Original Article

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Challenges and Opportunities: Addressing Gender Issues in Elite Sports

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Abstract: *Background.* The present study identifies the most critical practical challenges related to gender issues that elite female athletes and their coaches face when utilizing classical methods to monitor and assess general physical preparedness. *Material and methods.* An innovative approach was taken by conducting experimental studies to assess the practical effectiveness of applying classical scientific methods to gender differences in the overall physical fitness of elite female athletes. This approach, particularly in strength exercises such as the barbell squat, facilitated a multidimensional understanding of the profiles of 41 elite male and female athletes in team sports, including method of expert evaluation, psychophysiological, anthropometric, and biomechanical analyses. Considering the hormonal fluctuations inherent to the female body, we analyzed the results of a specialized Romberg test recorded exclusively during and designed for use with the optimal phases of the menstrual cycle they were subjected to analysis. *The results* demonstrated that female athletes exhibited an even higher quality of balance function during barbell squats (216 ± 2%) compared to their male counterparts (173 ± 3%). Our research experiment demonstrated that female athletes and their coaches encounter several practical challenges. Most monitoring methods necessitate the use of laboratory equipment, significantly entail considerable financial and time temporal costs, and are challenging to implement. *Conclusions.* In the context of new evolving technologies, the logistical challenge of developing reliable methodologies to monitor and support women's health in the context of fitness and sport is evident, as optimizing performance and ensuring long-term well-being is of crucial paramount importance.

Keywords: elite female athletes, gender characteristics, elite sports, special physical preparedness, hormonal fluctuations.

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INTRODUCTION

Female sports have achieved remarkable milestones in recent years, reflecting the concerted gender strategy efforts of all international sports organizations [1]. One example of the substantial progress in female sports is the gender strategy implemented by the International Olympic Committee (IOC). Over the years, the IOC has made significant strides in promoting gender equity. For instance, no women participated in the Games of the I Olympiad in Athens (1896). However, by the 26th Olympic Games in Atlanta (1996), the participation of female athletes increased to 34.2% of the total number of participants. This trend continued, and the Paris 2024 Olympic program aims for 50% participation of men and women, highlighting the IOC's commitment to gender equality in sports. Despite this progress, there remain substantial gaps in gender-specific research, particularly in training methodologies for female athletes.

Despite progress in female sports, informal observations suggest that general sports science provisions and infrastructure for many sportswomen lag behind those available to sportsmen [2]. Women competing at comparable levels to men may have less access to sports performance support (e.g., sports and medical science), possibly resulting from understated funding indicators. In terms of sports preparedness level, distinct gender differences have been observed in anthropometrics [3-5], physical performance [6-12], physiological characteristics [13,14], and movement demands [15-18]. The data on the lower percentage of skeletal muscles in the body composition, lower maximum velocity, and strength of women compared to men have been revealed [15,19,20]. The influence of the ovulatory-menstrual cycle on women's sports performance has been investigated in-depth [21-28]. The valuable insights into gender-specific issues in sports and the unique training needs of female athletes [27-32].

Research into gender-specific issues in sports science has made significant strides worldwide, yet numerous questions remain, particularly regarding female sports [10,11,33]. One critical problem is that many coaches of female teams still use male training programs, which can be especially dangerous for female health in strength training. Based on the works of the authors mentioned above, we have identified the leading indicators of the gender-specific psychophysiological, physiological, anthropometric, and biomechanical characteristics that influence the physical preparedness and effectiveness of strength exercises like squats with a barbell among elite athletes. While elite athletes generally require exceptional physical preparedness, these gender-specific factors highlight the importance of tailoring training programs, technique coaching, and performance monitoring to address male and female athletes' unique physiological, biomechanical, and psychophysiological characteristics in strength-based sports and exercises. Furthermore, some studies comparing male and female athletes suggest that men excel in most physical abilities.

