearing or real-time psychological readiness, rather than extending to highly practiced technical skills.

In conclusion, while previous research documented the prevalence and qualitative impact of PFD [30], our study provides statistical evidence of its independent predictive power within subjective performance domains, demonstrating a more prominent role than sleep quality. These results emphasize that addressing structural pelvic health, specifically organ prolapse symptoms, is not merely a quality-of-life issue but is closely tied to maintaining athletic self-efficacy. Beyond general pelvic floor training as a performance management tool, our findings highlight the potential value of screening for symptoms of "heaviness" and "instability." Practically, routine pelvic floor health screenings in women's sports could offer early pathways to identify these structural barriers, though their feasibility and cost–benefit ratio must be carefully interrogated. In elite environments, integrated medical teams and substantial resources easily facilitate confidential, routine screenings. Conversely, amateur or recreational sports frequently lack this infrastructure, meaning identification relies heavily on athletes independently recognizing symptoms and seeking specialist support. Therefore, future implementation strategies must balance clinical benefits against the socio-economic realities of different sporting contexts before universally recommending widespread screening protocols. Integrating symptom management into athletic care, while accounting for these logistical and resource constraints, may assist coaches and clinicians in better supporting an athlete's readiness and perceived success.

This study features several methodological and conceptual strengths. A primary strength is the rigorous statistical approach; beyond bivariate correlations, we employed multiple linear regression to evaluate PFD and sleep quality predictive power, providing a nuanced understanding of PSP variance. Furthermore, the PPSS provided a multi-dimensional evaluation encompassing physical, technical, tactical, psychological, and environmental perceptions. Methodological reliability is underscored by an a priori power analysis ensuring the sample size ($n=95$) was robust enough to detect meaningful predictors. Additionally, strictly excluding participants with confounding obstetric or surgical histories ensured the observed PFD was specifically linked to the athletic context. Despite these strengths, our sample was predominantly constrained to young adult women within two disciplines (volleyball and handball). Because PFD prevalence and mechanical triggers vary significantly across sporting contexts, this homogeneity limits external validity, which may not be fully generalizable to female athletes in low-impact or different disciplines.

Several limitations warrant caution when interpreting our results. First, the cross-sectional design precludes causal or temporal inferences among variables. Second, subjective self-reports (PPSS, PFDI-20, SISQS) may introduce recall or social desirability biases due to pelvic health stigma. Third, the SISQS lacks objective sleep architecture data or screening for diagnosed sleep, respiratory, or psychological disorders, introducing unmeasured confounding. Fourth, online data collection prevented clinical assessments (e.g., physical examinations, manometry, ultrasonography) to verify functional integrity. Fifth, although the sample size ($n=95$) was statistically sufficient, the assumed effect size ($r=-0.381$) was derived from a small pilot study ($n=30$), potentially inflating estimates. Sixth, retaining participants with general medical or non-pelvic surgical histories could introduce systemic confounders. Seventh, the sample predominantly comprised volleyball (55.8%) and handball (20.0%) players; this low representation of low-impact disciplines, alongside restricting the cohort to young women, limits its generalizability to broader athletic populations. Eighth, it must be acknowledged that the PPSS currently possesses limited validation beyond Turkish athletic samples, which restricts the broader cross-cultural generalizability of our findings. Finally, the small proportion of elite-level athletes (7.4%) limits generalizability to professional sports' highest echelons.

