Journal of Health, Wellness and Community Research
ISSN: 3007, 0570

OPEN ACCESS

JHWCR

Type: Original Article
Published: 18 August 2025
Volume: III, **Issue**: XI
DOI: https://doi.org/10.61919/g0hpyj46

Correspondence
✉ Muhammad Laeeq,
muhammad.laeeq@uipt.uol.edu.pk

Received 01, 08, 25
Accepted 14, 08, 2025

Authors' Contributions
Concept: ML; Design: ML; Data Collection: L, S, T, N, E; Analysis: ML; Drafting: ML

Declarations
No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

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Heavy Training and Menstrual Dysfunction: A Risk in Female Athletes

Neeraj Abbas[1], Muhammad laeeq[1], Laiba Ahmed[1], Eman Habib[1], Sibgha Fatima[1], Tehreem Fatima[1]

1 The University of Lahore, Lahore, Pakistan

ABSTRACT

Background: Menstrual health is an important indicator of physiological adaptation and overall wellbeing in female athletes, and menstrual dysfunction is frequently linked to high training load and low energy availability. Objective: To determine the occurrence of menstrual dysfunction in competitive female athletes and test its association with heavy training load. Methods: A cross-sectional survey was conducted among 151 competitive female athletes aged 18–35 years at the University of Lahore. Menstrual function and symptoms were assessed using the Menstrual Symptom Questionnaire (MSQ); training exposure was characterized using weekly training hours and the International Physical Activity Questionnaire–Short Form (IPAQ-SF); and low energy availability risk features were screened using the LEAF-Q. Associations between training exposure group (low, moderate, high) and menstrual function category (regular, irregular, amenorrhea) were evaluated using chi-square testing, with effect size and odds ratios (ORs) with 95% confidence intervals (CIs). Results: Overall, 58.3% (88/151) reported menstrual dysfunction, including amenorrhea in 25.8% (39/151) and irregular cycles in 32.5% (49/151), while 41.7% (63/151) reported regular cycles. Menstrual function differed significantly by training exposure ($\chi^2 = 67.693$, $df = 4$, $p = 0.001$; Cramér's $V = 0.473$). High training athletes had substantially higher odds of menstrual dysfunction versus low training athletes (OR 37.00, 95% CI 10.87–125.96). Conclusion: Heavy training load was strongly associated with menstrual dysfunction and multidimensional symptom burden in competitive female athletes, supporting routine menstrual health monitoring, education, nutritional support, and multidisciplinary care.

Keywords
menstrual dysfunction; heavy training; amenorrhea; oligomenorrhea; dysmenorrhea; female athletes; RED-S; physiotherapy

INTRODUCTION

Menstrual health is increasingly recognized as a core biomarker of overall health and training tolerance in female athletes because it reflects the integrity of hypothalamic–pituitary–ovarian axis signaling, recovery capacity, and longer-term endocrine and skeletal protection.(1) In athletic populations, menstrual dysfunction (MD), including amenorrhea, oligomenorrhea, and clinically burdensome menstrual symptoms, has been repeatedly linked to low energy availability, high cumulative training stress, and psychosocial strain, and is now conceptually embedded within the broader framework of relative energy deficiency in sport (RED-S).(2,3) Beyond reproductive implications, MD is clinically relevant because it co-occurs with fatigue, mood disturbance, impaired training adaptation, higher injury risk, and adverse bone outcomes that can compromise performance sustainability and future health.(1,2)

Although exercise is often beneficial for menstrual symptom control in the general population, the relationship is non-linear: moderate activity may reduce dysmenorrhea and perceived symptom burden, whereas prolonged high-volume and/or high-intensity training, especially when not matched by adequate dietary intake and recovery, appears to increase the risk of cycle disruption and related symptoms.(4,5) Large observational datasets of physically active women have shown that higher weekly training exposure, irrespective of intensity domain, is associated with amenorrhea/oligomenorrhea risk, supporting a dose–response pattern consistent with energy-deficiency physiology.(5) In elite and competitive cohorts, menstrual irregularities remain common across sport types and may be concentrated in endurance and aesthetic disciplines, as well as in athletes with low body mass or restrictive eating behaviors, reinforcing the multifactorial nature of MD in sport.(6–8) Importantly, knowledge and communication barriers in athletic settings frequently limit early identification; athletes may normalize missed cycles, and coaches/support staff may lack structured, evidence-based approaches to menstrual health conversations and surveillance.(9–11)

