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Evaluation of Knowledge for Risk Factors Causing Musculoskeletal Disorders Among Computer Users in Bulgaria

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Abstract: Prolonged computer work is among the most common causes for developing musculoskeletal disorders, as well as various of inflammatory and degenerative conditions affecting tendons, blood vessels and joints, among others. During recent COVID-19 lockdowns, many office workers were forced to work from home, where workplace ergonomic assessments were no longer possible. In such cases, computer users must rely on their ergonomic training and knowledge of risk factors to keep a healthy work environment. The current study focuses on the awareness and knowledge of various risk factors associated with work-related musculoskeletal disorders among office workers and university students. A cross-sectional survey among 197 participants was conducted during the first COVID-19 lockdown in Bulgaria. Respondents were asked if they had felt discomfort and pain in ten body areas due to prolonged computer use. All of the survey questions were designed with multiple-choice responses and rating scales to maximize the response rate and ease the data analysis. According to the findings, one out of every four persons is unaware of how to protect themselves from musculoskeletal pain. As a result, increased efforts through educational initiatives are required, which have a strong focus on changing working behaviors, as ergonomic interventions aimed at reducing unnatural body postures can be regarded as a significant step toward the prevention of musculoskeletal disorders.

Keywords: Computer Work, Musculoskeletal Disorders, Pain Prevention, Ergonomic Organization

1. Introduction

Computer-based office work dominates a wide spectrum of industry and business fields worldwide, including the European Union [1]. According to Lima, T. M. and D. A. Coelho [2], 70-75% of the workforce uses desktop or laptop computers as part of the job. Prolonged maintenance of the body in the same static posture, as well as the same type of repetitive motions can cause discomfort in the muscles and joints. Work-related musculoskeletal disorders (WMSDs) associated to prolonged computer work have defined as a most costly occupational and public health problem [3-6]. They are not life-threatening and are frequently overlooked, but long-term incorrect static postures and movements, as well as less physical exercise, can result in injury [7, 8]. This, in turn, has an impact on the quality of work and financial wellbeing, as well as overall quality of life. Sick leave is more frequently required, as is rehabilitation and lengthened rest to recover the body and fully restore the ability to work efficiently. Systemic pain increases the individual's stress level and mental health disorders (MHDs), which has a

negative impact on the company, family, and society [9, 10]. WMSDs and MHDs are the costliest occupational health problems in many countries [11].

Numerous scientific studies have been conducted to investigate the relationship between improperly set work-related psychosocial factors and WMSDs. Professions, distinguished by static postures and monotonous, repetitive tasks, such as computer use, are more likely to develop WMSDs [12-14]. Musculoskeletal disorders (MSDs) are the most commonly reported health issues in the EU-27 [7]. Around 60% of the respondents consider MSDs to be the cause of work-related health problems, followed by stress, depression, and anxiety (16%). Work-related MSDs are also said to contain a variety of inflammatory and degenerative conditions affecting the tendons, ligaments, joints, and blood vessels. In addition, MSDs comprise the majority of health-related work absences (9.9 million days), followed by stress, depression and anxiety (9.5 million days) [15].

However, because most of the research has focused on the individual employees' actions and the working environment, the majority of such studies are based on the notion that MSD is the result of human error and malfunctions [16].

As a step towards gaining further insights into recent shift in office work habits, many studies investigate the risk factors for developing musculoskeletal symptoms (MSS) in the upper body, especially in neck, back, and shoulders, due to prolonged computer use [17, 18]. Occupational exposures have been linked to up to 37% of all back pain and injuries [19].

Workplace ergonomic assessment plays a central role in determining the interaction between workers and their devices and furniture [20]. To lower the risk of work-related musculoskeletal issues, organizational, training, and diverse ergonomic measures were advised [18, 21, 22]. Lima, T. M. and D. A. Coelho conducted a survey among 96 office workers with over 96% of the respondents stating they have insufficient training on workplace ergonomics and health and safety at work, followed by non-ergonomic furniture (an average of 50%) [2]. The uncomfortable or prolonged posture is in fifth place as a source of occupational health problems with an average of 23.9%. Forward head posture (FHP) emerges when the position of the head is moved forward in respect to the point of support and is one of the most prevalent postural disorders [23]. Another common chronic disorder is the low back pain (LBP). Akkarakittichoke, N. and P. Janwantanakul concluded that workers with persistent LBP sat more asymmetrically than their healthy counterparts [24]. Postural changes were much more common in healthy participants than in chronic LBP participants.

Office workers in Bulgaria also shifted en masse to home office working using desktop or laptop computers during the last pandemic year. This type of work is associated with prolonged immobilization of the body, as it is performed primarily in a sitting position, characterized by the same type of repetitive hand movement and lengthy computer monitor screen staring. Many workers believe that there is a work-related risk only when it can result in a direct physiological injury or death. Employees and employers frequently accept the presence of pain in the musculoskeletal system as a normal result of work and age. According to a study for occupational risk among computer operators in engineering higher education, while 80% of respondents rate computer work as safe, more than 66% experience pain and numbness at the end of the workday [25]. The majority of MSD research has been conducted in developed countries, and it is possible that a percentage of the contributing factors, associated with MSD occurrence in the developing countries (such as Bulgaria), may differ due to sociocultural differences [26].

The aim of the current study is to assess the awareness and knowledge of various risk factors associated with WMSDs among Bulgarian office workers.

