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Risk Factors for Posture Disorders of Esportsmen and Master Degree Students of Physical Education and Sports in the Specialty "Esports"

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Czynniki ryzyka zaburzeń postawy e-sportowców i studentów studiów magisterskich wychowania fizycznego i sportu w specjalności „e-sport”

Streszczenie

Celem pracy było zbadanie czynników ryzyka zaburzeń postawy u e-sportowców i studentów studiów magisterskich kultury fizycznej i sportu. W badaniach wzięło udział 37 sportowców i studentów. Badania wykazały, że 32,4% z nich spędza przy komputerze ponad sześć godzin dziennie. Wykazano, że na postawę badanych najbardziej negatywnie wpływa obniżony poziom siły kończyn dolnych i tułowia, brak aktywnych przerw podczas długiej pracy z komputerem, brak świadomości w profilaktyce zaburzeń postawy podczas pracy z komputerem i zaniedbanie kontrolowania postawy użytkownika komputera. Badania sugerują strukturę czynników, które negatywnie wpływają na kondycję postawy e-sportowców i magistrantów specjalności „e-sport”. Struktura ryzyka zaburzeń postawy zawiera trzy czynniki, które wyjaśniają 66,2% całkowitej wariancji: „Niezastosowanie się do ergonomicznie optymalnej postawy użytkownika komputera”, „Zaburzenia układu mięśniowo-szkieletowego e-sportowców” oraz „Brak środków neutralizujących negatywny wpływ działań e-sportowych”. Niezbędne jest opracowanie i wdrożenie działań prozdrowotnych w profilaktyce zaburzeń postawy oraz chorób układu ruchu u e-sportowców i studentów.

Słowa kluczowe: e-sportowcy, czynniki ryzyka, użytkownik komputera, pozycja robocza, postawa.

Abstract

The purpose of this study was to investigate the risk factors for posture disorders in esportsmen and master’s degree students of physical culture and sports. The research involved 37 sportsmen and students. The research has found out that 32.4% of the respondents spend more than six hours a day on a computer. The research has proven that the posture of the respondents is most negatively affected by the reduced strength level of the lower extremities and torso, lack of active breaks during long work with a personal computer (PC), lack of awareness in the prevention of posture disorders when working with a PC, and neglect to control a PC user posture. The research suggests the structure of factors that negatively affect the posture condition of esportsmen and master’s degree students in the specialty “Esports”. The structure of risks for postural disorders contains three factors, that explain 66.2% of the total variance: “Failure to comply with the ergonomically optimal posture of a PC user”, “Disorders of the musculoskeletal system of esportsmen” and “Lack of measures to neutralize the negative impact of esports activities”. It is necessary to develop and implement health-improving measures to prevent postural disorders and diseases of the musculoskeletal system in esportsmen and students.

Keywords: esportsmen, risk factors, PC user, working pose, posture.

Introduction

Esports is gaining a stronger position in the gaming industry segment, gathering momentum as a promising business sector and as a popular sport that has

now received its official status. At the same time, there are serious reasons to expect the inclusion of esports in the program of the 2024 Olympic Games [22].

The rapid development of the cyber industry, the official recognition of esports and its active promotion as a new Olympic discipline – all this has led to the expansion of the problem field of modern Olympic sports and contributed to the formation of a new scientific field related to esports. Scientists have begun to study the origins of esports and the peculiarities of its formation [1]. As of today, the conceptual apparatus of esports science has been clarified [8], the educational-professional program "Esports" of the master's level of higher education in the specialty 017 "Physical Culture and Sports" has been developed and implemented, the role of esports in educational and entertainment practices of modern youth has been analyzed [16]. There are studies on esports' legal [22] and economic aspects [7], the research is conducted on the problems of statistical analysis and forecasting the results of esports competitions [17, 23].

However, the rapid development of esports has led to the appearance of new issues. Pedagogical observations prove that esports activities are accompanied by a predominantly sedentary lifestyle, which, provided that the optimal distribution of esports activities and recreation is not observed, can pose a threat to the health of esportsmen. In general, esportsmen are affected by a number of dangerous and harmful factors: reduced physical activity, lack of recreational health activities during the day, and significant psycho-emotional stress. However, the greatest risk to the health of esportsmen is probably static and dynamic load on their musculoskeletal system. It should be noted that static load on the spine and muscles, which are involved in maintaining a static posture of a personal computer (PC) user, is a significant risk factor for players' posture disorders and poses a threat to their musculoskeletal system. Moreover, the violation of the ergonomically optimal posture of a PC user exacerbates the negative impact of the factor. Similarly, the same type of load on the hand muscles, when using a computer mouse, is harmful for esportsmen.

