

## Developing a framework to transfer knowledge from operations into engineering design projects: understanding the knowledge management challenge

**Souza da Conceição, Carolina; Jensen, Anna Rose Vagn; Broberg, Ole**

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**PUBLICATIONS OF  
THE UNIVERSITY OF EASTERN FINLAND**

*Reports and Studies in  
Health Sciences*



UNIVERSITY OF  
EASTERN FINLAND

**SUSANNA JÄRVELIN-PASANEN (ED.)**

**NES2016 - ERGONOMICS IN THEORY AND PRACTICE**

*- Proceedings of 48<sup>th</sup> Annual Conference of Nordic Ergonomics and Human Factors Society*



***48<sup>th</sup> Annual Conference of Nordic  
Ergonomics and Human Factors Society***



SUSANNA JÄRVELIN-PASANEN (ED.)

***NES2016 - Ergonomics in theory and  
practice  
48<sup>th</sup> Annual Conference of Nordic  
Ergonomics and Human Factors Society***

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## **ABSTRACT**

The 48<sup>th</sup> Annual Conference of Nordic Ergonomics and Human Factors Society (NES) is organized by the Finnish Ergonomics Society (FES) together with University of Eastern Finland, Institute of Public Health and Clinical Nutrition, and with co-organizers Finnish Institute of Occupational Health and Savonia, University of Applied Sciences.

NES2016 conference gathers together researchers and practitioners with an interest in the field of ergonomics and human factors and occupational health. This facilitates sharing the experiences and results that help the development of research, work and ideas, the formation of networks as well as increasing the quality of the joint fields of ergonomics and human factors and occupational health.

This book contains the proceedings of the 48<sup>th</sup> annual conference of Nordic Ergonomics and Human Factors Society (NES) "NES2016 - Ergonomics in Theory and practice" held in Kuopio, Finland, August 14-17, 2016.

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**Yleinen suomalainen asiasanasto:** ergonomia; kansainvälinen yhteistyö; kokousjulkaisut; terveyden edistäminen; tutkimus; työterveys





# *Welcome*

Dear participants,

I warmly welcome you all to the 48<sup>th</sup> Annual Conference of Nordic Ergonomics and Human Factors Society (NES2016 – Ergonomics in Theory and Practice) to be held here in the middle of the Finnish Lake District, Northern Savo, and more specifically at Spa Hotel Kunnonpaikka, Siilinjärvi municipality just on the border to the City of Kuopio.

It is now five years since NES annual conference was organized last time in Finland. This time the main organizers of the conference are University of Eastern Finland and Finnish Ergonomics Society in collaboration with Finnish Institute of Occupational Health and the Savonia University of Applied Sciences.

We have altogether nearly 100 participants from 13 different countries not only from Nordic countries, but also from Central and Southern Europe and Far East. During the coming three days we will have five key note speeches (from Finland, Denmark, Sweden and the Netherlands), two workshops, 44 oral and five poster presentations.

Our Scientific Committee with the help of the International Scientific Advisory Board has succeeded in reviewing the abstracts and planning hopefully an interesting program covering many aspects of ergonomics, occupational health and well-being at work. The issues covered in the key note speeches include aging and work, shift work arrangements, ergonomic risk assessments, effectiveness of the ergonomic interventions and necessity theory building for of human factors/ergonomics. The topics of presentations in daily parallel sessions and posters deal with nursing and healthcare, agriculture, work ability, prevention of musculoskeletal diseases, management, leadership and teamwork, ergonomic interventions as well as other occupational health issues. Each of the presentations you will find as a four to five page proceeding-paper in this Electric Proceedings Book. In one of the workshops, ergonomics in process redesign will be dealt with examples of lean implementations in health care, while the other focuses on the basics of regulation and guidelines for heavy manual handling. As a whole, the three main domains of ergonomics – physical, cognitive and organizational –are well covered in our program.

We sincerely thank all our sponsors and exhibitors for their financial support: The Finnish Work Environment Fund, Federation of Finnish Learned Societies, City of Kuopio, Municipality of Siilinjärvi, Firstbeat Technologies Oy, MarskiData Oy, Easydoing Oy/Salli Systems, Dell Ltd, Top-Cousins Oy, Ergorest Oy, Finnergo, Suomen Terveystalo Oy, Kunto Kuopio Oy, Contour Design Sverige AB, Ergotekniikka Oy Tuolitalo, Scandinavian Business Seating AB and Saurum Oy. Without their contributions it would not have been possible to arrange this event.

Lastly, I also want to thank the members of our Organizing Committee for the hard work done during the more than one year preceding these coming – hopefully sunny – three days that we will spend together exploring the issues related to ergonomics, occupational health and well-being at work.

Kimmo Räsänen  
Chair of the Scientific and Organizing Committee

48<sup>th</sup> Annual Conference of Nordic Ergonomics and Human Factors  
Society: NES2016 - Ergonomics in theory and practice

Supported by:



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FEDERATION OF FINNISH LEARNED SOCIETIES

# Contents

Program .....	12
Organizing and scientific committee.....	18
International scientific advisory board .....	19
Keynotes .....	20
Healthy aging at work and beyond.....	21
How to arrange shift and night work when this is inevitable? .....	24
Ergonomic risk assessments – a need for reliable and attractive methods.....	28
Health outcomes of ergonomic interventions, lessons learned from Cochrane Reviews.....	33
Towards a necessity theory of human factors/ergonomics.....	37
Session 1A Nursing – health care.....	40
ErgocareBank - Good ergonomic solutions for both nursing home- and home care-work .....	41
Development of a sensing system to prevent bed-related accidents involving elderly persons .....	45
Ergonomic criteria and good practices for bariatric patients’ care .....	50
Practical nurses’ competency and perceptions of technology use in home care ..	55
Session 1B Work and safety in agriculture / Questions of work ability .....	59
Farmers’ physical workload and work ability in Finland .....	60
Occupational injuries among fishermen in Finland 1999-2013 .....	65
Socio-demographic and work-related factors associated with the work ability of the unemployed.....	70
Session 2A NES Student price competition .....	75
Implementation of workplace mediation as a method of conflict resolution at the University of Eastern Finland .....	76
Sexual harassment of women in the Danish Merchant navy.....	80
Interior Firefighting. The task, near accidents and occupational injuries.....	83
Session 2B Musculo skeletal disorders and prevention, Part I .....	88
Postural analysis of workers in clothing stores .....	89
Muscular activity and perceived exertion while mopping using different mop handle heights .....	94
Working postures and movements - A new WEA Guideline .....	99
Teaching ergonomics to dental students at the University of Eastern Finland ..	104

Session 2C Management, leadership, team work, Part I .....	109
Good practices and development needs of workplace change management .....	110
Managers need more knowledge about ergonomics .....	116
Connections between agile ways of working, team coherence and well-being at work .....	120
Developing a framework to transfer knowledge from operations into engineering design projects: understanding the knowledge management challenge .....	125
Poster Session.....	130
Characteristics of older construction workers' risk perception.....	131
The load of repositioning the supine patient by using draw sheet versus CareCare Transfer Slide Film.....	136
Ergonomics in theory and practice through the Ergonetti learning program.....	141
The specialist physician training program in occupational health care in Finland.....	146
The further employment and experiences of education among graduates in ergonomics.....	151
Session 3A Musculo skeletal disorders and prevention, Part II .....	155
Physical variation at work – a scientific review.....	156
Prevalence and localization of musculoskeletal strain in female office workers	160
Muscular fatigue and recovery after a heavy work bout in the heat: comparison of four recovery interventions on muscle architecture, tone and mechanical properties in firefighters .....	165
The introduction of R&D for the agricultural health & safety management in South Korea.....	169
Session 3B Management, leadership, team work, Part II.....	174
Some key issues in the development of ergonomic intervention tools .....	175
UX in the Shipping Industry .....	179
Does the organisation make a difference? - An evaluation of Women's Work Environment Programme .....	182
Accessible work environment Government assignment 2011-2016 for The Swedish Work Environment Authority.....	185
Session 4A Interventions.....	190
Accounting for effect modifiers in ergonomic intervention research.....	191
How suitable are multi-space offices for university work? .....	196
Field study investigating gear shifter usability in car rental scenario.....	201
Implementation and impact of an ergonomic intervention in elderly care.....	206
Comprehensive improving of well-being and productivity in SME's at forestry and health care sectors .....	211

Session 4B Occupational health.....	216
People with Type 1 Diabetes in work – Good practices for workplaces in commercial sector.....	217
Type 1 diabetes in work life: A matter of containment?.....	222
Ergonomics of Tele-Cytology for remote Pap-smear evaluation integrated with Big Data analytics and computing to optimize prevention of cervical cancer in developing countries.....	225
Musicians' opinions on prevention activities against occupational symptoms..	231
Core competencies in Ergonomics – Do master programs in ergonomics correspond to the requirements in practice?.....	236
Work Shops .....	237
Assessing implementation of Lean thinking into two Finnish University Hospitals .....	238
Heavy manual handling - Are there reasons to re-visit the basics for regulation and guidelines?.....	240
Session 5A Psychosocial strain, occupational stress and mental health.....	241
How does direct glare and psychological stress affect young women during computer work? .....	242
Predictors of return to work (RTW) in professional burnout. A systematic review .....	245
Self-perceived health and the impact of psychosocial work factors.....	249
Preventing psychosocial risks at work: A realist synthesis of labour inspection interventions .....	254
Session 5B Safety at work.....	258
The Occupational Safety Card (Työturvallisuuskortti®) for improved occupational safety in shared workplaces .....	259
Occupational safety at rail transport – personnel’s views for improving work .	262
A risk assessment method for visual ergonomics .....	267
Relation between dynamic coefficient of friction and subjective slipperiness in footwear soles .....	268
List of contributors.....	273

# Program

<i>Time</i>	<b>Sunday 14<sup>th</sup> August</b>
16.00	Registration opens
20.00 - 22.00	Get together and light meal, Kunnonpaikka, Kulkuri pub

<i>Time</i>	<b>Monday 15<sup>th</sup> August</b>	
9.00	Registration	
10.00	Welcome ceremony: <i>Chair Kimmo Räsänen</i> President of municipal council, Erkko Nykänen, Municipality of Siilinjärvi, Finland President of NES, Kasper Edwards, Denmark President of Finnish Ergonomics Society, Elina Parviainen, Finland	
10.30	Plenary session 1. Keynote 1. Professor Clas-Håkan Nygård, University of Tampere, Finland: "Healthy aging at work and beyond" Keynote 2. Professor Anne Helene Garde, The National Research Centre for the Working Environment, Denmark: "How to arrange shift and night work when this is inevitable?"	
12.00	Lunch	
13.00	Parallel sessions	
	Session 1A: Nursing – health care <i>Chair: Kaisa Pihlainen</i>	Session 1B: Work and safety in agriculture / Questions of work ability <i>Chair: Merja Perkiö-Mäkelä</i>
	Leena Tamminen-Peter (A11) ErgoCarebank - Good ergonomic solutions for both nursing home- and home care-- work	Merja Perkiö-Mäkelä (A49) Farmers' physical workload and work ability in Finland
	Masato Takanokura (A24) Development of a sensing system to prevent bed-related accidents involving elderly persons	Kim Kaustell (A39) Occupational injuries among fishermen in Finland 1999-2013
	Leena Tamminen-Peter (A25) Ergonomic criteria and good practices for bariatric patients' care	Marja Hult (A17) Socio-demographic and work-related factors associated with the work ability of the employed and the unemployed
	Kaisa Pihlainen (A45) Practical nurses' perceptions of technology use in home care – competency, safety and further training	
14.30	Coffee break, Exhibitions	

Time  
15.00 –  
16.30

Monday 15 <sup>th</sup> August		
Parallel sessions		
Session 2A: Student prize competition <i>Chair: Anja Tanttu</i>	Session 2B: MSD's and prevention, Part I <i>Chair: Pirjo Hakkarainen</i>	Session 2C: Management, Leadership, Team work, Part I <i>Chair: Terhi Saaranen</i>
Representative from Finland, Jaana Seppänen; Implementation of workplace mediation as a method of conflict resolution at the University of Eastern Finland	Edda Maria Capodaglio (A30) Postural analysis of workers in clothing store	Marjaana Lahtinen (A27) Good practices and developmental needs in workplace change management
Representatives from Denmark, Uli Heyden and Lisbeth Anna Skrae; Sexual harassment of women in the Danish Merchant navy	Mari-Anne Wallius (A18) Muscular Activity and Perceived Exertion While Mopping Using Different Mop Handle Heights	Mira Turunen (A34) Managers need more knowledge about ergonomics
Representative from Sweden; Johan Nordström; Interior Firefighting. The task, near accidents and occupational injuries.	Camilla Madsen (A19) Working postures and movements - A new WEA Guideline	Seppo Tuomivaara (A42) Connections between agile way of working, team coherence and well-being at work
	Jonna Kumpulainen (A65) Teaching ergonomics to dental students in University of Eastern Finland	Carolina Souza da Conceição (A46) Developing a framework to transfer knowledge from operations into engineering design projects: understanding the knowledge management challenge
17.30	Get together in the Reception of Kunnonpaikka for transfer to Kuopio by inland ship M/S Osmo Reception in the City Hall of Kuopio (19.30–)	



<i>Time</i>	<b>Tuesday 16<sup>th</sup> August</b>	
8.30	Welcome and information day 2.	
	Plenary session 2. <i>Chair Pasi Karjalainen</i>	
	Keynote 3. Professor Mikael Forsman, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden: "Ergonomic risk assessments – a need for reliable and attractive methods"	
	Keynote 4. Professor Jos Verbeek, Finnish Institute of Occupational Health, Kuopio, Finland: "Health outcomes of ergonomic interventions, lessons learned from Cochrane Reviews".	
10.00	Tiina Hoffman, FirstBeat Technologies Ltd, Finland: "Turning heartbeat data into lifestyle guidelines: Focus on sufficient recovery, good sleep and stress management"	
10.15	<b>Poster Session</b> and Coffee break	
	<b>Posters:</b>	
	Akiko Takahashi (A31) Characteristics of older construction workers' risk perception	
	Anneli Muona (A53) The load of repositioning the supine patient by using draw sheet versus CareCare Transfer Slide Film	
	Marja Randelin (A55) Ergonomics in theory and practice through the Ergonetti learning program	
	Jarmo Heikkinen and Marianne Rytönen (A69) The specialist physician training program in occupational health care in Finland	
	Susanna Järvelin-Pasanen (A70) The further employment and experiences of education among graduates in ergonomics	
10.45	Parallel sessions	
	Session 3A: MSD's and prevention, Part II <i>Chair: Arto Reiman</i>	Session 3B: Management, Leadership, team work, Part II <i>Chair: Kasper Edwards</i>
	Ruth Carlsson (A36) Physical Variation at work – a scientific review	Kasper Edwards (A47) Some key issues in the development of ergonomic intervention tools
	Triinu Sirge (A44) Prevalence and localization of musculoskeletal strain in female office workers	Hans Comtet (A33) UX in the Shipping Industry
	Satu Mänttari (A66) Muscular fatigue and recovery after a heavy work bout in the heat: comparison of four recovery interventions on muscle architecture, tone and mechanical properties in firefighters	Minke Wersäll (A37) Does the organisation make a difference? – An evaluation of Women's Work Environment Programme
	Kim Kyungsu (A13) Introduction to R&D for agricultural health & safety management in South Korea	Mirja Johansson (A40) Accessible work environment. Government Assignment 2011-2016 for The Swedish Work Environment Authority
12.15	Lunch	

Time	Tuesday 16 <sup>th</sup> August	
13.15	Parallel sessions	
	Session 4A: Interventions <i>Chair: Veli-Matti Tuure</i>	Session 4B: Occupational health <i>Chair: Jarmo Heikkinen</i>
	Kasper Edwards (A48) Accounting for effect modifiers in ergonomic intervention research	Pirjo Hakkarainen (A61) People with Type 1 Diabetes in work – Good practices for workplaces in commercial sector
	Pia Sirola (A26) How suitable are multispace-offices for university work?	Ulla Møller Hansen (A68) Type 1 diabetes in work life – a matter of containment?
	Sanna Lohilahti (A58) Field study investigating gear shifter usability in car rental scenario	Constantinos Mammias (A60) Ergonomics of Tele-Cytology for remote Pap-smear evaluation integrated with Big Data analytics and computing to optimize prevention of cervical cancer in developing countries
	Kristiina Hellsten (A16) Implementation and impact of an ergonomic intervention in elderly care	Marjatta Teirilä (A56) Musicians’ opinions on prevention activities against occupational symptoms
	Veli-Matti Tuure (A10) Comprehensive improving of well-being and productivity in SME’s at forestry and health care sectors	Annika Vänje (A64) Core competencies in Ergonomics –Do master programs in ergonomics correspond to the requirements in practice?
15.15	Coffee Break, Exhibitions	
15.45 – 17.15	Parallel sessions	
	Work shop I: Integrating ergonomics into process redesign – cases from lean and ergonomics in healthcare in Denmark and Finland”. <i>Chair: Elina Parviainen</i>	Work shop II: Heavy manual handling. Are there reasons to re-visit the basics for regulation and guidelines? <i>Chair: Jakob Ugelvig Christiansen</i>
	This workshop introduces the basics of lean and presents cases of lean implementations with an ergonomic focus. The last 30 minutes of the workshop will be a discussion on how we can improve integration of ergonomics into process redesign.	A workshop with focus on re-visiting the basics for legislation and guidelines, and how to achieve a better platform for prevention Re-visiting - The basics criteria’s for the dose-response and regulation; - target structures in the body, limit values and biomechanics - The basics of anthropometrics – and relations to Nordic population today

	<p>- Functional capacity in the working force and the individual</p> <p>- How do we understand risk assessment and guidelines for different ages and sex</p>
<p>1) Elina Parviainen – “An introduction to Lean and Ergonomics”</p> <p>2) Jori Reijula – “Assessing implementation of Lean Thinking into two Finnish University Hospitals”</p> <p>3) Kasper Edwards – “Experiences with integrating ergonomics into lean at a Danish hospital”</p>	<p>The first half of the workshop will be a presentation of facts and questions related to the above headlines – from an international and a Danish perspective.</p> <p>The second half will be allocated to work groups establishing an understanding of the implications of the presentation – and suggestions for constructive solutions.</p> <p>Workgroup themes:</p> <p>1) The ‘platform’ of knowledge and decisions leading to legislation and guidelines... is it still fresh and valid in 2016? – if not – what to recommend?</p> <p>2) Towards a more effective prevention – but how and with which strategies and guidelines?</p> <p>The groups present their work before the end of the workshop.</p>
<p>Discussion:</p> <p>a. Who is or should be responsible for integrating ergonomics into process redesign?</p> <p>b. Change is often planned and plotted long before its implemented - How do we influence the design stage?</p> <p>c. Are ergonomists well equipped to work with process redesign?</p> <p>d. When and how should ergonomics be used in design and implementation of work processes?</p>	<p>The material from the first half of the presentation will be the basic material in the workgroup. The material will be present in the workshop.</p>
<p>17.15-18.15</p>	<p>NES General Assembly Annual Meeting</p>
<p>19.30</p>	<p>Conference Dinner</p>