2. Methods

2.1. Design and Questionnaire

The cross-sectional survey was carried out between April and June of 2020, which was also the period of the first COVID-19 lockdown in Bulgaria. On March 13, 2020, students, lecturers, instructors, engineers, and other staff began working from home using their electronic devices (desktop computers, laptops, tablets, etc.). Many organizations, universities and businesses have recommended their employees to work from home.

The data was collected via an online questionnaire, similar to the web-based questionnaire in [27], but current one includes 26 questions regarding the participant's computer usage habits. The questions include a variety of images with various body and limb positions, from which participants must identify their own usual posture. Least number of points are assigned to neutral positions (1), while the riskiest positions are assigned the most points (5). In the current study, three to five distinct body position variants are utilized, comparable to the ROSA test [20]. At the end of the questionnaire, a modified Nordic musculoskeletal survey questions was used, in order to obtain data concerning pain and pain depth. The questionnaire is available at this link [36].

The study discusses a fraction of the data acquired via the questionnaire, emphasizing on: 1) the duration of computer use without breaks/interruptions; 2) types of devices - desktop computers, laptops, or both; 3) the period in years of regular computer usage (at least 4 days a week), and 4) the connection between the abovementioned and the level of users' knowledge on how to prevent MSDs while working with computers. The relationship between the knowledge for MSD prevention and the actual reports of body discomfort/pain along its severity (weak to intolerable) was investigated, as well as the personal opinion of the participants on how educated they are on the subject.

A survey questions from Nordic Musculoskeletal Questionnaire (NMQ) [28] were adapted and modified, in order to emphasize on the discomfort and pain from prolonged

computer work. Another body area (head) was included since extended gazing at the screen might cause discomfort and headaches. Table 1 shows the exact wording and layout of the questionnaire translated from the Bulgarian language.

Table 1. *Example of exact wording of question on musculoskeletal symptoms in questionnaire.*

Mark the place(s) of the body map where you feel discomfort/pain and think it is because you are continuously using a computer:

	1-2 times a week	3-4 times a week	At least once a time everyday	More than once a time everyday	Whole day everyday	I have no such complaints
Neck	□	□	□	□	□	□
Upper back	□	□	□	□	□	□
Shoulders	□	□	□	□	□	□
Low back	□	□	□	□	□	□
etc.	□	□	□	□	□	□

Rate the pain and the discomfort using body map (the body map is an image of human body with ten regions):

	Very light	Mild	Moderate	Severe	Unbearable	I do not feel pain
Neck	□	□	□	□	□	□
Upper back	□	□	□	□	□	□
Shoulders	□	□	□	□	□	□
Low back	□	□	□	□	□	□
etc.	□	□	□	□	□	□

2.2. Participants

Employees of the Technical and Medical Universities of Varna in Bulgaria were invited by e-mail to complete a web-based questionnaire. Furthermore, researchers invited students from both universities, as well as other staff members who worked from home and other peoples. The only criterion for participant selection was regular computer use.

Respondents were asked if they had felt discomfort and pain in ten body areas (head, neck, upper back, shoulders, lower back, elbows, wrists/hands, hips/thighs, knees, and ankles/feet) due to prolonged computer use. Questions regarding past MSDs and traumas were not used, instead, the study focuses on symptoms at the end of prolonged computer work sessions, which were used to refer to and analyze ergonomic risk factors. A total of 203 volunteers took part in the survey, of which 197 answered all questions and 6 provided partly incomplete answers and were not included in some of the data analyses.

Descriptive statistics were used to analyses the main characteristics of the respondents. Categorical data were presented by percentages and quantitative data – by means and standard deviations. Chi-square test and correlation analyses (Pearson's and Spearman's) were applied to determine the significant difference in the frequency of computer using and musculoskeletal symptoms in respondents. Level of statistical significance was set at $P<0.05$ in all performed analysis.

All statistical analysis was done using the SPSS (IBM Corp. IBM SPSS Statistics for Windows, version 20) software. Graphs were generated using Gnuplot version 5.4.

The basic information, such as gender, age, weight, height, and sport activity, given in Table 2, allows for a study of the lifestyle variations between men and women. Since the male/female ratio in current study is approximately 1:2, a percentage is provided in parenthesis according to gender, to make data comparable. Despite the difference in numbers, the share of males who exercise daily (22.1%) is very similar to that of females (21.5%). Participants who did not engage in any physical exercises had a comparable ratio: 36.8% males and 39.3% females. In terms of frequency of exercises, men conduct them more often than women. A total of 42.7% of men do one or more daily exercises, compared to 33.4% of women. Maintaining healthy muscle tone helps the body's resilience and resistance to incorrect posture and the development of MSS.

The majority of participants (142) had <25 BMI (M37 + F105) and only 55 had BMI 25+ (M28+F27). Individuals who exercise often usually have a normal BMI, and although men exercise more, 43.97% of them are overweight, compared to women - 20.45%.

