Influence of Combined Labour Environment Risk Factors on Employees of the Sewing Enterprise and Practical Solutions

Zenija Roja[1], Valdis Kalkis[2], Henrijs Kalkis[3], [1-3] *University of Latvia*,
Iveta Palmsalu[4], Janis Ievins[5], Janis Berzins[6], [4-6]*Riga Technical University*

Abstract. **The aim of the research has been to study the influence of combined labour environment risk on tailor's work ability at a sewing enterprise of medium size, as well as working out practical recommendations. Ten tailors (women) aged 24 to 65 years have been involved in the research. Tailors` inquiry has been carried out, and the labour environment has been analyzed according to laboratorial measurement results of indoor climate parameters, lighting, noise, vibration and dust. Ergonomic and psychosocial risks have been evaluated, and capacity index of tailors has been set. It has been concluded that the pace of work, tension at work, relationship with the seniour managers create psychological discomfort. Practical recommendations have been worked out, which are directed to combined labour environment reduction of efficiency.**

Keywords: **labour environment risks, influence of combined risks, tailors, preventive arrangements, workload.**

I. INTRODUCTION

Textile industry is the oldest economic sector in Latvia, which grew strongly in the thirties of the 20th century [1]. Employees of the textile industry are subordinated to the combined efficacy of the following labour environment risk factors: physical, mechanical, chemical, ergonomical, psychosocial and managerial [2, 3].

Over recent years in Latvia in this industry, the number of occupational diseases has grown. According to the statistic data, in 2007 the number of the registered occupational diseases was 112 on 100 thousand employees, but in 2009 – accordingly 174 on 100 thousand employees [4].

It is indicative that the number of occupational health problems increase; as a result, well-being at work is affected. The most common tailors` occupational diseases are related to overload of muscles, skeleton and connective tissue system at work and monotonous hand movements [2, 3].

It is notable that influence of combined risks strengthens the mentioned health problems. For example, employees, who suffer from psychosocial risks at work in combination with adverse ergonomical risks, noise or chemical risks, are more subordinated to damage of muscles, skeleton and connective tissue system than those employees who are only subordinated to the influence of one factor.

It is proven that the appropriate organization of work is also important. For example, limited control over the given work and disproportionate demands at work are related to the increasing injury risk of connective tissue system [5, 6]. The same can be said about colleges' support and short of solidarity at the enterprise. Employers need to take into account that requesting for higher work productivity will also lead to higher work health problems because of the stress at work. Thus, the aim of this research has been: to study the influence of combined labour environment risks on tailors` work ability at a sewing enterprise of medium size and to work out practical recommendations to improve the situation. In the research ten tailors took part aged 24 to 65 years. In the enterprise tailors work in teams. During the working time the tailors have to perform accurately and qualitatively the asigned tasks at a fast pace.

II. METHODS

The tailors have been inquired in order to analyse subjective opinions about possible risks at work and their influence on employees. Indoor climate parameters, lighting, noise, vibration, dust have been defined, and their analysis has been done in the air of work environment. To measure noise, pressure level and indoor climate, a universal light, noise, temperature and humidity measuring gadget "Environment Meter 4 in 1", has been used. To measure the vibration, the tester "PCE-VT2700" has been used. To define the dust concentration in work environment, the air aspirator "GILIAN 5000" has been used. For general assessment of lighting, indoor climate parameters and noise created risks in work environment matrices have been used [7]. The evaluation of ergonomic risks has been performed by using Quick Exposure Check (QEC) method [8] and work load has been assessed by means of Key Indicator Method (KIM) [9]. Psychosocial risks have been evaluated by Spalski test [6]. Tailor's work ability has been defined using Capacity Index (CI) [10], where work ability is represented by the number of points, which can be from 7 till 49 (I – bad work ability is equal to 7...27 points; II – medium work ability equals 28...36 points; III – good work ability is equal to 37...43 points; IV – very good work ability equals 44....49 points).

III. RESULTS AND DISSCUSION

A. Lighting evaluation

The result of measurement shows that at tailors` workplace the level of lighting corresponds to the Latvian legislative and regulatory requirements. In the working room there is combined lighting, which includes natural and artificial

lighting and combines ceiling lamps and light lamps above workplace equipment. As a local light source there is a table lamp by each sewing-machine.

TABLE 1

NON-REGULATED AND REGULATED LIGHTING IN TAILORS` WORK ENVIRONMENT

Work environment	Actual lighting level in lux (lx)	Regulated lighting level over work area
Tailors	1000 lx and 2750 lx (if the table lamp is switched on)	750 lx

It is defined that employees' subjective opinions about lightening adequacy do not match with objective evaluation, because some of tailors in the inquiry have marked that lighting is insufficient. Lighting measurement results are showed in Table 1.