Despite increased female participation in competitive sport, region-specific evidence from South Asia remains comparatively limited, and cultural stigma may further suppress disclosure, delay care-seeking, and reduce institutional prioritization of menstrual health monitoring.(10,11) This context creates a practical knowledge gap for coaches, physiotherapists, and sports medicine teams regarding the local occurrence of MD and its measurable association with training load among competitive female athletes. Therefore, this study aimed to estimate the occurrence of menstrual dysfunction among competitive female athletes and to test whether menstrual dysfunction is associated with heavy training load (higher weekly training exposure). The study hypothesis was that heavier training load is significantly associated with greater menstrual dysfunction prevalence and severity.(2,5)

MATERIALS AND METHODS

A cross-sectional observational survey was conducted among competitive female athletes aged 18–35 years at the University of Lahore over a six-month period following synopsis approval. Participants were recruited using convenience sampling from organized sports and athletic programs. Eligibility criteria included current engagement in regular training with a continuous training history of at least six months, non-pregnant and non-lactating status, and voluntary participation with written informed consent in English or Urdu. Athletes were excluded if they reported endocrine disorders that could independently affect menstrual function (including polycystic ovary syndrome or thyroid dysfunction), current use of hormonal contraceptives or medications affecting menstrual cycles, chronic systemic disease, pregnancy within the prior 12 months, diagnosed eating disorders under active medical/psychiatric care, major surgery or hospitalization within the previous six months, inability to complete questionnaires in Urdu/English, or withdrawal of consent during participation.(2,12)

Data were collected using a structured questionnaire package comprising: (i) the Menstrual Symptom Questionnaire (MSQ) to quantify menstrual symptoms and menstrual-cycle-related dysfunction across relevant domains; (ii) the International Physical Activity Questionnaire–Short Form (IPAQ-SF) to quantify physical activity exposure over the prior seven days, enabling standardized characterization of training load through activity duration and intensity categories; and (iii) the Low Energy Availability in Females Questionnaire (LEAF-Q) to screen for low energy availability risk and related symptom patterns, including gastrointestinal symptoms and injury history.(13–15) The primary outcome was menstrual function status categorized as amenorrhea, irregular cycles, or regular cycles based on menstrual symptom and cycle-pattern reporting. The primary exposure was training load operationalized using weekly training hours and activity profile captured via IPAQ-SF; participants were grouped into low, moderate, and high training exposure strata as per the study dataset grouping used for inferential analysis. Additional variables included sport type distribution, MSQ symptom severity patterns, injury history, and gastrointestinal symptom reporting as markers aligned with energy availability risk screening constructs.(2,14,15)

To reduce information bias, participants were briefed on questionnaire completion procedures and provided standardized definitions where required; anonymity was maintained to reduce social desirability bias for sensitive menstrual health disclosures. The sample size was set at 151 using a priori planning with Epitools. Data were analyzed using SPSS (version 25) with two-sided significance set at $p < 0.05$. Descriptive statistics were reported as mean ± standard deviation for continuous variables and frequency (%) for categorical variables. Associations between training exposure group and menstrual function category were evaluated using Pearson's chi-square test, with effect size reported using Cramér's V for contingency association magnitude. For clinically interpretable contrasts, odds ratios (ORs) with 95% confidence intervals (CIs) were computed for menstrual dysfunction (amenorrhea or irregular cycles) versus regular cycles between training exposure strata using 2×2 aggregation. Ethical approval procedures followed University of Lahore ethics committee requirements, and all participants provided written informed consent; confidentiality and voluntary withdrawal rights were protected throughout data handling.(12)