Table 2*. Main demographic characteristics and activities of the participants.*

Gender	Num.	Age (years)			Weight (kg)			Height (m)		
		Mean (±sd)	Min	Max	Mean (±sd)	Min	Max	Mean (±sd)	Min	Max
Male	65	26.88 (11.64)	17	75	81.18 (18.57)	52	140	1.79 (0.76)	1.6	1.97
Female	132	28.09 (12.3)	14	66	61.82 (11.98)	44	105	1.66 (0.65)	1.53	1.88
Total	197	27.69 (12.1)	14	75	68.21 (17.5)	44	140	1.71 (0.94)	1.53	1.97
p		0.49*			<0.001*			<0.001*		

BMI by gender ($\chi 2=15.5$; $p=0.001$)

BMI (kg/m^2)	Underweight <18.50	Normal 18.5-24.99	Overweight 25-29.99	Obese ≥30
Males, N_M=65 (%)	0 (0)	37 (56.92)	17 (26.15)	11 (16.92)
Females, N_F=132 (%)	13 (9.85)	92 (69.7)	20 (15.15)	7 (5.3)

Regular sport activities

	Several times a day	Once a day	More than 2 times a week	Once a week	No sport activities
Total N (%)	30 (14.8)	44 (21.67)	28 (13.8)	23 (11.3)	78 (38.4)
Male, N_M=68 (%)***	14 (20.6)	15 (22.1)	10 (14.7)	4 (5.9)	25 (36.8)
Female, N_F =135 (%)**	16 (11.9)	29 (21.5)	18 (13.3)	19 (14.1)	53 (39.3)

Daily computer use

Years of daily computer use - min 4 d/w	Up to 2 years	Between 2 and 5 years	Between 6 and 12 years	Between 13 and 20 years	Over 21 years
Total N (%)	20 (9.9)	43 (21.2)	66 (32.5)	59 (29.1)	15 (7.4)
Male, N_M=68 (%)	1 (1.5)	11 (16.2)	29 (42.6)	22 (32.4)	5 (7.4)
Female, N_F=135 (%)	19 (14.1)	32 (23.7)	37 (27.4)	37 (27.4)	10 (7.4)

*** NM male respondents; ** NF – female respondents; * t-test.

3. Results

3.1. Anthropometric Characteristics of Participants

There were 197 volunteers (from a total of 203) who answered all the questions for age, weight and height (132 women; 65 men). The mean age 27.69 ±12.06 years (14 ÷75 years) weight 68.21±17.5.kg (44÷140 kg) and height of 1.71 ±0.94.m (1.53÷1.97 m).

All the participants use a computer regularly, at least 4 days a week. The total duration of computer work is split into five groups. Each group has an age range based on different stages of student education and work. The majority of participants - 65 (32.5%) used a computer for a period of 6 to 12 years, closely followed by those with computer work experience from 13 to 20 years - 59 (29.1%), table 3. Participants used computers at least for days a week for work, study, gaming and watching content on a home or office desktop computer, laptop, or both.

In terms of age, 51 respondents are under the age of 20, 102 are between the ages of 21 and 30, and 48 are over the age of 30. The total number of young participants (under 30 years old) is 153 (76.35%), table 3.

3.2. Summary of Prevalence

The results show that only 34 (16.74%) of respondents do not experience any discomfort or pain as a result of prolonged computer activity. The majority of respondents report neck discomfort - 107 reports (52.71% of participants), followed by pain in the head - 82 reports (40.39%), and pain in the upper back - 78 reports (38.42%). Pain in the head is most commonly reported to occur 1-2 times per week - 52 (25.12%), followed by reports of neck pain - 42 (20.69%) with the same frequency of occurrence, while 28 (13.79%) report neck pain 3-4 times per week. Twenty participants reported neck pain every day, ten reported it several times a day, and seven experienced neck discomfort throughout the day. The ankles/feet have the fewest reports of discomfort, accounting for 7.39% of all participants.

The rate of the degree of pain and discomfort according to the subjective reports of the participants was calculated. People identify neck pain and discomfort as very light (21 (10.34%)), mild (23 (11.33%)), and moderate (45 (22.17%)). The total discomfort, regardless of the degree of pain, is again the greatest for the neck area - 109 reports (53.69%), followed by that in the head - 81 (39.9%) and in third place is Upper back with 78 reports (38.42% of participants). The total discomfort, regardless of the degree of pain, is again the highest in the neck region - 109 (53.69%), followed by the head - 81 (39.9%), and the upper back - 78 (38.42% of participants).

The discrepancy between the reports of lack of discomfort or pain (16.74%) and lack of assessment of the degree of pain (17.73%) is due to negligence and subjective judgment of the respondents.

Group A consists of 42 (20.69%) participants who answered: “I feel completely familiar”, to the question: “Do you think you know what a correct posture in front of a computer is (the posture that is most gentle on the health of your musculoskeletal system)?” However, those respondents reported 83 cases of any discomfort or pain on the body map. The most common region is once again the neck area - 23 (54.76%), as shown in Table 3. The majority of participants, 118 (58.13%), defined as Group B, responded “I feel quite familiar” and reported 285 cases of pain or discomfort. Most pain reports appear again in the neck region - 63 (53.39%), followed by the head - 49 (41.53%), and the upper back - 45 (38.14%).

