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UEMSD Risk Identification – Case Study

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***Abstract*—**The article demonstrates on a case study how it is possible to identify MSD risk. It is based on a dissertation *Risk identification model of occupational diseases formation in relation to the work activity* that determines what risk can endanger workers who are exposed to the specific risk factors. It is evaluated based on statistical calculations. These risk factors are main cause of upper-extremities musculoskeletal disorders.

***Keywords*—**Case study, upper-extremity musculoskeletal disorders, ergonomics.

I. Introduction

THERE is a very close relationship between productivity, quality and safety; therefore, it is necessary to place greater emphasis on promoting system approach to company management, there should be health and safety conditions at work in addition to the production and operation. Workplace safety and conditions that don't endanger health are secured by employers in practice. Employee's working life quality and company's productivity and competitiveness alike depend on environment and conditions created by company management [1].

Work-related diseases have been still great problem at company and social level. Current production patterns are different than a few decades ago and heavy manual labor is replaced by new technologies, so the workers are no longer forced to perform physically demanding task. But they are exposed to new risk represented by forced and unnatural positions, monotonous repetitive tasks, vibrations etc.

These risks are related mostly to upper extremities. Upper extremity musculoskeletal disorders represent great problem in the whole world, especially in the industrial developed countries. Many authors are focused on this problem [2]–[5].

Most common work-related disorders are carpal tunnel syndrome, ulnar and radial epicondylitis trigger finger, Morbus de Quervain other arthritis etc.

There are many analyses and methods for ergonomic risk assessment that are described by [6].

Most musculoskeletal disorders are recognized as occupational diseases. Several sources deal with it, e.g. [7], [8]. If a disease is recognized as occupational disease, considerable costs arise to employer for compensation of affected worker. Currently employer has to find replacement in case of inability of affected worker to return to the working process.

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II. Methods

Case study described in this article shows usage of Risk identification model of occupational diseases formation in relation to the work activity that is also summed in the article Model of MSD risk assessment at workplace [9]. Model comes out of study carried out in 2002 – 2005. Relevant factors forming this study were chosen for model creation. Other relevant values were added to these risk factors. Thanks to them it is possible to determine rate of UEMSD risk. In Table I there are relevant risk factors that were used for model creation. Following values are defined to the individual factors.

A. Relative Risk RR

Relative risk expresses the relationship between risk factor and disease. It describes the probability of the disease developing in an exposed group as compared with the same in unexposed group. It is a ratio of two conditional probabilities:

- Probability of the disease occurrence in an exposed population
- Probability of the disease occurrence in an unexposed population (1)

The parameter *a* represents the number of patients who have been exposed to the risk factor.

The parameter *b* represents the number of persons who have been exposed to a risk factor, but were disease-free.

The parameter *c* represents the number of diseased people who were not exposed to the risk factor.

The parameter *d* represents the number of persons who have not been exposed to the risk factor and disease-free.

$$\mathrm{RR} = \frac{\frac{a}{(a+b)}}{\frac{c}{(c+d)}} \quad (1)$$

RR = 1 there is no relationship between exposure and disease
RR> 1 in the exposed group, the risk of disease is higher than in the unexposed population
RR <1 exposure reduces the risk of disease

B. Attributable Risk AR

Attributable risk expresses the absolute effect of exposure to the risk factor describing how much higher is the incidence of health effect in exposed group compared to the unexposed group [11].

$$\mathrm{AR} = I_e - I_u \quad (2)$$

I_e incidence in an exposed group
I_u incidence in an unexposed group

$$I_e = \frac{a}{(a+b)} \quad (3)$$

$$I_u = \frac{c}{(c+d)} \tag{4}$$

C. Attributable Risk Percent AR%

It indicates the percentage of patients exposed to the risk factor that could have been avoided if patients were not exposed to the risk factor.

$$\text{AR\%} = \frac{AR}{I_e} \times 100 \tag{5}$$

D. Population Attributable Risk PAR

It is part of the incidence of the disease in the population (exposed and unexposed) that results from exposure to the risk factor.

PAR is the incidence of disease in the population, which would be eliminated if the exposure to the risk factor is excluded.

PAR is determined as a subtraction of incidence in unexposed population and a general population (exposed and unexposed).

$$PAR = I_p - I_u \tag{6}$$

$$I_p = \frac{a+c}{N} \tag{7}$$

E. Population Attributable Risk Percent PAR%

PAR% indicates the percentage incidence of the disease in the population (exposed and unexposed) that is caused by exposure.