**Time Wednesday 17<sup>th</sup> August**

8.30	Parallel sessions	
	Session 5A: Psychosocial strain, occupational stress and mental health <i>Chair: Knut Inge Fostervold</i>	Session 5B: Safety at work <i>Chair: Rauno Hanhela</i>
	Randi Mork (A57) How does direct glare and psychological stress affect young women during computer work?	Rauno Hanhela (A71) The Occupational Safety Card (Työturvallisuuskortti®) for improved occupational safety in shared workplaces
	Riitta Kärkkäinen (A35) Predictors of return to work (RTW) in professional burnout: A systematic review	Arto Reiman (A41) Occupational safety at rail transport – personnel’s view for improving work
	Knut Inge Fostervold (A63) Self-perceived health and the impact of psychosocial work factors	Hillevi Hemphälä (A43) A risk assessment method for visual ergonomics
	Rafaël Weissbrodt (A29) Preventing psychosocial risks at work: A realist synthesis of labour inspection interventions	Akihiro Ohnishi (A28) Relation between dynamic coefficient of friction and subjective slipperiness in footwear soles
10.00	Coffee break	
10.30	Plenary session 3. <i>Chair Kimmo Räsänen</i>	
	Keynote 5. Professor of Technology and Human Factors Jan Dul, Rotterdam School of Management, Erasmus University, Netherlands: “Towards a necessity theory of human factors/ergonomics”	
11.15	Closing Ceremonies Chair of the Scientific Committee of NES2016, Kimmo Räsänen, Finland President of FES, Elina Parviainen, Finland President of NES, Kasper Edwards, Denmark Presentation of NES2017 Conference (Lund, Sweden)	
12.00	Lunch	

## *Organizing and scientific committee*

Hakkarainen Pirjo (University of Eastern Finland)

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Øvergård Kjell Ivar, Norway

Österman Cecilia, Sweden

# *Keynotes*

- Keynote 1. Professor Clas Håkan Nygård, University of Tampere, Finland: “Healthy aging at work and beyond”
- Keynote 2. Professor Anne Helene Garde, The National Research Centre for the Working Environment, Denmark: “How to arrange shift and night work when this is inevitable?”
- Keynote 3. Professor Mikael Forsman, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden: “Ergonomic risk assessments – a need for reliable and attractive methods”
- Keynote 4. Professor Jos Verbeek, Finnish Institute of Occupational Health, Kuopio, Finland: “Health outcomes of Ergonomic Interventions, lessons learned from Cochrane Reviews”
- Keynote 5. Professor Jan Dul, Rotterdam School of Management, Erasmus University, Netherlands: “Towards a necessity theory of human factors/ergonomics”

# Healthy aging at work and beyond

Clas-Håkan Nygård,  
School of Health Sciences,  
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In many industrialized countries, there is a sharp increase of the ageing population due to a decrease in fertility and an increase in life expectancy. Due to that the age dependency ratio rises and may cause increased economic burden on the productive part of the population. This is why most industrialized countries have made plans to extend working lives, thus many people retire early, long before they reach the official retirement age. For this reason, it is important to monitor and follow work-related aging. Work life research and aging research (gerontology) have been separate research fields but during the last decades the aging of the population has caused that these two areas keep forming a discipline called occupational gerontology (industrial gerontology). Occupational gerontology can be defined as the study of work-related aging, focusing on the adaptation of middle-aged and older workers to employment and their transition to retirement (Schulz, 2006, Goedhard, 2011), and taken in to account that different ages has their own specific needs. It is about balancing work demands with individual capacities throughout the working life but also beyond it. There are several large changes in individual resources and capacities during the working life. Health and functional capacities as well as learning and skills change, some capacities decline but some increase. Changes are very much individual and the variation between individuals grows with age and a lot depends on own activity. Often experience may compensate for declined capacity. Productivity is most often not linked with age. (Ilmarinen, 2006).

Since the early 90s some models and tools have inspired occupational gerontology research: the Work Ability House model (Ilmarinen, 2006) and the Work Ability Index (Ilmarinen et al 1997). The tools were developed since there was a lack of good biomarkers of the rate of human aging. They help us follow the effects of work related determinants on individual work ability throughout the working life. The Work Ability House model is based on individual functional capacity and health (first floor), competence (second), motivation, values and attitudes (third) as well as both physical and socio-psychological work environment (fourth). The model also takes into account factors outside work (like family, community and society), but more indirectly. The globally used Work Ability Index measures individual capacity to work with a seven-item scale and it is used to screen work disability but also as a measure in follow-ups among people of different age.

Recent research has revealed that Work ability in average decreases with age, but not always linearly. Several different trajectories exists when people are followed from their midlife to old age (Bonsdorff, MB et al, 2011). Work ability of the majority of people decreases linearly but during long follow-ups both sudden decreases and increases are common. An important result is that work demands at midlife very much predict further work disability, health, functions and even mortality (Ilmarinen et al, 1997, Bonsdorff, ME et al, 2011, K.C. Prakash et al, 2016). Factors related to both ergonomics and general lifestyle explain the declines and improvements in work ability during aging. The better work ability is the later is the retirement



and the functional capacity in old age. High work stress in midlife is a very strong predictor of disabilities in old age (Bonsdorff et al, 2013). According to recent longitudinal studies, good mental health in combination with the opportunity to control work time seem to be key factors in extended employment into older age (Virtanen et al, 2015). Promoting work ability in midlife may also lead to more independent and active aging after retirement (Bonsdorff et al, 2016). This all makes work related factors, like work ability, an important public health issue when the age of the population increases.

Work ability is primarily a question of a balance between work and personal resources. Personal resources change with age whereas work demands may not change parallel to that, or only change due to globalization or new technology. Basically there are two ways of promoting work ability. The first is to change the physical and psychosocial work environment and the other is to change (train) the employee. Interventions should preferably be problem based, participative with employees, employers, occupational health and safety as well as human resource people involved. A recent review (Cloostermans et al, 2014) states that there are very few well-designed intervention studies (randomized and controlled) among older workers. For example, there is only a small or insufficient evidence of a favorable effect of interventions to promote sustainable employability of aging workers. However, according to another review (Rongen et al 2013) there is an ample amount of studies among the general working population showing effects of work place health promotion. Although there is a need for well-designed intervention studies among ageing workers, promising interventions on multifactorial determinants including health and work related characteristics have already been carried out.

It could be concluded, that due to aging there is an increased variation in work ability and capacities among persons of same age and with same work demands, suggesting that work demands should be better matched with human resources and functional capacities. From a public health view, it is important to notice, that work related factors has a strong impact on functional abilities and health in old age, which emphasize the importance of work place health promotion programs.

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## How to arrange shift and night work when this is inevitable?

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Shift work including work at night is frequent in the modern world. In Europe 17-19 % of all employees work at night (at least two hours between 10 pm and 5 am) and in shift work (1). Such working hour arrangements have an impact on health and well-being both in the short and possibly also long term. The short-term consequences of night and shift work are well established and include inadequate and disturbed sleep, increased fatigue, occupational injuries, poor work performance, and higher work-life interference (2;3). The long-term consequences are less well-established, but many studies show that shift workers particularly those working at night have an increased risk of cardiovascular disease, cancer, diabetes and gastrointestinal disorders (4-8). Yet, the causality of shift work in relation to disease e.g. cancer and cardiovascular disease is still debated. Despite decades of intense research on shift work and health, especially the epidemiological evidence is still limited (9).

There are several different suggested mechanisms for how shift work affects health. Working during the night and early morning disrupt circadian rhythms such as sleep/wake cycles, body temperature, blood pressure, hormone secretion, digestion and metabolism. Circadian rhythms are pivotal for survival. They are driven and maintained in a hierarchical manner by a central pacemaker (the biologic master clock) located in the suprachiasmatic nucleus (SCN) of the hypothalamus. The SCN also orchestrates the independent peripheral clocks in the rest of the body (10). The orchestration of these circadian rhythms are disrupted and desynchronised when workers work at night or in the early morning, which is speculated to cause disease.

Another possible mechanism is related to melatonin. Melatonin is produced during the biological night (from dusk to dawn), whereas the daytime production is virtually zero. The suppression of melatonin production by exposure to light at night, leading to augmented tumor growth and linoleic uptake/metabolism deserves serious consideration as a potential biological mechanism to explain the association between breast cancer and night shift work (10).

Shortened and disturbed sleep is another potential mechanism. Work at night interfere with the natural sleep cycle with shortened and disturbed sleep as a consequence (11). Long working hours and short rest time between two shifts also compromise sleep and reduce possibility for restitution. Short sleep is in turn associated with increased risk of cardiovascular disease and type 2 diabetes (12;13), and may therefore be another mechanism through which the arrangement of working hours affect health. Short sleep is also associated with sleepiness, and thereby increase risk of injury (14).

In addition, working in the evening and weekend work may affect health through desynchronisation with social rhythms, leading to work-life conflicts, social isolation, and compromise of sleep for social participation (15).

Based on this background 16 researchers in basic, epidemiological and applied sciences in Copenhagen in 2011 examined options for evidence-based preventive actions against shift work related breast cancer risk (10). They recommend:

- Restriction of the total number of years working night shift
- Restricting of the number of consecutive night shifts
- Reddish light and reduced light intensity during work at night
- Earlier or more intensive mammography screening among female night shiftwork is *not* recommended
- Preventive effects of melatonin supplementation may be a promising avenue
- Women with earlier or current breast cancer should be given advice not to work night shifts
- Large studies on the impact of various shift schedules and type of light on circadian rhythms need to be conducted

In addition there is moderate evidence that clockwise rotation (e.g. day -> evening -> night) is associated with better sleep compared with counter clockwise rotation (e.g. evening -> day -> night) (9).

Yet it is not known, if following these recommendations will reduce the risk of disease. For this purpose large studies are needed where working hours should be assessed as accurately and reproducibly as possible. Stevens et al. suggest several domains on aspects of shift work which should be captured in future epidemiological studies (16). Questionnaires are not optimal for obtaining all this information due to the large number of required questions, which may lower participation rates. Furthermore, subjective exposure information may be subject to memory bias and e.g. the difficulties to reach shift workers with "unfavourable working hours" compared to day workers increase the risk for differential exposure misclassification in case-control studies. Thus there is a need for more accurate, consistent and reproducible exposure information on individual bases. The introduction of large databases with pay-roll data with day-to-day information on starting and ending time of working hours are promising tools for future studies of associations between arrangement of working hours and health.

Furthermore, it may be difficult to follow the recommendations in an everyday setting, where there are also other issues to take into consideration. As an example there are large individual differences in preferences for the arrangement of night work. In a study on consequences of number of consecutive night shifts among 73 police officers 49% preferred four consecutive night shifts. Participants, who preferred longer spells of night work found night work less demanding, found it easier to sleep at different times of the day, and were more frequently evening types compared with participants who preferred shorter spells of night work [Nabe-Nielsen, 2015].

One way to accommodate individual differences is to increase work time control. A Cochrane review based on 6 studies of temporal flexibility concludes that interventions on flexible working hours, which increased worker control and choice, are likely to have a positive effect on health outcomes, but further intervention studies are needed (17). This was supported by a more recent systematic review of 53 studies which showed that there are theoretical and empirical reasons to view WTC as a promising tool for the maintenance of employees' work–non-work balance, health and well-being, and job-related outcomes (18). In an intervention study, the PRIO study, we aimed to investigate the consequences of self-rostering for working hours, recovery, and health, and to elucidate the mechanisms through which recovery and health are affected. 28 workplaces were allocated to an intervention or a reference group: Intervention A encompassed the possibility to specify preferences for starting time and length of shift down to

15 minutes intervals. Interventions B and C included the opportunity to choose between a number of predefined duties, but differed in the reasons for implementation. Questionnaires (n = 840) on recovery and health and objective workplace reports of working hours (n = 718) were obtained at baseline and twelve months later. Results showed that after implementation of self-rostering, employees changed shift length and timing, but did not compromise most recommendations for acceptable shift work schedules. Positive consequences of self-rostering for recovery and health were observed, particularly in intervention B, where influence on working hours increased, but less extensively than in intervention A. The benefits of the intervention were not related to changes in working hours (19). It was also found that work-life balance improved in A and B, but not C (20) and that job demands and the social environment of the workplace, especially if the intervention does not comprise drastic changes of the organisation of the employees' work and private life (21). The differences between the interventions indicate that there are many ways to implement self-rostering and the effects depend on how and why it is done. All the outcomes in the PRIO study are self-reported future studies should elucidate whether these positive effects are also reflected in objective measures of e.g. sleep and risk factors for disease.

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# Ergonomic risk assessments – a need for reliable and attractive methods

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*Observational risk assessment methods generally have low reliability. Also the inter-method reliability is low. There are now validated technical methods that are easy to use. But, today's inexpensive electronic devices should be utilized to a higher degree, in developing tools, together with practitioners, that are attractive, easy and time efficient to use, and which should increase the reliability in risk assessments of work tasks and jobs.*

Keywords: Biomechanical exposure, Observation, Direct measurements, Validity, Reliability, Usability

## 1. Introduction

Work-related musculoskeletal disorders (WMSDs) are still frequent, inducing very large costs for societies all over the world. Factors in the physical workload such as excessive and/or prolonged muscular load, repetitive work and work in awkward and constrained postures, are known risk factors for developing WMSDs in the neck/shoulder region and in arms and hands (European Agency for Safety and Health at Work, 2010).

In order to identify risk occupations, jobs and tasks, for interventions, as well as while planning new jobs and work stations, and to facilitate evaluations of interventions in terms of decreased exposure to risk factors, there is a need for valid, reliable and useful methods for risk assessment of biomechanical exposure.

Many researchers and company ergonomists have worked with this question and many methods, especially observational methods, have been proposed in the literature. It is still a popular and interesting field which is indicated by the fact that the observational methods review article (Takala et al., 2010), that was the result of an Nordic collaboration led by Esa-Pekka Takala, at the Finnish Institute of Occupational Health, have been cited about 75 times in other scientific publications. In that review, the authors identified 30 eligible observational methods. Of these, 19 had been compared to one or more methods. Intra- and inter-observer repeatability was reported for 7 and 17 methods, respectively. The methods are generally constructed based on epidemiologic findings, but their ability to predict future MSD (predictive validity) is rarely studied.

In a recent study, comparing observations and inclinometer measurements, Trask et al. concluded: "Since observations were biased, inclinometers consistently outperformed observation when both bias and precision were included in statistical performance" (Trask et al., 2014). Moreover, dynamic work is best quantified with technical measurements. The general opinion about technical measurements have been, at least until now, that they are time consuming, require expensive equipment and also demand technical knowledge to perform, and are therefore not suitable for actors in the work environment field, such as the occupational health

services. However, there are now, because of the development of electronics components, a number of low-cost (about \$100-\$300) technical devices available, i.e. accelerometers, that may be used to monitoring human motions (Dahlqvist et al., 2016, Korshøj et al., 2014, Skotte et al., 2014). These are of a new generation of accelerometers with integrated data loggers. There are also so-called IMUs that in addition to a three-axial accelerometer include a gyroscope and a magnetometer.

In this paper two research projects are described, and the future is discussed, in the field of ergonomics risk assessment.

## **2. Observational methods – reliability, validity, and usability**

Although there are many methods available, often ergonomists in the field, for different reasons, e.g. lack of time and/or lack of knowledge of adequate methods, use their own knowledge and experience, when performing risk assessments. Six selected risk assessment methods were evaluated concerning their reliability, validity, and usability (Forsman et al., 2015). For reliability, assessments - without any specific method - were also included (method 0 below).

The selected methods, 0-6, were:

0. Own experience – no method
1. Occupational Repetitive Actions checklist (OCRA; Takala et al., 2010)
2. Quick Exposure Checklist (QEC; Takala et al., 2010)
3. Strain Index (SI; Takala et al., 2010)
4. Assessment of Repetitive Tasks (ART; [www.hse.gov.uk/msd/uld/art/index.htm](http://www.hse.gov.uk/msd/uld/art/index.htm))
5. Hand Arm Risk-assessment Method (HARM; Douwes and de Kraker, 2009)
6. Repetitive work model by the Swedish Work Environment Authority (SWEA, 2012)

Ten video-recorded (3-6 minutes) work tasks were included: 2 supermarket work tasks, meat cutting and packing, engine assembly, hairdressing, 2 cleaning tasks and 2 post sorting tasks. For each work task, data of the work task length (between 2-7 hours per workday), pause schedules, handled weights and physical factors, as well as the employees' ratings of force exertion, work demands and control were given.

Twelve experienced ergonomists made assessments of the ten work tasks in their own pace. Firstly they did it without using any specific method, as over-all risk, and specified for eight body regions into: high risk (red), moderate risk (yellow) and or low risk (green). Then they used the six methods - twice. Before the assessment, the ergonomist were trained in each method. The videos could be paused or repeated as needed. The assessment times were registered, and the ergonomists were given an evaluation questionnaire on completion of each of the methods.

As an alternative for predictive validity, the experts' assessments were used as a gold standard for concurrent validity of the ergonomists' ratings, and for inter-method comparisons.

The linearly weighted Kappa coefficient,  $K_w$  was the parameter primarily chosen for inter- and intra-observer reliability and validity.

For sole observation (method 0), the average inter-observer,  $K_w$ , for the over-all risk was 0.32, i.e. the agreement above what could be expected by random was 32%. The intra-observer ditto was 0.41. The corresponding weighted Kappas for 8 body-part-ratings were in average 0.21, and 0.35.

The  $K_w$  of the inter-observer reliability for over-all risk in three levels were in OCRA 0.37, QEC 0.54, HARM 0.65, and SWEA 0.28. The  $K_w$  for specific body parts were, in QEC, 0.44 (shoulder), 0.49 (back), 0.67 (shoulder), 0.86 (neck), SI 0.47 (hand), ART 0.58 (left side) and 0.65



(right side). In the SWEA model, the  $K_w$  for all five questions were below 0.4. The  $K_{ws}$  were generally the lowest for ratings of body postures.

As expected, the intra-rater  $K_w$  was somewhat higher than the corresponding inter-rater  $K_w$  in all methods, and the validity correlated with the inter-rater  $K_{ws}$ . The obtained risk levels varied considerably between the methods, the pairwise  $K_w$  ranged from 0.10 (HARM-QEC) to 0.74 (ART-OCRA).

The mean score of 8 usability ratings was the highest for ART and the lowest for OCRA. OCRA also had the longest average assessment time.

