Original

Effects of participatory ergonomic intervention on the development of upper extremity musculoskeletal disorders and disability in office employees using a computer

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Abstract: Objective: To evaluate the participatory ergonomic method on the development of upper extremity musculoskeletal disorders and disability in office employees. **Methods:** This study is a randomized controlled intervention study. It comprised 116 office workers using computers. Those in the intervention group were taught office ergonomics and the risk assessment method. Cox proportional hazards model and generalized estimating equations (GEEs) were used. **Results:** In the 10-month postintervention follow-up, the possibility of developing symptoms was 50.9%. According to multivariate analysis results, the possibility of developing symptoms on the right side of the neck and in the right wrist and hand was significantly less in the intervention group than in the control group ($p < 0.05$). Neck disability/symptom scores over time were significantly lower in the intervention group compared with the control group ($p < 0.05$). **Conclusion:** The participatory ergonomic intervention decreases the possibility of musculoskeletal complaints and disability/symptom level in office workers. (J Occup Health 2016; 58: 297-309)
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Key words: Participatory ergonomics, Office ergonomics, Risk assessment, Musculoskeletal disorders, Upper limb disorders

1. Introduction

It can be said that the use of computers starts during the preschool period and rapidly increases during the school-

age period. In the U.S. and Europe, computer usage at work has increased over the years, involving more than half the workforce^{1,2}. In Turkey, the rate of computer use in adults reached 54.8% in 2015³.

Work-related musculoskeletal disorders (MSDs) of the upper body among computer users are common. The prevalence of neck pain among employees using computers in 11 companies in Denmark within the last year was 53% in women and 27% in men⁴. In the study by Cagnie et al., the prevalence of neck pain was reported as 45.5% (54.7% in males and 38.3% in females). They also reported that the rate of sickness absences due to neck pain was 10.2%⁵. In a prospective cohort study conducted with computer users in the U.S., the incidence rate of neck/shoulder symptoms in a 12-month follow-up period was 57.5%⁶.

MSDs constitute one-third of the occupational accidents and diseases in the U.S. every year, leading to approximately 620,000 lost workdays and accounting for approximately \$15-20 billion in workers' compensation costs⁷. It is possible to estimate a similar cost in the UK too⁸.

It is known that many personal factors and work-related risk factors^{2,5,6,9} play a role in the development of MSDs in office workers.

Implementation of participatory ergonomics in the field of occupational health is becoming an increasingly common approach in workplaces.

The broadest definition of participatory ergonomics was given by Wilson: "the involvement of people in planning and controlling of their own work activities to a significant extent with sufficient knowledge and power in order to achieve the desirable goal" (Wilson, JR., 1995, p.1071)¹⁰. Participatory ergonomics can also be defined as a concept that includes the use of various participation methods and techniques in the workplace¹¹.

Many different tools and methods are used in participa-

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tory ergonomic interventions. While most of them have been adapted and improved as ideas specific to participatory ergonomics, some of them have been borrowed from traditional interventions and then supported with a participatory implementation¹²⁾.

Participatory approaches can be achieved in two ways: direct and indirect. In indirect participation, elected or appointed representatives of employees participate; however, in direct participation employees themselves participate¹³⁾.

Kogi et al. indicated that the checklist or risk assessment methods are compatible with the participatory ergonomics steps, and thus, they are practical and easy to apply^{14,15)}. Most of the results obtained from studies in which control lists or the risk assessment method were used on those who use computers yield positive outcomes¹⁶⁻¹⁹⁾. In particular, participatory ergonomic interventions are effectively implemented in the Occupational Health and Safety Management System (OHSMS)²⁰⁾.

The purpose of this study was to determine the effects of participatory ergonomic intervention on the development of symptoms in upper extremities and neck in office employees using a computer and on their physical functions.

2. Methods

This study is a randomized controlled intervention study. It was conducted between November 2008 and November 2009. It comprised 116 office workers working in the municipality using computers. In this study, the workers were trained on risk identification and assessment, and “risk assessment implementation” was applied as a participatory ergonomic intervention method.