PAR% is the percentage of disease that would have been eliminated if an exposure to risk factors is avoided.

PAR% is determined as the ratio of the population attributive risk (PAR) and the incidence in the whole population (exposed and unexposed):

$$\text{PAR\%} = \frac{PAR}{I_p} \times 100 \tag{8}$$

III. Case Study

Case study was carried out in a machine company which deals with the production of steering columns of cars.

At the selected workplace there are made 1620 pieces, net working time amount is to 580 minutes. Cycle time is 21 seconds. Worker's activity is distinguished by high monotony, arm movements are very fast and it is difficult to keep pace (about 60 movements per minute).

The worker is woman, 52 years old, 163 cm tall, weighs 70 kg. According to BMI it is overweight. She has not any UEMSD yet.

TABLE I
Relevant Risk Factors

Risk factor	No. Sample	No. MSD	RR	AR	AR %	PAR	PAR %
Age							
< 30	875	39	1	0	0 %	0	0 %
31 – 34	572	44	1,73	0,03	42,1 %	0,01	22,3 %
35 – 39	508	61	2,69	0,08	62,9 %	0,03	38,4 %
40 – 44	561	73	2,92	0,09	65,7 %	0,03	42,9 %
45 – 49	538	109	4,55	0,16	78 %	0,06	57,4 %
50 – 54	451	103	5,12	0,18	80,5 %	0,06	58,4 %
≥ 55	198	42	4,76	0,17	79 %	0,03	41 %
BMI, kg/m²							
Normal (18,5 – 24,9)	2157	230	1	0	0	0	0
Underweight (< 18,5)	124	8	0,61	-0,04	-65,3 %	0	-2,2 %
Overweight (25 – 29,9)	1078	160	1,39	0,04	28,2 %	0,01	11,6 %
Obese (≥ 30)	300	59	1,84	0,09	45,8 %	0,01	9,3 %
≥ 1 prior UEMSD	713	226	3,86	0,23	74,1 %	0,05	35,5 %
High repetitiveness, ≥ 4 hours per day	958	183	1,82	0,09	45 %	0,02	17,5 %
High physical demand, RPE Borg scale ≥ 13	1856	309	1,89	0,08	47,2 %	0,04	30,9 %
Arms at or above shoulder level, 2 hours per day	487	104	1,87	0,1	46,5 %	0,01	10,3 %
Arms abducted, ≥ 2 hours per day	572	108	1,63	0,07	38,6 %	0,01	8,8 %
Full elbow flexion/extension, ≥ 2 hours per day	1214	221	1,81	0,08	44,8 %	0,03	21 %
Extreme wrist bending posture, ≥ 2 hours per day	1236	222	1,78	0,08	43,7 %	0,03	20,6 %
Holding tools/objects in a pinch grip, ≥ 4 hours per day	297	66	1,87	0,1	46,5 %	0,01	6,5 %