Domestic scientists have long conducted research aimed at assessing the state of the bio-geometric profile of the posture of different groups [10, 11, 13, 21]. Researchers pay special attention to the modelling of the rational posture of a PC user in the system "human-computer" [14], and to the organization of pedagogical control over the observance by students of higher education institutions of an ergonomically optimal posture of a personal computer user in the educational process [3, 12].

However, despite the fact that esports activities are accompanied by excessive static load on the musculoskeletal system of esportsmen and excessive dynamic local load on the hand muscles, it is still unknown, which risk factors for posture disorders of esportsmen and master degree students of physical education and sports in the specialty "Esports" are the most threatening.

The purpose of the research is to investigate the risk factors for posture disorders of esportsmen and master's degree students of physical culture and sports in the specialty "Esports".

Methods

Participants

The research was conducted at the Department of Innovation and Information Technologies in Physical Culture and Sports of the National University of Physical Education and Sport of Ukraine (NUPESU). It involved 37 sportsmen specializing in esports and students of the NUPESU, who are studying according to the educational-professional program "Esports" for their master's degree of higher education in the specialty 017 "Physical Culture and Sports". In addition, the research involved 14 students of the NUPESU studying according to the educational-professional program "System of training sportsmen in water sports" for their master's degree of higher education in the specialty 017 "Physical Culture and Sports". All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. All subjects of the institutional survey gave consent for anonymized data to be used for publication purposes.

Measures

The study involved such research methods as the theoretical analysis of literature sources, questionnaires, and statistical analysis, namely factor, correlation, and frequency analyses.

To conduct a survey using the Google Form, a questionnaire was developed and distributed to potential respondents through all possible means of disseminating information (primarily, Viber and Telegram). The obtained results were subject to statistical analysis. Each of the proposed questions involved choosing one of the three answers (Yes / Sometimes (Partially) / No). The processing of personal data was preceded by quantification of survey results, i.e. transfer of information into numerical form. Numbers 3 and 1 marked answer "Yes" and "No", depending on the question, and the intermediate result was marked with number 2.

Data analysis

STATISTICA 10.0 (StatSoft, USA) software package was used for data analysis. In the course of the statistical analysis when testing statistical hypotheses H_0, the level of significance was accepted $\alpha = 0.05$ ($p < 0.05$). It should be noted that when the calculated value of p was less than 0.0001, in the research it is presented as "$p < 0.01$". The hypothesis H_0 about the conformity of the observed data to the normal distribution law was tested using the Shapiro-Wilk consistency criterion *W*. In the case when $p > 0.05$, it was concluded that the analyzed distribution did not differ from normal [15].

All average indicators calculated on data other than normal are presented below as median and interquartile range (Me; 25; 75), and others – with the help of M – average value and SD – standard deviation (M±SD).

The comparative analysis of the duration of time spent by respondents in training and competition periods was performed using non-parametric Wilcoxon T-test and the comparative analysis of the duration of being in the working position of a PC user depending on the level of sportsmanship and achievements was conducted with the use of Mann-Whitney U-test [5]; the comparative analysis of factors that negatively affect the posture of esportsmen was performed using the Kruskal-Wallis H-test.

The research widely used the frequency analysis. The observed distribution of respondents by answers to the questions was compared with an even distribution using Pearson's chi-squared test χ^2. Pearson's chi-squared coefficient P and Fisher's angular criterion φ [6] were used to assess the statistical significance.

One of the research tasks was the development of a questionnaire and verification of its reliability and validity [2]. The questionnaire contained a motivational address to the respondents, a question part aimed at studying the contingent, and the main part aimed at solving the research tasks.

The reliability of the questionnaire was checked using Cronbach's alpha reliability test for surveys. It should be noted that at this research stage some questions for which the coefficient was less than 0.65 were removed from the questionnaire, namely the question "Indicate the length of time you usually spend at the computer" and "Are you interested in questions about what posture-preserving measures are recommended for long-term work with a PC?" After that, all the obtained coefficients were quite reliable, which indicates the consistency of the questionnaire (Table A1).

In addition, as recommended by the scientist [2], we assessed the reliability of the questionnaire with the Theta reliability using Varimax factor analysis. After the rotation of the main components, a three-factor model was constructed, which explains 66.2% of the total variance. The absolute weight of the main

component was 3.42, and the Theta reliability factor was 0.66. Therefore, the developed questionnaire has a factor structure, and the total coefficient of the explanatory variance exceeds 0.51, which indicates its stability and reliability (Table A2).

