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Gender-specific issues for sport preparedness of elite female athletes in team sport games

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Abstract

Purpose. The goal of this study was to identify gender-specific issues of sports training to assist in the planning of training and competition loads of female elite athletes in team sport games.

Material and methods. Bibliometric techniques were applied in this study to gather highly cited papers in sport sciences published during 2005-2022. The method of expert evaluations was used to determine the modern problems of female elite sports. To determine the model characteristics of the optimal psychophysiological state and balance function of elite male versus female athletes during physical exercises, two independent groups 17 women and 24 men were compared, elite athletes from such sport games, as: basketball (women, n=10 and men, n=14), handball (women, n=3 and men, n=5) and volleyball (women, n=4 and men, n=5). Mathematical and statistical processing and data analysis were carried out using the computing and graphic capabilities of the computer programs "Statistica" and Microsoft Excel 2010.

Results. The analysis of sports scientific literature regarding gender-specific issues and the experts' analytical notes allowed us to obtain information about the main problems, such as: using male models of physical preparation at the training process for women. We determined that the psychophysiological functions for men and women have very particular gender-specific characteristics. For men, it is a predominance of attention, and for women, mobility and strength of nervous processes, respectively. As for the ratio of the quality of the equilibrium function of elite athletes without and with visual control, significantly higher indicators are observed for women (0.98 ± 0.02, $p<0.05$) compared to the group of men (0.78 ± 0.06, $p<0.05$).

Conclusions. The research results obtained by us when comparing the psychophysiological and biomechanical indicators of elite athletes of different gender groups provide reliable information about the need to build different approaches in planning special physical loads for female and male athletes in sport games.

Key words: elite athletes, gender characteristics, sport games, sport of high achievements, expert evaluations

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Анотація

Вікторія Нагорна, Артур Митько, Ольга Борисова, Кат'я Обергофер, Базіль Ачерман, Сільвіо Лоренцетті. Гендерні проблеми спортивної підготовки висококваліфікованих спортсменок в командних видах спортивних ігор

Мета. Метою дослідження було - виявлення гендерних особливостей для планування тренувальних і змагальних навантажень висококваліфікованих спортсменок у командних видах спортивних ігор.

Матеріали і методи. Бібліометричні методи були застосовані в цьому дослідженні, щоб зібрати високоцитовані статті зі спортивних наук, опубліковані протягом 2005-2022 років. Методом експертних оцінок визначено сучасні проблеми жіночого спорту вищих досягнень. Для визначення модельних характеристик оптимального психофізіологічного стану та функції рівноваги висококваліфікованих спортсменів та спортсменок під час виконання фізичних вправ, порівнювали дві незалежні групи – 17 жінок та 24 чоловіки з таких видів спорту, як: баскетбол (жінки, n=10 та чоловіки, n= 14), гандбол (жінки, n=3 та чоловіки, n=5) та волейбол (жінки, n=4 та чоловіки, n=5). Математично-статистичну обробку та аналіз даних проводили з використанням обчислювальних та графічних можливостей комп'ютерних програм «Statistica» та Microsoft Excel 2010.

Результати. Аналіз спортивної наукової літератури з гендерної тематики та аналітичних записів експертів дозволив отримати інформацію про основні проблеми, такі як: використання моделей фізичної підготовки чоловіків у тренувальному процесі жінок. Ми встановили, що психофізіологічні функції чоловіків і жінок мають дуже специфічні гендерні характеристики. У чоловіків це переважання уваги, а у жінок відповідно - рухливість і сила нервових процесів. Щодо співвідношення якості функції рівноваги висококваліфікованих спортсменів без та з візуальним контролем, то у жінок спостерігаються достовірно вищі показники (0,98 ± 0,02, p<0,05) порівняно з групою чоловіків (0 ,78 ± 0,06, p<0,05).

Висновки. Отримані нами результати досліджень при порівнянні психофізіологічних та біомеханічних показників у висококваліфікованих спортсменів різних гендерних груп дають достовірну інформацію щодо необхідності побудови різних підходів у плануванні спеціальних фізичних навантажень для спортсменок та спортсменів в спортивних іграх.

Ключові слова: висококваліфіковані спортсмени, гендерні особливості, спортивні ігри, спорт вищих досягнень, експертні оцінки

Аннотация

Виктория Нагорная, Артур Митько, Ольга Борисова, Катя Оберхофер, Базиль Ачерманн, Сильвио Лоренцетти. Гендерные проблемы спортивной подготовки высококвалифицированных спортсменок в командных видах спортивных игр.

Цель. Цель данного исследования состояла в том, чтобы выявить гендерные особенности спортивной подготовки, для помощи планирования тренировочных и соревновательных нагрузок высококвалифицированных спортсменок в командных спортивных играх.

Материалы и методы. Библиометрические методы были применены в настоящем исследовании, чтобы собрать высокоцитированные статьи по спортивным наукам, опубликованные в течение 2005-2022 годов. Методом экспертных оценок определены современные проблемы женского спорта высших достижений. Для определения модельных характеристик оптимального психофизиологического состояния и функции равновесия высококвалифицированных спортсменов и спортсменок при выполнении физических упражнений сравнивали две независимые группы – 17 женщин и 24 мужчин из таких видов спорта, как: баскетбол (женщины, n=10 и мужчины, n= 14), гандбол (женщины, n=3 и мужчины, n=5) и волейбол (женщины, n=4 и мужчины, n=5). Математически статистическую обработку и анализ данных проводили при использовании вычислительных и графических возможностей компьютерных программ Statistica и Microsoft Excel 2010.