The study aims to identify the most critical practical challenges related to gender issues that elite female athletes and their coaches face when utilizing classical methods to monitor and assess general physical preparedness. In planning the experimental portion of the study, several tasks were defined: To reveal the main problems in elite sportswomen's training and competitive processes using expert estimations; To determine anthropometric, psychophysiological, and biomechanical indicators of men and women in the experimental group to analyze gender differences; To compare the results of tests for the effectiveness of general physical training exercises, squats explicitly with a barbell were used between two gender groups, and data were collected from women only in the optimal phases of the ovulatory-menstrual cycle. Concerning this, the following research questions have been formulated:

- What are elite female athletes and their coaches' primary challenges in monitoring and assessing general physical preparedness using classical methods?

- How do anthropometric, psychophysiological, and biomechanical indicators differ between elite male and female athletes, and what implications do these differences have for training practices?
- How does the ovulatory-menstrual cycle influence the performance outcomes of general physical training exercises in elite female athletes?
- How can gender-specific adaptations to innovative monitoring and assessment methods improve training effectiveness for elite female athletes?
- These questions address our study's core aim while providing a structured foundation for experimental inquiry and analysis.

MATERIAL AND METHODS

Participants

From 160 respondents, an expert group of 20 sports scientists and coaches of national teams experienced in working with elite female athletes was selected.

Two independent groups were compared to determine the leading indicators of the gender-specific psychophysiological, physiological, anthropometric, and biomechanical characteristics that influence the physical preparedness and effectiveness of strength exercises like squats with a barbell of elite male versus female athletes competing in basketball (women, n = 10; men, n = 14), handball (women, n = 3; men; n = 5), and volleyball (women, n = 4; men, n = 5). All participants were informed of the study's objectives, provided written informed consent, and willingly agreed to participate.

The Bioethics Commission of the National University of Physical Education and Sports of Ukraine supported experimental research protocols that adhered to the ethical standards of the Helsinki Declaration (protocol № 2 on 15.03.2024).

Procedure

The research lasted from 2021 to 2024 and was conducted in four sequential stages across Ukraine and Switzerland. Twenty distinguished experts representing diverse countries (America, Canada, England, Switzerland, Norway, China, Ukraine, Poland, and South Africa) were engaged, each with substantial experience collaborating with elite female athletes.

In Switzerland, the contemporary challenges in women's training for high-achieving sports were evaluated from June 1 to August 25, 2022. The observation period spanned from March 1, 2021, to January 25, 2022. Various performance indicators were meticulously recorded, encompassing balance function quality with and without visual control, attention efficiency, voluntary attention volume, productivity, motivational and volitional coefficients, typological components, and stress resistance. This comprehensive analysis aimed to provide a gender-nuanced understanding of the cognitive and psychological aspects influencing elite athletes in these sports disciplines.

Concurrently, we discerned the most cited countries, authors, and topics within the realm of sports science. In the second stage of the literature review, a comprehensive content analysis was undertaken, focusing on specialized information about research in the domain of female sports. This scrutiny was confined to leading countries exhibiting prominence in highly cited papers within sports sciences. This twofold approach ensured a nuanced understanding of the landscape, encompassing both global trends and the specific nuances of research on female sports in critical countries (America, Canada, England, Switzerland, Norway, China, Ukraine, Poland, and South Africa).

Method of Expert Evaluation

An expert survey was employed, a method reliant on the insights of competent and experienced specialists. From the initial pool of 160 respondents, a specialized expert group focusing on gender-specific issues comprised 20 sports scientists and coaches of

female national teams. These experts hailed from various countries, including America, Canada, England, Switzerland, Norway, China, Ukraine, Poland, and South Africa, all demonstrating substantial experience working with elite female athletes.

The experts were tasked with identifying contemporary challenges in women's training in high-achievement sports.

The degree of agreement among experts was quantified using Kendall's concordance coefficient (W). In addition, the normative coefficient of significance (α) was determined, representing the reciprocal of the number of ranked factors. This rigorous methodology ensured the reliability and validity of the expert opinions gathered in addressing contemporary issues in training elite female athletes.

Medical Research Methods

We investigated the impact of hormonal fluctuations throughout the menstrual-ovulatory cycle on women's coordination abilities and overall physical condition, aiming to explore potential reciprocal influences. A comprehensive series of control tests involving intricate exercises such as squat jumps and nonstandard movements were conducted under dynamically changing conditions and time constraints. The phases of the ovulatory-menstrual cycle in 17 female athletes were determined through basal temperature measurement, a specialized anonymous questionnaire, and the "fern leaf" phenomenon method. Cervical mucus (or mucus obtained from the nasal cavity) was allowed to air dry, leading to crystallization and changes in its physical and chemical properties, which depended on the menstrual cycle phase and the estrogenic influence of the ovary.