2.1. The study group

Office workers working in the municipality using computers comprised the study population ($n=125$). Those who met the inclusion criteria and agreed to participate in the study constituted the study group ($n=116$). The study group was divided into two groups: intervention and control.

2.1.1. Inclusion and exclusion criteria

Before inclusion in the study, the office workers were informed about the study. Those who used computers for at least 10 h, did not have a chronic disease related to the upper body regions, and agreed to participate were included in the study. Not being pregnant was another inclusion criterion for female participants.

2.1.2. Sample size

One of the result variables of this study was the presence of symptoms in the upper body. The possibility of developing symptoms determined as 47.2% in a previous study was used for the calculation of the sample size²¹⁾. On the basis of the prediction that the possibility of devel-

oping symptoms would be 50% less in the intervention group than in the control group, the smallest sample size for each group was 53 people (106 people in the two groups; power 80%, alpha error level 5%)²²⁾.

2.1.3. Allocation of the participants into the study groups (randomization)

For the allocation of the participants into the intervention and control groups, offices were used as cluster sampling units. Each office was stratified by the number of people working there with a simple random method, and then, the clusters were determined as intervention and control groups²³⁾.

The study population was 125 people. During the initial assessment of the study, four people did not want to participate in the study and five people who did not meet the inclusion criteria were excluded from the study. Thus, the study was conducted with 116 people (Fig. 1).

After the initial data of the study was collected and randomization was achieved, six more people (three from the intervention group and three from the control group) were excluded from the study for various reasons during the two-month follow-up period by the time the intervention started.

2.2. Intervention

Participatory ergonomic interventions prepared in advance were implemented to the intervention group. Participatory ergonomic interventions consist of two stages (Fig. 2).

The first intervention of the study was conducted in the third month. In the first stage, the participants were provided training aiming at the development of basic office ergonomics and individual risk assessment skills.

The content of the 2-h training was as follows:

- i. Introduction to ergonomics and MSDs
- ii. Adaptation of the work environment to avoid MSDs²⁴⁾.
- iii. Implementation of exercises and relaxation programs to avoid MSDs²⁵⁾.
- iv. Gaining risk assessment skills²⁶⁾.

The participants conducted a trial implementation of risk assessment for their office environment. Solutions determined after the implementation of risk assessment were implemented by the participant.

The second intervention of the study was conducted in the fourth month. In the second stage, the participants in the intervention group were visited at work. During the visit, each employee used the “Hazard Identification-Risk Assessment Checklist” developed by the researchers to assess their own risk assessment. The participants assessed their own risks through the checklist and produced solutions for those risks. The researchers and the participants together decided on how to implement these solutions. The solutions were implemented by asking questions of “who, where, when, and how” for each solution

Fig. 1. Allocation to the study groups.

proposal. This implementation took approximately 15-20 min for each participant.

During their monthly follow-ups, the participants in the intervention group were encouraged in terms of the problems they identified and solutions they produced for the problems.

An educational brochure developed during the study was handed out to the participants in the control group at the end of the study.

Fig. 2. Research Process

2.3. Variables

2.3.1. Independent variables

1. Sociodemographic characteristics
2. Job strain (Swedish Demand-Control-Support Questionnaire)
3. Determination of the working environment and conditions (working environment, working hours, work completed, working style, etc.).

2.3.2. Outcome variables

In this study, multiple outcome variables were calculated and assessed. At the beginning and the seventh and 13th months of the study, comprehensive and long measurements were performed. In addition, the presence and severity of the symptoms (pain, numbness, electricity, tingling, weakness, ineptitude, apathy, etc.) in the upper body were regularly determined every month. These variables are as follows:

2.3.2.1. The presence of symptoms

To determine the presence of upper body symptoms in participants, a form developed by the researchers was used. The form is an 11-point (ranging from 0 to 10) symptom severity scale. It depicts a human figure referring to various points on the upper body. While 0 indicates that there are no symptoms, 10 indicates that the symptoms' severity is unbearable.