### **3. New easy-to-use technical measurements of postures and movements during work**

As shown above, and which is in agreement with previous findings, there is a considerable variation not only between ergonomists' assessments of risks levels for MSDs in the observation methods, but also between methods. However, since observation without the use of any specific method, have a low, non-acceptable reliability, it is recommended to use one or more systematic methods, and to a larger degree combine observations with validated methods of direct measurements.

In this chapter a project will be described in which was set up to (1) together with actors at the OHS, develop easy-to-use methods of technical measurements of postures and movements during work, and which automatically provides informative charts and graphs; (2) validate the new methods against previously validated methods, which today are used by researchers, and (3) test the new methods concerning the time required and their usability for actors within the OHS (Dahlqvist et al., 2016).

The project focused on a method for full-day measurements, with a quality equal to similar research methods, and that makes these simplified measurements fully comparable with those reported in the literature. Such a method was developed. It consists of small devices with integrated USB-memories. They measure postures and movements of head, back and both upper arms. The method includes a simple protocol where you note the start- and end times for work and breaks. After the measurement, the devices are connected to a computer and the noted times are used in a program that presents the workload in figures and tables. An "even easier" method for shorter measurements was developed as an application for iPhone/iPod. It is called ErgoArmMeter and measures the arm elevations and directly afterwards shows the measured values for angles and angular velocities (Yang and Forsman, 2015).

The methods are validated (i.e. they are comparable with the previously used technical research methods). The methods have been presented at conferences and in education of ergonomists, and have been used by physiotherapists/ergonomists for workplace improvements, and in master thesis projects. They are easier to use and easier for the participants to carry than the previous research methods, and are now also used in research projects. During the project, we have received feedback from the OHS, and we have counteracted the weaknesses that we and the OHS discovered.

#### **4. Discussion**

In chapter two above, a low reliability was shown for observation methods, and also between different methods. Chapter three described new technical methods for risk assessments.

A vision, which researchers in this field, like myself, should have is that there should be practical tools available and that the ergonomists and other practitioners use them. Now, more and more methods are being developed, but there is a delay in the ergonomists' use of these methods. In Sweden the use of the QEC method (Takala et al., 2010) is increasing, also the use of HARM (Douwes and de Kraker, 2009) is becoming more frequent. But ergonomists, as well as other professionals, have their basic education and their usual way to work; it is hard to change the way you usually do things. Our recommendation is to use systematic tools for risk assessments, at least the scientifically documented observational methods. When presenting the results presented in chapter two, i.e. those revealing a very low reliability in assessments where no specific method were used, ergonomists agree that systematic methods should be used. Systematic and direct measurement risk assessment methods should be included in the education programs for ergonomists.

Direct measurements are more reliable. But observational methods may cover more dimensions. A possible future is to use a combination, i.e. combined methods, where the dimensions of the lowest reliability in observational methods are replaced by technical, practical methods.

In chapter three, a new iPhone application (ErgoArmMeter) for upper arm posture and movement measurements was presented. The app is very easy to use, and may be a start for of ergonomists to a new way to work. The app only include upper arm, but other measurements, as e.g. wrist postures and movements should be possible to include, by utilizing gyroscopes, accelerometers, and magnetometers on external inertial measurement units (IMU). These apps include measured repetitively, but they may also schemes for input of e.g. forces (measured or observed), additional factors such as auto-control, temperature, rest-schedules and vibrations. A development of an easy-to-use method including postures, movements, and handled tum-grip forces, have been started by a consortium with Swedish universities and companies (e.g. KTH Royal Institute of Technology, Karolinska Institutet, Chalmers, Universities of Borås and Gävle; Scania, Volvo and Hultafors workwear). The project is called "Smart clothes", and the plan is to integrate sensors in textiles. Measurements will be made easy, since analyses and interpretation will be carried out automatically. More reference data from different occupational groups and guidelines with risk action limits are needed for those interpretations. However, a first version of such guidelines are already published as a report in Swedish from Lund University (Hansson et al., 2016), and there are ongoing studies on large material of technical measurements of Danish blue collar workers (Jørgensen et al., 2013)

#### **5. Conclusion**

Observational methods generally have low reliability. Also the inter-method reliability is often low. Today's low-cost electronic devices should be utilized to a higher degree, in building tools, together with practitioners, that are easy and attractive to use, and results in reliable risk assessments.

## 6. Acknowledgements

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# Health outcomes of ergonomic interventions, lessons learned from Cochrane Reviews

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## Introduction

Ergonomics is very much involved with making the world a better place. The same holds for Cochrane which wants to improve the quality of health care. Health care is here defined in a broad sense including all preventive and occupational health activities. Here, I will apply the Cochrane framework of evaluating health interventions to ergonomics and discuss the pros and cons.

## Interventions and outcomes

The terminology of evaluation research can be confusing. The idea of evaluation research is that we obtain knowledge of the effects of an intervention and that the knowledge can be generalised to other times and places. Once an intervention is properly evaluated and shows beneficial effects that outweigh potential harmful effects, we are inclined to say that the intervention works. For example, drugs to cure people from disease have to undergo a rigorous evaluation procedure before they are permitted to be used in health care. A drug is an example of an intervention. The same or very similar evaluation procedures are used for many other types of interventions such as education and training, vaccination or reducing chemical exposures. An intervention can be defined as a deliberate try to change things with the aim to improve health or another outcome. An outcome is then an aspect of health or well-being that can be used to show if an intervention has led to an improvement. Interventions that aim at improving health or well-being are evaluated by symptoms and signs of disease for example levels of pain in back pain patients or levels of depression for interventions aimed at preventing depression. Thus, studies are built around interventions and outcomes and should provide evidence that the outcomes have improved after the intervention was applied. The results of the study are evidence in the sense that the study results provide ground for the belief or proof that the intervention works.

In occupational health and safety, the focus has traditionally been on showing that exposures at work are risk factors for occupational disease, disability or injury [1]. Once, the risk factors were established this was enough evidence to impose measures on employers to reduce the risks or to ban the exposure all together from the workplace. For example, once finally the risks of asbestos were established, many countries established bans on the use of asbestos. This seemed to have worked well with the use of asbestos in building new products and buildings. However, this did not solve the problem of the existing asbestos in products and buildings. Many years after the risks of asbestos have been established, we are still challenged by the existing asbestos and what is the best way to eliminate the risks it poses. This calls for a more evaluative framework after risks have been established. In figure 1, an example of such a framework is given. It also shows that we need studies that should provide evidence of the effectiveness of various

interventions. Once we know which interventions are effective, it becomes easier to establish regulation or other policy measures to implement these interventions.

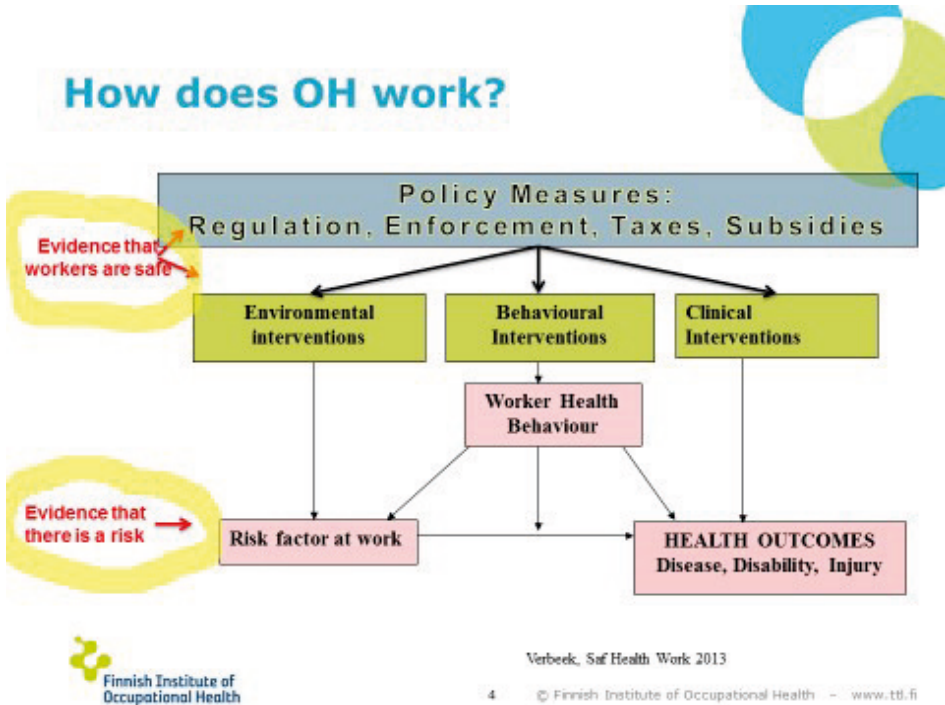


Figure 1 Model of OSH evaluation

### Ergonomics

The International Ergonomics Association (IEA) defines ergonomics as “the scientific discipline or profession that is concerned with the understanding of interactions among humans and other elements of a system and that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.” This definition carries two clear outcomes by which ergonomics interventions can be evaluated. They should either improve well-being or system performance. For well-being I imagine that this is used in a wide sense encompassing both physical and mental health in the sense of the WHO definition of health. System performance is a bit different and not necessarily related to the well-being outcomes. With a bit of adaptation, the same model as used for occupational health and safety can be used for ergonomics.

### Systematic Reviews

So far, we have only talked about a study as evidence for improvement of health outcomes or in other words effectiveness of an intervention. John Ioannidis has argued already more than ten years ago that most findings from studies in the end turn out to be wrong. This is due for example to publication bias that favours the publication of positive, beneficial results. Also in other disciplines, like psychology and physics, it has been argued that it is important that study results can be replicated. This would leave us with at least two studies that have measured the effects of an intervention. Therefore, we need a framework to synthesize the results of multiple studies [2].

The systematic review methodology, as elaborated by the Cochrane Collaboration, is such a method.

Cochrane emerged as an international collaboration in the beginning of the 90s with the aim to provide up to date and reliable evidence of the effects of all health care interventions. The organisation is named after Archie Cochrane, who in the 70s already, was the first to come up with the idea of using research to improve the quality of health care. In Kuopio, we run a small review group that does so for the effects of occupational health and safety interventions (<https://work.cochrane.org>).

### **Interventions to reduce workplace sitting**

A recent review of the Cochrane Work Group examined the effects of interventions to reduce sitting at work [3]. Physical inactivity is one of the major public health problems of our time. Also at work physical inactivity has increased with 30% in the past fifty years and is mainly replaced by sitting. It is unclear where this trend precisely comes from. Is this merely a change in occupational activity or is it a success of ergonomics that decreased work load in heavy physical occupations [4]. It is probably a result of both. Recently, research has shown that sitting could be a special form of inactivity that further increases the risk of physical inactivity. When sitting for prolonged periods of time and in spite of maintaining physical activity levels, there is an increased risk of mortality, cancer and diabetes. Countering sitting at work can be implemented by three major strategies: physical changes in the workplace like sit-stand desks, a different way of organising work for example by standing during meetings and by providing information and counselling to workers in the hope that this will change behaviour. In addition, all strategies can be applied at the same time. The review found 20 studies with 2174 participants that had studied interventions to reduce the outcome sitting time. The most promising results were found with the sit-stand desks that reduced sitting time from 30 minutes to two hours per day. However, the effect was only measured at three months follow up and for 217 participants. Moreover, the sitting was replaced with standing which uses barely more calories than sitting where it is clear that more intensive physical activity has greater health benefits. Experts have recently advised to gradually stand at least four hours per day to counter the effects of sitting. Whatever the evidence for this is, the studies did not show that this was realistic even in the short-term. The evidence in the review led many people to comment that if this is the evidence, maybe we should wait a little longer before we recommend that everybody to stand at work.

### **Conclusions**

To be able to assess the value of ergonomic interventions, a similar framework as used by the Cochrane Collaboration seems to be feasible. It is important to clearly define interventions and outcomes as evaluation studies around interventions and outcomes will be used as evidence of effectiveness. It is also important to realise that not a single study but the whole body of evidence, consisting of multiple studies will be used to assess if ergonomics work for a specific problem.

It also seems that there is still ample room for systematic reviews of ergonomic interventions.

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# Towards a necessity theory of human factors/ergonomics

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*Many human factors/ergonomics (HFE) specialists believe that HFE is essential for successful work and other systems. Without the integration of HFE in the design of products, services, productions systems etc. these systems cannot reach the highest levels of performance. This thinking refers to the “necessary but not sufficient” logic, which contrasts traditional additive logic where several factors are considered sufficient to produce an increase of the outcome, and can compensate for each other. This paper addresses the theoretical question whether human factor/ergonomics can claim to be necessary (crucial, critical, essential, required, etc.) for systems to be successful, and presents the necessity logic and its methodology (Necessary Condition Analysis-NCA) for testing this claim in empirical settings.*

Keywords: Theory, causality, necessity, sufficiency, “must have”, Necessary Condition Analysis (NCA), human factors/ergonomics discipline,

## 1. Introduction

The International Ergonomics Association (IEA) defines human factors/ergonomics (HFE) as “the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimize well-being and overall performance.” The phrase ‘in order to optimize well-being and overall performance’ implies the existence of a theoretical causal relationship between HFE and these outcomes. Figure 1 shows a conceptual model on the effect of HFE and other practices on ‘Performance’.

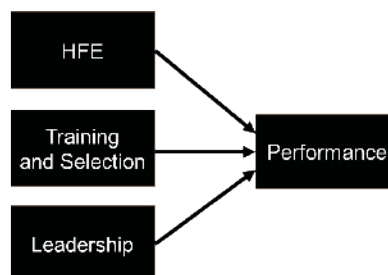


Figure 1. The effect of human factors/ergonomics (HFE) and other practices on Performance.



## 2. A sufficiency view on causality

Causal relationships are depicted in conceptual models by arrows: first the cause, then the effect. In Figure 1, HFE causes performance, but also Training and Selection of employees (one of the common Human Resource Practices in organisations), and Leadership (e.g., leadership style of the employees' supervisor) can cause performance to increase. Hence, in the conceptual model of Figure 1 three independent concepts ( $X_1$ =HFE,  $X_2$ = Training and Selection and  $X_3$ =Leadership) can cause the dependent concept ( $Y$ =Performance).

In the traditional understanding of conceptual models, of theories, and of causal relationships the independent concepts X can produce an increase of the dependent concept Y, and can compensate for each other. In this additive logic an X is sufficient but not necessary for increasing Y. This means that HFE, Training and Selection, and Leadership can all three increase Performance, but when one is not present this can be compensated by the others. For example if you don't have HFE you can focus on Training and Selection or Leadership to increase Performance. In other words it is nice to have HFE, but you don't need HFE because its absence can be compensated. This is probably the most common thinking about HFE in many organisations and by the general public.

## 3. A necessity view on causality

An alternative understanding of conceptual models, of theories, and of causal relationships acknowledges that some or all of the independent concepts X are required (=necessary). They allow an increase of Y (the dependent concept Y), but may not (automatically) produce it. Other X's cannot compensate for the absence of one X. In this logic the condition X is necessary but not sufficient for increasing Y. If the condition X does not have the right level, the outcome cannot occur. Hence the necessary condition can be a bottleneck, a constraint, a disqualifier for the outcome to exist. This non-additive logic is common in practice, but is not much recognized in academia. The necessary logic may be applicable to HFE as well: for high performance you must have HFE. Training and Selection, and Leadership cannot compensate for the absence of HFE. Focusing on Training and Selection or Leadership in the absence of HFE is a waste of time.

## 4. A necessity view of human factors/ergonomics?

If the necessity logic applies to HFE, any organization that wants to be successful must have HFE. In my keynote presentation I make a case for a necessity theory of HFE. I present the general characteristics of necessity theories and provide examples from every-day life. I discuss and give examples of the application of the necessity logic to the HFE field, and show how HFE researchers and practitioners can apply Necessary Condition Analysis (NCA) for identifying critical HFE factors that must be in place for a desired outcome.

## 5. What is Necessary Condition Analysis (NCA)?

Until recently no method was available to identify necessary conditions in datasets. Necessary Condition Analysis (NCA) was recently developed for that purpose (Dul, 2016). Details about the method can be found on the NCA website [www.erim.nl/nca](http://www.erim.nl/nca). This website links to publications and applications of NCA, and has an NCA calculator for a quick analysis of necessary conditions in (existing) data sets. For more advanced applications a free software package in R is available (Dul, 2015).

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## *Session 1A Nursing – health care*

### **Monday 15<sup>th</sup> August**

Leena Tamminen-Peter: ErgoCarebank - Good ergonomic solutions for both Nursing Home- and Home Care- work

Masato Takanokura: Development of a Sensing System to Prevent Bed-related Accidents Involving Elderly Persons

Leena Tamminen-Peter: Ergonomic criteria and good practices for bariatric patients' care

Kaisa Pihlainen: Practical nurses' perceptions of technology use in home care – competency, safety and further training

# **ErgocareBank - Good ergonomic solutions for both nursing home- and home care- work**

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*The aim of the ErgocareBank -project was to support carer's wellbeing and safety in their nursing home- & home care- work and to ensure client's quality of care and safety. The project team consisting of partners from the educational, research and social & health care field from 4 countries defined the problems of the nursing home- and home care- work methods used when assisting clients with their ADL and to find the best practice solutions based on the research evidence. Proposed solutions were tested, filmed and published for both educational facilities and workplaces on [ergocarebank.com/ergonomic-solutions](http://ergocarebank.com/ergonomic-solutions)*

Keywords: Ergonomics, Safe Patient Handling Movement, nursing, home care, good practice

## **1. Introduction**

Health care staff is subjected to significant risks of musculoskeletal disorders, likely to induce both human and economic costs. The work in elderly care is physically and psychologically demanding. The physical demand in aged care is even more strenuous than in other social and health care sectors (Laine et.al 2011). In most EU countries' the policy is to support old people, assisted by relatives or municipal home help services, to live at home for as long as possible, and this albeit timely institutionalising would allow a strain-reduction on carers. The ErgocareBank - project, funded by the EU, under the Transfer of Innovation programme, with partners from Finland, Greece, Sweden, and Estonia, responded to the challenge. The project consortium consisted of multi-professional partners from the educational, research and social & health care sector.

## **2. Objectives**

Supporting carer's wellbeing and safety in nursing home- and home care- work and ensuring client's quality of care and safety by

- developing ergonomics of social and health care work, assessing physical risks and creating ergonomic solutions for assisting the clients in ADL, moving & transferring
- testing, evaluating and disseminating the developed ergonomic solutions
- acquainting students with ergonomic patient handling principles as part of rehabilitative nursing.