The standardization of the questionnaire was based on the assumption that the answers to the same questions of different groups of PC users are correlated. Thus, we compared the answers to some questions of the questionnaire, which we took as control ones, by students of the NUPESU studying according to the educational-professional program "System of training athletes in water sports" for their master's degree of higher education with the answers of a group of respondents who participated in the research. It should be noted that given the online form of learning of modern students, they are forced to work with a PC much more time than in the classroom. In the course of the research, we established a correlation between their answers. The calculations have shown the absence of statistically significant correlations in the answers of respondents from different groups to the question "Do you know what PC user posture is ergonomically optimal?" (P = 2.73; p = 0.255), "Do you control the working posture of a PC user" (P = 3.47; p = 0.177) and "Do you take active breaks during long work with a PC" (P = 1.410; p = 0.494).

In addition, the validity of the developed questionnaire was checked. The correlation analysis has revealed direct statistically significant correlations (p < 0.05) between the proposed questions of the questionnaire, which suggests the existence of commonality between all questions of the questionnaire (Table A3).

Results

Considering the contingent of the research participants, it should be noted that the age of esportsmen and master's degree students of physical culture and sports in the specialty "Esports" ranged from 17 to 34 years old and made 22.1±3.5. At the same time, the competition and game experience of the research participants differed significantly (from 1 to 18 years) and its median value was (5; 2; 8) years.

To cluster the participants of the survey and to divide them into groups according to the level of sportsmanship and achievements, the questionnaire included the question "What category of players do you belong to?" which offered three possible answers: an amateur, a gamer and a professional. As the practice of Ukrainian esports has not yet defined sports categories and sports titles, the previous communication with esportsmen allowed identifying these levels, which cover the entire range of players and future esports professionals.

Therefore, further, by an amateur we mean an esportsman in the broadest sense of the word, who is fond of computer games, is engaged in esports in their free time and has the opportunity to develop in this sport and related activities in the cyber industry.

In turn, by a gamer, we mean a novice esportsman who participates in esports competitions and in the course of esports training and development of gaming skills is a potential professional esportsman.

Accordingly, we considered a professional esportsman to be a person engaged in one (or several) esports disciplines as a professional activity and participating in international esports tournaments.

Thus, the research showed that amateurs predominated among the respondents: their share was 54.1% (n = 20) of respondents. The shares of gamers and professional players were 29.7 and 16.2%, respectively.

Regarding social status, almost half of the respondents (48.7%; n = 18) were university students, and 37.8% (n = 14) were master's degree students of the NUPESU, who in the vast majority were not professional players, one of the respondents worked in the cyber industry and the rest were engaged in esports in their free time.

The majority of respondents, namely 67.6% (n = 25) of them, answered that they spent at the computer up to 6 hours a day. It should be noted that 64% (n = 16) of respondents who played computer games for up to 6 hours a day were amateurs.

Among other answers, the most common were 7-8 hours (13.5%; n = 5) and more than 12 hours (10.8%; n = 4). The remaining 8.1% of the respondents were distributed according to the answers to groups of esportsmen who spent 6–7 or 9–10 hours a day at the computer. It was proved that among the players who were at the computer up to 6 hours a day, the share of amateurs was statistically significant ($p < 0.05$).

The research has found out that in the pre-competition and competition periods, the share of esportsmen and future esports professionals who spend at the computer up to 6 hours a day is reduced by 10.8% and makes 56.8% (n = 21). At the same time, the share of players who spend more than 12 hours a day at the computer remains unchanged.

In the course of the comparative analysis of the length of daily stay of esportsmen at the computer, depending on the period, we have found the midpoints of the intervals and checked that the input data does not comply with the normal distribution law. Thus, the Shapiro-Wilk criterion for data during the training period is W = 0.604 ($p < 0.01$), and for the competition period it is W = 0.745 ($p < 0.01$). The median value of the duration of the respondents' stay at the computer during the training period is (5.5; 5.5; 7.5), and during the competition period (5.5; 5.5; 9.5) hours per day.

According to Wilcoxon T-test, the length of stay of the respondents at the computer does not significantly change statistically depending on the period (T = 15; z = 1.88; p = 0.06). Although the share of amateurs who stay in the working position of a PC user less than 6 hours a day statistically significantly exceeds the share of gamers and professionals with a given duration of daily work with a PC (φ = 2.125 at $p < 0.05$), the average length of their stay at the computer does not significantly differ statistically (U = 124 at $p > 0.05$).