Результаты. Анализ спортивной научной литературы по гендерной тематике и аналитических записей экспертов позволил получить информацию об основных проблемах, таких как использование моделей физической подготовки мужчин в тренировочном процессе женщин. Мы установили, что психофизиологические функции мужчин и женщин обладают очень специфическими гендерными характеристиками. У мужчин это преобладание внимания, а у женщин соответственно – подвижность и сила нервных процессов. Что касается соотношения качества функции равновесия высококвалифицированных спортсменов без и с визуальным контролем, то у женщин наблюдаются достоверно более высокие показатели (0,98 ± 0,02, p<0,05) по сравнению с группой мужчин (0,78 ± 0,06, p< 0,05).

Выводы. Полученные результаты исследований при сравнении психофизиологических и биомеханических показателей высококвалифицированных спортсменов разных гендерных групп дают достоверную информацию о необходимости построения различных подходов в планировании специальных физических нагрузок для спортсменок и спортсменов в спортивных играх.

Ключевые слова: высококвалифицированные спортсмены, гендерные особенности, спортивные игры, спорт высших достижений, экспертные оценки

Introduction

Today, it is possible to say with certainty about the incredibly large-scale support of elite sports from the side of scientific appropriations. New reports of scientific activity appear every day around the world: articles, works, reports, projects, ideas, dissertations. There is so much scientific information about sports that it makes it impossible to carry out an accurate statistical analysis in terms of reviewing the assets of each country from all officially recognized sports. From such a huge volume of scientific information, it is difficult to find the most relevant and important data for the end user: a coach, athlete, functionary, sports doctor and other practitioners. In this case, the high level of citation of scientific work is a qualitative and quantitative indicator of its demand in the field of sports.

The results of a literature review of highly cited papers in the field of sport sciences published during 2010-2020, indexed in the Web of Science of the Clarivate Analytics, show that most of the highly cited papers in sport sciences are in sport medicine and published by prominent and renowned researchers from the United States of America (U.S.) and Canada from the American continent, the United Kingdom (U.K.), Switzerland, and Norway from the European continent, Qatar and China from the Asian continent, and South Africa from the African continent were the most prolific countries [1].

On the other hand, investigations in sports science in the member states of the Soviet Union have developed separately from international structures for quite a long time, even after they left the alliance. Only recently, scientists from post-Soviet countries have begun to "share" their inventions and scientific works in international publications, whereby Google Academy is best used for the analysis of citations from one of these countries. As an example, Ukraine and its outstanding scientists in the field of sports: Platonov, the total number of citations is 30689, the most cited work was published in 2017 "The system of training athletes in Olympic sports. General theory and its practical applications"- 6654; Zatsiorskyi, the total number of citations is 18275, and the most famous work published in 2009 "Physical abilities of an athlete" is cited 3576 times [2, 3, 4].

From the above, it follows that on the issue of increasing the efficiency of the competitive activity of elite female athletes due to taking into account their gender characteristics in the process of sports training, it is necessary to analyse literary sources in countries where the authors of scientific works with high citations works.

In the world of sports science, there are many studies devoted to women's sports from Shahlina, Maslova, Kozina, Kalytka, Melnikova, Radziyevsykiy, Poholenchuk, Rumyantseva, Abe, Brown, Emmonds, Fukunaga, etc. [5-37]. Methodical and practical recommendations for coaches on the peculiarities of psychological and physical training of athletes have been developed and scientifically substantiated. Are these scientific achievements being implemented in practice? As an example, athletics is a sport with an excessive load in terms of speed and strength characteristics of the athlete. And as the practical experience of the majority of female athletes of national teams in various sports shows, only a small number of coaches take into account the peculiarities of biological rhythms in the body of female athletes when developing training recommendations. This neglect of sexual dimorphism can lead to an earlier end to the sports career of female athletes. And especially, the phases of the ovulatory-menstrual cycle of a female athlete should be taken into account when planning of the workload of special physical training. Further investigations into gender-specific issues are highly recommended.

Purpose: The goal of this study was to identify gender-specific issues of sports training to assist in the planning of training and competition loads of female elite athletes in team sport games. In particular, specific focus was given to the psychophysiological state and balance function to increase the efficiency of competitive activities.

Material and methods

Participants

After the initial survey from 160 respondents, an expert group of 20 sports scientists, coaches of national teams were selected who have experience working with elite female athletes. To determine the model characteristics of the optimal psychophysiological state and balance function of elite male and female athletes during training activity, two independent groups were compared (women, n=17 and men, n=24). All participants were aware of the objectives of the study and agreed to participate.

Procedure

The main stage of the present study was conducted in various sports and countries during 2021-2022: the indicators of the balance function quality with and without visual control, efficiency of attention, volume of voluntary attention, productivity, coefficients of motivational, volitional and typological components, stress resistance were observed for elite athletes from such sport games, as basketball (women, n=10 and men, n=14), handball (women, n=3 and men, n=5) and volleyball (women, n=4 and men, n=5) from March 01 2021 to January 25, 2022, Ukraine; the method of experts` evaluations was used to determine the modern problems of women's training in sports of high achievements from June 01 to August 25, 2022, Switzerland; the bibliometric and scientometric analysis was conducted from June 01 to October 25, 2022, Switzerland.

