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STUDYING OF THE HEALTH PROBLEMS AND WORK-RELATED MUSCULOSKELETAL DISORDERS CAUSED BY IT-TECHNOLOGIES

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The development of computer technologies makes our work easier to conduct, but on the other hand causes new but serious health-associated problems. The number of chronic diseases caused by IT technologies is growing increasingly all over the world. Sedentary behavior is one of the main factors contributing to degradation of health and, in some cases, to death. That is why we are encouraged to take the challenge and get involved in solving some of the fundamental problems. Here a question arises: how to protect humans against more serious health problems and complications in future? Health problems caused by IT technologies and Work-related Musculoskeletal Disorders (WMSDs) widely spread all over the world. What can be done to lighten the problem in this area? First of all, we need to ensure that all our doubts are correct and continue proposing solutions for them. Human health is mostly affected by the negligible attitude of people towards their sitting posture and health. As a result of our studies among more than 300 workers, we have revealed that most of them had a feeling of discomfort caused by the work they were doing and almost none of the interviewees did anything to improve the situation.

Keywords: activity monitoring, sedentary behavior, sitting posture, sedentary work, revelation of the posture changes, ergonomics, context-awareness.

Introduction. The development of computer technologies has made our jobs easier to conduct, but on the other hand causes new but serious health-associated problems [1]. Work at the office typically means to spend particular amount of time sitting on an office chair, which in its turn adds stress to the spine [2]. As it is well-known, back pain is one of the most common work-related health problems and is mostly caused by particular work activities, such as weight lifting or sitting in an office [2]. Office work-related pain in the neck is also very common nowadays, and it is agreed that the etiology of neck pain among office workers is multidimensional and is associated with complex factors with individual, physical and psychosocial components [3]. Musculoskeletal Disorders related to work include injuries of the soft tissues of the body, such as muscles, ligaments, blood vessels, tendons, nerves and may cause symptoms like pain, fatigue, stiffness, numbness and tingling, swelling or discomfort [1]. Risk factors that increase

the possibility to work-related musculoskeletal disorders include repetition, awkward postures, static loading or sustained exertions and mechanical contact stress [1]. Repetition, which is an issue among computer and office workers is doing the same motion repeatedly and may cause a trauma in the joints and the surrounding tissues or in worse cases - an injury [1]. Awkward postures may result in an injury as they bend the joints into a position that is more likely to be hurt [1]. Static loading or sustained exertions is when the muscles are holding the body in one position for a long time and this may cause reduced blood circulation and tension of muscles leading to an injury [1]. And the last risk factor, the mechanical contact stress, may cause injuries as a result of prolonged work where sharp or hard objects or surfaces press into the soft tissues [1]. All these risk factors are issues in office work places.

The system goal. In the introduction part, problems related to sedentary work were presented. We have problems and each problem requires a solution. In this situation, we would like to develop a system which will monitor the state of health of workers during the working time, as well as the bad habits like the sitting posture, viewing distance, etc. But before that, we need to make a study to reveal all the problems, to specify in which part our efforts should be concentrated. We will study three types of workers whose workstyle is active, partly active and sedentary. After analyzing the result we will have a clean representation about the problems and will focus the system in special targets.

Studying the discomfort for office workers - METHODS. The present study aims at revealing the problem of office workers who spend most of their working time in the office and don't have enough mobility during work. We will compare the employees' health status in other groups of employees. The main objective of the study was to get exhaustive quantitative data to help us with decision-making with regard to further development of a system which will monitor the workers in the office environment (eg. posture) or health status during worktime.

The present research was carried out by the method of prospective cohort study. Such studies widely vary in terms of size and complexity. A cohort study is mainly used in medicine, social science and business analysis, as well as in other disciplines. In this specific case, it is used for health evaluation purposes. A prospective cohort study follows patients over a particular period of time, by performing permanent or repeated monitoring of the risk factors or health status of patients or both [4]. A cohort is a group of people sharing a particular characteristic and tracked for a particular period of time.

Very different target groups of members were selected, from a small (maximum 10 employees) company of banks and telecommunication big companies.

Investigation instrument. The first thing done in the scope of the study was to filter the organizations according to the type of business they do, and only after that make a final selection of organizations and workers.