RESULTS

Training exposure stratification demonstrated a marked gradient in menstrual function. In the high training group (n = 48), amenorrhea was observed in 29 athletes (60.4%) and regular cycles in only 4 athletes (8.3%). In contrast, the low training group (n = 48) showed amenorrhea in 3 athletes (6.3%) and regular cycles in 37 athletes (77.1%), with the moderate group (n = 55) intermediate (amenorrhea 12.7%, regular cycles 40.0%) (Table 4A). The association between training exposure group and menstrual function was statistically significant ($\chi^2 = 67.693$, df = 4, $p = 0.001$) with a moderate-to-large association magnitude (Cramér's V = 0.473) (Table 4B). When menstrual dysfunction was dichotomized as amenorrhea/irregular cycles versus regular cycles, the odds of dysfunction were substantially higher in high training athletes compared with low training athletes (OR 37.00, 95% CI 10.87–125.96) and remained elevated versus the moderate group (OR 7.33, 95% CI 2.31–23.32), supporting a strong exposure–outcome gradient (Table 4C).

Table 1. Participant Characteristics (Descriptive Statistics)

Variable	N	Minimum	Maximum	Mean	SD
Age (years)	151	18	35	26.77	5.09
Training hours/week	151	8	25	15.30	5.29
MSQ total score	151	6	29	17.33	4.45

Table 2. Sport Type Distribution (N = 151)

Sport type	n	%
Football	19	12.6
Gymnastics	25	16.6
Swimming	34	22.5
Track & field	34	22.5
Volleyball	39	25.8

Table 3. Menstrual Function Status (Primary Outcome)

Menstrual function category	n	%
Amenorrhea	39	25.8
Irregular cycles	49	32.5
Regular cycles	63	41.7

Table 4. Training Exposure Group vs Menstrual Function, With Association Statistics A. 3×3 cross-tabulation

Training exposure group	Amenorrhea (n)	Irregular (n)	Regular (n)	Total

High	29	15	4	48
Moderate	7	26	22	55
Low	3	8	37	48
Total	**39**	**49**	**63**	**151**

B. Chi-square and effect size

Test	Statistic	df	p-value	Effect size
Pearson chi-square	67.693	4	0.001	Cramér's V = 0.473

*C. Odds ratios*MD defined as amenorrhea or irregular cycles; reference outcome = regular cycles.*

Comparison	OR	95% CI
High vs Low	37.00	10.87–125.96
High vs Moderate	7.33	2.31–23.32
Moderate vs Low	5.05	2.13–11.95

Table 5. MSQ Symptom Severity Profile (Score ≥3 indicates moderate-to-severe burden)

MSQ domain	n with score ≥3	% (of 151)
Cycle regularity disturbance	77	51.0
Amenorrhea symptom burden	80	53.0
Oligomenorrhea symptom burden	78	51.7
Dysmenorrhea	68	45.0
Heavy menstrual bleeding	74	49.0
Fatigue	69	45.7
Mood changes	74	49.0

Table 6. Injury History and Gastrointestinal Symptoms

Variable	Category	n	%
Injury history	Yes	55	36.4
	No	96	63.6
Gastrointestinal symptoms	Yes	36	23.8
	No	115	76.2

Symptom burden patterns were also prominent, with approximately half of the cohort reporting moderate-to-severe disturbance across multiple MSQ domains: cycle regularity disturbance (51.0%), amenorrhea symptom burden (53.0%), oligomenorrhea symptom burden (51.7%), heavy menstrual bleeding (49.0%), and mood changes (49.0%), while dysmenorrhea (45.0%) and fatigue (45.7%) affected nearly one in two athletes at moderate-to-severe levels (Table 5). Markers aligned with low energy availability risk screening constructs were also present: 36.4% reported prior injury history and 23.8% reported gastrointestinal symptoms (Table 6). Collectively, these findings indicate that menstrual dysfunction in this cohort is both prevalent and strongly patterned by training exposure, with a concomitant multidimensional symptom burden.