The next block of questions was aimed at studying and analyzing the risk factors for posture disorders among esportsmen and master's degree students of physical education and sports in the specialty "Esports".

The analysis of the answers to the question "Do you control the working posture of a PC user while working with a computer?" has shown that less than a half of the respondents, namely 48.7%, control posture while working with a PC. At the same time, almost a quarter of the respondents, namely 21.6%, said they did not think about this issue at all.

According to the calculations, in each of the subgroups of the respondents the share of those who try to adhere to the ergonomically optimal posture of a PC user prevailed: among amateurs, their share was 40%, among gamers – 54.5%, and among professional players – 66.7%. On the other hand, among the total number of respondents who answered in the affirmative, the share of amateurs prevails (only 44.4%) and the smallest is the share of professionals (only 22.2%). As for the respondents who did not think about this issue at all, there were no professionals among them, while 62.5% were amateurs. However, the share of amateurs is not statistically significantly different from the share of gamers and professionals who control the working posture of a PC user (φ = 1.148; $p > 0.05$), and the share of amateurs who do not control the working posture of a PC user is statistically significantly lower than of those amateurs who control the working posture always or sometimes (χ^2 = 5.0; df = 1; p = 0.025) (Table 1).

The next question of the main part of the questionnaire concerned the level of the respondents' awareness about the concept of "ergonomically optimal posture of a PC user". The distribution of the respondents by answers to the question "Do you know what PC user posture is ergonomically optimal, what are the posture risks for esportsmen and how to eliminate these risks?" has shown that among the respondents related to the esports industry who spend at least 5 hours and 30 minutes a day at a computer, only a quarter have full theoretical knowledge about posture disorders prevention while working with a PC. At the same time, the rest of the respondents, namely 75.0%, said that they were partially acquainted with this issue.

The following fact is alarming: the share of gamers and professionals, who have sufficient theoretical knowledge about the posture risks for PC users and ways to overcome them, together amounted to 46.4%, which, if the trend con-

tinues, may threaten their posture. At the same time, the study has shown that among the respondents who do not have good theoretical knowledge of the posture issues, a statistically significant majority are amateurs ($\chi^2 = 6.25$; df = 2; $p = 0.039$).

The distribution of respondents by answers to the question "Do you regularly engage in health-improving motor activity?" proves that in general esportsmen and master's degree students of physical education and sports in the specialty "Esports" are engaged in physical culture and sports: 70.3% of respondents answered "Yes". Among amateurs, the distribution of answers to the question was as follows: "Yes" – 65.0%, "Sometimes" – 30.0%, "No" – 5.0%; among gamers – 72.7 and 27.3%, and among professionals – 83.3 and 16.7%, respectively. At the same time, 50.0% of amateurs, 30.8% of gamers and 19.2% of professionals were among the respondents who answered in the affirmative. The analysis has shown that the distribution of amateurs regarding the regularity of health-improving motor activity is statistically significantly different from the average ($\chi^2 = 10.895$; df = 2; $p = 0.004$).

The research has revealed that 37.8% of all the respondents take breaks for mini-sets of exercises while working at a computer. The distribution of amateurs, gamers and professionals was as follows: 64.3, 14.3 and 21.4%, respectively. The results of the respondents' distributions somewhat differ regarding the question "Do you take active breaks during long work with a PC?" 75% of amateurs and 25% of gamers take active breaks, while 54.5% of amateurs, 27.3% of gamers and 18.2% of professionals never do. On the other hand, 50.0% of professional players gave an affirmative answer to this question.

It has not been proven that the share of amateurs who take breaks to perform mini-sets of exercises while working with a computer is statistically significantly higher than the combined share of gamers and professionals ($\varphi = 0.983$; $p > 0.05$). At the same time, the share of professionals who do not take active breaks at all is statistically significantly lower compared to the combined share of amateurs and gamers ($\chi^2 = 8.33$; df = 1; $p = 0.004$). The situation is similar regarding gamers ($\chi^2 = 4.45$; df = 1; $p = 0.034$) and professionals ($\chi^2 = 9.0$; df = 1; $p = 0.003$) who sometimes take active breaks while working with a PC (Table 1).

The answer "No" was given by a statistically significantly ($\chi^2 = 4.568$; df = 1; $p = 0.033$) lower number of professionals than amateurs and gamers together. At the same time, among professionals, a higher percentage of those who take active breaks while working with a PC is statistically significant ($\chi^2 = 4.568$; df = 1; $p = 0.033$). The research has revealed that among gamers the percentage of those who answered in the affirmative is statistically significantly ($\chi^2 = 9.757$; $p = 0.002$) lower than the combined number of those who answered "Sometimes" or "No".