EQ-5D-3L instrument applied in the study is a verified, approved and reliable tool used to evaluate the quality of life (QoL) [5] of people. The QoL Commission studied the problem in advance and offered a questionnaire consisting of several questions. Parallel to this questionnaire we also used the Cornell Musculoskeletal Discomfort Questionnaires (CMDQ) developed by Dr. Alan Hedge [6] from Cornell University.

Sample Size. A sample size is an important component of every study. It is highly important to understand that different studies require different sample sizes and that it is not acceptable to use the same formula for all of them. A sample is a part of anything that is a representative of a whole. Hence, a question arises: how many persons should our study sample be composed of? The sample size and the result achieved after the study should best and accurately represent the whole from which the sample is taken. In order to decide on how much accurate results we want to achieve after the study, we must calculate the sample size carefully.

Thus, the sample size for our study was calculated with the confidence level of 95%, power 80%, assumed relative risk of 1.7 and expected incidence in unexposed group of 19%, which is based on the results of the previously conducted study [7]. So the required sample in the scope of this particular study which will best represent Armenian population is 332 [8].

10 organizations were contacted, of which 4 organizations refused to participate in our study and 6 were included in it. Altogether, in those organizations were 834 employees, of which 590 met our inclusion criteria. So, 485 employees were contacted, from which 112 employees refused to participate, 24 were on vacation and 349 completed our in-depth interviews. After data collection and cleaning, 16 persons' data were excluded from the analysis due to the missing values.

So, the final sample available for the analysis was 333, which fully corresponds to the required sample size calculated previously.

Statistical considerations. Before entering the data into the SPSS (Statistical Package for the Social Sciences) database, we reviewed all questionnaires completed by interviewees. At that stage, a unique data entry was performed by us with further cleaning, which was rather a time-and-effort-consuming process. Data analysis was conducted via the SPSS and STATA software packages.

Categorical variables were presented as counts and percentages compared by *by-item* analyses and continuous variables were presented as means and standard deviation. As far as we have used categorical data we have used bivariate and multivariate logistic regression analysis.

P-values are used to define the statistical significance level in testing the hypothesis. As the null hypothesis refers to a statement that no significant difference is observed between the groups, so in our study, the null hypothesis is considered to be the lack of difference between the groups (active, partly active, sedentary). In other words, we consider the null hypothesis to be true if there is no difference between our groups. The p-value shows how compatible the data with the null hypothesis are. So the higher the p-values assume that the hypothesis under consideration is true, the lower p-values assume that the data observed are not consistent with the null hypothesis to be true, so it must be rejected. In our study, we considered the significance level (α) to be 5%. So if the p-value is less than 0.05 we reject the null, in other words our data are inconsistent with the assumption that the null hypothesis is true and we reject it. The p-value does not measure the support of any other hypothesis, it only interprets whether the hypothesis we are currently testing is true or whether it must be rejected.

Study variables. The dependent variable of the study was the quality of life of workers divided into three work categories: active, partly active and sedentary. Based on a few studies of regression analysis, the dummy variable was created for this variable. These types of variables (dummy) are used mainly in regression analysis to represent subgroups in a study. The investigator recodes the options of the variable and defines passive as “0” and partly active and active options as “1”, based on other studies carried out previously. The independent variables of the study were gender, time of working (months), sought or received medical assistance, changes performed at workplace to improve the quality of workplace, variables experiencing ache, pain and discomfort, including options of never, 1-2 times last week, 3-4 times last week, once every day, several times every day/uncomfortable feeling when experiencing ache, pain and discomfort/ache, pain and discomfort interfering with the ability to work, with options of slightly, moderately and very. It is worth to mention that for regression analysis, score was generated for these variables. For the neck, all options were summed and the maximum value was 8 and minimum 0, for shoulders 16 and 0, for upper back 8 and 0, for upper arm 12 and 0, lower back 8 and 0, forearms 14 and 0, wrist 16 and 0, hip buttocks 7 and 0, thigh 16 and 0, knee 16 and 0, respectively maximum and minimum values.

Ethical considerations. This study corresponds to local and international ethical standards. All participants were informed about their rights (participation was on a voluntary basis and they could refuse to further participate in the study and answer the questions; anonymity and confidentiality was fully ensured). Before the interview, all interviewees had read the notification agreement, which contained general information about the objectives and conditions of the study, the rights of the interviewee, confidentiality clause, as well as information about the group of researchers/interviewers. The main language of the study was Armenian. However,

whenever preference was given to English, the English version of the notification agreement and questionnaire was provided.