### 3. Methods

Three risk assessment methods the Patient Transfer Assessment Instrument (PTAI, Karhula et al. 2009), the Care Thermometer (Knibbe and Knibbe. 2012) and the Dortmund Approach (Jäger et al. 2010) were tested to ascertain both the

- most suitable methods for and
- most hazardous work tasks in,

nursing home- and home care- work in Oulainen, Tarto and Patras. The results were given to the nursing homes and home care with instructions to plan their own risk management policy applying physical risk management model (Tamminen-Peter et al. 2011). It is based on the Occupational Health and Safety Assessment System (OHSAS 18001:fi)

Multidisciplinary partners from the research, educational and social & health care field collaborated to develop ergonomic solutions for the encountered risks. The work tasks from a risk perspective were discussed and the manual handling experts in the project made a short list of tasks to be exercised and filmed. The principles of best practice in manual handling, the work process of the task and the appropriate assistive equipment used were defined for each of the tasks. The different work tasks of the shortlist were filmed on location by the participating partners. In all, 29 different film sequences were recorded in care facilities and at patients' home in Greece, Estonia, Finland and Sweden. The films were evaluated based on the existing evidence of safe manual handling (Tamminen-Peter 2005, Waters 2007) by the manual handling experts and some of the sequences were re-filmed while others were abandoned. A total of 19 film sequences were chosen for the final production; introductions, logos and voice-over narratives were added.

### 4. Results

#### 4.1. Risk assessment and management

The PTAI and Dortmund Approach methods worked well for nursing home- and home care-work, they were relatively fast to use and gave reliable results. The Care Thermometer –method was only used for classification of clients. Both in the home care and nursing homes the problems were a lack of space, low beds, hygiene care in the toilet and dressing clients. The physically heaviest tasks were assisting clients: from lying to sitting, with hygiene care in the toilet and up from the floor after a fall. Risk assessments revealed the need to improve nurse's patient handling skill. Physical risk management model (Figure 1) was used as a guide to planning the safe handling policy for home care and nursing homes. Home care in Finland informed the clients about its legal obligations, ergonomics and work safety and that it was their intention to redraft the treatment and management plans in such a way that the ergonomic working conditions of nurses are better considered. In Tarto and Patras, the need of more assistive devices and training of patient handling skills became evident.

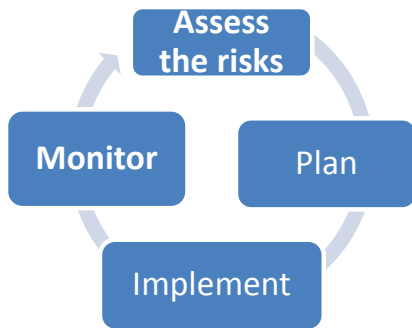


Figure 1: The management model for physical risks is a process

#### 4.2. Testing and filming solutions

The ergonomic solutions were developed for hazardous situations, based on the evidence of manual handling of patients and the test results. The accepted solutions consist of 19 video-clips: assisting a client up from the floor, lying to sitting (Figure 2), sitting to sitting (Figure 3), sitting to standing to sitting (Figure 4).



Figure 2. B-level client from lying to sitting



Figure 3. C-Level client from sitting to sitting



Figure 4. D-level client from sitting to standing to sitting

The web-site [ergocarebank.com](http://ergocarebank.com) comprises of guidelines for safe patient handling; practical solutions to avoid physical risks; required competence of the nursing home- & home care- work; descriptions of the assistive devices ; adequate equipment for different client's needs and requirement descriptions for the safe working environment. The solutions were published on in all partners' languages English, Estonian, Finnish, Greek, Swedish and some other languages.

## 5. Discussion/perspectives

Ergonomics knowledge and skills constitute a crucial part of carers' competencies which render the work less strenuous. All over Europe many carers are working in different institutions and environments, with insufficient qualifications, training and basic knowledge of rehabilitative ergonomic nursing. Most colleges can neither provide adequate education in patient handling skills to fulfil the requirements of the EU directive (1409/93) nor tuition regarding both, the national legislations or the professional competencies as for example set forth by the Ministry of Education. The ErgocareBank web-site is meant to help the teacher to find evidence –based material and to guide students and all carers in handling their clients in an ergonomic safe way.

As safe & rehabilitative manual handling requires versatile knowledge & skills and is, therefore, demanding to teach and learn. The Ergonomic Databank for Social & Health Care - portal together with the Finnish Ergonomic patient handling card® -scheme, will constitute a good starting point to develop learning paths with different starting levels depending on whether the starter is a teacher, student or carer.

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# Development of a sensing system to prevent bed-related accidents involving elderly persons

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*A body-motion sensing system was developed for prevention of bed-related falls for elderly persons. The system comprised a tool kit with an AVR microcontroller (Arduino Fio), force sensors, and a wireless network. The appropriate number, configuration, and placement of the force sensors were discussed. The three sensors with an elongated rectangular in shape were placed on the mattress under a care-receiver's shoulders and hip as well as at the edge of the bed. Falls occurred when an elderly person was standing up from the bed. The developed prototype of the sensing system could predict this dangerous motion and notify an alarm to other computers through a wireless network.*

Keywords: Falls, Pressure distribution, Force sensor, Wireless network

## 1. Introduction

Populations are rapidly aging in developed countries, including Japan. Social security costs have recently and significantly increased because of the aging society in Japan. In response, the Japanese government raised the country's sales tax from 5% to 8% in 2014, with an anticipated increase to 10% in 2019. These tax increases are intended to supplement annual revenue shortfalls resulting from the aging society and subsequent increase in social security costs. Elder care in Japan will be supported and enriched through this tax increase, but a quality of elder care should be enhanced simultaneously (Ministry of Health, Labour and Welfare Japan, 2015). Some political, organizational, and technical measures could be considered for enhancement of the quality of life (QOL) to elderly persons as the social system of healthcare. For example, devoted cares by care-givers enhance the QOL and well-being of their care-receivers like elderly persons. The working-age population should be a resource for elderly care, but such population is decreasing in Japan. There is an absolute lack in human resources for elderly care (Takanokura et al., 2015). In addition, a poor working environment for care-givers is regarded as a social problem (e.g., long working hours, low income, and high rate of care-givers leaving their jobs) (Yokokawa, 2013). These problems should first be solved politically. However, proper usage of technical devices and their management could relieve physical and mental workloads of care-givers in terms of ergonomics and human factors. Especially, an unexpected accident of care-receivers reduces the QOL of them, deteriorates the professional duties of care-givers, and expands care costs with increased length of stay (Bates et al., 1995, Rubenstein and Josephson, 2002). A fall is a typical and impactful type of accidents occurred in hospitals and nursing homes (Morse, 2002, Oliver et al., 2010). Preventing accidents due to falls would benefit both elderly persons and society.



We have developed a body-motion sensing system to prevent bed-related falls for elderly persons. The first prototype of the sensing system was already developed, and its validity was investigated previously (Takanokura et al., 2015). However, the first prototype was an independent system around a bed from other factors. It should be improved for enhancement of utility and usability of the system. Therefore, we improved the body-motion sensing system and implemented notification of an alarm from care-receiver's bed to care-givers through a wireless network.

## 2. System development

### 2.1. Force sensors and their placement to detect care-receiver's motion

Care-receivers have a higher possibility of accidents around a bed such as falls while standing up. Before such a motion, they sit at the bedside. We could predict this movement as a sign of dangerous motions before falls. The pressure distribution on the bed varies while the care-receiver sits at the bedside from lying position and stands up from the bedside. The sign of dangerous motions before falls could be measured by using a force sensing resistor (FSR) (No. 408, Interlink, USA) as a force sensor. The FSR was an elongated rectangular in shape with 609 mm long and 15 mm wide, and it was placed on the mattress of the bed. Thus, the FSR detected continuous variation of pressure on the mattress which the care-receiver lay down.

The system for preventing accidents around the bed comprised FSRs and a tool kit with an AVR microcontroller (*Arduino Fio*). In order to record pressure data, a secure digital (SD) memory card shield was also installed in the system. The data measured by force sensors were stored on the SD card through *Arduino Fio*.

However, it was critical to place FSRs on the mattress for development of the sensing system for accident prevention. Therefore, in order to determine placement of FSRs, we measured pressure distribution on the mattress by using the fabric pressure mapping system (BodiTrak BT3510, Vista Medical, Canada). The system was 1935 mm long and 875 mm wide. Sixty-four pressure sensors were placed in longitudinal direction, and twenty seven sensors in transverse direction. The total number of sensors was 1,278. The pressure mapping system was laid out on the mattress of the bed. Pressure distribution should be examined with participation of care-receivers in hospitals and nursing homes, but this measurement will be in danger of undesirable effects on their health. Thus, four healthy young males (age: 22 years; height: 165-173 cm; weight: 58-69 kg) were selected as the participant.

The participant was asked to sleep on the pressure mapping system for about one hour. Pressure distribution was measured by every three seconds by the system during the participant's sleep. We collected approximately 900 pressure values per sensor. Then, the collected data were summed up every sensor. The obtained value was called as *cumulative pressure*. Fig. 1 shows the cumulative pressure distribution of participants A and B. The participant A lay on his back and did not move considerably during sleep. Therefore, cumulative pressure was concentrated around both scapula and under the hip. The participant B slept sideways to the right side. Pressure distribution was concentrated on the right side, but high pressure values were also obtained around scapula and hip. The other participants showed individual pressure values, but their tendency was similar to the participants A and B.

Although cumulative pressure distribution during sleep was varied with body posture of the care-receiver as shown in Fig. 1, pressure was concentrated at two points on the mattress: under the scapula and the hip. In addition, the care-receiver sat at the bedside from lying position before standing up. Therefore, we placed three FSRs on the mattress: (1) under the shoulders, (2) under the hip, and (3) on the bedside as shown in Fig. 2.

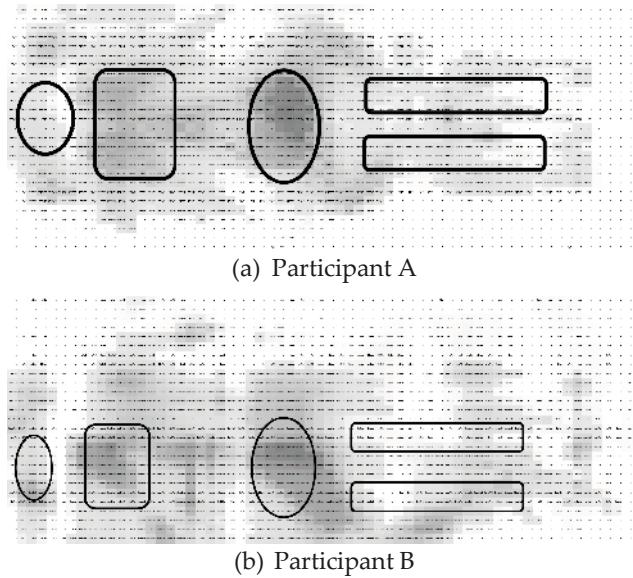


Figure 1. Cumulative pressure distribution of participants during sleep for one hour. Pressure values are graded from dark (high) to light (low).



Figure 2. Developed sensing system to prevent bed-related accidents.

## 2.2. Notification of dangerous motion to care-givers

The developed system could detect dangerous motions of care-receivers, but it was placed around the bed. Dangerous motions should be notified to care-givers properly for accident prevention. In this study, an alarm signal was notified to the other computer through a wireless network. The care-giver in a separate location from care-receiver's room such as a nurse station could recognize a dangerous motion of care-receivers by some alarms. The alarm was notified to care-givers on a monitor screen or a warning sound on the other computer. Therefore, an X-Bee 802.15.4 (ZigBee) module was attached to *Arduino Fio* as a transmitter. An X-Bee Explore USB was connected to the other computer as a receiver. If the developed system detected a dangerous motion of the care-receiver, an alarm signal was transmitted from *Arduino Fio* to the other computer through the wireless (ZigBee) network, and then care-givers recognized this motion from the warning message on the monitor or by the warning sound from the loudspeaker.

### 3. System evaluation

The validity of the developed system was examined experimentally. The system should be evaluated with participation of care-receivers in hospitals or nursing homes. However, the developed system was the second prototype for prevention of falls. Safety of the system was not guaranteed. Thus, similar to measurement of pressure distribution, the four healthy young males participated in system evaluation.

Fig. 3 shows the measured signals of the FSRs for the participant A. At the period (1), he lay down on the bed and did not move; therefore, the measured signals from the two FSRs under the shoulders and hip (S and H) were equal to the maximal value (1,023, arbitrary unit). The FSR at the bedside (BS) was not activated. The participant then sat up from lying position during period (2) and sat at the bedside during period (3). The measured signal was first reduced at the FSR under the shoulders (S), followed by that under the hip (H). However, the FSR at the bedside (BS) was activated at period (3) because the participant sat at the bedside. Similar results were obtained from the other participants.

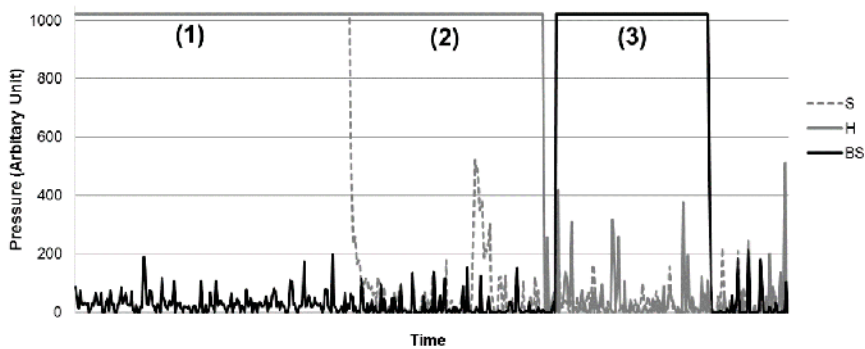


Figure 3 Measured signals from three FSRs for participant A. S, H, and BS indicate the pressure data from shoulders, hip, and bedside, respectively. The pressure was measured as an arbitrary unit.

As a result, the developed system could detect dangerous motions which led to falls. However, the information provided depended on how the system was used. In addition, dangerous motions were judged by using the threshold value of the measured signals (600 or 200 in an arbitrary unit) whether the FSRs were activated or not (Fig. 3). This was a simple algorithm. We should consider other algorithms such as a statistical measure, time-series analysis, or machine learning (neural network, etc.) for future research.

#### 4. Conclusions

We developed a sensing system for prevention of bed-related accidents occurring around a care-receiver's bed. The dangerous motion was measured by three force sensors and *Arduino Fio*, and then it was transmitted to the other computer through the wireless (ZigBee) network. The care-receiver recognized the dangerous motion from the warning message or by the warning sound. The system could improve the QOL of care-receivers and alleviate the professional duties of caregivers through a reduction in the number of falls. However, we should improve the ability of the sensing system through the use of more complex algorithms, such as machine learning. In addition, we should improve usability of the system by analysing actual nursing processes of care-givers in hospitals or nursing homes.

#### Acknowledgement

This research was partially supported by the Japan Society the Promotion Science (JSPS), Grant-in-Aid for Scientific Research (B), 26282091.

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# Ergonomic criteria and good practices for bariatric patients' care

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*During 2014-2015, the Satakunta Hospital District carried out the "Sataplus – ergonomic criteria and good practices" development project to support moving of bariatric patients. The aim of the project was to improve ergonomics and work safety when handling bariatric patients. Market survey of XXL-sized products was done, as well drafting ergonomic criteria for assistive devices and planning the policy for bariatric care to provide patient centred care in a safe and dignified manner. All the results of the project are gathered in the guidebook which is available on the internet in Finnish.*

Keywords: Patient handling, ergonomic criteria, bariatric patient

## 1. Introduction

The obese population (BMI > 30) is growing globally. In Finland 20% of the population is obese, for Europe it is 17 - 33 % (Männistö et al. 2012). The Finnish obesity is slightly above the European average, but lower than in Southern Europe and the UK. Hignett et al (2007) was looking at the bariatric pathway in the UK and identified five key risk areas: patient factors, building space & design, manual handling, clinical equipment & furniture, communication- & organisational- & staff-issues. In Finland, the problem is not as serious as in the UK however, the Finnish health care facilities are not sufficiently prepared to manage bariatric risks. Manual patient handling can induce high loads to carers' musculoskeletal system. The care of these patients present a specific challenge, partly due to individual factors but mainly for policies, space, equipment, vehicles, treatment and transportation. Thus, in the Satakunta Hospital District, the need to develop bariatric patients' care emerged.

## 2. Methods

Surveys about the current care practice and existing assistive devices in five pilot wards were carried out by means of both a questionnaire and the Care Thermometer (Knibbe and Knibbe 2012) to obtain a physical load assessment. An equipment and furniture survey were conducted to identify the range and availability of suitable devices for people weighing over 150 kg or BMI > 40 and/or having a hip width over 86 cm. Mapping of bariatric patients' journeys from home, for an emergency admission, to and through the hospital was carried out to identify the major risks. An action model for bariatric patient care was planned based on the research evidence of manual handling and bariatric protocols in USA and UK (Duke University Health System 2009, Smith J. et al. 2011)

### 3. Objectives

The aim was to improve ergonomics in manual handling in general and especially with regard to bariatric patients, by drafting ergonomic criteria for assistive devices, and by planning the policy for bariatric care to provide patient centred care in a safe and dignified manner.

### 4. Results

#### 4.1. *Baseline survey in the pilot wards*

The questionnaire survey and the physical load assessments identified that manual handling of heavy patients and their transporting in their beds were the biggest risks. There were not enough assistive devices in all other wards except the surgery unit. Contrary to the head nurses' belief the staff was not able to use all assistive devices. The Care Thermometer -results revealed, that the usage of hoists should be improved with D-level patients. The number of the normal size beds (80 cm) was enough, but there were too few wider beds ( $\geq 90$  cm). The spare beds were stored in the corridors. For the usage of assistive devices, most toilets were too small and the doors to the patient rooms and toilets were too narrow (80 cm).

#### 4.2 *Criteria and market survey for beds and hoists*

For the care of bariatric patients, XXL-products have been developed; they are made from stronger material for a higher carrying capacity. The most important furniture for both patients and care providers is the bed. In addition to the 80 cm wide medical bed, there were 90, 100 and even 122 cm wide beds available in the market. However, a bed should not be so wide as to force the nurse to overreach. For the bariatric bed, the crucial criteria were a larger sleep surface and lateral stability. Safe working load (SWL) varies from 180–450 kg and the bed must be marked with the corresponding maximum patient weight (SFS –EN 60601-22-52/A1 2010), which is usually 35–50% less than SWL. Besides the width and carrying capacity of the bed, the important features are height adjustability, the height of side rails, a sufficient length of the seat part and a possibility to rise into a sitting position. Desirable are, access and egress via the foot end, as it might be easier for some bariatric patient than via the side of the bed.

The maximum capacity of different hoist types in the Finnish market was: ceiling hoists 455 kg, twin motors 500 kg, the mobile hoist 385 kg and the sit to stand hoists 250 kg. For bariatric patients, hoists are essential pieces of equipment. Overhead ceiling hoists have been tested to be easier manoeuvrable than mobile hoists (Rice et.al. 2009). Important criteria are sufficient length of the spreader bar, a four to six-point spreader- or horizontal level spreader-bar. Important for the mobile hoists are the caster type with ease of pushing and slings bearing the working load safely.