Table 3. *Distribution of participants’ knowledge for health prevention and reports for pain/discomfort from prolonged computer work (multiple reports per respondent are allowed).*

Total reports	Group A n= 42 (respondents)	Group B n= 118 (respondents)	Group C n= 41 (respondents)	P
Body regions	FR, R=83	FR, R=285	FR, R=113	
Head, R (%n)	10 (23.81)	49 (41.53)	21 (51.22)	0.04*; 0.05**; >0.2***
Neck, R (%n)	23 (54.76)	63 (53.39)	20 (48.78)	>0.1*;**:***
Upper back, R (%n)	7 (16.67)	45 (38.14)	26 (63.41)	<0.001*:**;***
Shoulder, R (%n)	12 (28.57)	29 (24.58)	13 (31.71)	>0.1*;**:***

Total reports	Group A n= 42 (respondents)	Group B n= 118 (respondents)	Group C n= 41 (respondents)	P
Lower back, R (%n)	9 (21.43)	30 (25.42)	10 (24.39)	>0.1*;**;***
Elbows, R (%n)	7 (16.67)	8 (6.78)	3 (7.32)	>0.1*;**;>0.2***
Wrists/Hands, R (%n)	5 (11.9)	13 (11.02)	3 (7.32)	>0.1*;**;***
Buttock, R (%n)	8 (19.05)	24 (20.34)	10 (24.39)	>0.2*;**;>0.3***
Knee, R (%n)	2 (4.76)	15 (12.71)	2 (4.88)	>0.1*;>0.9**;***
Ankles/Feet, R (%n)	-	9 (7.63)	5 (12.2)	>0.31***
Age:				
≤20 years old (n=51)	12 (23.53)	26 (50.98)	13 (25.49)	Spearman's ρ= 0.38; p<0.001
21-30 years old (n=102)	23 (22.55)	63 (61.76)	16 (15.69)	
30+ years old (n=48)	7 (14.58)	29 (60.42)	12 (25.0)	
Gender:				
Female, N_F=133, (%N_F)	27 (20.3)	80 (60.15)	26 (19.55)	
Male, N_M=68, (%N_M)	15 (22.06)	38 (55.88)	15 (20.06)	
Type of device:	n=42 (%n)	n=118 (% n)	n=41 (% n)	
PC	5 (11.9)	25 (21.2)	9 (22.0)	Pearson's r= 0.05; p= 0.53
PC+laptop aprox. equal time	6 (14.3)	15 (12.7)	5 (12.2)	
Laptop	31 (73.8)	78 (66.1)	27 (65.9)	
Total time for 24 h				
≤ 6h	24 (57.1)	52 (44.1)	21 (51.3)	Spearman's ρ= 0.12; p=0.1
6 - 8 h	11 (26.2)	44 (37.3)	10 (24.4)	
>8 h	7 (16.6)	22 (18.6)	10 (24.4)	
Time without break				
≤ 2h	27 (64.3)	75 (63.5)	17 (41.5)	Spearman's ρ= 0.16; p=0.02
2-4 h	11 (26.2)	24 (20.3)	18 (43.9)	
>4 h	4 (9.5)	19 (16.1)	6 (14.6)	
Regular sport activities				
Yes, 1 or more per day	24 (57.1)	38 (32.2)	11 (26.8)	Spearman's ρ= 0.22; p=0.001
Yes, 1 or more per week	8 (19.0)	31 (26.3)	12 (29.3)	
No	10 (23.0)	49 (41.5)	18 (43.9)	
Years computer work				
≤ 5 years	10 (23.8)	40 (33.9)	12 (29.3)	Spearman's ρ= -0.11; p=0.13
6-12 years	9 (21.4)	40 (33.9)	16 (39.0)	
13-20 years	19 (45.2)	33 (28.0)	7 (17.1)	
20+ years	4 (9.5)	5 (4.2)	6 (14.6)	
Timing software				
Yes	3 (7.1)	2 (1.7)	1 (2.4)	Pearson's r=0.11; p=0.11
Track alone	13 (31.0)	26 (22.0)	6 (14.6)	
No	26 (61.9)	90 (76.3)	34 (82.9)	

FR-Frequency report; R= number of reports; *F-test for completely (Group A) and quite familiar (Group B) responses; **F-test for completely (Group A) and not familiar (Group C) responses; ***F-test for quite (Group B) and not familiar (Group C) responses;

People who are unfamiliar with correct computer posture but want to learn more make up 41 (20.20%) of the participants (Group C). Most of them – 26 (63.41%) are uncomfortable in the upper back and 9 (21.95%) of them feel this pain 3-4 times per week. Only two individuals are "not familiar but they do not want to know more or think posture in front of the computer do not affect their health".

As per data evaluation on Group A participants, the neck has the most overall pain - 20 (47.62%). Every second Group A respondent feels pain ranging from very light to mild - a total of 5 (11.9%). Moderate pain is experienced by 8 (19.05%), severe pain by 6 (14.29%), and one reports unbearable pain. There is no significant difference in the distribution of reports of discomfort in the most affected area - the neck, among Group A (54.76%), Group B (53.39%) and Group C (48.78%). Almost every second respondent, whether he knows how to maintain his health or not, experiences neck pain or discomfort. Reports of lower back and buttocks discomfort are observed in 25.45% of those in Group C and 25.42% of those in Group B, suggesting that one in four marked these regions as painful.

3.3. Correlation

In table 3, the relationship between the knowledge for disease prevention and age, gender, health education and the reports of pain and / or discomfort in various areas of the body is compared, as well as the type of computer used, the total time spent on the computer and the time spent remaining in the same posture without moving.

More than half of the participants are fairly knowledgeable with how to prevent MSS, regardless of whether they are women (60.15%) or men (55.88%) or what age range they fall into: ≤20 years (50.98%), 21 ÷ 30 (61.76%) and 30+ (60.42%). One in every four participants under the age of 20 and over 30 admits to being unfamiliar and wishes to learn more. There is no significant gender difference in those who have some understanding of the subject - 20.2% of women are knowledgeable compared to 22.06% of men.