Study of the discomfort for office workers - RESULTS. Employees' baseline characteristics are presented in Table 1. Of 333 employees included in the sample 65 (19.52%) had active, 71 (21.32%) partly active and 197 (59.16%) sedentary working conditions. More females were in sedentary group (55.33%) than in the partly active (49.30%) or active (35.38%) groups ($p=0.020$). Fewer people were working more than 61 months (approximately 5 years) in each group (29.23% versus 70.77%, 43.66% versus 56.34% and 35.53% versus 64.47%, $p=0.210$). And in all the groups people were less likely to sought or receive medical assistance.

Table 1

Baseline characteristics				
Characteristics	Active n=65	Partly active n=71	Sedentary n=197	p-value
Gender				0.020
Male	42 (64.62)	36 (50.70)	88 (44.67)	
Female	23 (35.38)	35 (49.30)	109 (55.33)	
Time of working (months)				0.210
<61	46 (70.77)	40 (56.34)	127 (64.47)	
≥61	19 (29.23)	31 (43.66)	70 (35.53)	
Sought or received medical assistance				0.680
Yes	21 (32.31)	19 (26.76)	53 (26.90)	
No	44 (67.69)	52 (74.24)	144 (73.10)	
Changes performed at workplace to improve quality of workplace				0.151
Yes	12(18.46)	6 (8.45)	35 (17.77)	
No	53 (81.54)	65 (91.55)	162 (82.23)	

*Results are presented as frequencies and percentages, unless specified otherwise.

People with active lifestyle had more chances to never experience neck pain (68.25% versus 46.48% or 34.01%, $p=0.000$). Regarding shoulders, 81.54% of people working with active conditions never experienced a pain in the shoulders or discomfort compared to people from partly active (64.79%) or sedentary group (64.47%) ($p=0.011$). The groups also differed significantly in the rates of lower backache, pain or discomfort. And employees in the sedentary (75.63%) or at least partly active (66.20%) group experienced lower part of back pain, ache or discomfort at least once a week compared to people from the active group (43.08%, $p=0.000$).

There is also a significant difference in hip/buttocks, as people from the sedentary group had worse results, experiencing ache, pain or discomfort more often than those

from partly active or active groups (35.53% versus 21.13% or 4.62%, $p=0.000$). And it is also worth to mention that people experience pain, ache or discomfort in lower parts of legs more frequently with active work than people with sedentary working conditions (29.23% versus 25.38%, $p=0.006$). No differences were found regarding shoulders, upper back, upper arms, wrists and thighs.

The most significant differences are found in neck, shoulders, lower part of back, forearms, hip/buttocks and knees. The by-item analysis showed worse results for employees with sedentary working conditions compared to the ones with partly active and active working conditions, showing a very uncomfortable feeling in the neck (25.89% versus 14.08% or 4.62%, $p=0.000$), shoulders (15.25% versus 5.63% or 0.00%, $p=0.007$), lower back (26.40% versus 23.94% or 10.77%, $p=0.000$) and hip/buttocks (3.55% versus 0.00% or 1.54%, $p=0.000$). No significant differences were observed regarding the other parts of the body.

The analysis was also conducted, regarding the ability of employees to work, as they experience ache, pain or discomfort (Table 2). Significant differences were found, showing substantially worse results in ability to work when experiencing ache, pain or discomfort in the neck, the lower part of the back, the wrists and hip/buttocks. The employees' neck pain, ache or discomfort substantially interfered with their ability to work for the people with sedentary working conditions compared to the ones with active or partly active work (25.89% versus 4.62% or 9.86%, $p=0.000$). People from the sedentary group also had higher chances to have a backache in the lower part, pain or discomfort that substantially interferes with their ability to work if compared to people from partly active or active groups (28.93% versus 15.49% or 7.69%, $p=0.000$). No significant differences were observed in domains of upper back, upper arms, forearms, thighs or knees.

Bivariate analysis: simple logistic regression. Table 3 presents the results of the simple or bivariate logistic regression analysis for the associations between the dependent variable and other independent variables. It is worth taking into consideration that the regression coefficient is the obvious increase in the log odds of the dependent variable's per unit which increases in the value of the independent variable.