In case a participant reported the severity of symptoms

in any part of the upper body as ≥ 5 , it was decided that the symptoms outcomes developed for used analyses. To decide on the presence of symptoms, the participant's injury should not be an off-the-job injury, he/she should work with the computer 1-2 h per day at least for 10 days in that month, and if the participant is female, she must not be pregnant.

The presence of symptoms was assessed 13 times on a monthly basis.

2.3.2.2. Disability and symptoms

This assessment was conducted at the beginning, in the middle (seventh month), and at the end (13th month) of the study (Fig. 2). To assess disability/symptom, two measurement tools were used.

i. Northwick Park Neck Pain Questionnaire (NPNPQ)

NPNPQ was adapted from the Oswestry Low Back Pain Disability Questionnaire. It has nine items. Each item is scored from 0 to 4. The questionnaire questions neck-related functional difficulties. Increasing scores indicate disability²⁷⁾.

ii. Quick Disability of the Arm, Shoulder and Hand Questionnaire (Quick DASH)

The quick DASH assessment form questions the ability level to perform daily activities, symptoms, sleep, work, and the limitation in performing daily activities. The disability/symptoms section consists of 11 questions. The re-

sponse scale ranges from 1 to 5. It also consists of a four-question "work module." Responding to this section is optional. Increasing scores indicate disability²⁸⁾.

2.4. Data collection and analysis

To collect the study data, the Filemaker 11.0 database program was used.

One of the result variables in this study was the development of symptoms in certain points of the upper body. To analyze this variable, the univariate Mantel-Haenszel comparison was conducted. The results were presented as Mantel-Haenszel rate ratios. For the multivariate analysis, the Cox proportional hazards model was used.

For the analysis of NPNPQ and quick DASH scores, the GEE analysis was used.

The statistical analysis was performed using the Stata 11.1 statistical software package.

2.5. Ethics committee approval

Approval of Dokuz Eylul University Faculty of Medicine, Clinical and Laboratory Research Ethics Committee (protocol number 43/2008) and the participants' informed consent were obtained for this study.

3. Results

Findings related to the basic characteristics of the respondents are shown in Table 1.

Preintervention assessment of the severity of the symptoms in the upper body revealed no difference between the intervention and control groups ($p > 0.05$). There were no significant differences between the intervention and control groups in terms of their quick DASH disability/symptom and work module and NPNPQ scores ($p > 0.05$).

In the 10-month postintervention follow-up of the study, the highest incidence rate was observed on the right side of the neck in the control group (50.9%) and on the left side of the neck in the intervention group (40%; Table 2).

In the 10-month postintervention follow-up, the possibility of developing symptoms on the right side of the neck was significantly lower in the intervention group than in the control group ($p < 0.05$). Analysis results of the multivariate Cox proportional hazards model adjusted for variables that are likely to affect the possibility of developing symptoms in the upper body revealed that the possibility of developing symptoms was significantly lower on the right side of the neck and in right wrist and hand region in the intervention group than in the control group ($p < 0.01$; Table 3).

While the variation of the scores obtained from NPNPQ, and quick DASH disability/symptom severity and work module questionnaire between the groups was performed using the univariate analysis, its multivariate analysis adjusted for covariates was performed using the

GEE analysis method.

The scores obtained from the results of the multivariate analysis of NPNPQ based on the GEE analysis were significantly lower in the intervention group than in the control group ($p < 0.05$). The difference between the intervention and control groups in terms of the quick DASH disability/symptom and work module scores was not significant ($p > 0.05$; Table 4).

4. Discussion

It takes a considerably long time to see the effects of the interventions aimed at preventing the musculoskeletal system. In a review by Westgaard and Winkel, it was indicated that health outcomes should be followed up for a period of at least one year and that follow-up conducted for a period shorter than six months would not be suitable. In addition, they also report that evaluation should be performed more than once during postintervention follow-up²⁹⁾. A similar assessment of follow-up is indicated in a systematic review by Brewer et al.³⁰⁾.