#### 4.3 *Recommended furniture and assistive devices for the bariatric patients*

As the need of XXL-products varies from ward to ward it is rational to buy or lease them to joint ownership, set up a mutual storage and entrust a person with their maintenance and advising others in their usage. Recommended furniture and assistive devices for bariatric patients in a medium sized hospital are listed in Table 1 and example of the bariatric devices in figures 1 and 2.

Table 1. Recommended furniture and assistive devices for the bariatric patients

Bed width ( $\geq 90$ cm) with stronger frame	4
Bariatric hoist and scale	1
Bariatric manual wheelchair	2
Bariatric sit to stand lift	1
Bariatric commode chair	1
Shower chair with commode	1
Shower trolley (450 kg SWL)	1
Bariatric Walker/ Frame	1
Bariatric ford	1
Power drive assists for ease of transport	1
Position Cover	2
Sliding turning sheets, Sliding materials and boards	



Figure 1. Bariatric shower chair with commode



Figure 2. Bariatric wheelchair

#### 4.3 Environment

There should be sufficient space for the equipment to perform the tasks using good body dynamics and posture. Hignett and Lu (2007) carried out functional space experiments to determine the needed space for different tasks with bariatric persons. Also, the ArjoHuntleigh guidebook for architects and planners gives instructions (Table 2).

Table 2. Functional space for bariatric patients with different mobility levels.

Patient Mobility level	Width (m)	Length (m)	Area (m <sup>2</sup> )	Reference
BMI $> 40$	3,93	4,23	16,61	Hignett and Lu (2007)
A -level	3,58	3,13	11,21	Arjo Huntleigh (2014)
D-E -level	3,58	4,53	16,22	Arjo Huntleigh (2014)

As wider than normal beds (width of a 90 cm plus side rails = 100 cm) require wider doorways. Advance consideration is to be given as to, which rooms and elevators can be used, the table capacity of operation theatres and X-rays, the tube dimensions of CT, MRI, and the mortuary environment.

#### 4.4 The action model to take care of bariatric patients

It is good to map the patients' journey from home, for an emergency medical admission, to the caretaking ward to pinpoint possible problems. For example, what is the carrying capacity of the ambulances? It is advisable to notify the hospital of a bariatric patient's arrival to allow preparation of the appropriate equipment and staff.

In the admission of the bariatric patient the functional capacity and risks are to be assessed by:

- weighing the patient and counting his BMI,
- applying the Care Thermometer, FIM or Rafaela –scale to assess functional capacity
- evaluating patient’s ability to move and the situations in which he needs assistance,
- applying the algorithm to choose needed assistive devices and furniture (Figure 3.)
- considering into which ward and room the patient can be placed
- how many carers will be needed ?

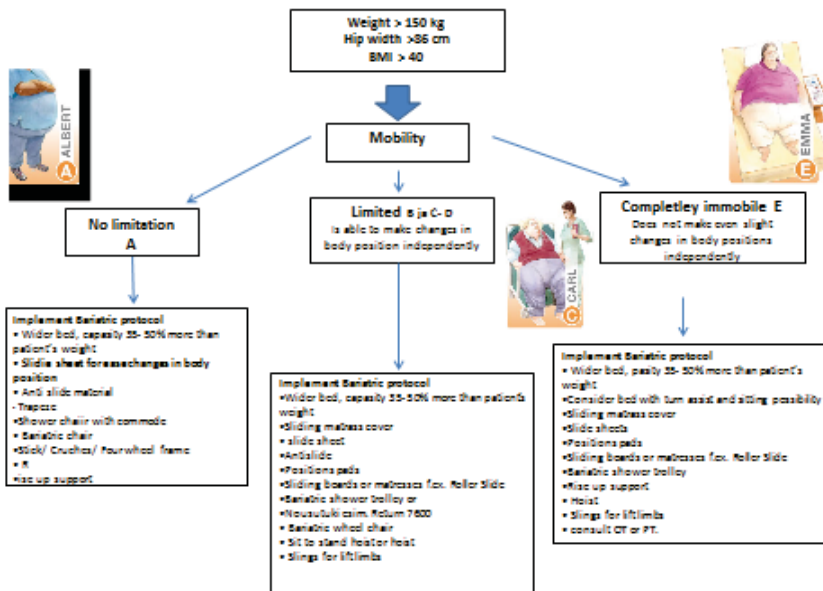


Figure 3. Algorithm guides to choose furniture and assistive devices for different levels of bariatric patients.

Bariatric patients have a high decubitus risk. Skin folds require daily check -up and usage of position pads to prevent skinfolds from pressing each other. Every two hours repositioning is crucial. To make repositioning easier, different sliding materials are needed on the bed. If the patient is completely immobile the hoist is to be used also for turning the patient and not only for lifting him. Repositioning of a mobile patient in bed, using a friction reducing device, is estimated to require one caregiver per 45 kg of patient weight (ArjoHuntleigh guidebook 2014). The manual lifting and supporting of limbs can be a high-risk task. If the patient’s weight is 150 kg, his leg is weighing 24 kg or more, therefore, the recommendation is to use a mechanical device e.g. hoist and slings (Waters et al. 2011) to perform the transfer.

In order to apply the new action model, all staff in the pilot wards underwent a new assistive device training. Dissemination of the results of the project and training will continue.

## 5 Conclusion/perspectives

Health and safety legislation places a responsibility on the employer to provide a safe system of work supported by policies and procedures (Safety and Health Act 738, 2002). The Satakunta



Hospital District has followed these rules and recorded the results of the project in the SATAPLUS -guidebook, which is freely available in Finnish on the internet and contains much more information than this article. As evidently the bariatric population is increasing, a proactive rather than reactive approach to caring for these people is needed.

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# Practical nurses' competency and perceptions of technology use in home care

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*Due to an increasing use of technologies, practical nurses working with elderly people in home care need to master various technologies. In this paper we investigate the practical nurses' perceptions of their knowhow of information and communication technologies and the role of technologies in home care. According to online survey, the practical nurses felt quite competent about using technologies at work. Even though the practical nurses perceived technology as supporting the home care, they were hesitant of seeing robot assistants helping their work. Safe technologies and appropriate training to use them is needed to support the wellbeing and work performance of practical nurses.*

Keywords: Practical nurses' perceptions, Home care, Technology

## 1. Introduction

In the current information society the use of technologies has increased both at work and in free time. Practical nurses working with elderly people in home care need to master various technologies that elderly people use as well as other technologies for administrative purposes. The increase in the use of technologies challenges the work performance and wellbeing of practical nurses at work. (e.g. Callen et al., 2013; Kuo, Liu & Ma, 2013; Lind et al., 2007; Schaller et al., 2015).

The challenges of nurses' and care providers' use of technology are related to attitudes, lack of training and division of time. In fact, care providers and nurses have been identified as the most significant barrier in the implementation of technology in health care (see e.g. Wälivaara et al., 2011). As Kuo et al. (2013) have stated among healthcare professionals, nurses are not always computer literate and therefore they may have more anxiety and negative attitudes or expectations towards computers than the other professionals. Therefore it is necessary that continuous education and training programs are available for nurses to enhance their information technology literacy, help them learn to take advantage of the benefits of information technology, and to minimize their stress and discomfort about information technology.

However, care professionals' critical views on the use of technology in their work need to be listened carefully and not only to describe the care professionals as barriers and gatekeepers to the introduction of new technology in health care. Professionals' caution is expressed from a professional perspective based on knowledge, ethical consideration and experience. Therefore, understanding reasoning about the use of technology in health care must form the basis for implementing technology (Wälivaara et al., 2011).

In this paper we introduce results of a survey on the practical nurses' perceptions of technology use in home care. The research questions were: 1) How did practical nurses see their know-how of information and communication technologies (ICT)? 2) What was the role of technologies in home care? The survey was implemented as a part of the Learning of elderly and technologies for well-being project (2015-2017) that is organized by the University of Eastern

Finland (UEF) (Department of Special Education, Department of Computer Science and Department of Health Economics), The Karelia University of Applied Sciences (Karelia) (Health care, Social services) and the City of Joensuu. The focus of the project lies in learning and welfare technologies that are used in home care by practical nurses and their customers, especially elderly people with memory disorders.

## **2. Research method**

The data was collected from an online survey for practical nurses in autumn 2015. Respondents for the survey were obtained through email lists of the practical nurses in the surroundings of a medium-size city in Finland. We got altogether 60 responses (21 %). The data for the multiple choice questions were analysed quantitatively and open questions qualitatively.

## **3 Results**

Most (96 %) respondents were women that reflects the gender distribution in nursing field in Finland (National Institute for Health and Welfare, 2015). Moreover, most (93 %) respondents did practical work with customers while seven per cent were managers. The respondents were experienced workers in social and health care services since almost half (45 %) have worked 6-15 years and 39 per cent more than 16 years in the field.

According to survey results, the practical nurses felt quite competent about using technologies at work. Three quarters (74 %) of the respondents claimed to have basic skills of ICT and even more (82 %) perceived competence in using smartphones. Nevertheless, many practical nurses perceived their knowledge of technologies in home care as insufficient. According to the practical nurses, they needed the most guidance in the use of office software (15 %), administrative programs, such as human resources programs (12 %) and electronic communication (7 %). Besides, more knowledge was needed about the safe use of electronic technologies since 39 per cent of the respondents can - of their opinion - moderately use electronic technologies safely.

In average, 66 per cent of practical nurses perceived being competent in using ICT at work. Compared to that, practical nurses' felt more competent using technical tools at customers' homes such as using motorized beds, physical devices or hearing devices (in general, 74 %) (Figure 2). The most advice was needed to use the devices that their customers rarely need such as care devices or hearing devices.

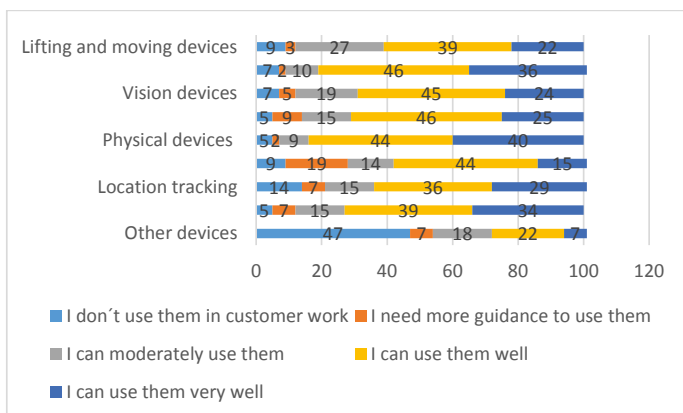


Figure 1. The practical nurses' perceived use of technical tools at customers' home (% , N = 60).

When asking about practical nurses' views of technology use in home care, they (86 %) perceived technology as strengthening the quality of home care and supporting and easing the workers' work load (91 %). According to one respondent, "Some routine type of work tasks that can be substituted with technologies will ease the work." However, the practical nurses were hesitant of seeing robot assistants' help in home care. Two thirds of the practical nurses rejected the robot assistants e.g. in measuring the blood pressure or blood sugar. As one respondent mentioned in open-ended questions, "I don't accept care robots. I think their work is "cold" for the customers. Customers need contacts with other people. There are already too many lonely elderly people." In general, practical nurses felt that technologies in home care decreased equality among the workers because of increasing differences in nurses' ICT skills.

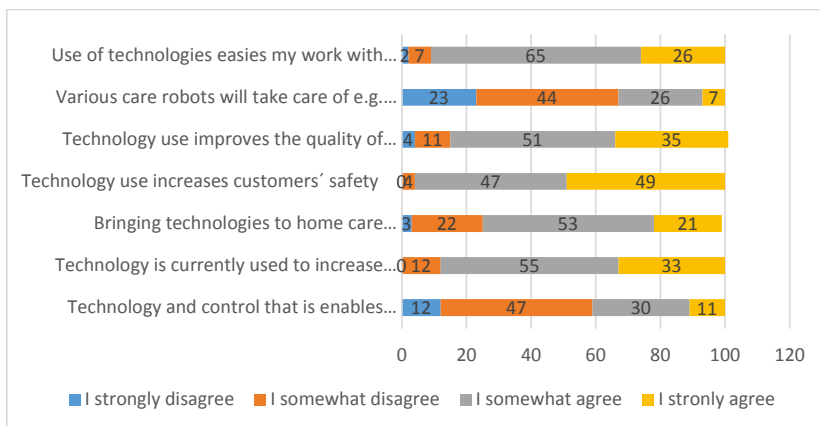


Figure 2. Practical nurses' perceptions of technologies in home care. (% , N = 60)

#### 4 Discussion

In this study the most of the practical nurses felt competency to use various technologies in home care. This reflects positively the current situation that is usually described as being with challenges of attitudes, lack of training and division of time (Wälivaara et al., 2011). However, the

ongoing technology development maintains the need for continuous training that focuses on the safety and adaptable use of technologies (Kuo et al., 2013). Safe technologies and appropriate training to use them is needed to support the wellbeing and work performance of practical nurses.

Regardless of the positive situation in general, technology and especially the robots were seen as a replacement or solely work agents in the home care. This concern is probably due to fear of decreasing quality in home care that affects mostly the elderly people or respondents' fear of losing their jobs. The question of increasing technology use is many times seen as a resource question in overall situation where the number of elderly people at home and care units is increasing rapidly and the number of employees taking care of them is not increasing due to both economic and demographic reasons (Heart & Kalderon, 2013).

When considering the reliability of this study, we should be aware of the possible bias in the study concerning the selection of the practical nurses who filled the survey. The survey was implemented online so it is probable that those nurses who participated are those nurses who are more willing and able to use ICTs. However, all care professionals' views need to be taken into account when deploying new technologies in work and providing further education to update the ICT skills in the changing information society.

### Acknowledgements

We warmly thank all practical nurses who participated in the survey. The financial support from the Regional Council of North Karelia that is funding the project from the European Regional Development Fund is highly appreciated.

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## *Session 1B Work and safety in agriculture / Questions of work ability*

### **Monday 15<sup>th</sup> August**

Merja Perkiö-Mäkelä: Farmers' physical workload and work ability in Finland

Kim Kaustell: Occupational injuries among fishermen in Finland 1999-2013

Marja Hult: Socio-demographic and work-related factors associated with the work ability of the employed and the unemployed

# Farmers' physical workload and work ability in Finland

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*The aim of this study is to determine Finnish full-time farmers' opinions of their physical workload and work ability, and of the changes over the last ten years. In 2014, nearly half (47%) of all farmers considered their work to be quite or very physically demanding (42% in 2004). One in three reported reduced work ability in 2004 and 2014. Confidence in being able to continue working until retirement age from the standpoint of one's own health had increased from 77% in 2004 to 85% in 2014. Perceived work ability, and confidence in being able to continue working until retirement age were strongly connected to perceived workload.*

Keywords: Agriculture, Physical workload, Work ability, Retirement

## 1. Introduction

In recent decades, agriculture has undergone rapid restructuring in Finland. Field areas and the sizes of herds per farm have increased, whereas the number of actual farms has decreased. Mechanization and automation have taken over.

Finland had 53 000 agricultural and horticultural enterprises in 2014, and 72 000 in 2004. Their average utilized agricultural area was 43 hectares in 2014, and 31 hectares in 2004. Most (87%) Finnish farms were family farms in 2014 and 2004 (88%). The average age of farmers on privately-owned farms was 50.6 in 2014, and 48.8 in 2004. In 2014, plant production represented 65% of farms, and livestock production 31%. The corresponding figures in 2004 were 58% for plant production and 41% for livestock production (Luke 2015, Tike 2006).

## 2. Objectives

The aim of this study is to determine Finnish farmers' opinions of their physical workload and work ability, and of the changes over the last ten years. We also studied the relationship between physical workload and work ability in 2014.

## 3. Material and Methods

The study population comprised two different samples of farmers aged 18–64. The *Farming and occupational health in Finland 2004* (MTH2004) (Rissanen et al. 2006) study consisted of 1182 full-time farmers, and the *Occupational health and safety in agriculture in Finland 2014* (MTH2014) (Perkiö-Mäkelä et al. 2016) study had 2076. The data from 2004 comprised a random sample from the 2004 Agricultural and Horticultural Enterprise Register. The 2014 data were weighted to be equivalent to the actual distribution of the production sector in Finland in 2014 (Luke 2015).

The data were collected through computer-assisted telephone interviews (CATI). The structure of the interviews was planned by a group of experts at the Finnish Institute of Occupational Health, and included questions on farms and farmers, the work environment and working conditions, health and work ability, accidents, management, mental well-being, and

occupational health services. The length of the interviews varied greatly, but was usually about 46 minutes.

The questions concerning physical workload were:

- Is your work physically: light, fairly light, somewhat demanding/fairly demanding, very demanding?
- How much do awkward working postures bother you: not at all, a little/quite much, very much?
- How much does heavy lifting or carrying bother you: not at all, a little/quite much, very much?

The questions concerning work ability were:

- Let us assume that your best possible work ability is 10 points on a ratings scale. How would you rate your work ability today on a scale of 0–10? A rating of 0 would mean that you are unable to work. (0–7/8–10)
- Do you believe that, from the standpoint of your health, you will be able to continue farm work until retirement age? (no, not really/mostly, yes)

The results are presented according to production sector, age and gender. We used cross-tabulations for analysing the associations between physical workload and work ability. The statistical analysis was carried out by SAS (statistical analysis system) software (version 12.3).

#### **4. Results**

In 2014, nearly half of all full-time farmers considered their work to be quite or very physically demanding. This was most common among farmers of dairy farms, big husbandry and other animal husbandry, farmers aged 54–64, and women. Perceived physical workload had increased over ten years. (Table 1).

In 2014, every fifth farmer considered awkward working postures quite or very harmful. These were mostly farmers from dairy farms and other animal husbandry, farmers aged 54–64, and women. In 2014, every fifth farmer considered heavy lifting/carrying quite or very harmful. This was most common among farmers of other animal husbandry, farmers aged 54–64, and women. (Table 1).



Table 1. Physical workload, awkward working postures and heavy lifting/carrying. Full-time farmers, 2004 (n=1182) and 2014 (n=2076), %.

	Quite or very physically demanding work, %		Harm from awkward working postures: quite or very much, %		Harm from heavy lifting/carrying: quite or very much, %	
	2004	2014	2004	2014	2004	2014
<b>All</b>	42	47	23	22	22	21
<b>Production sector</b>						
• Dairy farms	50	60	22	26	22	24
• Other cattle husbandry	41	49	22	18	24	20
• Pig husbandry	40	58	13	14	12	11
• Other animal husbandry	48	56	28	25	29	31
• Cereals production	32	35	22	20	20	19
• Other plant production	37	44	36	21	27	20
• Forestry	46	45	31	13	37	22
<b>Age</b>						
• 18–34	29	42	10	12	12	10
• 35–44	40	39	18	17	17	17
• 45–54	47	47	28	21	26	19
• 55–64	44	53	26	27	26	28
<b>Gender</b>						
• Male	41	46	22	21	19	19
• Female	47	58	24	25	31	33

One in three farmers reported reduced work ability (0–7 on a scale from 0 to 10) in 2004 and 2014, and two in three rated work ability as 8–10. Farmers from the forestry sector and those aged 54–64 most often had reduced work ability. (Table 2).