Participants who did not engage in any physical exercises fall more in Group B (41.5%) and the Group C (43.9%), while

every second respondent from Group A does exercises or stretching once or several times a day (57.1%), exhibit significantly correlation (Sp=0.22, p=0.001). This indicates that these respondents are aware of the risks of prolonged sedentary posture and take precautions.

On the other hand, the Group A and Group B respondents spent approximately the same amount of time (≤2 hours) in front of the computer without rest: 64.3% and 63.5%, respectively. Correlation analysis show that less time without break is significantly correlated with the knowledge for MSD prevention (Sp=0.16, p=0.02). The share of Group C respondents, spending 2-4 hours without rest, is twice as high - 43.9%, suggesting that two out of every five individuals maintain the same posture in front of a computer for a period of up to half a business day. Furthermore, nearly every fourth Group C individual (24.4%) spends more than 6 or 8 hours each day in front of a computer.

As a result, Group C respondents put their health at greater risk, and this risk increases significantly relative to a five-day work week. These participants report a higher rate of pain and discomfort in the area of the upper back - 63.4% and also report discomfort in the areas of the lower back and buttocks in 24.39% of the cases.

The percentage of respondents using laptop computers is 68%. A laptop is used by two out of every three participants, who fall in either Group B or Group C. Of those in Group A, 73.8% use a laptop.

People are sometimes unaware of how much time they have spent immobilized, so there are reminder software applications that keep track of time spent and recommend that it is time to get up, move, shift the focus point, and so on, in order to take a short break and help prevent damage to the body. Although only a small percentage of respondents use such reminder applications, those in Group A (31%) track their own time spent, whereas those in Group B (22%) and Group C (16.4%) rarely track their own time and do not use reminder programs (76% and 82% respectively).

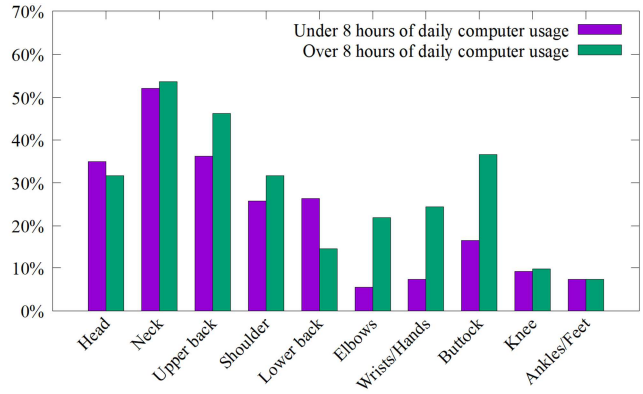

Figure 1. *Prevalence of musculoskeletal symptoms (MSS): Based on daily computer usage ≤ 8h/day and > 8 h/day.*

On the other hand, people with limited or no knowledge at all, report discomfort in the buttocks area - 24.39% and 20.34% respectively, whereas the Group A participants have less pain in the same area - 19.05%. People who use a computer device over 8 hours for a longer period of time during the day report higher discomfort in the neck (53.66%), upper back (46.34%), and buttocks (36.59%), - see Figure 1. Current results are similar to Cho et al. [29], however, they have the largest proportion of musculoskeletal symptoms in shoulders (77.3%), neck (75.6%), and UB (63.9%). Figure 2 depicts statistics for short periods of less than four hours, with the highest discomfort reported in the neck and upper back, while for periods of more than four hours the most significant is the discomfort is reported in the shoulders.

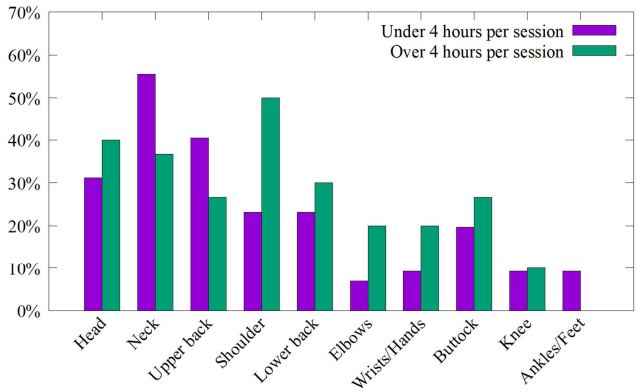

Figure 2. *Prevalence of musculoskeletal symptoms (MSS): Based on continuous work session ≤ 4h/session and >4 h/session.*

4. Discussion

Many participants do not know how to protect themselves and are unaware that specific actions, workplace conditions, prolonged immobilizations harm their bodies and that it is preventable without big expenditures.

Those who claim to be knowledgeable about injury prevention actually report more neck pain (54.76%), while those who acknowledge they are unfamiliar but wish to learn more (Group C) point to the upper back as the area with the highest percentage of discomfort - 63.41%.

Following the analysis of the study's results, a series of logical questions occurred: “Why do half of the people who know how to protect their body from damage when working with a computer allow themselves to be in pain and discomfort? Why aren't they taking care of their health if they actually know how to? And do they really know how to protect themselves from MSS or MSD, or do they simply believe they know what they need to do to maintain their muscles and joints healthy?”