In the present study, upper body-related symptoms of the office workers were regularly followed up every month during the 10-month postintervention period. In the present study, it was also found that the decrease in the possibility of developing symptoms in certain areas of the body was statistically significant.

Similarly, in two studies conducted by Vink et al. on the participatory ergonomics approach, they reported a decrease in symptoms^{31,32)}. On the other hand, Street et al. did not find any changes in the quality of life of call center employees during their two-week postintervention follow-up³³⁾.

Occasionally, the efficacy of the interventions gradually decreases and disappears after a long time. This may be unavoidable, particularly in implementations that are not reinforced²⁹⁾. Ketola et al. conducted a study on office workers using a checklist similar to the one used in the present study, and they determined that the effects of the interventions observed over a short term disappeared during the 10th month of evaluation¹⁷⁾. The participants in our study were monitored on a monthly basis, suggesting that this follow-up contributed to the continuity of the efficacy of the interventions in the intervention group. However, these periodic visits may have led to unwanted training effects in the control group. Nevertheless, it is noteworthy that the participants in the intervention group reported fewer symptoms and less disability than did those in the control group.

In addition to health outcomes, some other outcomes are also used in intervention studies in which participatory ergonomics methods are implemented. In a review by Westgaard and Winkel, it was reported that in such interventions, mechanical exposures can be evaluated in terms of the short-term effects of the interventions²⁹⁾. For

Table 1. Sociodemographic characteristics of the participants.

Variables	Number (n=116)	Percentage (%)
Study Groups		
Intervention	58	50.0
Control	58	50.0
Gender		
Male	47	40.5
Female	69	59.5
Education		
Elementary school	1	0.9
Junior high school	2	1.7
Senior high school	37	31.9
University	76	65.5
Age		
20-29	31	26.7
30-39	45	38.8
40-49	34	29.3
50-54	6	5.2
Age (years) Mean $\pm$ SD [#]		36.0 $\pm$ 8.4
Median age (years)		35.0
Lowest-highest age (years)		21.0-54.0
Smoking status		
Smoker	67	57.8
Ex-smoker	14	12.1
Never smoked	35	30.2
Regularly exercising		
Yes	42	36.2
No	74	63.8
Number of the children		
0	55	47.4
1	35	30.2
2	23	19.8
3	3	2.6
Body mass index (BMI) kg/m ²		
Underweight (between 16 and 18.4)	4	3.4
Normal weight (between 18.5 and 25.0)	71	61.2
Overweight (between 25.1 and 30.0)	30	25.9
Obese (between 30.1 and 35)	8	6.9
BMI Mean $\pm$ SD [#]		23.9 $\pm$ 3.5
Median BMI		23.1
Lowest-highest BMI		16.2-34.7
Total length of service (years)		
Total length of service Mean $\pm$ SD [#]		12.0 $\pm$ 7.9
Total length of service median		11.0
Lowest-highest length of service		0.0-29.5

[#] Mean $\pm$ SD: mean $\pm$ standard deviation

Table 2. The incidence of the symptoms in the upper body during the 10-month postintervention follow-up period.

Body area	Group			
	Intervention (n=55)		Control (n=55)	
	Left (%)	Right (%)	Left (%)	Right (%)
Neck	40.0	30.9	43.6	50.9
Shoulder	38.2	27.3	36.4	43.6
Arm	21.8	20.0	23.6	32.7
Elbow	23.6	12.7	10.9	20.0
Forearm	21.8	14.5	20.0	27.3
Wrist-hand	21.8	18.2	29.1	32.7

example, in two studies conducted among office workers by Vink et al. using the participatory ergonomics approach, they reported that the participants were able to perform a more suitable working environment adjustment^{31,32}. In another study by Ketola et al., it was determined that the participants in the intervention group achieved a significantly better ergonomic assessment of the work environment after the office workers began to use the checklist¹⁷. In Street et al.'s education and job counseling interventions, a significant decrease was observed in posture risk assessment after a two-week follow-up³³. In the present study, a similar assessment of the working environment was conducted, and a significant improvement was observed in the intervention group in terms of the results not presented in this article.