From Table 3, it is obvious that in the working period, upper arm problems, forearm problems, wrist problems are not associated with any odds of the dependent/outcome variable, meaning that when the $OR=1$, the independent variable has nothing to do with the dependent variable. In the case of thigh, knee and leg problems, OR is marginally higher for 1 ($OR>1$) meaning that those variables are associated with higher odds of the dependent variable. In the other cases, when $OR<1$, independent variables are associated with lower odds of the dependent variable.

Table 2

Ache, pain and discomfort interfering with the ability to work

Characteristics	Active n=65	Partly active n=71	Sedentary n=197	p-value
Neck				0.000
Not at all	51 (78.46)	41 (57.75)	94 (47.72)	
Slightly	11 (16.92)	23 (32.39)	52 (26.40)	
Substantially	3 (4.62)	7 (9.86)	51 (25.89)	
Shoulders				0.053
Not at all	56 (86.15)	50 (70.42)	139 (70.56)	
Slightly	7 (10.77)	16 (22.54)	34 (17.26)	
Substantially	2 (3.08)	5 (7.04)	24 (12.18)	
Upper back				0.089
Not at all	58 (89.23)	53 (74.65)	150 (76.14)	
Slightly	7 (10.77)	13 (18.31)	30 (15.23)	
Substantially	0 (0.00)	5 (7.04)	17 (8.63)	
Upper Arms				0.309
Not at all	64 (98.46)	64 (90.14)	180 (91.37)	
Slightly	1 (1.54)	5 (7.05)	14 (7.11)	
Substantially	0 (0.00)	2 (2.82)	3 (1.52)	
Lower Back				0.000
Not at all	45 (69.23)	38 (53.52)	65 (32.99)	
Slightly	15 (23.08)	22 (30.99)	75 (38.07)	
Substantially	5 (7.69)	11 (15.49)	57 (28.93)	
Forearms				0.276
Not at all	65 (100.00)	66 (92.96)	190 (96.45)	
Slightly	0 (0.00)	3 (4.23)	5 (2.54)	
Substantially	0 (0.00)	2 (2.82)	2 (1.02)	
Wrists				0.033
Not at all	64 (98.46)	64 (90.14)	191 (96.95)	
Slightly	1 (1.54)	4 (5.63)	1 (0.51)	
Substantially	0 (0.00)	3 (4.23)	5 (2.54)	
Hip/Buttocks				0.048
Not at all	62 (95.38)	67 (94.37)	166 (84.26)	
Slightly	3 (4.62)	4 (5.63)	27 (13.71)	
Substantially	0 (0.00)	0 (0.00)	4 (2.03)	
Thighs				0.635
Not at all	61 (93.85)	69 (97.18)	187 (94.92)	
Slightly	2 (3.08)	1 (1.41)	8 (4.06)	
Substantially	2 (3.08)	1 (1.41)	2 (1.02)	
Knees				0.139
Not at all	54 (83.08)	57 (80.28)	174 (88.32)	
Slightly	5 (7.69)	9 (12.68)	18 (9.14)	
Substantially	6 (9.23)	5 (7.04)	5 (2.54)	
Lower legs				0.051
Not at all	49 (75.38)	57 (80.28)	162 (82.23)	
Slightly	12 (18.46)	6 (8.45)	29 (14.72)	
Substantially	4 (6.15)	8 (11.27)	6 (3.05)	

Table 3

<i>Bivariate logistic regression analysis</i>			
Variable	Crude OR	p-value	CI (95%)
Independent variables			
Gender: Male	0.60	0.023	(0.38; 0.93)
Period of working	1.00	0.700	(0.99; 1.00)
Neck problems	0.80	<.001	(0.73; 0.88)
Shoulder problems	0.95	0.046	(0.89; 1.00)
Upper back problems	0.95	0.327	(.85; 1.05)
Upper arm problems	1.00	0.897	(0.91; 1.11)
Lower back problems	0.85	<.001	(0.78; 0.92)
Forearms problems	1.00	0.960	(0.89; 1.13)
Wrist problems	1.00	0.948	(-0.91; 1.10)
Hip buttocks problems	0.63	<.001	(0.51; 0.78)
Thigh problems	1.03	0.486	(0.94; 1.13)
Knee problems	1.10	0.004	(1.02; 1.15)
Leg problems	1.05	0.071	(0.996; 1.10)

Multiple logistic regression. Multiple logistic regression analysis was carried out to identify the factors associated with the outcome/dependent variable while controlling other significant variables. In Table 4, the final model is described and only significant variables from the bivariate analysis were included in this model to control the potential confounders. The independent variables from this model are shown to be significantly associated with the dependent variable (p-value=<0.001). As it is seen, only gender (OR=0.76), neck problems (OR=0.78), lower back problems (OR=0.90) and hip/buttocks problems (OR=0.67) are associated with lower odds of the dependent variable, that means the above mentioned variables are associated with a passive lifestyle of the employee.