According to lighting evaluation matrix [7] and regulated parameters, lighting has been evaluated with II stage of risk, which defines that lighting fixtures need to be cleaned regularly and also other defects corrected.

B. Noise

In the inquiry it has been stated that 26% tailors aged 30 to 50 years consider that they are exposed to noise influence, especially if they work with fastening and buttonhole sewing-machines. However, analyzing the objective noise level at the tailors' workplace, it has been concluded that for universal sewing-machines equivalent noise throughout the work shift (8 hours) does not exceed the standard and is situated 68...79 dB(A) margin, because sewing-machines are equipped with muted electric motors (see Table 2). The calculated average level of noise at the department corresponds to 76 dB(A).

Taking into account the laboratorial measurement results of noise, which specify sewing-machine equivalent level of noise at the department (L_{AeqT}), as well as the calculated everyday level of noise throughout the work shift ($L_{EX,\ 8}$), it is defined that according to the evaluation matrix [7], the noise in the work environment corresponds to I stage of risk, and no special preventive measures should be taken.

C. Vibration

As a result of such an inquiry, it has been found out that 30% of tailors with length of service over 30 years, in the 50- to 60-year-old age group complain about tingling of hands and the pain in forearm, connecting it with adverse influence of vibration.

TABLE 2

MEASUREMENT RESULTS OF NOISE

No.	Workplace	Defined level of noise, L_{AeqT}, dB(A)	Permissible level of noise, dB(A)
1.	Sewing	68	80
2.	Making buttonholes	78	
3.	Making fastening joints	79	

Analysing the results of inquiry, these complains can be linked only with sustained work in compulsive pose and monotonous hand movements.

Sewing-machines and other sewing equipment are new; they are in running order, and laboratorial measurements show that the standards of vibration are not exceeded – the costof vibroacceleration (A8) during the work shift does not exceed 2.41 m/s^2 (see Table 3).

According to evaluation of vibration matrix [7] and regulation parameters, the stage of risk is I; thereby, special preventive measures to decrease vibration are not necessary.

D. Dust

The cloth, which mainly is used by tailors, consists of 50% cotton and 50% synthetic polyester. The concentration of dust in the sewing department is lower than border cost of occupational exposure (the dust of cloth OEL = 4.0 mg/m^3), and it oscillates at an average from 0.18±0.05 to 0.26±0.06 mg/m^3. Even though exhausting ventilation, regularity of cleaning and airing are not set up, the workplace gives opportunity to avoid increased concentration of dust at the workplace.

E. Indoor climate

Measurement parameters of indoor climate have been set according to outside temperature +12°C (see Table 4). It is defined that indoor climate of workplace corresponds to legislative and regulatory requirements. At an average air temperature at the workplace is 23...25°C during the cold season of the year, but during the warm season of the year it oscillates from 25...27C°. During the warm season there are not specific problems with sunlight getting into the workplace, because the windows are placed on the north side of the building. If there is a need for airing, then it can be done through windows. Thereby indoor climate is evaluated with II stage of risk and it corresponds to the acceptable level.

TABLE 3

MEASUREMENT RESULTS OF VIBRATION

No.	Workplace	Defined hand palm vibroacceleration, m/s²	Permissible level of hand palm vibration – day's exposures working cost, A(8), m/s²
1.	Sewing	1.86	2.5
2.	Making buttonholes	2.41	
3.	Making fastening joints	1.95	

TABLE 4

TEMPERATURE AND RH IN TAILORS` WORK ENVIRONMENT

Temperature, °C		RH, %	
Actual index	Regulatory index	Actual index	Regulatory index
23	19...25 (cold season of the year) 20...28 (warm season of the year)	52	30...70

F. Evaluation of the ergonomic risks

The data of inquiry shows that mainly tailors` upper body, hands and femur are loaded during the working hours. Almost 60% of tailors recognize that they work at fast pace and are subordinated to higher tension at work.

Measurement of load for separate parts of body by rapid exposure control method presents that load of shoulder/hand and neck area and also the pace of work and tension level are evaluated with II stage of risk. Then according to the received data interpretation, the tailors have to carry out regularly the mandatory health examination if they are over 40 years old, as well as it is necessary to evaluate possible change of work type in order to relieve tired muscle groups.

When evaluating load by means of the main indicator method KIM, which takes into account frequent movements with hands, it has been defined that the load of hands is evaluated with III stage of risk. Thereby, the physical load of hands has increased vitally for tailors in the studied age group. The following indicators have taken into account for evaluation: force exerted indicator, organizational conditions, work environment, working posture, hand position and movements and also intensity of the work.

Obtained results match with many world researchers' opinions that tailors' work is connected with ergonomic risks; as a result, employees suffer from muscle, skeleton and connective tissue system damage and chronic pain mainly in the upper body [11−13].