The research shows that 78.4% of esportsmen and future esports professionals indicated no posture disorders. Among them, 51.7% are amateurs, 34.5%

are gamers, and 13.8% are professionals, and the defined distribution differs from the uniform ($\chi^2 = 6.274$; df = 2; $p = 0.043$). On the other hand, amateurs predominate among respondents without postural disorders ($\chi^2 = 5.0$; df = 1; $p = 0.025$). However, 16.2% and 5.4% of respondents have posture disorders and spinal diseases, respectively.

Table 1. Distribution of esportsmen and master's degree students of physical education and sports in the specialty "Esports" regarding control of the working posture of a PC user and regarding taking active breaks while working with a PC

	Total	**Amateurs (*n* = 20)**	**Gamer (*n* = 11)**	**Professional (*n* = 6)**	***p*-value**
Control of the working posture					
Yes, *n* (%)	18 (48.6)	8 (44.5)	6 (33.3)	4 (22.2)	0.56
Sometimes, *n* (%)	11 (29.7)	7 (63.6)	2 (18.2)	2 (18.2)	0.37
No *n,* (%)	8 (21.7)	5 (62.5)	3 (37.5)	0 (0.0)	0.48
Taking active breaks					
Yes, *n* (%)	14 (37.8)	9 (64.3)	2 (14.3)	3 (21.4)	0.28
Sometimes, *n* (%)	11 (29.7)	6 (54.5)	3 (27.3)	2 (18.2)	0.76
No *n,* (%)	12 (32.4)	5 (41.7)	6 (50.0)	1 (8.3)	0.56

Note: p-value when comparing observed and expected frequencies of animators and gamers together with professionals.

At the same time, 70.3% of respondents do not feel discomfort after long work with a PC, of which 53.9% are amateurs, 34.6% –gamers, and the remaining 11.5% – professionals. It should be noted that the share of amateurs among them is statistically significant ($\chi^2 = 6.997$; df = 2; $p = 0.030$). According to the research, 29.7% of esportsmen and master's degree students of physical education and sports in the specialty "Esports" complained of muscle pain after static load in the working position of a PC user, which may indirectly indicate a reduced level of basic muscle groups of their bodies. It should be added that among respondents who experience discomfort in the muscles involved in maintaining posture after prolonged work with a PC, there are 54.6% of amateurs, 18.2% of gamers and 27.3% of professionals.

The research has found out that 16.2% of respondents do not have a specially designed PC user workplace, and another 8.1% have a partially equipped workplace in terms of ergonomics. It should be emphasized that all the interviewed professionals say that their workplaces are properly arranged.

Regarding the condition of the bio-geometric profile of the working posture of a PC user, among the respondents, 29.7% have a reduced assessment of the position of the torso, 8.1% of the position of the upper extremities and 24.3% of the position of the lower extremities.

The research has proven that the share of the respondents (78%) with a low or medium level of torso position when working at a PC was statistically significantly ($\chi^2 = 11.919$; df = 1; $p < 0.001$) bigger than the share of respondents with a high level. Similarly, in the case of assessing the position of the lower extremities, the share of the respondents (85.6%) with low or medium location of the lower extremities when working with a PC was statistically significantly ($\chi^2 = 19.703$; df = 1; $p < 0.001$) bigger, and the share of the respondents with a low or medium level of the position of the upper extremities did not differ statistically significantly from the high level ($\chi^2 = 0.676$; df = 1; $p = 0.411$).

The comparative analysis of adverse factors has shown that their impact on the posture of esportsmen and master's degree students of physical education and sports in the specialty "Esports" is statistically significantly different depending on the factor (Table 4). For example, as it can be seen from the table, the reduced position of the lower extremities and torso, lack of active breaks during long work with a PC, lack of awareness in preventing posture disorders while working with a PC, and neglect of the working posture of a PC user had the most negative impact on the posture of the respondents (Table 2).