Confidence in being able to continue working until retirement age from the standpoint of one's own health had increased from 77% in 2004 to 85% in 2014. Dairy farmers, 45–54 year-old farmers and women most often had doubts about being able to continue working until retirement age. (Table 2).

Table 2. Work ability (scale 0–10) and confidence in being able to continue working until retirement age from the standpoint of one’s own health (those who answered no or probably not). Full-time farmers 2004 (n=1182) and 2014 (n=2076), %.

	Work ability 0–7, %		Doubts about being able to continue working until retirement age, %	
	2004	2014	2004	2014
<b>All</b>	<b>33</b>	<b>32</b>	<b>19</b>	<b>15</b>
<b>Production sector</b>				
• Dairy farms	30	32	26	23
• Other cattle husbandry	43	34	18	12
• Pig husbandry	22	29	10	15
• Other animal husbandry	38	28	19	18
• Cereals production	35	32	13	10
• Other plant production	33	30	16	11
• Forestry	51	45	20	12
<b>Age</b>				
• 18–34	11	12	11	9
• 35–44	17	19	19	17
• 45–54	41	30	26	20
• 55–64	49	47	14	10
<b>Gender</b>				
• Male	33	32	18	14
• Female	34	32	24	20

Perceived work ability, evaluated on a scale of 0 to 10, and confidence in being able to continue working until retirement age were strongly connected to perceived physical workload.

Farmers with reduced work ability (0–7 points) considered work quite or very physically demanding (59%) more often than those who rated their work ability as 8–10 (41%). Farmers with reduced work ability (0–7 points) perceived awkward working postures (37%/15%) and heavy lifting/carrying (38%/13%) as causing quite or very much harm more often than those who rated their work ability as 8–10.

Farmers who had doubts about being able to continue working until retirement age considered work quite or very physically demanding (71%/42%), and perceived awkward working postures (50%/16%) and heavy lifting/carrying (47%/16%) as causing quite or very much harm more often than those who had confidence in being able to continue working until retirement age.

## 5. Discussion and Conclusions

Full-time farmers considered their work to be quite or very physically demanding more often (47%) than the total Finnish working population (26%). Reduced work ability was more common among farmers (32%) than among the total Finnish working population (19%). Most (85%) full-time farmers were confident that they would be able to continue working until retirement age

from the standpoint of their own health, which was more than among the total Finnish working population (79%). (Perkiö-Mäkelä, Hirvonen 2013).

The perceived physical demands of farm work had increased during the last ten years. This is quite surprising, if we take into account mechanization and automatization. Larger farms, larger herd sizes, the increased average age of farmers, and better awareness of loading factors may partly explain these results.

Dairy farmers in particular considered their work more physically demanding in 2014 than in 2004. The average number of dairy cows had increased from 21 in 2004 to 34 cows in 2014 in the dairy farms in our study populations, and mean arable areas had increased in dairy farms from 40 hectares in 2004 to 61 hectares in 2014. Moreover, the mean age of dairy farmers had increased from 46.3 to 48.2.

Farm work continued to be physically demanding. Every third farmer perceived their work ability as reduced but had strong confidence in being able to continue working until retirement age from the standpoint of their own health. Perceived work ability was strongly connected to perceived physical workload. Thus, a need for continued efforts to balance the physical workload of farmers through, for example, developing work tasks, work tools and the work environment, is essential in order to improve farmers' work ability.

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# Occupational injuries among fishermen in Finland 1999-2013

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*Fishermen have high occupational injury rates in many countries, and there is a need for better understanding of the work environment, injury risks and preventive measures in fishing. The aim of this study was to describe injury characteristics during the past 15 years among commercial fishermen in Finland. The material consisted of compensated injury claims (567 injuries and 27 occupational diseases). According to the results, fishing has high injury rates and longer average sick leaves times compared to most occupations. The main focus on prevention should be on reducing slips, trips, falls, falls from elevation, and drownings.*

*Keywords: Occupational injury, Occupational disease, Fishermen, Fishing*

## 1. Introduction

Fishing has long traditions in Finland, but hard physical work in varying weather conditions, unpredictable catch, economic pressures, and strict governmental controls have made this old profession less attractive in recent years. The number of fishermen has decreased from 3744 registered fishermen in 1999 to 2458 in 2013. Fishermen have high occupational injury rates in many countries, and there is a need for better understanding of the work environment, injury risks and preventive measures in fishing.

In Finland, most of the full-time and part-time fishermen (accounting for 25% and 75% of registered commercial fishers, respectively) fish perch, white fish, and pike perch in coastal water areas with nets and fyke-nets. Vessels are typically small; less than 12 meters. However, the most important fish is Baltic herring, which is mainly caught by trawlers in open sea areas. The economic value of the Baltic herring catch was 28 million € in 2014. The total fish catch of commercial fishers from sea areas was 148 million Kg, and about 40 million € in 2014 (Luke statistics 2015).

As a leisure time activity, fishing is very popular in Finland with about 1,5 million recreational fishers. This is about 28% of the total population.

## 2. Objective

The aim of the study was to describe injury characteristics during the past 15 years among commercial fishermen in Finland.

### 3. Material and methods

The material consisted of compensated injury claims (567 injuries and 27 occupational diseases) from the Finnish Farmers Social Insurance Institution's (Mela) accident insurance (Mata). This insurance is mandatory for fishermen and their family members if their income from fishing is at least 3779 € per year (2016 level). During the period 1999 – 2013, 1195 to 618 or 25 – 32 % of all registered fishermen were covered by Mata insurance (Figure 1). The insurance system does not cover small scale fishing, fishing outside of the territorial waters of Finland, and also mainly not fish farming. Comprehensive data of the whole professional fishermen population are not available, because the rest are insured as farmers, fish refining entrepreneurs, or other, and are thus not included in the data source used in this study.

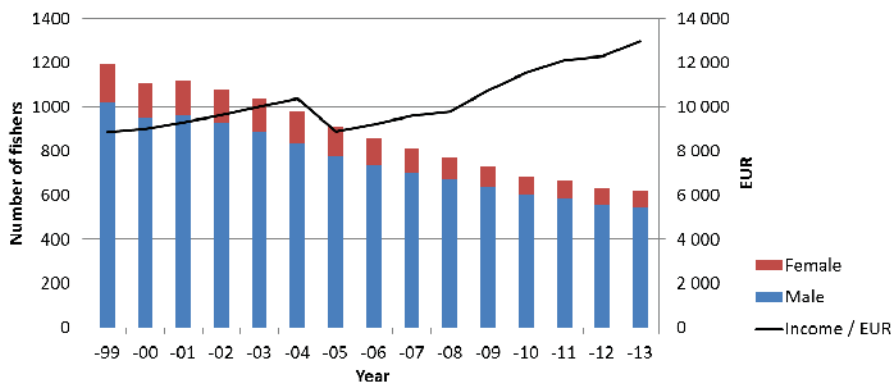


Figure 1. Number of Mata-insured fishers (t/m) and mean yearly income

The claims data included gender, age, date of incident, county, work activity, nature of incident, cause, injured part of body, type of injury/illness, compensated lost time, and short description of the injury/illness incident. Numeric and coded data were used for descriptive statistics, and incident descriptions were analysed and categorized for additional insight into causation.

The Mata source data does not include information on work years, nor does it distinguish between full or part time occupation fishers. This ratio (main vs. part time) was estimated using the ratio indicated in the register of all commercial fishers. The calculation of person-workyears is based on the assumption of main occupation fishers accounting for 0.9 person-workyears per year, and part time occupation fishers accounting for 0.45 person work-years per year, as used in McGuinness et al. (2013).

### 4. Results

There were a total of 594 occupational injuries or diseases during the period; 92% of these occurred to males and 8% to females. Approximately 40 % of all fishing-related injuries occurred on fishing vessels/boats while the rest occurred ashore or on sea or lake ice. The estimated average injury rate was 7,8 injuries per 100 person-workyears, with a slight downward trend over the 15-year period (Figure 2). The most typical injury mode was fall to same level (Figure 3).

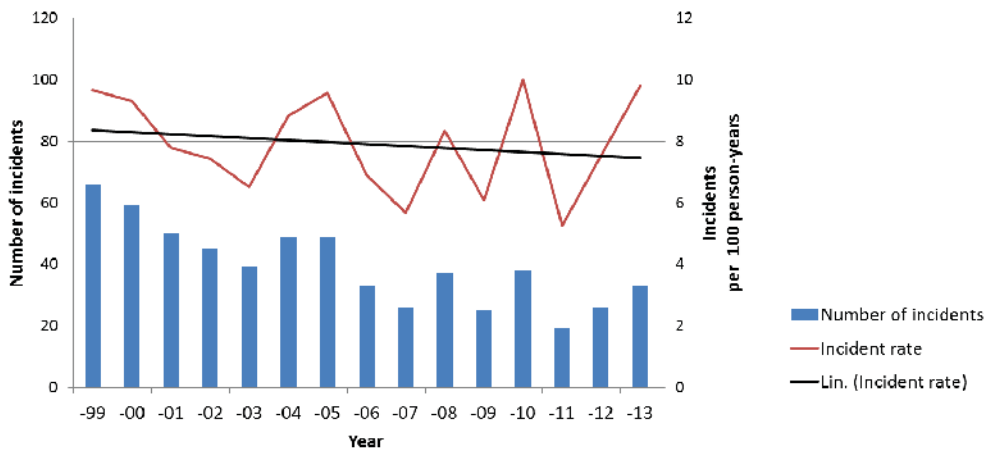


Figure 2. Incident number and incident rate per 100 person-workyears

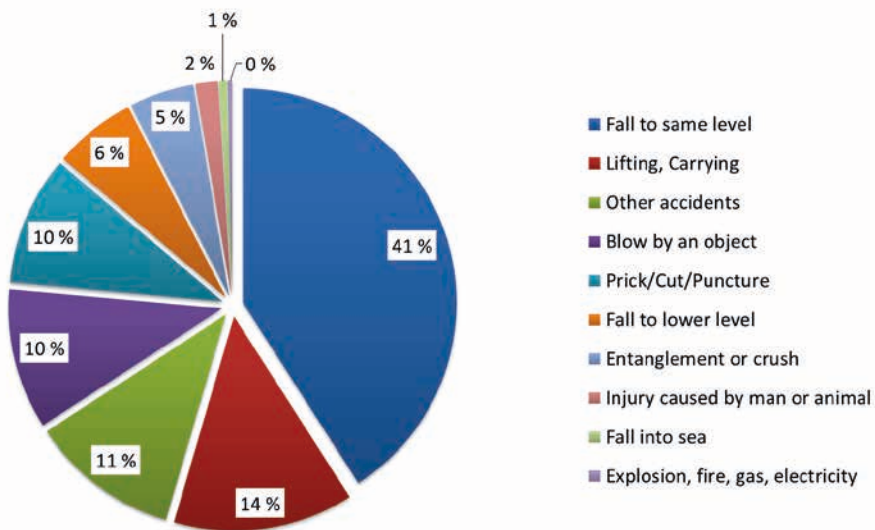


Figure 3. Modes of injury

#### 4.1. Non-fatal injuries

The average sick leave from injuries, excluding fatal injuries and occupational diseases, was 45 days. The mean age of insured person was 48,5 years, with an increasing trend through the observation period. Most injuries resulted from slip, loss of balance, fall or fall from elevation (48 % of all injuries, 267 cases). Injured part of body was typically upper limb (45%), lower limb (23%) or back (16%). The most common types of injuries were dislocations/luxation, twists and sprains (39%), cuts and superficial injuries (26%), and broken bones (16%).

## 4.2. Fatal injuries

There were nine fatal injuries during the period, fluctuating from 0 to 3 per year. The most recent fatal injury among insured fishermen occurred in 2007. All fatal injuries were drownings (may have also other injuries) and all the drowned fishers were men, mean age 42 years. Particular causes or chains of events that lead to drowning are not known. Storm was mentioned in two injury descriptions. Six happened in October or November, one in February and two in April, and all during open waters (not on ice).

## 4.3. Occupational diseases

There were 27 occupational disease cases in the 15-year data, three for female and 24 for male fishers. Based on short incident descriptions, occupational diseases were most typically caused by hard physical and/or repetitive work and severe weather conditions (Table 1).

Table 1. Occupational diseases of fishermen in 1999-2013.

	n	Example
ALL	27	
<b>Diagnosis</b>		
Humeral epicondyle inflammation	12	<i>During net fishing and because of high wind, I was forced to exceptionally hard lifting of nets into the boat by hand. During a couple of days of storm, my left hand got sore because of lifting work.</i>
Tenosynovitis	11	<i>Ice was thicker than normal during winter 1999. I had to use an ice pick to make more holes than usually, and with harder work, for more than one hundred spring hooks and 60 nets. My left hand became overstrained and got sore. I went to a doctor one month later.</i>
Epidemic nephropathy	2	<i>N.N. had sudden high fever and muscle pain. Diagnosis: mole fever. Possible infection source repairing fishing equipment in a barn, where above-mentioned equipment were stored.</i>
Vibration white finger	2	<i>Fingers become white, cold and get pain in cold conditions. This happens when weather has been cooling down. Hands are cold for a long time. The situation has slowly been getting worse and stopped winter fishing.</i>

## 5. Discussion and conclusions

Fishing has high injury rates and longer average sick leave times compared to most occupations based on available information from studies and statistics.

The annual number of fatal injuries has decreased during the observed period. The latest fatal injury occurred in 2007. The number of fishermen has also decreased and due to small numbers it is not possible to conclude if the reduction in the frequency of fatalities is statistically significant. Jensen et al. (2014) compared fatal injury trends in eight northern areas/countries and noticed also mainly decreasing trends of the fatal injury incidence rates from 1980 to 2010. They stated that small vessels have the highest risk.

Fishing in Finland is typically small-scale and seasonal, which leads to the need for additional income/other employment (Salmi 2005). If possibilities for other income are very limited in the area, it might put high stress on getting good catch during the season, which can be short. In practice this means very long working hours, fatigue and safety risks during the

season. Fatigue has been found to be a serious health and safety problem among fishermen (Høvdanum et al. 2014).

The main focus on prevention should be on reducing slips, trips, falls, falls from elevation, and drownings. In the future, it would be important to evaluate an effect of age, income level, and other possible injury risk factors, and also the effectiveness of preventive measures. Further studies of occupational safety in fish farming, especially when they are situated in open sea areas, as well as better understanding of fatigue and strain in the fishing profession in general, would be important.

### **Acknowledgments**

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# Socio-demographic and work-related factors associated with the work ability of the unemployed

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*This study examines the work ability of the unemployed, focusing in particular on sociodemographic and work-related factors. We analysed survey data on 1975 unemployed participating in a population-based ATH study (The Regional Health and Well-being Study) by National Institute for Health and Welfare. Good perceived work ability was assessed using the Work Ability Score. Age, education, short-term unemployment, employment status, doing physically or mentally non-strenuous job, and work satisfaction were significantly associated with good work ability. Work ability of those at risk of becoming unemployed should to be observed attentively by occupational health personnel.*

Keywords: Unemployed, work ability, sociodemographic, occupational health

## 1. Introduction

The work ability of unemployed persons is lower than that of the employed (Szlachta et al. 2012, Pensola et al. 2008). This is problematic because maintaining good work ability during unemployment is important for re-employment, and for protecting against long-term unemployment. Long-term unemployment is a major risk factor for socioeconomic marginalization. Preventing socioeconomic marginalization and reducing inequalities in health and well-being are the main targets of health and social policy in Finland (MSAH 2013), as well as in international level (Third Health Programme 2014-2020).

Although a generally accepted definition of work ability is lacking (Tengland 2011), it primarily involves a balance between personal resources and job demands (Ilmarinen et al. 2008). Work ability is also a process that remains dynamic across the life span (Lederer et al. 2014). Lifelong observation considers paths in and out of employment, which in times of widespread economic depression can be rapid and unexpected. Perceived work ability is the clearest determinant of the work ability of the unemployed, since in addition to self-perception it includes several work-related and personal resources (McGonagle et al. 2015).

During unemployment, the individual's work ability and resources for coping tend to decline (Vastamäki et al. 2014, Szlachta et al. 2012, Laiho et al. 2010). Coping resources are essential to assessing good work ability. Determinants of excellent and poor work ability differ (Lindberg et al. 2006). Recently there has been increased interest in the protective factors of work ability (Pensola et al. 2016).

Research on the work ability of the unemployed is scarce. Previous research has investigated the issue by identifying risk factors, such as long-term unemployment, age over 45, low education, and economic difficulties. (Szlachta et al. 2012, Laiho et al. 2010, Pensola et al. 2008.) However, knowledge of predictors of good work ability of unemployed is insufficient. The

aim of this study is to explore the connection between positive indicators of good work ability of the unemployed and sociodemographic and work-related factors.

## 2. Methods

### 2.1. Data

We used the Regional Health and Well-being Study (ATH) data (sample N=76 000). The data were collected by postal and internet-based surveys during 2014 and 2015. 30598 persons participated, i.e. the response rate was 40.3%. The data of this study are from unemployed or laid-off persons (n=1975) between the ages of 20 and 65.

### 2.2. Measures

Self-assessed work ability was measured with the Work Ability Score (WAS), a single-item question scaling from 0 to 10. A score of 0 indicates total disability, whereas 10 indicates the best possible work ability. Following El Fassi et al. (2013), we used a score of 8 as the cut-off point for good work ability. The WAS has been found to have high validity for evaluating subjective work ability, health, and health-related quality of life (Ahlström et al. 2010).

Age was divided into *less than 45 years* and *45 years or more*, and marital status as *married or cohabiting* or *not married or cohabiting*. Having children in a household was indicated as *children under 18*. Education, described as years spent in basic or professional training, was classified as *13 years or more* and *less than 13 years*. Length of unemployment was divided into short-term (less than a year) and long-term unemployment.

Employment status was classified as *a wage or salary earner* or *not a wage or salary earner*. Both physical and mental strain were classified as *light* (light, fairly light) and *strenuous* (a bit, quite or very strenuous). Work satisfaction was divided into *satisfied* (extremely or fairly satisfied) or *not satisfied* (neither satisfied nor dissatisfied, fairly or extremely dissatisfied).

### 2.3. Statistical analysis

Logistic regression analyses were applied to evaluate the association of the good work ability with sociodemographic and work-related predictors. The results were calculated by changing the positive and negative value of both dependent and independent variables. The statistically significant *p*-value was < 0.05. Due to the sampling design and non-response, weights were used in the analyses.