Table 4

Multivariate logistic regression analysis					
Variable	Crude OR	p-value	CI (95%)	Pseudo R2	p-value
Independent variables				<0.1417	<0.001
Gender	0.76	0.299	(0.45; 1.27)		
Neck problems	0.78	<.001	(0.68; 0.89)		
Shoulder problems	1.06	0.100	(0.99;1.15)		
Lower back problems	0.90	0.042	(0.82; 0.99)		
Hip buttocks problems	0.67	0.001	(0.54; 0.85)		
Knee problems	1.11	0.004	(1.03; 1.19)		
Leg problems	1.07	0.038	(1.00; 1.14)		

As it is seen from the Fig. 1, active workers experience ache, pain or discomfort in the lower part of the body less than workers from the partly active and sedentary groups.

It is also obvious, that workers from the partly active group experience ache, pain or discomfort more frequently than those from the active group.

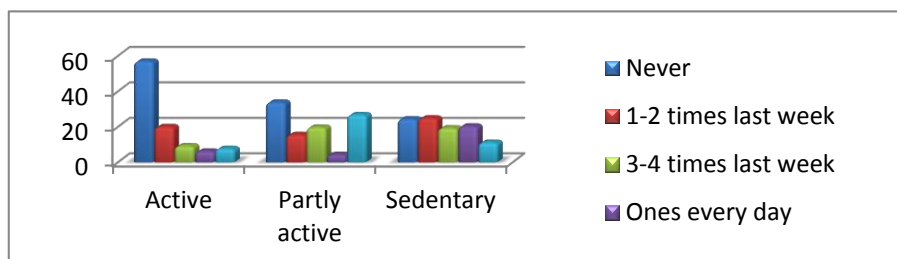


Fig. 1. Ache, pain and discomfort in the lower back

As shown on the Fig. 2, the uncomfortable feeling of ache, pain and discomfort is increasing from active lifestyle to sedentary.

From Fig. 3 it is obvious that ache, pain or discomfort in the neck affects the ability to work in different groups of workers doing different jobs and especially workers doing sedentary jobs, as compared with workers doing an active or a partly active job.

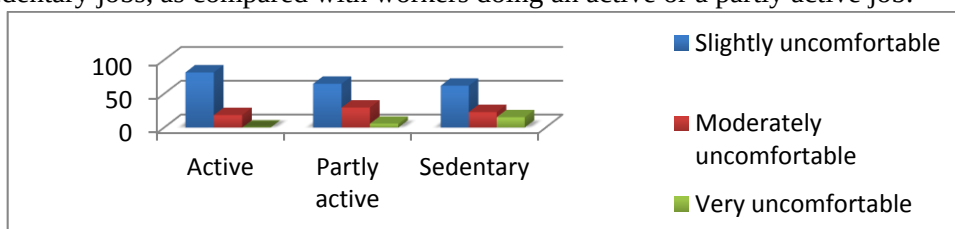


Fig. 2. Uncomfortable feeling of ache, pain and discomfort in shoulders

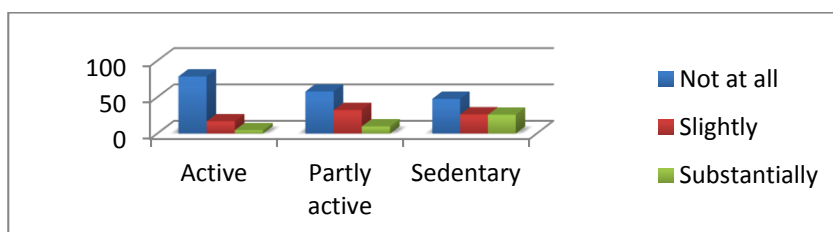


Fig. 3. Ache, pain and discomfort in the neck interfering with the ability to work

Conclusions. The results of this study indicate that sedentary working conditions may cause pain, ache or discomfort in different parts of the body resulting in an uncomfortable feeling in the neck, shoulders, lower part of the back, forearms, hip/buttocks and knees, but a more important finding is the ability to work, which decreases with the experience of ache, pain or discomfort especially in the neck and

lower back. Significant association was found between the gender, neck problems, lower back problems, hip/buttocks problems and the passive lifestyle of the employees.