The bibliometric and scientometric analysis

Data collection was carried out through several stages. First, bibliometric techniques were applied to gather highly cited papers in sport sciences published during 2005-2022 (Scopus search, the Clarivate Analytics Web of Science Core Collection, Google Academy, webometrics). At the same time, we determined the most cited countries, authors and topics of sports science. In the second stage of the literature review, we conducted a content analysis of special information on research in the direction of female sports, but only in the leading countries in terms of the highly cited papers in the subject area of sport sciences.

The method of expert evaluations

We collected primary information based on a sociological survey as the key source of research. The survey in our study was used as a method of collecting sociological information about the level of theoretical and practical knowledge of sports professionals (m=160) regarding the specifics of female sports (oral and written survey, interviews) communication with representatives of various sports and countries during 2021-2022.

Expert survey is a method of obtaining information using the knowledge of competent persons, qualified, experienced specialists who express their own point of view on certain issues. From 160 respondents after the initial survey, we selected an expert group of sports scientists, coaches of national teams (m=20) with demonstrated experience working with elite female athletes. The task of the experts was to determine the modern problems of women's training in sports of high achievements.

The modern problems of women's training in sports of high achievements are determined by the method of expert evaluations. The following calculation algorithm was performed:

• determination of relative values (interviews of experts);

• calculation of group evaluations taking into account the weight scale of experts. The group of experts was determined by an objective method of assessing their competence, based on their professional characteristics - from 160 respondents, an expert group of scientists, coaches of national teams (m=20) who had experience working with elite athletes was selected;

• determination of the reliability of the difference between the obtained values - calculation of the reliability of the received expert opinion. For this purpose, the degree of unanimity of experts was determined using: the mean square deviation and the coefficient of variation (the coefficient of variation >30% would mean the wrong selection of the expert group, its high heterogeneity in terms of the degree of competence regarding this question and the impossibility of considering the obtained result significant);

• research of interdependence between experts' conclusions (using Kendall's rank correlation methods);

• ranking.

The degree of agreement between experts' answers was determined using Kendall's concordance coefficient (W). Determination of the normative coefficient of significance (K_N), which is the reciprocal of the number of ranked factors.

Psychophysiological and biomechanical methods

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, efficiency of attention, volume of voluntary attention, productivity, coefficients of motivational, volitional

and typological components, stress resistance.

When conducting psychophysiological testing, elite athletes from such sport games, as basketball (women, n=10 and men, n=14), handball (women, n=3 and men, n=5) and volleyball (women, n=4 and men, n=5) were initially asked to pass the proposed tests in a training mode. 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 a second of completing the task, determined using 16-cell tables (4x4) with the location of points on them in various variants. The examination was carried out for 0.75 seconds. for each table.

The state of the main mental functions was assessed using a computer test of psychophysiological diagnosis. Based on the results of the test, the coefficient of operational thinking (COT) was calculated: COT=Nr/T·100, where T is the average time for completing the test task (ms); 100 is the coefficient. The study of short-term visual memory was carried out according to the method of Makarenko M. According to this technique, the subject was given a table with ten clearly drawn two-digit numbers that were not logically connected to each other for 30 seconds. During the specified exposure time of the table, the subject wrote in the protocol in random order the numbers he or she had memorized within one minute. To translate the results into points on a nine-point scale, we used the table proposed by Makarenko M.

The quality of the balance function is one of the important informative stabilometric indicators, the higher its value, the better the athlete can maintain balance. Thus, standard and complicated Romberg tests were used to assess its level in the present study. To assess the level of development of the balance function of athletes, standard and complicated Romberg tests with open and closed eyes were used with 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 tests (displacement of the center of pressure, spread along the axes, length of the statokinesigram curve, assessment of movement, quality of the balance function, etc.) and special tests (area of the deviation zone, the number of points scored and errors with visual and verbal stimuli and others) indicators. At the same time, this method cannot be called only biomechanical, since we used Romberg tests consisting of two parts: with open eyes (using visual stimulation in the form of alternating-colored circles on the screen), and with closed eyes (using sound stimulation in the form of tone signals). This allows us to qualitatively assess both biomechanical and psychophysiological gender differences among elite athletes who specialize in sport games. Statistical analysis of the functional parameters of the resistance of elite female and male athletes was carried out using the Student's parametric test.

Statistical analysis

We evaluated the statistical significance between the studied indicators using the Student's parametric test. To compare two independent groups (women, n=17 and men, n=24) on quantitative characteristics, we used the Student's t-test for independent samples. Testing of the hypothesis about the equality of the means of two samples from a normal distribution was performed under the conditions of equal variances.

When determining the statistical significance of the difference between the athletes' indicators using the non-parametric Mann-Whitney test, a reliability level of 95% was assumed (significance level p=0.05).

Since the original data obeyed the normal distribution law, the Student's parametric test was used to compare sample means.

The statistical significance of the correlation coefficient was checked using the Student's t-test. The degree of agreement between experts' answers was determined using Kendall's concordance coefficient.

To study the interdependence between the conclusions of sports experts and indicators of the level of scientific developments in the specified topic, the Spearman's rank correlation coefficient ρ was calculated and its statistical significance was assessed using the t-criterion. When determining the impact of a single cause on the final result, the coefficient of determination was calculated, which can take values from 0% to 100%.

All statistical hypotheses were tested at the α=0.05 significance level (p<0.05).

Mathematical and statistical processing and data analysis were carried out using the computing and graphic capabilities of the computer programs "Statistica" (Statsoft, version 7.0) and Microsoft Excel 2010.