Psychophysiological and Biomechanical Methods for the Performance Tests

To determine the model characteristics of the optimal psychophysiological state of elite male and female athletes during exercise activity, we used indicators of the quality of the balance function with and without visual control, the efficiency of attention, the volume of voluntary attention, productivity, coefficients of motivational, volitional, and typological components, and stress resistance. When conducting psychophysiological testing, 41 elite athletes competing in basketball, handball, and volleyball were initially asked to pass the proposed tests in training. The attention span of elite athletes was determined according to standard methods. The results were characterized by the number of objects perceived by the athlete in less than 1 s of completing the task, determined using 16-cell tables (4 × 4) with the location of points on them in various variants. The examination was carried out for 0.75 s for each table.

The state of the primary mental functions was assessed using a computer test of psychophysiological diagnosis. Based on the test results, the coefficient of operational thinking (COT) was calculated: $COT = Nr / T \cdot 100$, where T was the average time for completing the test task (ms), and 100 was the coefficient. Short-term visual memory was investigated using Makarenko's method [35], where the subjects were given a table with ten drawn two-digit numbers not logically connected for 30 s. During the specific exposure time, the subjects wrote the numbers memorized in random order in the protocol within 1 minute. To translate the results into points on a nine-point scale.

In addition, hand dynamometry was used to determine the maximum hand strength of elite athletes. Hand strength was measured using a CAMRY electronic hand dynamometer (model EH 101), with d-100 g and max–90 kg. The best performance from three attempts with each hand was recorded in the study protocol.

The quality of the balance function is one of the most critical informative stabilometric indicators - the higher the value, the better the athlete can maintain balance. Thus, standard and complicated (incorporating psychophysiological assessments) Romberg tests were used to assess its level. To determine the level of development of the balance function of athletes, standard and complicated Romberg tests with open and closed eyes were used with the help of the stabilographic complex "Stabilan-01."

The kinetic stability of the body of elite female and male athletes was assessed directly during the performance of tests using universal (e.g., displacement of the center of pressure, spread along the axes, length of the statokinesigram curve, assessment of movement, and quality of the balance function) and special tests (e.g., area of the deviation zone, the number of points scored, and errors with visual and verbal stimuli) indicators.

Importantly, this method was not only biomechanical because we used Romberg tests consisting of two parts: 1) with open eyes (visual stimulation using alternating-colored circles on a screen) and 2) closed eyes (sound stimulation using tone signals). This setup allowed us to qualitatively assess biomechanical and psychophysiological gender differences among elite athletes specializing in sports.

Statistical Analysis

This study assessed the normality of data distribution to ensure the validity of subsequent statistical analyses. The Shapiro-Wilk test was applied to evaluate whether the data followed a normal distribution within each group (women, n=17; men, n=24). Levene's test was also employed to test the assumption of equal variances between the groups. These preliminary checks validated the assumptions necessary for further analyses, such as the Student's t-test, which was used to compare the means of the two independent groups. Ensuring these assumptions allowed for accurate interpretation and consistency of the results across all data subsets. The study maintained methodological rigor using parametric methods where data followed a normal distribution. Alternative non-parametric methods, such as the Mann-Whitney U test, would have been considered for non-normal data or when the normality assumption was in doubt. However, in this case, the adherence to the normal distribution law supported the appropriateness of parametric testing. Finally, the reliability level of 95% (significance level p<0.05) ensured that the findings were statistically robust. Correlation analyses and measures of agreement, such as Kendall's concordance coefficient and Spearman's rank correlation coefficient (ρ), complemented the t-test by exploring relationships and interdependencies, further validating the statistical framework of the study. The difference between two independent means (17 women and 24 men): Type of power analysis - A priori; Effect size (Cohen's d) - 0.8 (large); α err prob - 0.05; Power (1-β err prob) - 0.60. The mathematical and statistical processing and data analysis were conducted using Statistica (Statsoft, version 7.0) and Microsoft Excel 2010.