Another result that was evaluated during the interventions on computer use is the change in the knowledge level. In Robertson et al.'s participatory ergonomic intervention study conducted among university students using computers, a significant increase was observed between the participants' pre- and postintervention knowledge levels¹⁸. In Jacobs et al.'s participatory ergonomic intervention study conducted among university students using laptops, the students were asked to use the checklist. In that study, it was determined that the participants took breaks more regularly after intervention than before intervention and received higher grades in the tests given after the intervention¹⁶. A similar increase in the level of knowledge was also observed in the study by Korkmaz et al.³⁴. In this present study, the focus was not only on changes in the knowledge level but also on individual health outcomes, and the assessment was conducted accordingly. The expected change in the results was the development of no new health problems. From this aspect, during the one-year period in our study, fewer symptoms and less disability and better disability/symptom levels were reported, which suggests that the interventions implemented were effective.

Table 3. Symptom development status of the upper body in the intervention group compared with the control group.

Body area	Crude RR	
	Left RR [95% CI] [§]	Right RR [95% CI] [§]
Neck	0.91 [0.48-1.72]	0.51 [0.26-1.00] * *
Shoulder	1.08 [0.55-2.11]	0.54 [0.27-1.10]
Arm	0.88 [0.39-2.00]	0.53 [0.24-1.17]
Elbow	2.20 [0.82-5.90]	0.57 [0.21-1.54]
Forearm	1.04 [0.44-2.45]	0.46 [0.19-1.13]
Wrist-hand	0.67 [0.30-1.46]	0.48 [0.21-1.10]
Body area	Adjusted HR	
	HR [95% CI] [¥]	HR [95% CI] [¥]
Neck	0.85 [0.43-1.70]	#0.74 [0.62-0.89] * *
Shoulder	#0.87 [0.75-1.02]	0.46 [0.21-1.02]
Arm	#0.88 [0.72-1.07]	0.57 [0.20-1.55]
Elbow	1.70 [0.45-6.41]	0.63 [0.17-2.32]
Forearm	0.76 [0.23-2.44]	0.30 [0.07-1.21]
Wrist-hand	0.43 [0.16-1.14]	0.20 [0.06-0.66] * *

[§] RR [95% CI]: Mantel-Haenszel rate ratio [95% confidence interval]

[¥] HR [95% CI]: hazard ratio [95% confidence interval]

Crude RR: univariate Mantel-Haenszel rate ratio results

Adjusted HR: cox regression models adjusted by gender, age, educational status, having children, job strain, social support at work, duration of computer use at workplace, exercise at work, short breaks at work, paying attention to posture at workplace during work hours, level of ergonomic risks encountered, suitability level of the work environment, smoking status, sport participation, body mass index, and baseline pain intensity level.

time-dependent analysis results

*p<0.05, **p<0.01

In work places other than offices, checklists and risk assessment steps have been implemented during participatory ergonomic interventions, and positive results have been achieved³⁵⁻³⁷. Kogi et al. report that implementation of checklists and risk assessment methods are not only useful but also easy because they are compatible with participatory ergonomics^{14,15}. The advantageous feature of these checklists is that they enable employees to evaluate themselves or the environment via predefined risks or implementations and produce appropriate solutions. The results obtained from most of the studies in which computer users used checklists or risk assessment methods were similar to the results obtained from our study¹⁶⁻¹⁸.

One of the important points that contributes to the success of participatory methods is that the method should be simple and easy to implement. While a participatory intervention method is developed, characteristics of the target group should be taken into consideration, and the

Table 4. Changes in the upper body disability status over time in the intervention group compared with the control group (results of multivariable generalized estimating equations).