Results

Based on the research of Gholampour S, Gholampour B, Noruzi A. [1], the implementation of content analysis of information on sports science using search engines that index scientific publications of all formats and disciplines, we identified the leaders in sports science of the countries: America, Canada, England, Switzerland, Norway, China, South Africa. In addition, the analysis of scientific publications and dissertations in the field of "Sport" in recent years allowed us to add Ukraine and Poland to the list of countries with the most cited authors. We analysed not only quantitative, but also qualitative indicators of the work of sport scientists in the direction of developments in the field of female sports.

It was found that in America, England and Ukraine, there is a significant percentage of scientific works dedicated to women's sports, while Swiss scientists do not pay enough attention to this issue. As an example, the statistics of the defence in the specialty "Physical culture and sport" in Ukraine: only in Kyiv for the years 2010-2022, 23,2% of dissertations were devoted to gender issues in elite sports. At that time, for the same period, 5,059 dissertations on topics related to sports were defended in Swiss Universities. Only a few scientific works in sports of high achievements contained data on the specifics of the training of elite female athletes, and nothing about the women's strength training. Although the topic of strength training is very popular in Switzerland. Therefore, we were interested in this direction of scientific research, which influenced further research on the definition of the main data that affect the special physical training of elite female athletes.

The study used retrospective, statistical, qualimetric methods and content analysis in accordance with the rules of systematic analysis and systematic approach to study the place, structure and content of physical training of elite athletes, taking into account the characteristics of sexual dimorphism. The study involved 20 national coaches and officials from America, Canada, England, Switzerland, Norway, China, Ukraine, Poland, South Africa, who formed an expert group. The expert group was formed by analyse the answers of 160 respondents to the questions in the preliminary survey. We took into account the following indicators of selection to the expert group: high qualification, experience working with female athletes, knowledge of the specifics of women's sports training. At the next stage of the research, coaches of national teams and highly qualified specialists in basketball, volleyball, handball, baseball, rugby, football, athletics, billiards, boxing, ice hockey and sambo provided individual expert evaluations using analytical notes on the main factors that have a negative impact on the effectiveness of training and competitive activity of women in sports of higher achievements.

The analysis of the experts' analytical notes made it possible to obtain not only individual information about the state of women's sports in each country or kind of sport, but also to identify general issues regarding the planning of training and competition loads for female athletes.

The assessment of the disagreements of experts' opinions shows that the coefficient of variation is 18.75%, which indicates a sufficient level of unanimity of experts and the possibility of introducing this system into the practical activities of family doctors.

To determine the most significant factors in the structure of women's sports training, an expert assessment was conducted, which was used to determine the problems of modern sports training of elite athletes taking into account the peculiarities of sexual dimorphism.

Therefore, the following factors were more popular at experts` answers (more than 50%) as problems in women's sports: transferring the training models of male athletes to the training of women; old injuries or illnesses that arose as a result of the incompetence of the previous/youth coaches; insufficient pharmacological and medico-biological support of women's national teams during training, competitions and recovery; outdated systems of training female athletes without taking into account their biological cycles; less attention to women's sports in financial and organizational aspects; load planning during special physical training is the same as for men.

A large number of scientific works on research in the field of women's sports does not give a 100% guarantee against the occurrence of problems in practice. As we can see in the graph (Figure 1), most experts agree on the relevance of transferring knowledge directly to coaches regarding the specifics of the impact of loads on the female body, on the one hand, and the impact of cyclical biological rhythms on the performance of female athletes, on the other hand. In addition, in almost all countries and types of

sports, the main problem in working with women's teams is the implementation of special physical training with the same loads, methods, and technique of performing elements of exercises as for men.

In order to identify the general opinion of experts regarding the existing gender problems on the way to the effective development of elite women's sports, an analysis of the materials of expert assessments was carried out. For this purpose, we created a matrix of ratings of ranked factors by each expert. The factor numbering is given in Table 1 with the corresponding matrix of ratings in Table 2. Experts chose which tools are, in their opinion,