RESULTS

An expert assessment was conducted to determine the most important factors in the structure of women's sports training, considering the problems of modern sports training for elite athletes and the peculiarities of sexual dimorphism. The following factors were highly prevalent in experts' answers concerning problems in women's sports: 1) load planning during special physical training similar to men, 2) transferring the training models of male athletes to the training of women, 3) outdated systems of training female athletes without considering their biological cycles, 4) old injuries or illnesses due to the incompetence of previous or youth coaches, 5) insufficient pharmacological and medico-biological support of women's national teams during training, competitions, and recovery, and 6) less attention to women's sports in financial and organizational aspects.

An analysis of the materials of expert assessment was conducted to identify the general experts' opinions regarding the existing gender problems on the effective development of elite women's sports. For this purpose, we created a matrix of ratings of ranked factors by each expert. Considering W = 0.94, an approximate result of 1, the experts' assessments had the highest level of agreement. Thus, we accepted the hypothesis of an agreement between specialists and determined that the results of the expert group's questionnaire could be trusted. Expert analysis in modern conditions is one of the most effective means of obtaining and analyzing qualitative information to identify existing problems in the practice of elite female sports [10, 11].

Therefore, considering the results of modern scientific research and using a systematic approach to evaluating the innovative potential of the development of women's sports, following the main gender problems in high-achievement sports identified by experts, we divided the obtained indicators for its evaluation into three groups: 1) improper training load planning, 2) insufficient awareness of the youth coach, and 3) the impact of "gender inequality" in society (Table 1).

The processing of expert evaluation data was the source material for synthesizing predictive hypotheses and options for optimal ways to increase the effectiveness of managing elite female athletes' training and competitive activities. Hence, based on the defined problems and available scientific developments in female sports, we examined complex coordination sports with an anaerobic-aerobic load, where the basis of special physical training consists of speed-strength direction exercises and coordination. Specifically, according to regulations in sports games (e.g., basketball, volleyball, and handball), the volumes of loads in competitions are the same for men and women. They are sometimes incorrectly interpreted when building the training process of female athletes, especially when transferring male models using the same techniques of performing movements, methods, and amounts of load during special physical training.

Many scientific studies on gender characteristics in sports have indicated that men and women differ considerably in their psychophysiological properties. Women are characterized by greater emotional excitability than men and increased sensuality. Athletes often react negatively to the atmosphere of competitions, and excessive excitement may disrupt their ability to achieve higher results. The statistical analysis of the results using the non-parametric Mann-Whitney U-test showed that, in general, men were likely to differ from women in the following indicators (Table 2): the latency period of a simple visual-motor reaction and a complex visual-motor reaction of choosing two of three stimuli ($p < 0.05$) [10,11].

Table 1. Gender-specific problems in elite sports using expert evaluation (n = 20)

Group No.	Group name	The main gender-specific problems in elite sports				
Group I	Improper training load planning	Training without considering biocycles	Load planning during special physical training similar to men	Transferring male athlete training models to women	Low qualifications of national female sports coaches	The same requirements for women's sports results as for men's
Group II	Insufficient awareness of the youth coach	Old injuries as a result of the youth coach's incompetence	Low awareness of the youth coach about female sports	Girls' technical and tactical preparation is similar to that of boys	Forcing training and competition loads without considering age characteristics	Psychological breakdown in elite female sports due to youth sports
Group III	Impact of "gender inequality" in society	Less attention to women's sports in financial and organizational aspects	Insufficient pharmacological and medico-biological support in female sports	Low levels of scientific and logistical support for women's national teams	Fewer participants in female sports on average	Lower funding in female sports, so lower motivation to stay in professional sports

Table 2. Differences in values of indicators of neurodynamic functions between elite female (n = 17) and male athletes (n = 24)

Indicator	Female athletes		Male athletes		t	p
	Mean	SD	Mean	SD		
A latency period of a simple visual-motor reaction (ms)	265.09	32.03	234.24	21.55	3.46	**<0.01**
A latency period of a complex visual-motor reaction of choosing two out of three stimuli (ms)	451.28	54.89	411.62	44.66	2.46	**<0.01**
Functional mobility of nervous processes (stimuli/minutes)	86.31	11.83	89.27	15.36	0.70	<0.05
Strength of neural processes (% of errors)	5.38	2.11	4.75	0.97	0.57	<0.05
A latency period of a simple visual-motor reaction (ms)	265.09	32.03	234.24	21.55	3.46	**<0.01**
A latency period of a complex visual-motor reaction of choosing two out of three stimuli (ms)	451.28	54.89	411.62	44.66	2.46	**<0.01**

M = mean; SD = standard deviation; t = result of t-test; p = statistical significance

Table 3. Differences in values of indicators of anthropometric measurements and dynamometry metrics between elite female (n = 17) and male athletes (n = 24).