The leading cause for disability measured in years lived with disability (YLD) in Bulgaria is low back and neck pain, accounting for 18.8% of total YLD, followed by sensory organ diseases (10.4%) and depressive disorders (6.8%) [30]. About 20% of Bulgarians have visited their GPs once or twice a year [31].

Because the muscles in the body change and relax as people age, the body posture of elderly people bends and twists. The modern way of life has an impact on the posture of the body since school due to prolonged sitting, immobility, and inconsistent sports activities [32]. In Bulgaria, a

university student typically completes a bachelor's degree by the age of 22. In the data sample, such young individuals (<22 years old) are 108 (53.2%), whereas people over 23 years old are 95 (46.8%).

The highest share of daily sports activities is among the Group A participants - 57.1%, while to some extent, the Group B (41.5%) and Group C (43.9%) ones do not engage in sports in large numbers. Regular sports maintain good muscle tone and proper posture, which in turn protects and strengthens the body, making it more resistant to harmful postures.

Nearly 70% of the participants reported always using a laptop as a computer device in the US [33], in the present Bulgarian survey more than half - 138 (68%) of participants use laptops as well. Prolonged use of this type of computer without the addition of a separate monitor, keyboard, and mouse frequently results in neck twisting and tilting of the head, known as pretracheal posture, and is a risk factor for developing MSD.

The study's cross-sectional format and the use of solely online questionnaires for data collection may have impacted the results because information about the general health of the respondents was not collected, such as whether they have used sick leave due to occupational diseases. There is also no data on what the working conditions at their home office are [34].

Discomfort in any part of the body, such as numbness, tingling, or heaviness in any part of the body is often perceived as normal fatigue due to work. Immobilization can also result from a prolonged imposed stay and work from home The majority of people's office work is seated, with an average of 7.3 hours of sitting per day [35].

According to the sixth European Working Conditions Survey (EWCS), the number of Bulgarian workers reporting any musculoskeletal disorders grew by 9% over five years, reaching 54% in 2015. Furthermore, according to the same survey, the second risk factor (58%) is working with desktop computers, laptops, smartphones, and other electronic devices for a quarter of the time [7]. In addition, women are more likely to report MSD than men. Muscle pain was reported by 44% of women in the shoulders, neck, and/or upper limbs, compared to 39% of men. Pain in the same areas (shoulders, neck, and/or upper limbs) increases with age, from 30% for 25-year-olds to 45% for those over 40, and 48% for those 55 and older. Participants in the current study reported nearly the same areas as the most painful, with approximately 53% experiencing neck pain.

Women are more likely to suffer from MSDs due to incorrect postures, and their problem areas are predominantly in the shoulders [12]. According to the current study, women were found to have a greater number of uncomfortable body areas and a higher risk of MSD problems than men - Figure 3, similar to the results of de Kok et al. [7] and Cho et al. [29].

For the period 2010-2018, there were no national initiatives related to the prevention of work-related MSDs in Bulgaria [8], and people's awareness of the risks associated with potential musculoskeletal system damage is insufficient. In comparison, countries such as Germany and Italy have ten initiatives from their national responding institutions, and MSD reports have decreased by 9% and 15%, respectively, over five years [7].

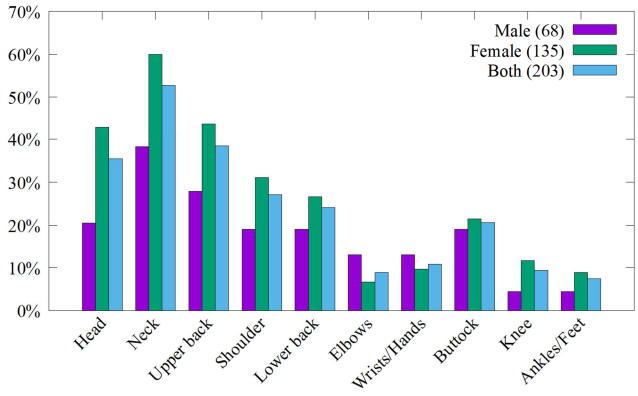

Figure 3. *Prevalence of musculoskeletal symptoms (MSS) Based on gender.*

Based on the acquired results, there is a need for additional research on: (1) the reasons for MSD emergence and their relationship to the prolonged sedentary computer work; and (2), research supplemented with media files (images, video) and expert evaluation of non-neutral body position.

5. Conclusion

In conclusion, according to the conducted study, one in every four people is unfamiliar with how to protect themselves from musculoskeletal pain. The completely and fairly familiar respondents frequently experience discomfort and pain, leading us to believe that they have not taken preventive measures to maintain their health and require more information, presentation of good practices, and training in ergonomic work-place organization. The completely familiar and fairly familiar respondents often feel discomfort and pain, which leads us to believe that they have not taken preventive measures to maintain their health and need more information, presentation of good practices, and training in the ergonomic organization of their work. The training programs should have a strong focus on changing working behaviors, as ergonomic interventions aimed at reducing unnatural body postures can be regarded as a significant step toward the prevention of MSS.

This results acquired in the current study support the need for more initiatives or training to increase workers' knowledge of WMSD risks during computer use in Bulgaria, since preventing health damage is easier and less expensive than treatment, and it has an impact on people's productivity and quality of life.

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References

[1] European Quality of Life Survey 2007, https://www.eurofound.europa.eu/surveys/european-quality-of-life-surveys/european-quality-of-life-survey-2007, last visit 17.02.2022.