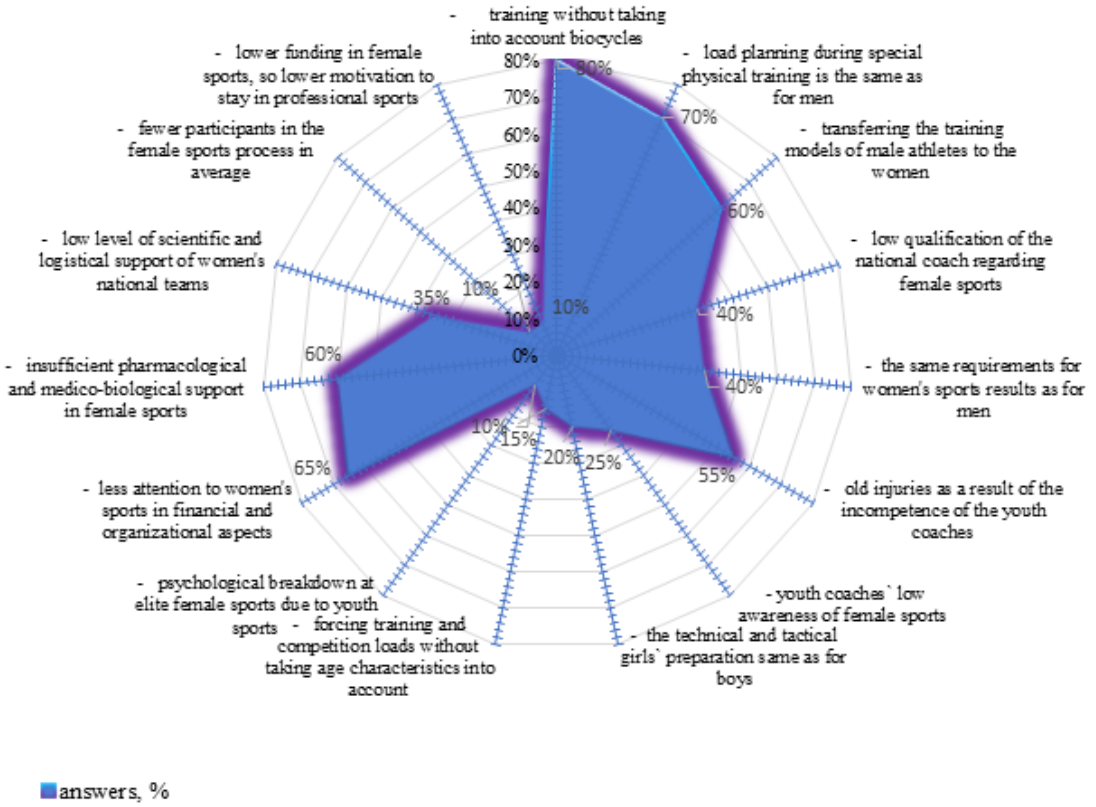


Fig. 1. The analysis of the experts' analytical notes about the problems of modern sports training of elite athletes taking into account the peculiarities of sexual dimorphism (with m=20)

Table 1

Numbering (n) of 15 key factors that are associated with existing gender problems according to expert survey

Name of the factor	Factor number (n)
training without taking into account biocycles	1
load planning during special physical training is the same as for men	2
transferring the training models of male athletes to the women	3
low qualification of the national coach regarding female sports	4
the same requirements for women's sports results as for men	5
old injuries as a result of the incompetence of the youth coaches	6
low awareness of the youth coach about female sports	7
the technical and tactical girls` preparation same as for boys	8
forcing training and competition loads without taking age characteristics into account	9
psychological breakdown at elite female sports due to youth sports	10
less attention to women's sports in financial and organizational aspects	11
insufficient pharmacological and medico-biological support in female sports	12

low level of scientific and logistical support of women's national teams	13
fewer participants in the female sports process in average	14
lower funding in female sports, so lower motivation to stay in professional sports	15

Table 2

Ratings of the 15 key factors according to each expert (m=20) with the average score $\bar{x}$ and the coefficient of significance of each factor (K_j) established as a whole by the group of experts (Matrix of experts' assessments)

Number of the expert (m)	Factor number (n)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	3	2	4	9	11	7	8	10	14	12	1	5	6	15	13
2.	1	4	3	8	7	6	10	12	13	11	5	2	9	14	15
3.	1	2	4	6	7	5	9	11	12	14	3	8	10	15	13
4.	2	1	4	7	8	5	10	12	11	13	3	6	9	15	14
5.	1	3	5	7	8	6	9	11	12	13	2	4	10	15	14
6.	1	4	2	8	7	5	10	13	11	12	3	6	9	14	15
7.	4	1	3	6	8	5	9	14	10	13	7	2	11	15	12
8.	1	2	4	8	7	6	10	11	12	13	3	5	9	14	15
9.	1	3	2	6	8	7	10	12	13	11	4	5	9	14	15
10.	1	2	3	7	6	8	10	12	9	13	5	4	11	15	14
11.	1	2	4	7	8	6	10	12	11	13	3	5	9	14	15
12.	1	2	3	5	8	7	10	13	11	12	4	6	9	14	15
13.	1	2	3	5	8	7	9	12	11	14	4	6	10	13	15
14.	1	3	4	5	9	6	8	12	11	13	2	7	10	14	15
15.	1	4	2	6	8	7	9	11	12	13	3	5	10	15	14
16.	1	3	5	6	9	7	10	11	12	15	2	4	8	13	14
17.	1	2	4	7	8	6	10	12	11	13	3	5	9	14	15
18.	1	2	3	4	7	8	10	11	13	12	6	5	9	15	14
19.	1	3	2	7	8	6	11	10	12	13	4	5	9	15	14
20.	2	1	3	6	9	7	10	11	13	12	5	4	8	15	14
x_j	27	48	67	130	159	127	192	233	234	255	72	99	184	288	285
K_j	0.13*	0.12*	0.11*	0.08*	0.07*	0.08*	0.05	0.03	0.03	0.02	0.11*	0.1*	0.06	0.01	0.01

* - the factor is significant, as the value of the coefficient significance is equal to or exceeds the value of the normative coefficient ($K_j \geq 0.07$), because of the normative coefficient of significance $K_N = 0.07$

As we can see in Table 3, there are no connected (same) assessments (according to the condition) in the experts' statements, therefore the concordance coefficient (expert agreement) W was calculated according to the standard formula. Since W=0.94, which is an approximate result to 1, it can be argued that the experts' assessments have the highest level of agreement. Thus, we accept the hypothesis that there is agreement between specialists and determine that the results of the expert group's questionnaire can be trusted. That is, the method of expert analysis in modern conditions is one of the most effective means of obtaining and analysing qualitative information regarding the identification of existing problems in the practice of elite female sports.