Table 2. Comparative analysis of factors that negatively affect the posture of the respondents

Factor N	**Multiple Comparisons p values (2-tailed); Kruskal-Wallis test: H (9, *n* = 370) = 60.31; *p* < 0.001, *n* = 37**									
	1	2	3	4	5	6	7	8	9	10
1		1.00	1.00	1.00	0.63	1.00	1.00	1.00	1.00	1.00
2	1.00		0.28	1.00	0.08	1.00	0.49	1.00	1.00	1.00
3	1.00	0.28		0.08	1.00	1.00	1.00	<0.001*	1.00	<0.001*
4	1.00	1.00	0.08		0.02*	1.00	0.14	1.00	1.00	1.00
5	0.63	0.08	1.00	0.02*		1.00	1.00	0.00	1.00	<0.001*
6	1.00	1.00	1.00	1.00	1.00		1.00	0.12	1.00	0.04
7	1.00	0.49	1.00	0.14	1.00	1.00		0.01*	1.00	<0.001*
8	1.00	1.00	0.00	1.00	<0.001*	0.12	0.01*		1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		0.63
10	1.00	1.00	0.00	1.00	0.00	0.04*	<0.001*	1.00	0.63	

Note: * – statistically significant difference between the factors has been proven ($p < 0.05$).

The factor analysis of the survey results has identified three factors that influence the posture condition of esportsmen and master's degree students of physical education and sports in the specialty "Esports". General factor 1, whose share of variance is 30.2%, can be called "Non-compliance with the ergonomically optimal posture of a PC user" and includes the factor "Lack of a specially designed workplace" taking into account ergonomic requirements ($r = 0.83$).

This indicator directly correlates with assessments of the location of the lower (r = 0.75) and upper (r = 0.71) extremities when working with a PC. That is, the lack of a specially designed workplace causes a decrease in the level of the biogeometric profile of a PC user and the deviation of the position of the upper and lower extremities from the ergonomically optimal one.

The second factor "Unsatisfactory condition of the musculoskeletal system of an esportsman" with a load of 18.6% includes the presence of posture disorders or spine diseases (r = 0.93) and reduced development of major muscle groups involved in maintaining the appropriate posture (r = 0.91). Thus, congenital or acquired spine and posture disorders, and low levels of development of the main muscle groups of the body involved in maintaining the optimal posture increase the negative impact of esports on the posture of gamers.

The last factor "Lack of measures to neutralize the negative impact of esports" with an indicator of 17.4% includes the lack of control over the working posture of a PC user (r = 0.79) and failure to take active breaks during long work with a PC (r = 0.71). It can be argued that the lack of control over the working posture of a PC user by esportsmen and their failure to take active breaks has an adverse effect on their posture.

Discussion

Against the background of the growing popularity of esports and the involvement of a significant proportion of modern adolescents and young people in esports, the study of risk factors for posture of esportsmen and master's degree students of physical education and sports in the specialty "Esports" is extremely relevant.

The scientific and methodological literature has repeatedly raised the issues regarding the factors that affect the condition of a gamer. In particular, Kovaleva G. [18] considered the risk factors for reducing their gaming potential. Among the factors that negatively affect the professional status of esportsmen, the author singles out the prolonged stress of the visual analyzer, intense information, intellectual and psycho-emotional stress, prolonged static load on the musculoskeletal system, improper workplace organization, and failure to follow a healthy lifestyle, which includes eating disorders, lack of physical activity, etc. Analyzing the author's reasoning, we assumed that these factors have a negative impact not only on the gaming potential of esportsmen, but also on their health, including the condition of the posture.

Similarly, scientists have accumulated significant knowledge about the negative consequences of the use of information technology in the educational process [9]. Experimental studies have confirmed that a prolonged stay in a static

position of a PC user in the context of computerization of education provokes a deterioration in the physical health of university students and lowering of their mental capacity level [4].

Our previous research determined that an ergonomically optimal working posture of a PC user is the position while working at a computer, which meets the hygienic requirements for the organization of the workplace and at which the spine and joints have the least load, and which scientifically substantiates the need to control the working posture of a PC user [13]. The previous research also defined the risk factors leading to certain manifestations of office syndrome in working age women under the influence of negative working environment [19, 20]. Esports activities are similar in nature to those of office workers and are associated with significant potential risks of posture disorders for esportsmen. At the same time, we assumed that in the case of students' distance learning, the posture of study participants may be negatively affected by such factors as lack of theoretical knowledge on the prevention of posture disorders when working with a PC, low bio-geometric profile of the working posture of a PC user, lack of a specially designed PC user workplace, and neglect of active breaks while working with a PC. Based on the identified factors, a questionnaire was developed, which, after testing and adjustment, contained 10 questions. It should be noted that the research process included checking the questionnaire for reliability and validity.

Summarizing the results, it should be noted that regarding the number of questions, including the duration of stay in the working position of a PC user up to 6 hours and breaks for mini-sets of exercises when working with a computer, amateurs statistically significantly ($p < 0.05$) differ from gamers and professionals. Such results give grounds to conduct further research taking into account the level of sportsmanship and achievements of esportsmen and master's degree students of physical education and sports in the specialty "Esports".