Result variables	Crude Expβ [95% CI]	Adjusted Expβ [95% CI]
Disability measurements		
Northwick Park Neck Pain Score	0.92 [0.83-1.03]	0.90 [0.82-0.98]*
Quick DASH symptom severity score	0.96 [0.86-1.08]	0.93 [0.85-1.02]
Quick DASH work module score	0.94 [0.84-1.05]	0.90 [0.82-1.00]

Expβ [95% CI]: Expβ (exponential regression coefficients of group variables) [95% confidence interval].

Crude: Results of the univariate analysis.

Adjusted: analysis results adjusted by gender, age, educational status, having children, job strain social support at work, duration of computer use at workplace, level of ergonomic risks encountered, suitability (adaptation) level of the work environment, smoking status, sport participation, body mass index, and baseline pain intensity level.

*p<0.05

RISK ASSESSMENT FORM FOR THE INTERVENTION GROUP

Unit / Room Assessed:		Profession (occupation) of the person assessed:	
Name of the person filling in the form:		Assessment Date	____/____/20____

ERGONOMIC FACTORS

APPROPRIATE SITUATIONS OR BEHAVIORS →→→		Is it appropriate? ☐ No → ☐ Yes ↵	Risk Score*	PRECAUTION (What could be done to prevent risks [Who, what, when and how to do])	Follow-up
The place you work in must be affected by the airflow directly		☐ No → ☐ Yes ↵	☐		
The work surface of a desk should be the appropriate width. (in gaining access to objects in the work surface, you should not have difficulty or extremely stretch your body)		☐ No → ☐ Yes ↵	☐		
The work surface of a desk should be made of anti-glare material.		☐ No → ☐ Yes ↵	☐		
The leg area of the desk should be wide enough to move legs comfortably and be regular.		☐ No → ☐ Yes ↵	☐		
The seat pan of the office desk chair should be moved forward and backward and the height of the back of the chair should be adjustable.		☐ No → ☐ Yes ↵	☐		

You can add problems not included on the list.

(*) Risk score (probability X severity to face risks) and Rating of Decision Making to Prevent Risks

Score	Risk Rating	Precaution
1-2	LOW RISK [I rarely face]	Plan and implement precautions, make a long-term planning and implementation
3-4	MODERATE RISK [I sometimes face]	Implement priority initiatives, Make a long-term planning and implementation
6-9	HIGH RISK [I always face]	TAKE EMERGENCY PRECAUTIONS and apply them. Make a long-term planning and implementation

1

method should be as simple as possible³⁸⁾. Participatory methods implemented should be appreciated and regarded as interesting and acceptable by those who implement them³⁹⁾. In case the method is unacceptable in nature, it may lead to unsatisfactory results⁴⁰⁾. The risk assessment

method used in our study required participants to receive training beforehand. In addition, the office ergonomics checklist developed in this study is simple and easy to implement, which will enable participants to implement a participatory approach without any prior training.

RISK ASSESSMENT FORM FOR THE INTERVENTION GROUP

Unit / Room Assessed:		Profession (occupation) of the person assessed:	
Name of the person filling in the form:		Assessment Date	___/___/20___

APPROPRIATE SITUATIONS OR BEHAVIORS →→→		Is it appropriate?	Risk Score*	PRECAUTION (What could be done to prevent risks [Who, what, when and how to do])	Follow-up
The back of the chair should have an upper and lower back support		☐ No → ☐ Yes ←	☐		
The feet should touch the floor horizontally, or a footrest should be used.		☐ No → ☐ Yes ←	☐		
The chair should allow a 90-degree angle at three places in the sitting position (between arm / armrest - body / thighs - thighs / legs)		☐ No → ☐ Yes ←	☐		
The monitor should be placed so the top line of screen is at or slightly below eye level.		☐ No → ☐ Yes ←	☐		

You can add problems not included on the list.