G. Analysis of psychosocial work environment

Analysing the obtained results by means of Spalski test, it has been defined that the tailors mainly consider that in the work team healthy and friendly psychological indoor climate dominates. Only 7% of tailors consider psychological indoor climate to be unhealthy. The most negative evaluations have been set towards superiors and mutual communication.

H. Work ability

Analyzing employees` ability of work with Finland's worked out work ability index [10], it is defined that work ability is very high (46 points) and corresponds to IV category which has 44...49 rating scale points. According to work ability index terms, tailors predict that they are going to be able to work next 2 years at 100%. Analyzing the obtained data about their diseases, it is notable that mainly tailors have been sick with a cold. Thereby it would be necessary to keep healthy habits, restrict smoking and other bad habits, which could cause the mentioned diseases.

IV. CONCLUSIONS AND PRACTICAL RECOMMENDATIONS

Tailors are subordinated by the influence of different combined risk factors at work. The influence of combined risk factors could be explained as interactive influence of risk factors but not the result of combined influences. Despite received information from inquiry questionnaires about unhealthy working conditions the objective risks evaluation shows that tailors work under appropriate working conditions in the given enterprise and their capacity of work is evaluated as very good. A conclusion has been drawn that the pace of work, tension at work, relationship with seniour managers may cause discomfort for tailors at work. The developed practical recommendations turned to ergonomic development and psycho-emotional risk prevention in a work team.

REFERENCES

[1] *Association of Light Industry Enterprises* [2011.03.01.]. Website:http://www.vrua.lv/latvia_industry4.

[2] *Work environment risk factors and workers' health protection.* V. Kalkis, Z. Roja. Riga: Elpa-2, 2001, 500 p. (in Latvian)

[3] **Gunning, J., Eaton, J., Ferrier, S.,** et.al**.** *Ergonomic Handbook for the Clothing Industry*. Toronto: Union of Needletrades, Industrial and Textile Employees, the Institute for Work & Health, and the Occupational Health Clinics for Ontario Workers, Inc., 2001, p. 11-55.

[4] State labour inspectorate [2011.03.01]. Website: http://www.vdi.gov.lv/.

[5] **Roja, Z**. *Ergonomcis basics*. Riga: Drukatava, 2008, 190 lpp. (in Latvian)

[6] **Roja, Z., Roja, I., Kalkis, H**. *Stress un harassment at the work*. Riga: 2006, 49 p. (in Latvian)

[7] **Kalkis, V.** *Work environment risk assessment methods.* Riga: Latvijas Izglitibas fonds, 2008, 242 p. (in Latvian)

[8] **David, G., Woods, V., and Buckle, P.** *Further development of the usability and validity of the Quick Exposure Check*. University of Surrey, Guildford, HSE Books, 2005.

[9] **Steinberg U., Caffier G.** Methodische Aspekte bei der Anwendung der Lastenhandhabungsverordnung. *Z. Arbwiss*, 1998, vol. 2, N 24, p.101-109.

[10] **Ilmarinen, J., Tuomi, K.** Past, present and future of work ability. *People and Work Research Reports*, Finnish Institute of Occupational Health, Helsinki, 2004, vol. 65, p. 1-25.

[11] **Westgaard, R.H., Jansen, T.** Individual and work related factors associated with symptoms of musculoskeletal complaints. II. Different risk factors among sewing machine operators. *Br J Ind Med*, 1992, vol. 49, N 3, 154-162.

[12] **Andersen, J.H., Gaardboe, O.** Musculoskeletal Disorders of the Neck and Upper Limb among Sewing Machine Operators: A clinical investigation. *American Journal of Industrial Medicine*, 1993, vol. 24, N 6, 689-700.

[13] **Kaergaard, A., Andersen, J.H.** Musculoskeletal disorders of the neck and shoulders in female sewing machine operators: prevalence, incidence, and prognosis. *Occup Environ Med,* 2000, vol. 57, 528-534.

Zenija Roja, Associate Professor, MD, PhD
University of Latvia, Ergonomics Research Centre
Address: 48 Kr. Valdemara Street, LV-1013, Riga, Latvia
Phone: 29563591; E-mail: Zenija.Roja@lu.lv

Valdis Kalkis, Professor, Dr.habil.chem.
University of Latvia, Department of Chemistry
Address: 48 Kr. Valdemara Street, LV-1013, Riga, Latvia
Phone: 29198476; E-mail: Valdis.Kalkis@lu.lv

Henrijs Kalkis, Lecturer, Mg.sc.soc.
University of Latvia, Faculty of Economics and Management
Address: Aspazijas Boulevard 5, Riga
E-mail: Henrijs.Kalkis@lu.lv

Iveta Palmsalu, M.Sc.
Priva Ltd., Product Manager
Address: 16b Unijas Street, LV-1084, Riga, Latvia
Phone: 29275470; E-mail: Ivetap@inbox.lv

Janis Ievins, Professor and also Head of the Institute of Labour Safety and Civil Defence at the Faculty of Engineering Economics and Management, Riga Technical University.
In 1993 he received a Degree of Doctor in Economics (Dr.oec.) from Riga Technical University. He holds lectures in work safety, management and economics. He specialises in work safety and economic aspects of labour protection, as well as risk assessment. Honorary Ambassador of European Network Education and Training in Occupational Safety and Health (ENETOSH).