The research has revealed that according to the level of theoretical knowledge, control of the working posture of a PC user, measures taken to maintain posture when working with a PC, statistically significant ($p > 0.05$) differences between the study participants depending on their skills have not been established. Therefore, it is also advisable to organize joint activities aimed at expanding the knowledge of cyber industry professionals regarding posture issues and the formation of skills of maintaining the ergonomically optimal posture of a PC user.

Despite the fact that 78.4% of the study participants currently do not have posture disorders, and 70.3% do not feel discomfort after long work with a PC, we are convinced that in the absence of adequate health measures, in the future we can predict posture disorders in esportsmen and master's degree students of physical education and sports in the specialty "Esports".

According to the results of the study, the lower position of the lower extremities and torso, lack of active breaks during long work with a PC, and lack of awareness concerning the prevention of posture disorders while working with a PC have the most negative impact on the posture of the respondents.

The research has allowed identifying and investigating the risk factors for posture disorders of esportsmen and master's degree students of physical education and sports in the specialty "Esports". In the course of factor analysis of factors that negatively affect the posture condition of the respondents, the research identified three factors that explain 66.2% of the total variance. The first factor "Failure to comply with the ergonomically optimal posture of a PC user" (30.2%) includes the lack of a specially organized workplace, which leads to the deviation of the lower and upper extremities when working with a PC from an ergonomically optimal position. The second factor (18.6%) is related to the condition of the musculoskeletal system of esportsmen, and the third factor "Lack of measures to neutralize the negative impact of esports activities" explains 17.4% of the total variance.

Conclusions and perspectives of further research

Along with the promotion of esports, there is a steady increase in the number of people involved in esports activities. Among the threats to the health of esportsmen, like in the case of office workers, attention should be paid to the risks of musculoskeletal diseases and musculoskeletal spine pain caused by inadequate static and dynamic loads on the spine, typical of PC users. This situation requires a study of risk factors for posture disorders of esportsmen and master's degree students of physical education and sports in the specialty "Esports".

The research has identified and analyzed factors that can lead to postural disorders in esportsmen and master's degree students of physical education and sports in the specialty "Esports". The adverse factors include lack of theoretical knowledge on the prevention of postural disorders when working with a PC, lack of control of the working position of a PC user, congenital or acquired curvature of the spine, insufficient development of major muscle groups, especially of the so-called muscular corset, insufficient motor activity, failure to take active breaks during long work with a PC, lack of a specially designed workplace, and a low level of a bio-geometric profile of a PC user.

The research has revealed that despite the long time that both esportsmen and master's degree students of physical education and sports in the specialty "Esports" spend in the working position of a PC user, 75.0% cannot clearly determine which position of a PC user is considered ergonomically optimal and what measures can reduce the negative impact of working with a PC. The re-

search has found out that 51.3% of the respondents do not always or never control the working posture of a PC user. At the same time, 29.7% are not engaged in health-improving motor activity, and 62.2% only sometimes or never take breaks to perform mini-sets of exercises while working with a PC. The research has shown that 16.2% of the study participants do not have a specially designed workplace of a PC user, 29.7% have a reduced assessment of the torso position, 8.1% of the upper extremities position and 24.3% of the lower extremities position.

Currently, 78.4% of the respondents do not have postural disorders, and 70.3% do not feel discomfort after prolonged work with a PC, but with the trend towards neglecting the rules of safe behaviour when working with a PC, we can predict in the future an increased risk of postural disorders among esportsmen and master's degree students of physical education and sports in the specialty "Esports".

Within the research, the factor analysis of the factors that negatively affect the posture of esportsmen and master's degree students of physical education and sports in the specialty "Esports" has been conducted. A three-factor model, which explains 66.2% of the total variance, has been developed. The first general factor "Failure to comply with the ergonomically optimal posture of a PC user" (30.2%) includes the lack of a specially designed workplace, which leads to the deviation of the lower and upper extremities when working with a PC from an ergonomically optimal position. The second factor (18.6%) is related to the condition of the musculoskeletal system of esportsmen, and the third factor "Lack of measures to neutralize the negative impact of esports activities" explains 17.4% of the total variance.

There is an urgent need to create a database and gather information on the impact of esports on the health of esportsmen, including their posture. To obtain comprehensive information on the peculiarities of the static and dynamic load on the musculoskeletal system of esportsmen and master's degree students of physical education and sports in the specialty "Esports" is the task of further research in this area.