## 3. Results

The mean age of the participants was 43.2 years, over half men (57.5%). Participants were more often married or cohabiting (55.1%), and one quarter had young children living in the household (25.1%). The educational level was 13.3 years on average, and about half (52.2%) having higher education. The average length of unemployment was 16.3 months (ranged between 0 to 192 months), but well over half of participants (61.5%) were short-term unemployed. Employment status was for the majority a wage and salary earner (88.5%), and participants were satisfied with their most recent job (58.8%). Participants had done physically strenuous work (65.1%); three-quarters (74.5%) had had work that was mentally strenuous.

Bivariate analysis demonstrated significant associations with good work ability for all variables, except for gender and employment status. In multivariate analysis, in addition to gender, marital status and children under 18 decreased to non-significant. Employment status (OR 2.14) was significantly associated with good work ability.

Sociodemographic factors including age below 45 (OR 1.41), education for more than 13 years (OR 1.53), and short-term unemployment (OR 2.34) were significantly associated in multivariate analysis with work ability perceived as good. Having a physically or mentally non-strenuous job (OR 1.89 and OR 1.64, respectively) and reporting a high level of work satisfaction (OR 2.03) maintained their significant associations with good work ability.

#### **4. Discussion**

We aimed to examine sociodemographic and work-related predictors of perceived good work ability of the unemployed in this paper. Our findings provide further evidence that employment status, physical and mental strain, work satisfaction, and other work-related factors remain significant beyond employment. That is, their significant positive effects on mental and physical wellbeing carry on into unemployment also.

We found that younger age, higher educational level, and shorter duration of unemployment were all directly proportional to good work ability. Not surprisingly, these findings are supported by earlier research (Szlachta et al. 2012, Laiho et al. 2010, Pensola et al. 2008). These studies found that being over 45 years of age, having a low level of education, and long-term unemployment are the major risk factors for limited work ability during unemployment.

The role of sociodemographic factors in determining the work ability of the unemployed is therefore clear from the aforementioned previous studies, but the role of work-related factors was far less clear. It is here that the present study makes its main contribution. We found very little in the literature on the contribution of work-related factors to the work ability of the unemployed. In our results, type of most recent job as a salary or wage earner was associated with good work ability. Being a salary or wage earner possibly refers to secure contracts, full-time work and regularly income compared to more insecure types of work, such as being entrepreneur.

Both physical and mental strains were largely experienced in most recent job by the unemployed of this study. Concerning limited work ability, physical stress is obvious predictor; moreover, it has a strongest effect on socioeconomic inequalities in work ability (Aittomäki et al. 2003). Interestingly, insecure employment and jobs of the poorest psychosocial quality are turned out to be even more harmful for psychological wellbeing than remaining unemployed (Butterworth et al. 2015, Griep et al. 2015).

Our most interesting finding was that satisfaction in the most recent job is associated positively with good work ability also among the unemployed. Among the employed, work satisfaction directly predicts work ability (Palermo et al. 2013). On the other hand, dissatisfied workers are at most risk of dismissal (Wagenaar et al. 2015). Arguably, this finding may result from a causation process.

Another possible explanation for this finding might be that unemployed people with good work satisfaction continue activities similar to their work. These activities may offer the person possibility to have some social influence during unemployment also. The possibility to exert some type and degree of social influence and to engage in activities that demand challenges and struggles help to create a meaningful life, and therefore also contribute to better work ability (Ball and Orford 2002). On the other hand, poor prospects for development and to exert social influence seem to have a detrimental effect on work ability during unemployment (Aittomäki et al. 2003) This might in turn reduce the person's motivation for job seeking.

As we see it, the main methodological strengths of this study are the use of population-based sampling and the use of weights to control the sampling design and the effect of non-

responses. The weights we applied were based on inverse probability weighting (IPW) and socio-demographic register-based variables (Härkänen et al. 2014). Unemployed persons, but also young men of low educational level tended to participate less in ATH studies, and the weights stabilised this loss. The major limitation of this study, in our view, is its cross-sectional design, which does not allow for any examination of causes and effects.

To conclude, education is significant in promoting the work ability of the unemployed and in helping to regain employment. Keeping the length of unemployment as short as possible is beneficial for work ability. Work-related factors are important in addressing work ability during unemployment. Therefore, occupational health services should pay closer attention to the work ability of those at risk of unemployment.

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## *Session 2A NES Student price competition*

### **Monday 15<sup>th</sup> August**

Jaana Seppänen (Finland): Implementation of workplace mediation as a method of conflict resolution at the University of Eastern Finland

Uli Heyden and Lisbeth Anna Skräe (Denmark): Sexual harassment of women in the Danish Merchant navy

Johan Nordström (Sweden): Interior Firefighting. The task, near accidents and occupational injuries.

# Implementation of workplace mediation as a method of conflict resolution at the University of Eastern Finland

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*Workplace mediation is a method of solving conflicts. The main aim of this study was to analyse how the implementation of workplace mediation has actualised at the UEF. The findings indicated that the implementation of workplace mediation succeeded well. Mediation had many positive implications and the model was perceived to be functional. Possible further actions include the continuation of training and informing and, furthermore, case-specific time management and follow-up. Implementation of mediation can prevent the emergence of harmful conflicts and have a positive influence on well-being at work in the long term.*

Keywords: Well-being at work, conflict resolution, mediation

## 1. Introduction

Well-being at work is an important factor of a successful organization. It is a broad concept that doesn't have one conclusive definition. In addition to certain factors on the individual level, it involves factors relating to work, work communities, management, and organization. Still, well-being at work is one of the basic human rights in a society.

Conflicts in work communities are natural but, if not dealt with, they may escalate and cause costs in the form of sick leaves, reduced work efficiency, or early retirements. According to studies, about 25 to 40 percent of the supervisors' working hours is spent on dealing with conflicts. Consequently, conflict resolution is one of the central factors of enhancing well-being at work. Furthermore, studies indicate that investing one euro to well-being at work generates six or even twenty euros through reduced costs in terms of sick leaves, disability pensions, and accidents.

Workplace mediation is a method of solving conflicts. During mediation, parties can take responsibility and modify their actions by agreeing on the issues subject to conflict. Mediation is a restorative learning process that increases understanding and enables the parties to reach an agreement through interaction. Such a process results in changes in behaviour. Mediation proceeds in stages consisting of an initial phase, separate meetings, a possible conclusion of an agreement in a joint meeting, announcement phase, an ending of mediation and a monitoring phase.

The University of Eastern Finland (UEF) has adopted a model of early support, where workplace mediation constitutes a means of conflict resolution. This study has been commissioned by human resources development services in the UEF. The study was concluded in order to assess the implementation of the new model and to accumulate new knowledge on the model for the needs of the UEF.

## 2. Objectives and methods

The main aim of the study was to analyse the extent to which the implementation of workplace mediation has actualised at the UEF. The study examines the implementation of the model from two perspectives: that of the mediators and the supervisors. The research was twofold; first, the data was analysed with a method of inductive content analysis and, second, with a deductive analysis based on the Burke-Litwin model of organisational change and performance. The model is based on the system theory, consisting of nine factors situated at the organizational level, at the work unit level and at the individual level.

In the inductive part of the analysis, the suitability of workplace mediation was studied as a method of conflict resolution. In addition, the aim was to analyse the results mediation has produced and to examine whether workplace mediation provides any added value to individuals and work communities. Furthermore, in the deductive part of the analysis, a holistic view on the implementation of the model was presented by comparing the research material to the Burke-Litwin model. Thus, the effects of the implementation of workplace mediation could be seen more accurately in the different levels of the organization.

The research material consisted of the interviews of a mediator, four mediator trainees and six supervisors involved in mediation processes. The material was collected through individual and theme-centered interviews. The findings indicated that conflicts are usually formed between supervisors and subordinates, and they are related to behaviour and interaction, work, or leadership. The conflicts were described as prolonged, complicated, and multifaceted.

## 3. Results

The findings indicated that the implementation of workplace mediation at the UEF succeeded well. The mediation process proceeded according to the same pattern, regardless of the case. Workplace mediation resulted in an agreement in each mediation process. The joint meeting and the conclusion of the agreement were perceived to be the most difficult stages of mediation. Furthermore, the key components of successful mediation were the mediators' expertise and the voluntary nature of the participants.

The study also found that workplace mediation had many positive implications. It was perceived to improve the performance and atmosphere of the work community, to enhance open discussion and to develop supervisory activities into a more solution-oriented direction. One of the main findings was that at the individual level, workplace mediation provided added value as a means to understand the importance of early intervention. Moreover, at the work community level, mediation sparked proliferation of appropriate behaviour and generated learning.

However, the study found that there was room for improvement. The method has yet to be established in all the units of the organization. Possible further actions include the continuation of training and informing; case-specific time management and follow-up; an agreement on the information policy; and, finally, discussion on the possible introduction of mediation with two mediators or the commencement of mediator exchange between organizations.

The findings in the deductive part of the analysis indicated that the model was perceived to be functional, solution-oriented, and prompt by both mediators and supervisors. At the organizational level, it was considered important that the management has officially accepted mediation as a method of conflict management, creating a strong basis on its implementation. At the work unit level, the findings indicated that information flows and trust are considered important in the mediation process. The participants hoped that the mediation is established as a part of normal supervisory work. Moreover, supervisors estimated that, in general, the supervisors lack instruments and expertise on conflict resolution.



At the individual level, the findings indicated that supervisors' possible negative attitude to conflicts and their overall approach to conflict situations may influence their willingness to use mediation as a solution method. In the examined mediation cases, the supervisors were included in the mediation process and they were motivated. The study found that both supervisors and mediators were impressed by the advantages of mediation.

#### 4. Discussion and conclusion

To conclude, restorative learning means learning comprehensive solution-focused mindset. The role of supervisors is essential; however, everyone in the organization is responsible for dealing with conflicts in a solution-focused manner. The key factors when establishing mediation as an accepted supervisory activity include management training, distribution of information on workplace mediation, and guidance on how to use it in challenging situations.

Consequently, the implementation of mediation can prevent the emergence of harmful conflicts and have a positive influence on well-being at work in the long term. However, the matter has not been studied sufficiently, and much remains to be done. There are several interesting topics of further research. First, a follow-up study is needed to examine the long-term results of workplace mediation. It could extend the scope of the study to cover the parties to mediation and the work community. Another interesting topic of further research would be the examination of the effect of supervisors' leadership style and attitudes on the utilization of workplace mediation.

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# Sexual harassment of women in the Danish Merchant navy

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*This report examines the prevalence of sexual harassment against women in the Danish merchant navy, what types of sexual harassment is experienced and how women handle this. The empirical study is conducted with a qualitative questionnaire distributed to female seamen, and followed by qualitative questions. In addition, the results were compared to a similar survey conducted by the Danish Defense who charted sexual harassment among the women employed. The results are analyzed using Hofstede's theories of cultural dimensions and theory of organizational culture. It is found that women in the Danish merchant fleet is exposed to excess incidence of sexual harassment in conjunction with land-based jobs, and women are often not aware of how to handle this harassment.*

## 1. Introduction

The purpose of this paper is to examine and describe the occurrence and types of sexual harassment of women in the Danish merchant navy.

## 2. Methodology

The current investigation involves previous research on the subject, a study made by the Danish Defense in 2003 (Bente Øhrstrøm, 2003) and from that report, we created our empirical study among women in the Danish Merchant Navy. Furthermore, a qualitative study gave the women an opportunity to write about their experiences. The theoretical frame was cultural dimensions by Hofstede (Hofstede, 2010).

The report is divided into different parts:

- Sexual harassment in general
- Research on the subject and other results
- Empirical study
- Qualitative study by email
- Analysis and discussion
- Suggestions for improvement
- Conclusion

### 3. Results

To determine the frequency of sexual harassment we asked the question: "Have you, in the previous 12 months, experienced unwanted sexual attention at work?" (Heyden, 2015).

To this question, 37 % of the respondents answers positively. Compared to the questionnaire made by the Danish National Research Centre for the Working Environment in 2012 (Arbejds miljø, 2012), the frequency of experienced unwanted sexual attention is 2 %.

If answered positively, the respondents were then questioned about their relation to the offender, and how they handled the experience afterwards. The results indicate that the unwanted sexual attention is mostly coming from colleagues or from authorities like pilots, customs or immigration. About half of the respondents did not do anything about the harassment, they just ignored the offence or offender. Almost half of the respondents confronted the offender and some of the respondents reported the incident to a superior officer.

We then asked a number of questions to examine the type of sexual harassment, how offended the respondents felt, who the offender was and finally how the respondents handled the sexual harassment.

Our results from the questionnaire shows that women at sea are exposed to all kinds of sexual harassment, from "dirty jokes" to sexual assault. Meanwhile, they do not experience all kinds of sexual harassment as offensive. The respondents find degrading remarks about women at sea and remarks about women being unable to do their jobs properly at sea, just because of their sex, as very offensive, and they are not offended by dirty jokes or by exposure to pornography.

The most common way to handle sexual harassment is to ignore the incident or to ignore the offender, which disables the power the offender holds over the woman. Not a single respondent have reported an incident to the Safety Organization on board, or contacted their Union or Seahealth. Many of the respondents have not talked to anyone about the incident(s), and sexual harassment is widely considered as a ground condition you have to accept if you are aiming at a career at sea.

Based on our results, we have made suggestions for improvement and reduction of sexual harassment at sea using the theories of H.J Limborg and others (Mathiesen, 2010).

Some of our suggestions for improvement is to establish a hotline to Seahealth, making it possible for crew on board ships to contact Seahealth directly without permission from the shipping company. This is not an option today. Another suggestion is to start changing the culture on board the vessels by educating the new officers in handling and preventing sexual harassment. We have also suggested to change the regulation / law at sea in regards to working environment. As it is now, the law on working environment at sea does not include sexual harassment. We suggest that bullying and harassment is implemented in the law/ regulation at sea.

### 4. Conclusion

We have concluded that the frequency of sexual harassment against women in the Danish Merchant Navy is greater than ashore. Women at sea are not offended by dirty jokes but seriously offended if colleagues question their right to be at sea, or their level of competency based on their sex.

Most women handle the sexual harassment by ignoring the offender or the harassment. None of the respondents have reported the incident to the Safety organization on board, to their union or to Seahealth.

The respondents indicate that sexual harassment is a part of the culture on board, and that you have to live with it and accept it if you are aiming at a career at sea.

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# **Interior Firefighting. The task, near accidents and occupational injuries**

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*All occupational injuries and near accidents concerning interior firefighting that were reported to the Swedish Work Environment Authority during 2002 to July 2014 have been analysed. The analyses showed that more injuries and near accidents occurred during nighttime operations than during daytime operations. There are also more occupational injuries among retained firefighters than among wholetime firefighters. Most occupational injuries occurred in detached houses, often due to poor risk assessment or inadequate communication. Most of the near accidents occurred in underground car parks because of problems locating and fighting fires in these kind of buildings.*

Keywords: Interior firefighting, Near accidents, Occupational injuries

## **1. Introduction**

This paper is based on the author's MSc degree project in Ergonomics at KTH Royal Institute of Technology, Sweden (Nordström 2015).

During interior firefighting the firefighters are exposed to several risks e.g. poor visibility, high temperatures, unexpected and sudden fire spread, toxic smoke, risk of entanglement in different objects etc. (AFS 2007:7, Mäkinen 2005). In addition to this interior firefighting is often carried out in premises where the firefighters lack local knowledge, which in combination with the poor visibility makes it difficult for the firefighters to orientate themselves. Despite the use of modern personal protective equipment, governmental regulations and local instructions to protect firefighters the demands on the firefighters are high and according to the Swedish Work Environment Authority interior firefighting is the most dangerous work task that is allowed in Sweden (AFS 2007:7). Therefore, there are good reasons to develop alternatives to interior firefighting and to develop equipment and methods to help the firefighters and increase the safety when interior firefighting cannot be avoided.

Due to the problems that the firefighters face during interior firefighting the company AB Realisator Robotics, in cooperation with the rescue services in Stockholm, Gothenburg and Södertörn as well as the Swedish Civil Contingencies Agency and the Swedish Fire Research Board, are developing a firefighting Robot, FUMO™, to assist firefighters in difficult operations.

## **2. Objectives**

The aim of this study is to describe which factors influence firefighters during interior firefighting from a Man, Technology and Organisation (MTO) perspective. The study should also answer why and where near accidents and occupational injuries occur. The results from the study should also be able to use as a starting point for a further development of a firefighting robot.

## **3. Method**

The study was carried out in three steps. In the first step literature studies were carried out to create an understanding for how firefighters are affected during interior firefighting operations.

In the second step an analysis was carried out of reported near accidents and occupational injuries. According to the Swedish Work Environment Act (SFS 1977:1160) all occupational injuries and near accidents that entailed serious danger to life and health are to be reported to the Swedish Work Environment Authority. All 39 reported near accidents and occupational injuries that concerned interior firefighting during the period 2002-01-01 to 2014-07-17 were included in this study. The Swedish Contingencies Agency's collection of accident investigations (MSB 2014) was examined to see if there were accident investigations that contained additional information about the rescue operation where the near accident/accident occurred.

The Human Factors Analysis and Classification System, HFACS, developed by Wiegmann and Shapell (2003) was used for studying the underlying causes of the occupational injuries and near accidents.

Chi-square-tests were used to calculate if there were significant differences in the number of near accidents and occupational injuries between wholetime and retained firefighters and between daytime and nighttime operations.

In the third step case studies of firefighting operations in parking garages were carried out. All seven accident investigations concerning fires in underground parking garages found in the Swedish Civil Contingencies Agency's collection of accident investigations (MSB 2014) were studied as well as all reports of near accidents in parking garages.

## **4. Results**

The analyses show that the time of the day, mode of employment and type of building are contributing factors for near accidents and occupational injuries during interior firefighting.

### **4.1. Time of the day**

When analysing near accidents and occupational injuries it turns out that most of the near accidents occur during the night (defined as 00:00 to 05:59) and most of the accidents occur during the day (06:00 to 23:59) see table 1. However, during the examined time period fires were approximately five times more common during the day than during the night according to statistical data over rescue operations in Sweden (MSB n.d.).

Table 1. Number of near accidents, accidents, injured firefighters and building fires (MSB n.d) during daytime and nighttime operations 2002-2014. The expected value used when calculating chi-square values is given within brackets.

Time of day	Day	Night
Number of near accidents	3 (10.0)	9 (2.0)
Number of accidents	13 (17.5)	8 (3.5)
Injured firefighters	16 (24.2)	13 (4.8)
Total number of fires	111 094	21 857

The chi-squared tests (95% confidence interval) show that there are significant more near accidents, accidents and injured firefighters during interior firefighting operations at night than during the day.