Name of metrics	Female athletes		Male athletes		t	p
	Mean	SD	Mean	SD		
Athlete's age (years)	20.11	3.12	19.83	3.06	0.29	<0.05
Body length (cm)	178.36	11.32	184.24	12.35	1.58	<0.05
Body weight (kg)	58.12	4.15	77.20	5.41	12.81	**<0.01**
Dynamometry of the dominant hand (kg)	30.59	3.54	53.54	4.75	17.65	**<0.01**
Dynamometry of the non-dominant hand (kg)	29.06	3.42	50.67	5.26	16.00	**<0.01**

M = mean; SD = standard deviation; t = result of t-test; p = statistical significance

The latency periods of a simple visual-motor reaction were the shortest for men ($p < 0.05$); more precisely, the average value of latent periods of simple visual-motor reaction for men was = 234.24 ms, with standard deviation – SD = 21.55 ms and – 265.09 ms and 32.03 ms for women, respectively. Defining the latent period of the choice reaction in sports games is critical because its duration determines the athlete's speed qualities, which are essential in speed-strength sports.

Thus, the average latency period of the choice 2–3 reaction in men was = 411.62 ms, with standard deviation – SD = 44.66 ms and – 451.28 ms and 54.89 ms for women, respectively. Such results are attributed to the fact that the activity of a woman's nervous system is much more mobile and tightly associated with different biological factors of the body than in men. Thus, the analysis of the obtained indicators revealed that the manifestation of the characteristics of psychophysiological functions for men and women differed according to gender. More specifically, attention predominates for men and mobility and strength of nervous processes for women.

The function of motherhood determines the formation of several features of the female body structure and the activity of many organs and systems of the body in different periods of life. For instance, physiological features of a woman's bone and joint apparatus are a special configuration and size of the body, the prevailing length of the spine with height, a short and wide chest, and the characteristic placement of the femoral head and neck.

The round shape of a woman's body is caused by a subcutaneous fat layer comprising 28% of her body weight (only 18% in men) because the oxidative processes in women proceed much more slowly. The subcutaneous fat layer is a protective barrier for the female body, requiring much energy during menstruation and pregnancy. Therefore,

all listed aspects represent crucial factors that a coach should consider in the training process for women, especially concerning speed-strength exercises [10,11].

Anthropometric measurements of elite athletes in two experimental groups enabled determining that, on average, women's bodies are longer than men's, whereas arms and legs are shorter. Specifically, female athletes in the group were 5.88 cm shorter in height and 7–8 kg lighter in weight, explained by the smaller volume of the woman's body and the weaker muscle development.

In addition, women's muscle strength is much lower than men's because their muscles are thinner and have many layers of fatty tissue. We determined the following indicators of hand strength for elite athletes using the dynamometry method: statistically significant differences $p < 0.01$ in male athletes' dynamometry of the dominant (53.54 ± 4.75 kg) and non-dominant (50.67 ± 5.26 kg) hands compared to the group of female athletes' dynamometry of the dominant (30.59 ± 3.54 kg) and non-dominant (29.06 ± 3.42 kg) hands (Table 3). Hand dominance was determined using a standardized self-report questionnaire alongside practical tests of manual dexterity and grip strength.