The processing of expert evaluation data serves as the source material for the synthesis of predictive hypotheses and options for optimal ways to increase the effectiveness of managing the training and competitive activities of elite female athletes. That is why, on the basis of the defined problems and already available scientific developments in female sports, we conducted research specifically in complex coordination sports with anaerobic-aerobic load, where the basis of special physical training consists of speed-strength direction exercises and coordination. After all, it is precisely in sport games (basketball, volleyball, handball, and others) that the volumes of loads in competitions are the same according to the Regulations for both men and women, which is sometimes incorrectly interpreted when building the training process of female athletes, especially when transferring male models of use the same techniques of performing movements, methods and amounts of load during special physical training.

Therefore, the hypothesis of our further

research was the statement about the need to individualize programs for special physical training of elite athletes according to gender characteristics. To confirm our statements, both the analysis of existing scientific works on women's sports training and our own research on the psychophysiological state of women and men in the same competitive situations were used. An analysis of the static stability of elite male and female athletes was also carried out, since, in our opinion, indicators of the quality of balance in various ascending positions can give an accurate picture of the features of the correct technique of performing exercises for physical training of women to prevent injury, which most often occurs against the background of the approach to training just like with male athletes.

To answer the question "are the same factors and their component indicators determining the state of psychophysiological functions for women and men?", the present results are given in Table 3 and Figure 2.

The study of sensorimotor reactions and properties of the main nervous processes in athletes of game sports made it possible to determine the gender characteristics of neurodynamic functions.

Table 5 shows the values of neurodynamic functions of individual gender groups of elite athletes in game sports.

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: the latency period of a simple visual-motor reaction and the latency period of a complex visual-motor reaction of choosing two out of three stimuli ($p < 0.05$).

Latency periods of a simple visual-motor reaction were the smallest for men ($p<0.05$). So, the average value of latent periods of simple visual-motor reaction for men was = 234.24 ms, standard deviation – S = 21.55 ms, for women – 265.09 ms and 32.03 ms, respectively.

The definition of the latent period of the choice reaction in sports games is of great importance. The duration of this indicator determines the athlete's speed qualities, which is very important in speed-strength sports. Thus, the average value of the latency period of the choice 2-3 reaction in men was = 411.62 ms, standard deviation – S = 44.66 ms, for women – 451.28 ms and 54.89 ms, respectively.

Thus, as a result of the study, differences in the time characteristics of different complexity visual-motor reactions for elite athletes were found, which are associated with the detection of sexual dimorphism.

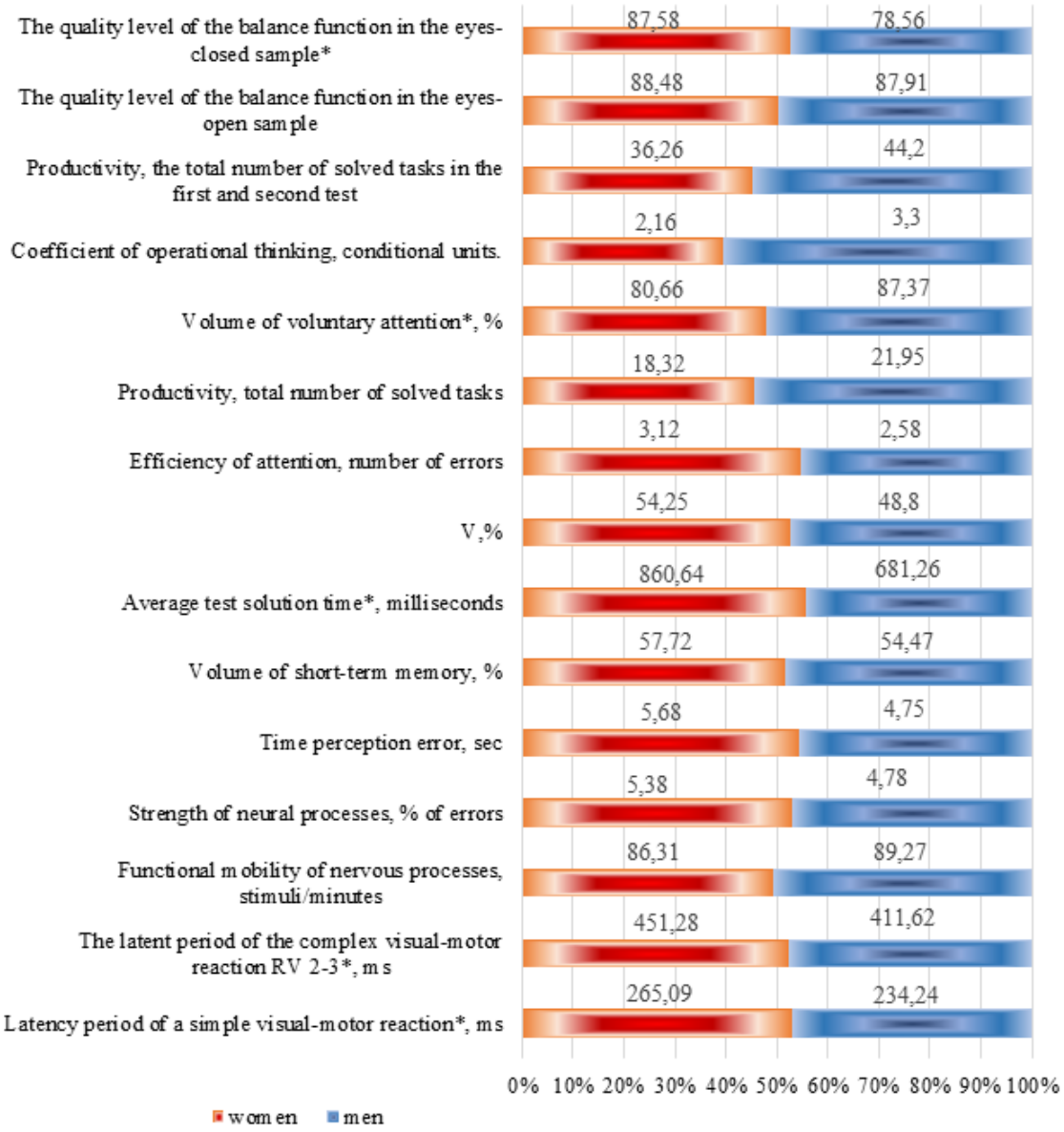
Thus, the analysis of the obtained indicators makes it possible to consider that the manifestation of the characteristics of psychophysiological functions for men and women has its own gender characteristics. For men, it is a predominance of attention, and for women, mobility and strength of nervous processes.