Janis Berzins, Practical Lecturer
Riga Technical University, Faculty of Engineering Economics and Management, Institute of Occupational Safety and Civil Defence
Address: 1/7 Meza Street, LV-1048, Riga, Latvia
Phone: 26414998; E-mail: Janis.Berzins@rtu.lv

Ženija Roja, Valdis Kalkis, Henrijs Kaļķis, Iveta Palmsalu, Jānis Ieviņš, Jānis Bērziņš. Kombinēta darba vides riska faktoru ietekme uz šūšanas uzņēmumā nodarbinātajiem un praktiskie risinājumi
Tekstilrūpniecība ir viena no vecākajām Latvijas tautsaimniecības nozarēm, kas strauji attīstījās pagājušā gadsimta trīsdesmitajos gados. Ir zināms, ka šīs nozares darbinieki ražošanas vidē sastopas ar dažādiem riskiem. Ļoti svarīgs faktors jebkurā nozarē ir darba vidē sastopamo risku ietekme uz nodarbināto darbspējām. Tekstilrūpniecība ir nozare, kura ietver ne tikai audumu ražošanu, kā arī apģērbu ražošanu. Apģērbu ražošanas nozarē ir paaugstināts trokšņa līmenis, nepietiekams darbvietas apgaismojums, gaisa piesārņojums, darba vides mikroklimata problēmasm, vibrācija un ergonomiskās problēmas, it sevišķi šuvēju darbvietās. Darba mērķis bija pētīt kombinētu darba vides risku ietekmi uz šuvēju darbspējām vidēja lieluma šūšanas uzņēmumā un izstrādāt praktiskas rekomendācijas situācijas uzlabošanai. Pētījumā piedalījās 10 šuvējas vecumā no 24 līdz 65 gadiem, tika veikta darbinieku aptauja un analizēti darba apstākļi (mikroklimata parametri, apgaismojums, troksnis, vibrācija un putekļu koncentrācija darba vidē), izmantojot šādus mērinstrumentus: – vibrometru „PCE-VT2700", gāzu analizatoru „Gillian 5000" un mēriekārtu „Environment Meter 4 in 1". Neskatoties uz aptaujas anketās iegūto informāciju par neveselīgiem darba apstākļiem, objektīvais risku novērtējums uzrāda, ka šuvējas pētītajā uzņēmumā strādā piemērotos darba apstākļos un viņu darbspējas vērtējamas kā ļoti labas. Izstrādātās praktiskās rekomendācijas vērstas uz ergonomiskiem risinājumiem un psihoemocionālā riska novēršanu darba komandā.

Жения Роя, Валдис Калькис, Хенрийс Калькис, Ивета Палмсалу, Янис Иевиньш, Янис Берзиньш. Комбинированное воздействие рисков рабочей среды на работающих в швейном произвдстве и практические рекомендации
Текстильная промышленность в Латвии является одной из старейших отраслей экономики, которая начала быстро развиваться в тридцатые годы прошлого века. Известно, что рабочие текстильной промышленности подвергаются воздействию различных рисков производственной среды. Целью исследования являлось изучение комбинированного воздействия рисков рабочей среды на швеи, работающих на предприятиях средней величины, и разработка практических рекомендаций. В исследовании принимали участие 10 швей (женщины) в возрасте от 24 до 65 лет. Проведен опрос работниц и анализированы условия работы (микроклиматические параметры, освещение, шум, вибрация, концетрация пыли), используя следующие измерительные инструменты – виброметр «PCE-VT2700», газоанализатор «Gillian 5000» и «Environment Meter 4 in 1» для определения уровня шума, вибрации и освещенности. Оценены эргономические и психосоциальные риски (метод определения основных индикаторов тяжести труда, быстрый метод определения экспозиции эргономической нагрузки и др.), а также определен индекс работоспособности. Получен вывод, что темп работы, стресс на работе, отношение с руководством создает психологический дискомфорт. Несмотря на то, что швеи субъективно (анкетные данные) определили воздействие вредных условий труда в течение рабочей смены, объективная оценка рисков показывает, что они работают в соответствующих производственных условиях труда, о чем также свидетельствует индекс работоспособности: очень хороший. Разработаны практические рекомендации, направленные на снижение влияния комбинированного воздействия рисков.