In a large-scale study, we investigated the impact of hormonal changes associated with the ovulatory-menstrual cycle on women engaged in team and individual sports. The study aimed to evaluate the specific effects on their athletic performance. Our analysis confirmed findings from prior research [27,28,34,36-39] and broadened our understanding of how hormonal fluctuations in different phases of the ovulatory-menstrual cycle impacted female athletes during their sports training. Key findings included:

- Menstruation Phase (Days 1-5): Characterized by a decrease in muscle strength and endurance, longer motor reaction times, and reduced speed, but an increase in short-term work capacity. Additionally, this phase often saw occurrences of depression and indifference in the initial days.
- Postmenstrual Phase (Days 6-12): This phase demonstrated the most favorable parameters for achieving heightened sports and technical performance. The autonomic nervous system was in a balanced state during this period.
- Ovulation Phase (Days 13-14): Marked by decreased work capacity, attention, and the ability to execute new technical actions accurately.
- Postovulatory Phase (Days 14-22): This phase signified the peak of working capacity, resembling the advantageous features of the second phase.
- Premenstrual Phase (Days 23-28): Known for observable reduced coordination abilities, speed, endurance, and overall work capacity.

Integrating psychophysiological, anthropometric, and hormonal analyses provided a comprehensive understanding of female athletes' unique physiological and hormonal profiles. These insights could profoundly inform the design of tailored training programs to maximize the performance and well-being of female athletes. Furthermore, by combining knowledge of hormonal fluctuations with gender-specific physiological characteristics, we conducted an experimental Romberg test exclusively for female athletes during their 2nd and 4th menstrual cycle phases, which was known for yielding optimal coordination ability results. However, women outperformed men in the accuracy of movement coordination, demonstrating that female athletes obtained significantly better indicators of the quality of the balance function.

The balance function is an integral characteristic of the human condition. In sports, various tests are often used, including stabilometric tests for balance, to assess the psychophysical state of an athlete. Such studies are relevant because the use of the stabilographic control technique for assessing the kinetic stability of the body of athletes is a modern diagnostic tool for normal conditions and various disorders. Furthermore, it can be used to control the quality training of the vestibular analyzer, coordination abilities, and psychophysiological sustainability.

To assess the level of development of the balance function of elite female and male athletes, standard and complicated Romberg tests were used with open and closed eyes,

using visual stimulation (e.g., alternating-colored circles) in the first case and sound stimulation (e.g., tone signals) in the second case. The posture of the athletes was modeled using the technique of the initial position during the exercise - squat with a barbell. As shown, women achieved very good postural stability under the influence of external stimuli, both with and without visual control.

Interestingly, for men, there was a deterioration in the indicators of posture stability under the influence of external verbal stimuli without visual control. Based on the comparison of the stabilograms of two samples, we determined the degree of visual stability of standing and feedback provided by optical sensitivity (i.e., the Romberg coefficient) and the significant differences between the results of men (173 ± 3%) and women (216 ± 2%; see Table 4). The higher the percentage, the better the athlete was coordinated and trained. Considering the ratio of the quality of the equilibrium function of elite athletes without and with visual control, significantly higher indicators were observed for the women (0.98 ± 0.02) than the men (0.78 ± 0.06).

A determined difference in the time characteristics of the visual-motor reactions of elite athletes of different sexes that differed in complexity affected the reduced determinism and increased stochasticity in the information processing system in women compared to men. The stochasticity of the functional system ensures the search for the necessary links to determine the optimal level of functioning. Thus, stochasticity in women in the conditions of sports activities is a basis for forming a functional system of information processing, which enables a compensatory search for the optimal organization of the integrative function of the brain in the conditions of adaptation to sports activities. Thus, one psychophysiological feature of sexual dimorphism in elite athletes is the better development of cognitive functions in men than women.

Table 4. The ratio of the quality Indicators of elite athletes' balance function without and with visual control.