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. The relevance of such studies also lies in the fact that the use of the stabilographic control technique for assessing the kinetic stability of the body of athletes is a modern diagnostic tool not only for normal conditions, but for various disorders, which allows it to be used to control the quality training of the vestibular analyser, coordination abilities, psycho-physiological 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 in the form of alternating-colored circles on the screen in the first case, and sound stimulation in the form of tone signals in the second case. The posture of the athletes modelled the technique of the initial position during the exercise "squat with a barbell". Based on the comparison of stabilograms of two samples, we determined the degree of visual stability of standing - the degree of feedback provided by optical sensitivity, the so-called Romberg coefficient, and determined significant differences in the results of men (173% ± 2,62) and women (216% ± 2,32), Table 4. The higher the percentage, the better the athlete is coordinated and trained. As for the ratio of the quality of the equilibrium function of elite athletes without and with visual control, significantly higher indicators are observed for women (0,98 ± 0,02) compared to the group of men (0,78 ± 0,06).

The results of the relationship between the temporal characteristics of sensorimotor functions and typological features of high nervous activity are shown in Table 5. The analysis of Spearman's rank correlation coefficients R indicates that there is a probable relationship between the latent periods of simple and complex sensorimotor reactions, which was 0.47 ($p <0.001$).

The latent period of a simple visual-motor reaction had no significant relationship with functional mobility and strength of nervous processes ($p> 0.05$).

The latent period of the visual-motor reaction of choosing two out of three stimuli is also reliably correlated with functional mobility ($r=-0.28$, $p<0.05$), and with the strength of nervous processes ($r=0.30$, $p<0.05$).



Note: * – the result is significant at p< 0.05

Fig. 2. Statistical values of indicators of the psychophysiological state and the balance function of elite athletes (women, n = 17; men, n = 24)

Table 4

The ratio of the quality indicators of the balance function of elite athletes without and with visual control

Indicators	Female athletes (n=17)	Male athletes (n=24)	t	p
	$\bar{x}$ ± m	$\bar{x}$ ± m		
Romberg coefficient	216 ± 2,32	173* ± 2,62	12,29	< 0.01
The quality of the equilibrium function	0,98 ± 0,02	0,78*± 0,06	3,5	< 0.01

Note: * - denotes statistically significant differences p < 0.01 between indicators of male athletes compared to the group of women

Table 5

Correlation coefficients (R) between indicators of basic nervous processes and latent periods of sensorimotor reactions in various degrees of complexity of elite athletes

Indicators	Latency period of a simple visual-motor reaction (ms)	Latency period of a complex visual-motor reaction of choosing two out of three stimuli (ms)	Functional mobility of nervous processes (stimuli/minutes)	Strength of neural processes (% of errors)
Latency period of a simple visual-motor reaction (ms)	1.00			
Latency period of a complex visual-motor reaction of choosing two out of three stimuli (ms)	0.47*	1.00		
Functional mobility of nervous processes (stimuli/minutes)	-0.14	-0.28*	1.00	
Strength of neural processes (% of errors)	-0.03	0.30*	-0.15	1.00

Note: * – the result is significant at $p < 0.05$.

The lack of correlation between the individual-typological properties of higher nervous activity and the time characteristics of sensorimotor reactions may be due to the fact that the latter is an automated reaction that can be realized in an elite athlete with minimal involvement of the higher parts of the brain. The latent periods of a simple visual-motor reaction can be considered as components of the properties of functional mobility and strength of nervous processes, which characterize the functional state of the organism, the level of excitation of the nervous system, and the speed of propagation of excitation by nerve circuits. With the complication of the task of differentiating positive and inhibitory stimuli in athletes, a connection between the properties of the main nervous processes and sensorimotor functions appears. The processing of more complex information requires a more complex functional organization of neural ensembles of the neocortex, which is largely determined by the individual typological properties of higher nervous activity.

Since we found a certain difference in the time characteristics of the visual-motor reactions of elite athletes of different sexes, which differ in complexity, this affects the presence of reduced determinism and increased stochasticity of the information processing system in women, compared to men. The stochasticity of the functional system ensures the search for the necessary links to form the optimal level of functioning. Thus, the presence of stochasticity in women in the conditions of sports activities is one of the forms of the formation of a functional system of information processing, thanks to which there is a possibility of compensatory search for the optimal organization of the integrative function of the brain in the conditions of adaptation to sports activities.