[2] Lima, T. M., D. A. Coelho, Ergonomic and psychosocial factors and musculoskeletal complaints in public sector administration - A joint monitoring approach with analysis of association, 2018, International Journal of Industrial Ergonomics 66 (2018) 85-94, doi.org/10.1016/j.ergon.2018.02.006.

[3] Szeto, G., L. Straker, S. Raine, A field comparison of neck and shoulder postures in symptomatic and asymptomatic office workers, 2002, Applied Ergonomics 33 (1), 75–84, DOI: 10.1016/S0003-6870(01)00043-6.

[4] Annual report 2013: Working for safer, healthier and more productive workplaces in the European Union, https://osha.europa.eu/en/publications/annual-report-2013-working-safer-healthier-and-more-productive-workplaces-european, last visit 17.02.2022, doi: 10.2802/92394.

[5] Erick PN, Smith DR: A systematic review of musculoskeletal disorders among school teachers. BMC Musculoskelet Disord. 2011, 12: 260-10.1186/1471-2474-12-260.

[6] Bevan, S., 2015, Economic impact of musculoskeletal disorders (MSDs) on work in Europe, Best Practice & Research Clinical Rheumatology 29 (3), 356-373, doi.org/10.1016/j.berh.2015.08.002.

[7] de Kok, J., P. Vroonhof, J. Snijders, G. Roullis, M. Clarke, K. Peereboom, P. van Dorst, I. Isusi, Work-related musculoskeletal disorders: prevalence, costs and demographics in the EU. European risk observatory report, 2019, EU-OSHA, doi: 10.2802/66947.

[8] Graveling, R., E. Giagloglou, Prevention policy and practice: approaches to tacking work-related musculoskeletal disorders. European risk observatory report, EU-OSHA, 2020, doi: 10.2802/581582.

[9] Marinova, G. K., T. Ganchev, N. Nikolov, Application of machine learning methods for prediction of distress in patients with oncological diseases, Annual Journal of TU-Varna, 2020, doi.org/10.29114/ajtuv.vol4.iss2.204.

[10] Marinova, G., T. Ganchev and N. Nikolov, Synthesis of characteristic descriptors for the detection of distress, Book of International Conference of Biomedical Innovation and Applications, 2020, Varna, pp. 73 -76, DOI: 10.1109/BIA50171.2020.9244488.

[11] Oakman, J., W. Macdonald, T. Bartram, T. Keegel, N. Kinsman, Workplace risk management practices to prevent musculoskeletal and mental health disorders: What are the gaps?, 2018, Safety Science 101 (2018) 220–230, oi.org/10.1016/j.ssci.2017.09.004.

[12] Cui, A., K. Emery, A-S. Beaudoin, J. Feng, J. N. Côté, Sex-specific effects of sitting vs standing on upper body muscle activity during text typing, 2020, Applied Ergonomics 82: 102957, doi.org/10.1016/j.apergo.2019.102957.

[13] Filkova S., N. Usheva: Ergonomic requirements for learning environment for prevention of spinal deformities, Book of International Conference of Biomedical Innovation and Applications, 2020, Varna, pp. 49-52, ISBN: 978-1-7281-7073-2, DOI: 10.1109/BIA50171.2020.9244504.

[14] Mohammadipour, F., M. Pourranjbar, S. Naderi, F. Rafie, Work-related Musculoskeletal disorders in Iranian office workers: Prevalence and risk factors, 2018, Journal of Medicine and Life 11 (4), 328–333, DOI: 10.25122/jml-2018-0054.

[15] Dimate-Garcia, A. E., D. C. Rodríguez-Romero, Risk factors associated to musculoskeletal disorder perception in college students, Bogota, 2016, International Journal of Industrial Ergonomics 81 (2021) 103010, doi.org/10.1016/j.ergon.2020.103010.

[16] Goode, N., S. Newnam, P. M. Salmon, Musculoskeletal disorders in the workplace: Development of a systems thinking-based prototype classification scheme to better understand the risks, 2019, Safety Science 120 (2019) 146–156, doi.org/10.1016/j.ssci.2019.05.037.

[17] Barbieria, D. F., D. Srinivasan, S. E. Mathiassenc, A. B. Oliveira, Variation in upper extremity, neck and trunk postures when performing computer work at a sit-stand station, 2019, Applied Ergonomics 75 (2019): 120-128.

[18] Parno, A., K. Sayehmiri, M. Parno, M. Khandan, M. Poursadeghiyan, M. Maghsoudipour, M. H. Ebrahimi, The prevalence of occupational musculoskeletal disorders in Iran: A meta-analysis study, Journal: Work, vol. 58, no. 2, pp. 203-214, 2017, DOI: 10.3233/WOR-172619.

[19] Bazazan, A., I. Dianat, N. Feizollahi, Z. Mombeini, A. M. Shirazi, H. I. Castellucci, Effect of a posture correction–based intervention on musculoskeletal symptoms and fatigue among control room operators, 2019, Applied Ergonomics 76 (2019): 12-19, doi.org/10.1016/j.apergo.2018.11.008.

[20] Rodrigues, M., M. Sonne, D. M. Andrews, L. F. Tomazini, T. de O. Sato, T. C. Chaves, Rapid office strain assessment (ROSA): Cross cultural validity, reliability and structural validity of the Brazilian-Portuguese version, 2019, Applied Ergonomics 75 (2019) 143–154, doi.org/10.1016/j.apergo.2018.09.009.