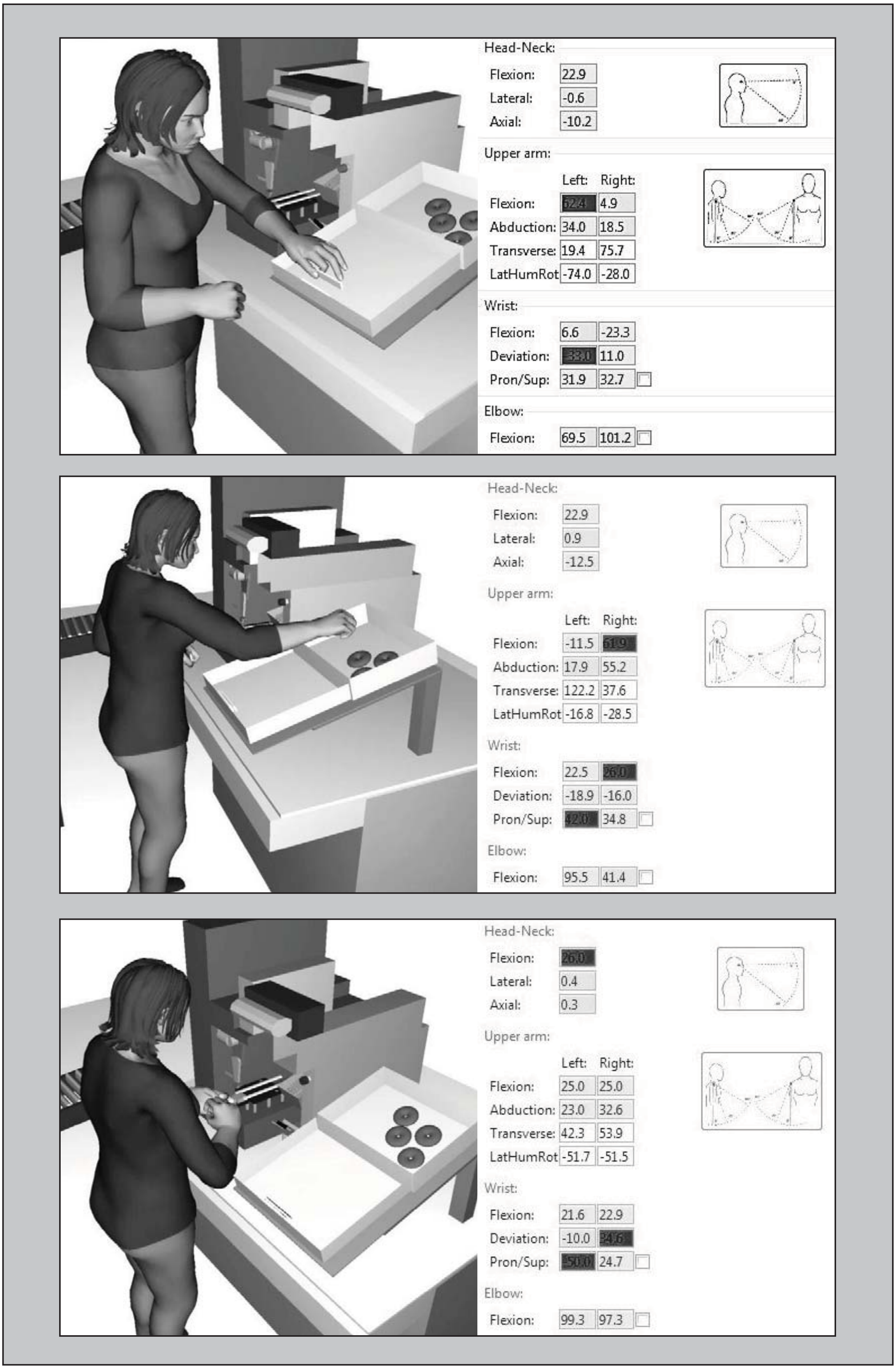

Fig. 1 Analysis of working postures

Fig. 1 represents workplace that was created in ergonomic software Tecnomatix Jack (mentioned in [10]).

Applied analysis shows positions of individual parts of body. Values in dark boxes are unacceptable from the point of view of ergonomics and these positions should be eliminated.

During working process the arms were abducted and at or above shoulder level, wrist was extremely bended, elbow was in flexion.

What are the risks for this woman compared to unexposed workers?

- In the age of 52 the risk of MSD is 5.2x higher than in the age under 30.
- Overweight (value of BMI 26.3) means 1,39x higher MSD risk than normal weight.
- Monotony means 1.82x higher MSD risk. If the monotony would be eliminated, MSD incidence decreases about 8.6 for every 100 workers; it means 45% reduction of MSD.
- Arms at or above shoulder level mean 1.87x higher MSD risk. If this risk factor would be eliminated, MSD incidence decreases about 9.9 for every 100 workers; it is 46.5% reduction of MSD.
- Bended elbow means 1.81x higher MSD risk. If this risk factor would be eliminated, MSD incidence decreases about 8.1 for every 100 workers; it is 44.8% reduction of MSD.
- Wrist flexion means 1.78x higher MSD risk. If this risk factor would be eliminated, MSD incidence decreases about 7.9 for every 100 workers; it is 43.7% reduction of MSD.
- Abducted arms mean 1.63x higher MSD risk. If this risk factor would be eliminated, MSD incidence decreases about 7.3 for every 100 workers; it is 38.6% reduction of MSD.
- If all work-related factors would be eliminated, MSD incidence decreases about 84%.

Some risk factors were eliminated at this workplace (bended elbow and upper-extremities abduction). The MSD incidence decreased about 16%.

IV. Conclusion

In this article there was shown on case study, how it is possible to determine MSD risk based on accessible data. Complete model is result of dissertation Risk identification model of occupational diseases in relation to the work activity. Results can help not only by workplaces design but also by MSD risk identification. Employers can save some costs and make better working conditions for their employees.

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