Thus, one of the psychophysiological features of sexual dimorphism in elite athletes is the presence of better development of cognitive functions in men, compared to women.

The presence of stochasticity in the organization of the information processing system in women is one of the forms of the formation of a functional system, thanks to which there is a possibility of a compensatory search for the optimal organization of the integrative function of the brain in the conditions of adaptation to sports activities.

Discussion

The present work will serve as the basis for studying the specifics of strength training of elite athletes, taking into account their gender characteristics for the further development of practical recommendations. Today, without the success of

women's sports, no country can be among the leaders of world sports. Sports scientists from all over the world have revealed insights into topics of women's sports such as: the peculiarities of psychological and tactical preparedness [38, 39, 40], the dependence of the functional state on the phases of the menstrual cycle [17, 33, 34], gender-specific anthropological and morphological features [5], the influence of hormonal changes on sports performance [19] or the specifics of technical training and formation on motor qualities [16].

Therefore, the question of the peculiarities of the training of elite female athletes is highly relevant among scientists, trainers, officials and the athletes themselves. But despite the growing popularity of women's sports, a huge number of scientific works devoted to this topic, in practice, coaches of national teams face real problems. And our research helped to detail the current problems of elite women's sports. Using the method of expert evaluations, it was determined that until now, women's sports receive less attention in the context of economic and organizational support, which can also affect the motivation to continue the sports career of a female athlete.

The list of problems of women's sports also included comments such as the low level of awareness of previous coaches regarding the specifics of the impact of physical exertion on the female body and, on the contrary, the complete isolation of opinions about the need for constant control of the main psychophysiological, biological and morphofunctional indicators of female athletes for adequate planning of sports results. Such "ignorance" or "negligence" of the coach most often leads to an increase in the risk of injury and an earlier end to the sports career of female athletes. At the same time, the analysis of literary sources provides an opportunity to access the necessary information regarding the optimization of preparation for the peak of sportsmanship of female athletes in the chosen sport. Nevertheless, there are some issues in this direction that are not sufficiently disclosed and have actual weight in women's sports of higher achievements. One of these directions is the special physical training of elite athletes, and especially the strength training of women.

Our research among elite female and male athletes regarding their psychophysiological state and balance function, the location of the centre of balance, as well as the other specific biomechanical indicators, allowed us to confirm previous scientific data on the relationship between individual typological properties of the higher nervous system and sensorimotor reactions with psychophysiological indicators of highly qualified athletes of various sex. This conclusion is expressed in the results obtained regarding the gender differences in the formation of psychophysiological functions of elite athletes, the functional specificity of psychomotor and mental activity, as well as the peculiarities of the psychophysiological organization of information processing in male and female elite athletes.

We have also obtained new data regarding better indicators of balance function with eyes closed in female athletes compared to male athletes. The data on the differences in the location of the centres of gravity are also confirmed - in women it is lower than in men, which affects the difference in the recommended angle in the knee during squats with a barbell for female athletes relative to the existing recommendations in the special literature based on research in this direction for male athletes.

Prospects for further research

Our further research will be aimed at improving the programs of special physical training of female elite athletes, taking into account the peculiarities of the influence of the biorhythms of the female body on the performance of specific exercises, especially in relation to strength training, and the use of innovative technologies as means of pedagogical control.

Conclusions

1. The analysis of expert evaluations made it possible to establish that, despite extensive scientific and methodological support, problematic issues regarding women's sports remain in various countries of the world. The replies cover many areas of sport and some of these issues are generally problematic for the international female sports.
2. The following factors were identified based on the experts` answers as the main problems in female sports: outdated systems of training female athletes without taking into account their biological cycles (80%); old injuries or illnesses that arose as a result of the incompetence of the previous/youth coaches (55%); transferring the training models of male athletes to the training of women (60%); insufficient pharmacological

and medico-biological support of women's national teams during training, competitions and recovery (60%); load planning during special physical training is the same as for men (70%); less attention to women's sports in financial and organizational aspects (65%).

3. The study of the connections between the properties of the main nervous processes and sensorimotor reactions of varying complexity in athletes of game sports made it possible to reveal relationship between the latent periods of simple and complex sensorimotor reactions, which was 0.47 ($p < 0.001$), as well as between the latent period of the visual-motor reaction of choosing two out of three stimuli is also reliably correlated with functional mobility ($r=-0.28$, $p<0.05$), and with the strength of nervous processes ($r=0.30$, $p<0.05$).
4. With help of correlation analysis, the relationships of individual typological properties of the higher nervous system and sensorimotor reactions with psychophysiological indicators of elite athletes of different sexes were established in sport games. For men, it is a predominance of attention, and for women, mobility and strength of nervous processes.
5. The analysis of indicators of postural stability of athletes allowed us to establish that a high coefficient of the balance function for female players in sport games (average indicators of the Romberg coefficient for men is 173% ± 2,62 and for women - 216% ± 2,32) is achieved due to the biomechanical adaptation of the stance technique, taking into account the gender characteristics of the athletes. The nuances regarding the indicators of maintaining balance among elite athletes, depending on gender, were revealed, which is primarily related to the location of the centres of gravity: in women, it is located in the hips, and in men, it is much higher. For example, this will directly affect the difference in the recommended angle in the knee area for female and male athletes during the strength exercise "squat with a barbell".

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Conflict of interest

The authors declare that there is no conflict of interest.

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