[21] Hoe, V. C., D.. M Urquhart, H. L. Kelsall, E. N. Zamri, M. R. Sim, Ergonomic interventions for preventing work-related musculoskeletal disorders of the upper limb and neck among office workers, Cochrane Database Syst Rev. 10 (10): CD008570, 2018, doi: 10.1002/14651858.CD008570.pub3.

[22] Heidarimoghadam, R., I. Mohammadfam, M. Babamiri, A. R. Soltanian, H. Khotanlou, M. S. Sohrabi, Study protocol and baseline results for a quasi-randomized control trial: An investigation on the effects of ergonomic interventions on work-related musculoskeletal disorders, quality of work-life and productivity in knowledge-based companies, 2020, International Journal of Industrial Ergonomics 80 (2020) 103030, doi.org/10.1016/j.ergon.2020.103030.

[23] Kocur, P., M. Wilski, M. Goliwąs, J. Lewandowski, D. Łochynski, Influence of Forward Head Posture on Myotonometric Measurements of Superficial Neck Muscle Tone, Elasticity, and Stiffness in Asymptomatic Individuals With Sedentary Jobs, 2019, Journal of Manipulative and Physiological Therapeutics 42 (3), 195-202, DOI: 10.1016/j.jmpt.2019.02.005.

[24] Akkarakittichoke, N., P. Janwantanakul, Seat Pressure Distribution Characteristics During 1 Hour Sitting in Office Workers With and Without Chronic Low Back Pain, 2017, Safety and Health at Work 8 (2) 212-219, doi.org/10.1016/j.shaw.2016.10.005.

[25] Vachinska S., Assessment study for occupational risk among computer operators in engineering higher education, Book of International Conference of Biomedical Innovation and Applications, 2019, Varna, pp. 85-89, DOI: 10.1109/BIA48344.2019.8967466.

[26] Maakip, I., Keegel, T., Oakman, J., 2017, Predictors of musculoskeletal discomfort: A cross-cultural comparison between Malaysian and Australian office workers, Applied Ergonomics 60, 52-57, doi.org/10.1016/j.apergo.2016.11.004.

[27] Ijmker, S., J. Mikkers, B. M. Blatter, A. J. van der Beek, W. van Mechelen, P. M. Bongers, Test–retest reliability and concurrent validity of a web-based questionnaire measuring workstation and individual correlates of work postures during computer work, 2008, Applied Ergonomics 39 (6) 685–696, DOI: 10.1016/j.apergo.2007.12.003.

[28] Kuorinka, I., B. Jonsson, A. Kilbom, H. Vinterberg, F. Biering-Sørensen, G. Andersson, K. Jørgensen, Standardised Nordic questionnaire for the analysis of musculoskeletal symptoms, 1987, Applied Ergonomic, 18 (3), 233-237, doi.org/10.1016/0003-6870(87)90010-X.

[29] Cho, C.-Y., Y.-S. Hwang, R.-J. Cherng, Musculoskeletal symptoms and associated risk factors among office workers with high workload computer use, 2012, Journal Manipulative and Physiological Therapeutics, 35 (2012), 534-540, doi.org/10.1016/j.jmpt.2012.07.004.

[30] Dimova A, Rohova M, Koeva S, Atanasova E, Koeva-Dimitrova L, Kostadinova T, Spranger A., 2018, Bulgaria: Health system review. Health Systems in Transition, 20 (4): 1–256, 2018, https://apps.who.int/iris/handle/10665/330182.

[31] Eurostat: Half of Bulgarians did not Visit their General Practitioner in 2017, https://www.novinite.com/articles/195418/Eurostat%3A+Half+of+Bulgarians+did+not+Visit+their+General+Practitioner+in+2017, last visit 17.02.2022.

[32] Usheva, N., S. Filkova, Influence of the Exercises with Sports Hammock on Functional Durability of the Postural Stability Muscles, Scripta Scientifica Salutis Publicae vol. 2, Varna, pp. 177-181, 2016, DOI: 10.14748/sssp.v2i0.4036.

[33] Gerding, T., M. Syck, D. Daniel, J. Naylor, S. E. Kotowski, G. L. Gillespie, A. M. Freeman, T. R. Huston, K. G. Davis, An assessment of ergonomic issues in the home offices of university employees sent home due to the COVID-19 pandemic, PubMed, Work 68 (4): 981-992, 2021, doi: 10.3233/WOR-205294.

[34] Blatter, B. M., P. M. Bongers, Duration of computer use and mouse use in relation to disorders of neck or upper limb, 2002, International Journal of Industrial Ergonomics, 30 (4–5), 295-306, doi.org/10.1016/S0169-8141(02)00132-4.

[35] Coenen, P., N. Gilson, G. N. Healy, D. W. Dunstan, L. M. Straker, 2017, A qualitative review of existing national and international occupational safety and health policies relating to occupational sedentary behavior, Appl. Ergon., 60 (2017), 320-333, doi.org/10.1016/j.apergo.2016.12.010.

[36] Questionnaire: “Do you use a computer? Do you know how to prevent Musculoskeletal disorders (MSD)?”, available at: https://docs.google.com/forms/d/e/1FAIpQLScQ2VrPDVYn1dR-7ffgSHQSEFGmSfeUglWZ7gu_SJlXbcH68A/viewform