Indicators	Female athletes	Male athletes	*t*	*p*
	M±SD	M±SD		
Romberg coefficient (%)	216 ± 20	173 ± 30	12.29	**<0.01**
The quality of the equilibrium function	0.98 ± 0.02	0.78± 0.06	3.5	**<0.01**
Normalized area of the vector-gram (mm^2/s)	1.06 ± 0.23	2.12 ± 0.82	1.25	<0.05
Movement abrupt change ratio (%)	1.42 ± 0.45	0.89 ± 0.56	0.74	<0.05
Average line speed (mm/s)	1.04 ± 0.42	1.64 ± 0.38	1.05	<0.05
Linear velocity variation amplitude (mm/s)	0.96 ± 0.39	1.61 ± 0.57	0.94	<0.05
Linear velocity variation period (s)	0.87 ± 0.12	0.95 ± 0.30	0.25	<0.05
Angular speed average (°/s)	1.2 ± 0.30	0.90 ± 0.26	0.75	<0.05
Amplitude of angular velocity variation (°/s)	1.10 ± 0.06	1.00 ± 0.08	1.00	<0.05
Angular velocity variation period (s)	1.04 ± 0.21	0.98 ± 0.60	0.09	<0.05
Angular velocity asymmetry coefficient (%)	–3.9 ± 2.40	49.7 ± 3.2	13.37	**<0.01**
Accumulated offset angle (revolutions)	–4.63 ± 1.88	44.6 ± 2.0	17.67	**<0.01**
Frontal velocity component (mm/s)	0.70 ± 0.85	1.30 ± 0.36	0.65	<0.05
Sagittal velocity component (mm/s)	1.50 ± 0.47	1.80 ± 0.42	0.48	<0.05
Coefficient of asymmetry of the frontal velocity component (%)	0.88 ± 0.24	0.92 ± 0.35	0.10	<0.05
Asymmetry coefficient of the sagittal velocity component (%)	–0.02 ± 0.22	2.87 ± 0.31	7.60	**<0.01**
Vectorgram power (mm^2/s)	1.10 ± 0.23	2.68 ± 0.42	3.29	**<0.01**
The ratio of linear and angular velocities (mm/°)	0.88 ± 0.34	1.85 ± 0.26	2.25	**<0.01**

M±SD = mean ± standard deviation; t = result of t-test; p = statistical significance

DISCUSSION

The persistent evidence indicating a gap in sports science provisions and infrastructure between male and female athletes, resulting in limited access to vital sports performance support, underscores a longstanding issue in the field [40]. However, our research indicates that female athletes can achieve superior results when compared during the correct menstrual cycle phases. Our study aims to identify and highlight the most critical practical challenges related to gender issues faced by elite female athletes and their coaches when using classical methods to monitor general physical preparedness, exemplified by the barbell squat exercise.

Our study substantially contributes to the current dialogue on gender-specific characteristics in elite athlete training, speed, and strength performances. The persistent evidence indicating a gap in sports science provisions and infrastructure between male and female athletes, resulting in limited access to vital sports performance support, underscores a longstanding issue in the field. In line with established literature, our findings reinforce the existence of notable gender differences across various dimensions of sports preparedness [6,41-43]. Anthropometric variations, physical performance indicators, physiological characteristics, and movement demands all exhibit discernible gender-related distinctions. Our study aligns with previous investigations into crucial aspects such as skeletal muscle composition, maximum velocity, and strength, consistently affirming the trend of lower values in women than men.

Our results confirmed well-documented gender differences in anthropometric and physiological characteristics [3,19,20]. Women were generally shorter in height and lighter in weight than men, with a higher percentage of body fat and lower muscle mass. These findings align with existing literature, consistently reporting similar gender differences. This information is crucial for coaches and trainers when designing training programs to accommodate these differences.

The psychophysiological tests indicated significant gender-specific differences. Men had shorter latency periods for simple and complex visual-motor reactions than women. This suggests that men generally exhibit faster reaction times, critical in team sports games. The results align with prior studies that report quicker reaction times and greater attention in men, while women demonstrate higher emotional excitability and greater mobility and strength in nervous processes [44].

Our analysis of the impact of hormonal changes associated with the ovulatory-menstrual cycle on women's sports performance provided nuanced insights. The findings indicated variations in muscle strength, endurance, motor reaction times, and overall work capacity across different menstrual cycle phases. For instance, the menstruation phase was characterized by reduced muscle strength and endurance, while the postmenstrual phase showed the most favorable parameters for sports performance. These results corroborate previous research and underscore the importance of considering menstrual cycle phases in female athletes' training and performance evaluation [22,23,28,34].

The expert assessment identified several critical issues in the current training practices for female athletes:

- Load Planning: Many training programs plan loads similarly for men and women without considering gender-specific needs.
- Training Models: The direct transfer of male training models to female athletes was deemed inappropriate due to biological differences.
- Outdated Systems: Existing training systems often fail to incorporate women's biological cycles.
- Previous Injuries and Incompetence: Injuries or illnesses from past coaching inefficiencies remain problematic.
- Pharmacological and Medico-Biological Support: Insufficient support during training, competition, and recovery.