(*) Risk score (probability X severity to face risks) and Rating of Decision Making to Prevent Risks

Score	Risk Rating	Precaution
1-2	LOW RISK [I rarely face]	Plan and implement precautions, make a long-term planning and implementation
3-4	MODERATE RISK [I sometimes face]	Implement priority initiatives, Make a long-term planning and implementation
6-9	HIGH RISK [I always face]	TAKE EMERGENCY PRECAUTIONS and apply them. Make a long-term planning and implementation

2

RISK ASSESSMENT FORM FOR THE INTERVENTION GROUP

Unit / Room Assessed:		Profession (occupation) of the person assessed:	
Name of the person filling in the form:		Assessment Date	___/___/20___

APPROPRIATE SITUATIONS OR BEHAVIORS →→→		Is it appropriate?	Risk Score*	PRECAUTION (What could be done to prevent risks [Who, what, when and how to do])	Follow-up
The monitor should be at a comfortable viewing distance. [About an arm's length (50-75 cm)]		☐ No → ☐ Yes ←	☐		
Lighting should not cause glare on the monitor screen or the screen surface of the monitor should not reflect lights.		☐ No → ☐ Yes ←	☐		
The color, brightness, contrast and screen refresh of the monitor should be appropriately adjusted.		☐ No → ☐ Yes ←	☐		
The keyboard should be directly in front of the monitor and opposite the user.		☐ No → ☐ Yes ←	☐		

You can add problems not included on the list.

(*) Risk score (probability X severity to face risks) and Rating of Decision Making to Prevent Risks

Score	Risk Rating	Precaution
1-2	LOW RISK [I rarely face]	Plan and implement precautions, make a long-term planning and implementation
3-4	MODERATE RISK [I sometimes face]	Implement priority initiatives, Make a long-term planning and implementation
6-9	HIGH RISK [I always face]	TAKE EMERGENCY PRECAUTIONS and apply them. Make a long-term planning and implementation

3

Participatory process can effectively function only if the solutions produced are rational. Different studies re-

port solution proposals that cannot be fulfilled because of conditions such as cost and their incompatibility with the

RISK ASSESSMENT FORM FOR THE INTERVENTION GROUP

Unit / Room Assessed:		Profession (occupation) of the person assessed:	
Name of the person filling in the form:		Assessment Date	___/___/20___

APPROPRIATE SITUATIONS OR BEHAVIORS →→→		Is it appropriate?	Risk Score*	PRECAUTION (What could be done to prevent risks [Who, what, when and how to do])	Follow-up
The slope angle of a computer keyboard should allow your wrists to be straight and in-line with your forearms.		☐ No → ☐ Yes ↙	☐		
The mouse should be positioned close to the keyboard and be at the same height.		☐ No → ☐ Yes ↙	☐		
When the mouse is gripped, the wrist should be in the straight position.		☐ No → ☐ Yes ↙	☐		
When using the mouse, one should avoid contact with sharp edges, and forearms should be fully supported.		☐ No → ☐ Yes ↙	☐		
When reaching the mouse, the user's body should not be forced		☐ No → ☐ Yes ↙	☐		

You can add problems not included on the list.

(*) Risk score (probability X severity to face risks) and Rating of Decision Making to Prevent Risks

Score	Risk Rating	Precaution
1-2	LOW RISK [I rarely face]	Plan and implement precautions, make a long-term planning and implementation
3-4	MODERATE RISK [I sometimes face]	Implement priority initiatives, Make a long-term planning and implementation
6-9	HIGH RISK [I always face]	TAKE EMERGENCY PRECAUTIONS and apply them. Make a long-term planning and implementation

4

RISK ASSESSMENT FORM FOR THE INTERVENTION GROUP

Unit / Room Assessed:		Profession (occupation) of the person assessed:	
Name of the person filling in the form:		Assessment Date	___/___/20___

APPROPRIATE SITUATIONS OR BEHAVIORS →→→		Is it appropriate?	Risk Score*	PRECAUTION (What could be done to prevent risks [Who, what, when and how to do])	Follow-up
While using the mouse, the user's hand should not be in the grip or contraction position for a long time.		☐ No → ☐ Yes ↙	☐		
Movements requiring power or repetitive movements should be avoided (repetitive pushes on the keyboard and mouse or pressing and holding the mouse buttons for a long time).		☐ No → ☐ Yes ↙	☐		
While sitting on the chair, posture should be upright, back and waist reinforced, shoulders in a natural position, head and neck straight, chest forward and thighs parallel to the floor.		☐ No → ☐ Yes ↙	☐		
Sitting in the same position for long periods should be avoided.		☐ No → ☐ Yes ↙	☐		

You can add problems not included on the list.