These findings suggest opportunities for intervention strategies as to stimulate an ergonomic setting in the workplaces. Based on the results of all studies we have done, we propose to develop a system for workers' monitoring, which will use a video camera, or special devices. The devices will provide various data necessary to measure both the ergonomic conditions and the worker's health status in the workplace. With the help of those parameters we can provide the necessary recommendation related to the employees' health status.

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**ՏԵՂԵԿԱՏՎԱԿԱՆ ՏԵԽՆՈԼՈԳԻԱՆԵՐՈՎ ՊԱՅՄԱՆԱՎՈՐՎԱԾ ԱՌՈՂՋԱԿԱՆ
ԽՆԴԻՐՆԵՐԻ ԵՎ ԱՇԽԱՏԱՆՔԻ ՀԵՏ ԿԱՊՎԱԾ ՀԵՆԱՇԱՐԺԱԿԱՆ ԱՊԱՐԱՏԻ
ԽԱՆԳԱՐՈՒՄՆԵՐԻ ՈՒՍՈՒՄՆԱՍԻՐՈՒԹՅՈՒՆ**

Պ.Ա. Հարությունյան, Ա. Մոլդովեանու, Ֆ. Մոլդովեանու

Համակարգչային տեխնոլոգիաների զարգացումը մի կողմից՝ թեթևացնում է մարդու աշխատանքը, դարձնում ավելի հեշտ կառավարելի, բայց մյուս կողմից՝ առաջացնում է նոր, լուրջ առողջական խնդիրներ: Ողջ աշխարհում գնալով աճում է տեղեկատվական տեխնոլոգիաներով պայմանավորված շարունակական հիվանդությունների թիվը: Նստակյաց կենսակերպն այն հիմնական գործոններից մեկն է, որը պատճառ է դառնում առողջության վատթարացմանը: Մարդու առողջությունը մեծապես պայմանավորված է նստակյաց կենսակերպի նկատմամբ անփոյթ վերաբերմունքով: Ավելի քան 300 աշխատակիցների շրջանում մեր կողմից կատարված հետազոտության ընթացքում պարզվել է, որ նրանց մեծ մասն ունի անհարմարավետության զգացողություն՝ կապված իրենց աշխատանքի հետ, և նրանցից ոչ մեկը չի ձեռնարկել որևէ միջոց՝ այդ խնդրի բարելավման ուղղությամբ:

Առանցքային բաներ. գործունեության մշտադիտարկում (մոնիթորինգ), նստակյաց կենսակերպ, նստելու դիրք, նստակյաց աշխատանք, կեցվածքի փոփոխությունների հայտնաբերում, էրգոնոմիկա, իրավիճակի մասին իրազեկություն:

**ИССЛЕДОВАНИЕ ПОМЕХ, ОБУСЛОВЛЕННЫХ ИНФОРМАЦИОННЫМИ
ТЕХНОЛОГИЯМИ И СВЯЗАННЫХ СО ЗДОРОВЬЕМ И РАБОТОЙ
ОПОРНО-ДВИГАТЕЛЬНОГО АППАРАТА**

П.А. Арутюнян, А. Молдовеану, Ф. Молдовеану

Развитие компьютерных технологий, с одной стороны, облегчает работу, с другой - вызывает серьезные проблемы, связанные со здоровьем. Во всем мире все больше и больше растет количество хронических заболеваний, связанных с развитием новейших технологий. Сидячий образ жизни - это одна из основных причин, которая приводит к ухудшению здоровья. Вот почему мы должны принять этот вызов и попробовать найти решения возникаемых задач. Человеческое здоровье во многом зависит от небрежного отношения к сидячему образу жизни. В результате проведенного нами исследования среди более чем 300 рабочих было выявлено, что у большинства из них было чувство дискомфорта, связанное с работой, которую они осуществляли, и почти никто из опрошенных не предпринял никаких мер по улучшению данной проблемы.

Ключевые слова: мониторинг деятельности, сидячий образ жизни, сидячая поза, сидячая работа, выявление изменений осанки, эргономика, осведомленность о ситуации.