- Financial and Organizational Support: Less attention and funding are directed towards women's sports.

The high level of agreement among experts (W = 0.94) supports the validity of these findings and highlights the need for tailored approaches in female athlete training. While our study provides comprehensive insights into gender-specific differences and their implications for training, it has some limitations. The substantial sample size may not capture the full diversity of elite athletes. Additionally, focusing on specific sports means that findings may not be generalizable across all disciplines.

Some coaches fail to apply this knowledge, leading to deteriorating health in female athletes and shortening their peak competitive performance periods. The reasons for this reluctance to apply gender-specific knowledge are varied and remain under investigation. However, the primary reasons identified thus far are as follows:

- The desire for immediate results. Some coaches prioritize immediate performance gains without considering the long-term health consequences for female athletes.
- Complexity and costs. The methods for monitoring women's health are often seen as complex, financially burdensome, and time-consuming.

Future research should expand on these findings by exploring interventions tailored to female athletes, considering hormonal cycles, and developing training models that address the identified issues. Longitudinal studies could provide deeper insights into the long-term effects of tailored training programs on performance and injury rates.

Our research identifies primary practical challenges associated with gender-specific issues for elite female athletes, influencing the efficacy of executing strength exercises such as squats with a barbell. By highlighting the anthropometric, psychophysiological, and hormonal differences between male and female athletes, our findings advocate for a gender-inclusive approach in sports science. This approach promotes overall performance and well-being and ensures that female athletes receive the support and training they need to excel in their respective sports.

CONCLUSION

The method of expert assessments has revealed a common problem in sports practice - insufficient integration of gender knowledge among children's coaches. This deficiency leads to suboptimal planning of training loads, negatively affecting female athletes' health and future sporting longevity. Numerous existing scientific approaches are often ignored, which necessitates a search for the causes of this negative phenomenon.

Our findings align with previous research on gender differences in sports performance across anthropometric, strength, psychophysiological, and biomechanical parameters. Female athletes in the experimental group were, on average, 5.88 cm shorter and 7–8 kg lighter than male athletes, reflecting smaller body volumes and less muscle development. Hand strength demonstrated statistically significant differences ($p < 0.01$), with male athletes exhibiting higher dynamometry values in both dominant (53.54 ± 4.75 kg) and non-dominant (50.67 ± 5.26 kg) hands compared to females (30.59 ± 3.54 kg and 29.06 ± 3.42 kg, respectively). Psychophysiological assessments revealed shorter latency periods of simple visual-motor reactions in men (234.24 ± 21.55 ms) compared to women (265.09 ± 32.03 ms, $p < 0.05$), likely influenced by hormonal and biorhythmic fluctuations more pronounced in women. Biomechanical analysis showed significant differences in the Romberg coefficient, with men achieving 173 ± 3% and women 216 ± 2%, indicating better visual stability and optical sensitivity in female athletes at optimal menstrual phases (II and IV). However, the equilibrium function ratio without and with visual control was higher in women (0.98 ± 0.02) than men (0.78 ± 0.06), suggesting superior adaptive coordination in women athletes. These results highlight the importance of gender-specific considerations in sports training and rehabilitation.

During the experimental part of the study, several practical problems were identified that female athletes and their coaches face when using classical monitoring

methods. These methods often require laboratory equipment, significant financial resources, and considerable time, which makes them difficult to use in a regular training environment. This underscores the urgent need to develop more accessible, cost-effective, and reliable methodologies for monitoring and supporting the health and fitness of women in sports.

In the era of new technologies, there is a clear need to develop innovative and reliable methodologies for monitoring and maintaining the health and performance of female athletes. Optimizing performance and ensuring long-term well-being are vital goals.

Addressing the identified gender issues and integrating scientific knowledge into coaching practice is essential to improving elite female athletes' training, health, and performance.

Data Availability. All the required data has been included in the manuscript.

Conflicts of Interest. The authors declare that there is no conflict of interest regarding the publication of this paper.

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