Future research should employ longitudinal or prospective cohort designs to track pelvic floor health, sleep quality, and performance trajectories over entire competitive seasons. To reduce subjective bias, investigations should incorporate objective diagnostic tools, such as perineometry or rehabilitative ultrasound imaging. Regarding sleep, utilizing wearable technology or polysomnography would provide precise data on efficiency and fragmentation. Additionally, advanced statistical frameworks, such as structural equation modeling or process macro tools, should formally test whether sleep quality mediates the relationship between specific pelvic floor symptoms and performance self-efficacy. Finally, future methodologies must explicitly screen for and exclude clinical sleep disorders, CPAP utilization, and sleep-disrupting psychological conditions to ensure robust outcomes. In tandem, future research should utilize larger, multi-center designs with balanced numbers of participants across diverse sporting contexts, including low-impact, endurance, and power-based disciplines, rather than relying on small pilot cohorts, thereby systematically investigating how specific mechanical loading profiles differentially impact pelvic floor health while avoiding the risk of inflated or unstable effect size estimations. Concurrently, future protocols should implement comprehensive screening to exclude systemic chronic diseases and general surgical histories, even if non-pelvic or non-abdominal, to eliminate physiological confounders biasing symptomatology and performance metrics. Focusing on specific high-impact sports with larger, homogeneous samples of elite and Olympic-level athletes would clarify how extreme physical demands relate to pelvic health. Furthermore, future studies should aim to validate the PPSS across more diverse international athletic populations to enhance its cross-cultural applicability. Finally, interventional studies exploring the effects of pelvic floor muscle training and sleep hygiene education on PSP could provide actionable evidence for sports professionals and coaches.

Conclusion

This study provides preliminary evidence that PSP in female athletes is significantly influenced by pelvic floor health, specifically pelvic organ prolapse symptoms. Our regression models highlight that pelvic organ prolapse distress serves as a dominant independent predictor among the examined variables, though the absolute explained variance remains modest, accounting for 13.7% of the variance in overall PSP, 10.7% in physical, 11% in tactical, and 17.5% in psychological perceptions. Crucially, because most variance remains unexplained, this 'dominance' is strictly relative to the limited predictors tested. Finally, while initial analyses clarified a negative trajectory between poor sleep and performance, regression models reveal that the mechanical burden of PFD acts as a primary somatic barrier, overshadowing sleep quality.

While these cross-sectional findings cannot support immediate clinical guidelines, they establish a foundation for future interventional research to explore whether integrating pelvic health screenings into athletic care yields measurable benefits. If validated longitudinally, coaches, physiotherapists, and sports physicians should consider prioritizing symptoms such as "heaviness" or "instability," as these structural concerns potentially influence athletic self-efficacy and mental confidence. Crucially, implementation must account for competitive levels, given that infrastructure, confidentiality, and feasibility differ substantially between elite and recreational environments. Ultimately, future clinical trials exploring targeted physiotherapy and rehabilitation are required to confirm if these strategies can formally support PSP, safely addressing these stigmatized somatic barriers to optimize the holistic readiness and competitive success of female athletes across appropriate sporting contexts.

Author's Contribution ES: Protocol/project development, data collection/management, data interpretation, manuscript writing/editing; STC: Protocol/project development, data collection/management, manuscript writing/editing; MK: Protocol/project development, data collection/management, manuscript writing/editing; KB: Data collection/management, manuscript writing/editing; DOK: Protocol/project development, manuscript writing/editing.

Data Availability The data that support the findings of this study are available from the corresponding author, [ES], upon reasonable request.

Declarations

Ethical Approval The study was approved by Manisa Celal Bayar University Health Sciences Ethics Committee (Approval No: 20.478.486/3736).

Conflicts of interest None.

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Authors and Affiliations

Erhan Secer[1] · Seyda Toprak Celenay[2] · Merve Keskin[3,4] · Kazim Bayram[5] · Derya Ozer Kaya[3,4]

✉ Erhan Secer
erhnscr86@hotmail.com

Seyda Toprak Celenay
sydtoprak@hotmail.com

Merve Keskin
mervekeskin60@gmail.com

Kazim Bayram
fztkazim@gmail.com

Derya Ozer Kaya
deryaozer2000@yahoo.com

1 Vocational School of Health Services, Department of Health Care Services, Manisa Celal Bayar University, Manisa, Türkiye

2 Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Ankara Yildirim Beyazit University, Ankara, Türkiye

3 Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Izmir Katip Celebi University, Izmir, Türkiye

4 Physiotherapy and Rehabilitation Research and Application Center, Izmir Katip Celebi University, Izmir, Türkiye

5 School of Health Sciences, Department of Physiotherapy and Rehabilitation, Kapadokya University, Nevşehir, Türkiye