DISCUSSION

This study demonstrates a strong, clinically meaningful association between heavier training exposure and menstrual dysfunction among competitive female athletes aged 18–35 years. The high-training group showed a pronounced shift away from eumenorrhea, with regular cycles observed in only 8.3% (4/48), while amenorrhea alone affected 60.4% (29/48). In contrast, the low-training group had predominantly regular cycles (77.1%, 37/48) with amenorrhea in only 6.3% (3/48). The observed association was statistically robust ($\chi^2 = 67.693$, $p = 0.001$) and of moderate-to-large magnitude (Cramér's V = 0.473), and the odds of menstrual dysfunction (amenorrhea/irregular cycles) were markedly higher in high-training athletes versus low-training athletes (OR 37.00, 95% CI 10.87–125.96). These findings align with contemporary models that position menstrual disturbance as an early, observable marker of maladaptation to training stress, particularly when cumulative load is not adequately matched by energy intake and recovery capacity, as emphasized in RED-S and female athlete triad paradigms.(16–18)

The symptom profile further supports a multidimensional burden, with approximately half of athletes reporting moderate-to-severe disturbance across cycle regularity, amenorrhea/oligomenorrhea burden, heavy menstrual bleeding, mood changes, fatigue, and dysmenorrhea. This pattern is consistent with systematic syntheses indicating that female athletes commonly experience both cycle disorders and cycle-related symptoms that affect health and training availability, and that symptom burden is not restricted to one sport type or performance tier.(19) Mechanistically, heavy training may contribute to functional hypothalamic suppression through sustained low energy availability and neuroendocrine stress, reducing gonadotropin-releasing hormone pulsatility and downstream ovarian steroidogenesis, which clinically manifests as oligomenorrhea or amenorrhea.(17,20,21) The co-occurrence of fatigue, mood changes, gastrointestinal symptoms (23.8%), and injury history (36.4%) in this cohort is also compatible with a broader energy-deficiency phenotype in which musculoskeletal resilience, gut function, and psychological wellbeing are affected alongside reproductive function.(16,18,22)

When contextualized with prior literature, the present prevalence of non-regular menstrual function (58.3%) sits at the higher end of reported ranges, likely reflecting the combination of intensive training exposure in a university competitive setting and sociocultural barriers that delay recognition and structured care. Large datasets of active women recruited via digital training platforms have similarly demonstrated that greater weekly training exposure is associated with higher risk of amenorrhea/oligomenorrhea, supporting a dose–response relationship that is not limited to elite sport alone.(23) Studies in elite cohorts have also reported substantial menstrual disorder prevalence and have emphasized the need for routine surveillance and clinical pathways, particularly where low energy availability or restrictive eating behaviors co-exist.(24–26) The high

proportion of athletes with moderate-to-severe menstrual symptom domains in this study indicates that the clinical impact extends beyond cycle timing to day-to-day function, reinforcing calls for menstrual health literacy interventions and improved communication structures within athlete support environments.(27,28)

From a practice standpoint, these data support integrating menstrual-cycle monitoring into routine athlete health screening, with particular attention to athletes in high weekly training exposure strata. Screening tools that capture menstrual patterns and low energy availability risk can be combined with education for athletes, coaches, and allied health staff to reduce normalization of amenorrhea and improve early referral for nutritional assessment, training-load modification, and psychosocial support.(16,18,27) Training periodization that explicitly manages cumulative load, recovery, and fueling strategies is likely central to prevention, while multidisciplinary care pathways are recommended when dysfunction is identified to mitigate longer-term consequences for bone health, fertility, and performance sustainability.(16–18) Future research in this setting should prioritize longitudinal designs, incorporate objective exposure metrics (e.g., session-RPE load, wearable-derived volume), and include biochemical or clinical indicators (e.g., dietary intake assessment, bone indices) to better clarify causal pathways and identify modifiable risk thresholds.

CONCLUSION

In competitive female athletes, heavier training exposure was strongly associated with menstrual dysfunction, with a substantial gradient in amenorrhea and irregular cycles across training strata and a concurrent high burden of menstrual symptoms affecting physical and psychological wellbeing; these findings support routine menstrual health monitoring and early multidisciplinary intervention (education, nutrition-focused fueling support, and training-load optimization) to protect long-term health and performance sustainability.

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