The results of the research have proven that against the background of prolonged daily stay of the respondents in the working position of a PC user, esportsmen and master's degree students of physical education and sports in the specialty "Esports" do not pay enough attention to the posture issues. Therefore, it is necessary to develop and implement health-preserving measures to prevent postural disorders and diseases of the musculoskeletal system in esportsmen and master's degree students of physical education and sports in the specialty "Esports".

Appendix

Table A1. The value of Cronbach's alpha reliability criterion for the questions of the questionnaire (n = 37)

N	Questions	α = 0.73; α(st) = 0.75
1	Do you control the working posture of a PC user?	0.77
2	Do you know which PC user posture is ergonomically optimal, what are the posture risks for esportsmen and how to eliminate these risks?	0.71
3	Do you regularly engage in health-improving motor activity?	0.69
4	Do you take active breaks during long work with a PC?	0.68
5	Do you have inborn or acquired spine or posture disorders?	0.73
6	Do you feel discomfort in the muscles involved in maintaining posture after long work with a PC?	0.73
7	Do you have a specially designed workplace of a PC user?	0.66
8	Assess the location of your torso at the moment (1 – sharp deviation, 2 – moderate deviation; 3 – working posture corresponds to the ergonomically optimal pose of a PC user).	0.70
9	Assess the location of your upper extremities at the moment.	0.70
10	Assess the location of your lower extremities at the moment.	0.71

Note: α – Cronbach's alpha coefficient; α(st) – standardized Cronbach's alpha coefficient.

Table A2. Factor analysis of negative factors (the method of rotation of the main components, Varimax normalized, n = 37)

Factor N	Negative factor	Factors		
		Factor 1	Factor 2	Factor 3
1	Lack of control of the working posture of a PC user	−0.19	−0.11	0.79*
2	Lack of theoretical knowledge on the prevention of postural disorders when working with a PC	0.22	0.10	0.72
3	Lack of regular health-improving motor activity	0.69	0.26	0.14
4	Lack of active breaks during long work with a PC	0.48	−0.02	0.71*
5	Posture disorders or spine diseases	−0.00	0.93*	−0.05
6	Decreased level of development of the main muscle groups involved in maintaining posture	0.14	0.91*	0.04
7	Lack of a specially designed workplace	0.83*	0.10	0.25
8	Deviation (from the ergonomically optimal one) of the torso position when working with a PC	0.67	0.17	−0.02
9	Deviation (from the ergonomically optimal one) of the upper extremities position when working with a PC	0.71*	0.00	0.06
10	Deviation (from the ergonomically optimal one) of the lower extremities position when working with a PC	0.75*	−0.20	0.02
Expl. Var		3.020	1.858	1.740
Prp. Totl		0.302	0.186	0.174

Note: * – the significance of the correlation coefficient has been statistically proven (p < 0.05).

Table A3. Intercorrelation of questions of the questionnaire when checking the construct validity on internal coherence (Kendalltau coefficients, n = 37)

Factor N	1	2	3	4	5	6	7	8	9	10
1	1.00	0.27	−0.01	**0.35***	−0.02	−0.08	−0.00	−0.09	0.07	0.02
2	0.27	1.00	0.23	0.49	0.12	0.09	0.32	0.24	0.06	0.22
3	−0.01	0.23	1.00	0.39*	0.22	0.24	0.54*	0.43*	0.28	0.30
4	0.35*	0.49*	0.39*	1.00	−0.00	0.11	0.58*	0.24	0.34*	0.29
5	−0.02	0.12	0.22	−0.00	1.00	0.80*	0.13	0.13	0.07	−0.09
6	−0.08	0.09	0.24	0.11	0.80*	1.00	0.19	0.18	0.15	−0.01
7	−0.00	0.32	0.54*	0.58*	0.13	0.19	1.00	0.45*	0.49*	0.48*
8	−0.09	0.24	0.43*	0.24	0.13	0.18	0.45*	1.00	0.22	0.44*
9	0.07	0.06	0.28	0.34*	0.07	0.15	0.49*	0.22	1.00	0.51*
10	0.02	0.22	0.30	0.29	−0.09	-0.01	0.48*	0.44*	0.51*	1.00

Note: * – the significance of the correlation coefficient has been statistically proven ($p < 0.05$).

STATEMENT OF ETHICS

This study was conducted in accordance with the World Medical Association Declaration of Helsinki. The study protocol was reviewed and approved by the Commission on Biomedical Ethics at the National University of Physical Education and Sports of Ukraine, № 57, Kyiv, Ukraine. All participants provided written informed consent to participate in this study

DECLARATION OF CONFLICTING INTERESTS

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