(*) Risk score (probability X severity to face risks) and Rating of Decision Making to Prevent Risks

Score	Risk Rating	Precaution
1-2	LOW RISK [I rarely face]	Plan and implement precautions, make a long-term planning and implementation
3-4	MODERATE RISK [I sometimes face]	Implement priority initiatives, Make a long-term planning and implementation
6-9	HIGH RISK [I always face]	TAKE EMERGENCY PRECAUTIONS and apply them. Make a long-term planning and implementation

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manufacturing process⁴¹⁾. On the other hand, it is well known that an organization's support for and attitude toward the solution proposals are important prerequisites

for successful implementation^{12,38)}. In our study, when interventions were conducted without the support of high-level managers. Ensuring effective participation at all lev-

RISK ASSESSMENT FORM FOR THE INTERVENTION GROUP

Unit / Room Assessed:		Profession (occupation) of the person assessed:	
Name of the person filling in the form:		Assessment Date	___/___/20___

APPROPRIATE SITUATIONS OR BEHAVIORS →→→		Is it appropriate?	Risk Score*	PRECAUTION (What could be done to prevent risks [Who, what, when and how to do])	Follow-up
1-2-minute short breaks should be given every 20-30 minutes.		☐ No → ☐ Yes ←	☐		
5-10-minute long breaks should be given every 1-2 hours.		☐ No → ☐ Yes ←	☐		
Office exercises should be performed at least once or twice a day (e.g. neck, shoulders, back, arms, hands and legs should be moved to include stretching exercises. It is not necessary to do all the exercises each time).		☐ No → ☐ Yes ←	☐		

Risk Score Matrix	Severity		
Probability	Low (1)	Medium (2)	High (3)
Low (1)	1	2	3
Medium (2)	2	4	6
High (3)	3	6	9

You can add problems not included on the list.

(*) Risk score (probability X severity to face risks) and Rating of Decision Making to Prevent Risks

Score	Risk Rating	Precaution
1-2	LOW RISK [I rarely face]	Plan and implement precautions, make a long-term planning and implementation
3-4	MODERATE RISK [I sometimes face]	Implement priority initiatives, Make a long-term planning and implementation
6-9	HIGH RISK [I always face]	TAKE EMERGENCY PRECAUTIONS and apply them. Make a long-term planning and implementation

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els will increase the likelihood of successful implementation. The ergonomist who is the executive of the participatory ergonomics approach and who will assume the role of a mediator and guide at this point plays an important role in the achievement of the success⁴²⁾.

The study has some limitations. First, the participants were chosen from only one workplace. Second, the time spent in front of computer varied from one participant to another. In addition, the results obtained were self-reported, and only the symptoms were assessed at gaps of 1 month, which involves the memory factor and may create a confounding effect. The effect of these types of confounders was attempted to eliminate multivariate analyses.

5. Conclusion

The participatory ergonomic intervention implemented in this intervention study produced a positive impact both on the development of symptoms in the upper body and on disability/symptom levels.

During the follow-up period, symptom development on the right side of the neck and in right wrist and hand was significantly lesser in the intervention group than in the control group. Except for the left elbow, symptom development in all the designated points of the upper body was less in the intervention group than in the control group.

Disability in the neck region in the intervention group was significantly lower than that in the control group. The disability/symptom score determined for the shoulder-arm-hand region during the follow-up period was lower in the intervention group, although not significant.

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