#### 4.2. Difference between wholetime and retained firefighters

The conditions for wholetime firefighters and retained firefighters differ. Wholetime firefighters usually have the possibility to work out during working hours, have more time for training and more calls to accidents than retained firefighters, which lead to more experience. On the other hand wholetime firefighters, in general, are employed in larger towns and cities where there are more complex buildings. In the reports to the Swedish Work Environment Authority wholetime firefighters were involved in 9 of 11 of the near accidents and 9 of 22 accidents, see table 2. During the examined period 16 of 29 injured firefighters were wholetime firefighters.

Every year there are approximately 3 200 interior firefighting operations carried out in Sweden (AFS 2007:7) whereof approximately 800 are carried out by retained firefighters (Räddningsverket 2002). This means that during the examined period approximately 30 094 interior firefighting operations were carried out by wholetime firefighters and 10 031 operations were carried out by retained firefighters.

Table 2. Number of near accidents, accidents, injured firefighters and interior firefighting operations, depending on mode of employment 2002-2014. The expected value used when calculating chi-square values is given within brackets.

Mode of employment	Wholetime	Retained
Number of near accidents	9 (8.3)	2 (2.7)
Number of accidents	9 (16.5)	13 (5.5)
Injured firefighters	16 (21.7)	13 (7.3)
Total number of interior firefighting operations	Appx. 30 094	Appx. 10 031

The chi-squared tests (95% confidence interval) carried out show that there is no significant differences between wholetime and retained firefighters concerning the number of near accidents. Accidents on the other hand occurred significantly more often among retained firefighters than wholetime firefighters and there were significantly more injured retained firefighters than wholetime firefighters during interior firefighting operations.



### 4.3 Building types

The Swedish building regulations control load-bearing capacity, fire compartments, lining materials and smoke ventilation. In general, a building with three or more floors should have a load-bearing resistance of at least 60 minutes. For detached houses, the limit is 15 minutes (Uneram 2009). In spite of this the analyses showed that 11 firefighters were injured during interior firefighting as a consequence of stepping or falling through the floor or being hit by falling parts of the building.

Eleven of 26 accidents during the examined time period occurred in detached houses and it is the most common type of building when firefighters are injured followed by multiple-apartment dwellings (5 accidents) and industries (3 accidents).

Near accidents are most common in parking garages (4 of 13 near accidents) followed by multiple-apartment dwellings (2 near accidents) and industries (2 near accidents). When considering the number of firefighting operations carried out in the different types of buildings it turns out that near accidents in parking garages are 13 times more common than near accidents in industries and 30 times more common than near accidents in multiple-apartment dwellings.

#### *Case studies of fires in parking garages*

The case studies show that fires in parking garages can be very difficult for the rescue service to extinguish because of a combination of a large volume, very dense smoke and difficulties in ventilating the smoke out of the garage. It is also difficult to locate the fire from the outside, which in turn can cause the firefighters to attack the fire from a door that is not necessary closest to the fire. This leads to a longer time to locate the fire and consequently a higher strain on the firefighters who are exposed to the heat and bigger damages to property because of the fire spread.

In several cases, the local rescue service's standard operating procedures for interior firefighting in large complex buildings have not been followed. In other cases, the standard operating procedures themselves have proved to give the incident commander inadequate support. It also appears that the local rescue services, in several cases, failed to provide adequate training and exercise to the firefighters with reference to interior firefighting in large complex buildings.

In one case, noise from appliances and fans for ventilation have concealed a "mayday"-call from the firefighters in the parking garage, which contributed to the near accident. According to the accident investigator, this is a common problem.

## 5. Discussion/conclusion

There are significantly more near accidents, accidents and injured firefighters during interior firefighting at night than during the day. One reason for this may be sleep inertia which means that the cognitive functions, performance and reaction time are affected up to 30 minutes after a sudden awakening (Bruck and Pisani 1999, Oken et al. 2006). Since firefighters may be asleep at night, sleep inertia may be present which could be one reason for the higher amount of accidents at night. Other reasons may be that fires at night tend to be larger when they are discovered than during the day (MSB n.d.)

Retained firefighters are significantly more often involved in accidents during interior firefighting than wholetime firefighters and significantly more retained firefighters are injured than wholetime firefighters. An explanation for this is that the conditions for the two groups differ when it comes to training, exercises and experience.

The calculations showed that there are no significant difference for near accidents between retained and wholetime firefighters, but this may be due to underreporting since the near

accidents involving retained firefighters are suspiciously low considering the amount of accidents.

A significant difference between retained and wholetime firefighters can be found in the underlying factors for accidents. For retained firefighters, accidents are significantly more often caused by "organizational climate" according to the HFACS-model. Examples of problems within organizational climate are that the standard operation procedures have not been followed or that the incident commander does not give an order not to conduct interior firefighting. In some cases a contributing factor to the accident was that interior firefighting is so much associated with the role as a firefighter that the involved firefighters conducted interior firefighting despite the apparent dangers in the situation.

Most accidents during the examined period involved firefighting in detached houses. In most cases contributing factors to these accidents have been that, the incident commander did not make a proper risk assessment or made errors when assessing the risks. In other cases the incident commander failed to communicate his decision to the other firefighters.

Most near accidents during the examined period involved firefighting in parking garages. These near accidents were often caused by firefighter disorientation in combination with large open areas, thick smoke, high temperatures, deficits in standard operating procedures and failures in providing adequate training to the firefighters in how interior firefighting in complex buildings should be conducted.

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## *Session 2B Musculo skeletal disorders and prevention, Part I*

### **Monday 15<sup>th</sup> August**

Edda Maria Capodaglio: Postural analysis of workers in clothing store

Mari-Anne Wallius: Muscular activity and perceived exertion while mopping using different mop handle heights

Camilla Madsen: Working postures and movements - A new WEA Guideline

Jonna Kumpulainen: Teaching ergonomics to dental students in University of Eastern Finland

# Postural analysis of workers in clothing stores

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*The postural risk is reported as emerging in the service sector in Europe. 70 sales assistants were observed while they worked in prolonged standing posture. The Reba, Rula, Owas indexes show a low-to-medium level of risk. The ratings of discomfort of the lower limbs and the circumference of the leg do increase significantly along the work shift, suggesting a potential risk of developing disorders of the lower limbs. The postural risk is insufficiently considered by the traditional assessment tools, and guidelines fail to provide details for preventive interventions. More effort is needed to understand the health impact of the prolonged standing posture at work.*

Keywords: prolonged standing work; postural discomfort; lower limbs

## 1. Introduction

Working in prolonged standing posture has been recognized as an occupational risk factor emergent in Europe (European Agency for Safety and Health at Work 2005). Prolonged standing work (PSW) is associated with discomfort, fatigue, health problems, including pain and musculoskeletal disorders, also of the lower limbs.

Lower limbs disorders (LLDs) range in severity from perceived discomfort to oedema, nocturnal cramps and chronic venous insufficiency (CVI), with women especially at risk (Laurikka et al., 2002; Lehman et al., 2001). It has been claimed that LLDs have been hitherto not adequately addressed, or underrated in the female population (European Agency for Safety at Work, 2010). While discomfort of the lower limbs can be perceived as early as after 1 hour of PSW (Lin et al., 2012), CVI is associated with maintenance of the orthostatic posture for over 50% of the work shift (Sancini et al., 2010).

The risk associated with PSW has already been studied in many sectors and ergonomic recommendations were drafted to reduce the exposure level. The clothing retail sector, strongly represented by females, was not thoroughly explored.

Many methods are available to assess the postural strain, including simple observational tools and psychophysical rating of the postural discomfort. In most tools, consideration of the risk for the lower limbs is very limited.

Objective of this study is to report if PSW in clothing stores exposes the sales assistants to any postural risk, particularly of the lower limbs.

## 2. Methods

70 sales assistants (90% females) employed in 9 big clothing retail stores in Northern Italy participated in the study, given their voluntary informed consent.

At the beginning and (t0) at the end (t3) of the work shift, and before (t1) and after (t3) the meal break, the circumference was measured on the left leg of each worker. Each worker was asked to rate the discomfort of the lower limbs on the Borg's CR10 scale (Borg, 1998). The metabolic data were recorded on 21 representative workers with the Sense Wear Armband throughout the work

shift. Video recordings were made on representative phases of the worker's activities along the work shift.

The RULA (McAtamney and Corlett, 1993), the REBA (Hignett and McAtamney, 2000) and the OWAS (Kahru et al, 1981) indexes were calculated assigning scores to posture, force, duration and frequency of the tasks performed. Quick assessment of the postural strain was also applied by the ISO 12295 (2014) and ISO 11226 (2000). The dimensions and layout of the work area, and the type of work organization were recorded in each observed context.

### 3. Results

The workers (7 males and 63 females; age  $41 \pm 10$  years; job seniority  $18 \pm 12$  years) are employed on a full (39 cases) or part-time (31 cases) basis; mean duration of the work shift is 5,7 hours per day. PSW relates to checkout (35%) and sorting activities (47%), together accounting for over 80% of the work shift spent in a fixed position. Postural relief aids were not provided in the observed stores.

The assignment to checkout or sorting activities is determined by work organization of each store, either according to fixed roles or depending on variable conditions related to the flux of customers in the shop. In high sale periods, checkout tasks could take up to 90% of the work shift for a single worker. Scheduled rest breaks are often not adequately enjoyed by the workers because of pressure at work; unscheduled micro breaks are interspersed when waiting between customer transactions during non-peak times. Frequent walking shifts between checkout-sorting tasks occur in scant staff conditions or when lots of goods have to be prepared/exposed/dismantled. Overall, the walking displacements account for 12-20% of the work shift, with a cumulative covered distance of  $3.9 \pm 2.5$  km. Repetitive actions of the upper limbs (mean frequency  $>30/\text{min}$ ) occur both during selling sequences and during preparation of shelves and expositors with goods.

The physical layout influences the postures adopted during work: absence of any seat and of enough space for the legs and feet of the worker standing at checkstand; fixed-height of the checkstand, implying shoulder flexion more than  $80^\circ$  for smaller workers while handling items to be sold (Figure 1); the extreme-height of shelves and expositors causes awkward postures (trunk flexion, kneeling, extended reaching, crouching, stooping) adopted during sorting activities, and sometimes maintained for more than 2 minutes which is set as acceptance limit (Miedema et al., 1997).

The Rula, Reba, Owas indexes vary from low to medium. Assessment with the ISO TR 12295 (2014) denotes an uncertain level of risk, while application of the UNI EN ISO 11226 (2000) reveals acceptable conditions (Table 1).

The energy expenditure estimate assessed on 21 representative workers by Sense Wear Armband is of low-medium physical intensity (2.8 Kcal/min), a level which is acceptable for 95% of the working population (Haskell et al., 1989).

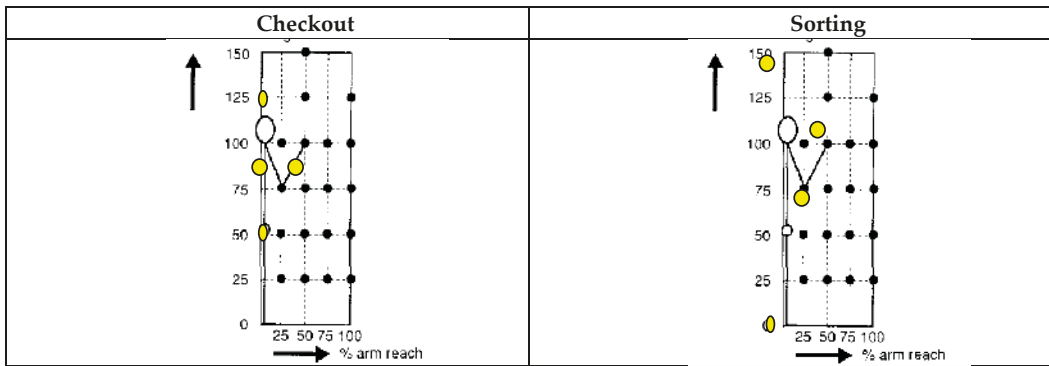


Figure 1. Prevalent work areas reached by the hands, according to the classification of Miedema (1997)

Table 1. Indexes of postural risk

	RULA	REBA	Owas	ISO 12295	SO 11226
<b>Checkout</b>	4 (medium)	6 (medium)	1 (low)	uncertain	acceptable
<b>Sorting</b>	6 (medium-high)	9 (medium-high)	1.2 (low)	uncertain	acceptable

The discomfort of the lower limbs perceived at the end of the work shift is generally of low-moderate intensity (2-3 on the Borg's CR10 scale) increasing up to heavy (4-5 on the CR10 scale) for some workers. Especially older females or those who reported to be affected from musculoskeletal disorders rate the discomfort as high.

The circumference of the leg shows a significant increase ( $t=3.33$ ,  $p=0.00008$ ) between beginning-end (t0-t3) of the work shift, while a significant decrease occurs in between beginning-end (t1-t2) of the meal break ( $t=-2.47$ ,  $p=0.04$ ) (Table 2).

Table 2. Circumferences of the leg measured at different times during the work shift

	t0-t1 (n=68)		t1-t2 (n=38)		t2-t3 (n=33)		t0-t3 (n=33)	
mean circumference (cm)	36,0	36,4	36,9	36,8	36,2	36,4	36,1	36,5
p (statistical significance)	0,00008		0,04908		0,00104		0,00008	

#### 4. Discussion

The literature reports that musculoskeletal disorders exist among the job category of cashiers through the world, both if standing and sitting during work (Lehman et al., 2001), and ergonomics tradeoffs are recommended between sitting and standing postures. Foot swelling has been reported by Winkel and Jorgensen (1986) for the sitting position, and high prevalence of phlebopathies was demonstrated in workers who stand up for over 50% of the work shift (Tomei et al., 1999).

PSW is a job characteristic in big clothing stores. Unfortunately, there is still no consensus in the literature about the definition of PSW: this may mean anything from a time of 4 (Lin et al., 2012) to 8 (McCulloch, 2002) hours, or from 62% (Messing and Kilbom, 2001) to 75% (Tüchsen et al., 2005) of the work shift.

To date, prevention norms have devoted scant attention to the postural risk at work relatively to the lower limbs. According to the current legislation in Italy, the health surveillance is not mandatory for sales assistants in the clothing stores.

The two simple parameters adopted in this study as indicators of potential risk for the lower limbs (subjective rating of discomfort and leg circumference) show that PSW for over 80% of the work shift without a seated alternative could actually be critical. The risk could be greater for older females working full time. Structural and organizational factors act as aggravating the exposure level. Although the observed activities include both static and dynamic components, their alternation and characteristics are probably not suitable to complete the physiological recovery from discomfort. The concurrence of static awkward postures of trunk and legs together with repetitive actions of the upper limbs, and lack of alternative sitting and of regular recovery, puts a substantial stress on the workers.

Recent publications draw urgent attention to gender-related issues in relation to safety of PSW, and highlight the need for greater focus on potential long-term disorders (Aittomaki et al., 2005, Lagro-Janssen et al., 2008, Kärkkäinen et al., 2013).

According to the clinical medicine, orthostatic pooling related to prolonged standing is limited by activation of the skeletal muscle pump (i.e. through ambulation and postural sway) and by avoiding certain circumstances (i.e. heat exposure, sudden postural changes) (Figueroa et al, 2010). However, no threshold values are set by which the postural suitability can be determined on the basis of leg volume. The personal judgment still plays a major role in determining the suitability of a working posture, and techniques to analyze working postures have not yet been fully developed and evaluated (Colombini et al., 1985).

Preventive measures to reduce the cumulative effect of low loads and to allow recovery from discomfort of the lower limbs through suitable mode and times of breaks (Ebben 2003, vanDieen and Oude Vrielink, 1998) are still to be conceived and adapted.

## 5. Conclusions

This field study shows that PSW in fixed position for over 80% of the work shift, even if gauged to acceptable energetic and biomechanical levels, could predispose the development of LLDs.

The traditional ergonomic risk assessment tools are not focused on the lower limbs and don't provide for a comprehensive preventive understanding of the postural risk.

There is a clear need to elaborate holistic assessment methods and plan preventive measures apt to protect workers exposed to PSW, with special attention to the ageing female workforce and to the emerging critical sectors.

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# Muscular activity and perceived exertion while mopping using different mop handle heights

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*The purpose of this study was to examine the effects of mop handle height on shoulder muscle activity and perceived exertion during floor mopping using the figure-eight method. Experimental study with 13 cleaners was conducted using surface-EMG and Borg's category ratio scale (CR-10 scale). The results of this study showed that increased mop handle height was associated with higher muscle activity levels. These findings were corroborated by perceived exertion ratings. It seems that a mop height adjustment between chin and shoulder level may be recommended as a basis for floor mopping with the figure-eight method.*

Keywords: Muscle activity, Electromyography, Perceived exertion, Floor mopping, Cleaner, Shoulder

## 1. Introduction

Floor mopping is characterised by a high level of physical demand including static muscular load, repetitive movements (Søgaard et al., 1996) and awkward postures for the upper limbs (Woods and Buckle 2005, Hägg et al., 2008). Electromyography (EMG) studies have found that during mopping the static load on the upper trapezius muscle exceeds the level of 2% - 5% maximal voluntary contraction (MVC) suggested as a threshold limit for long-term work (Hagner and Hagberg 1989, Søgaard et al., 1996). It seems that the shoulder muscle load is high for the hand placed higher on the mop handle (Hagner and Hagberg 1989, Hopsu et al., 2000, Søgaard et al., 2001). Despite the fact that the telescopic mop handles are often used, the advice on the optimal mop handle height differs among cleaning professionals and occupational health services. Cleaners are still working with arms elevated (Hägg et al., 2008), which is widely recognized as physical risk factor for musculoskeletal shoulder disorders (van Rijn et al., 2010). However, it is uncertain whether the high muscle load during mopping with the commonly used figure-eight method is partly due to the use of unsuitable mop height.

The purpose of this study was to examine the effects of mop handle height on shoulder muscle activity of the upper position arm and perceived exertion during floor mopping with a figure-eight method. We hypothesized that shoulder muscle activities and perceptions of exertion would differ among different heights of the mop handle.

## 2. Methods

### 2.1 Subjects

A total of 13 volunteer cleaners (12 females and 1 male) participated in this experiment. The mean age of the subjects was 41 years (SD 14.6), and their average work experience as a cleaner was 11 years (SD 11.4). The mean height was 163 cm (SD 8.1), weight 70 kg (SD 9.6) and Body Mass Index (kg/m<sup>2</sup>) 26.5 (SD 4.0). All except one of the subjects were dominant right-handed and used the right hand in the upper position of the mop handle.

### 2.2 Electromyography

A Biomonitor ME6000 (Mega Electronics Ltd, Kuopio, Finland) was used for measuring muscular activity. EMG activity were recorded from the upper trapezius (UT), infraspinatus (IP), middle (MD) and anterior of the deltoid (AD) muscles, from the side that the subject preferred to use higher on the mop handle. The skin was carefully prepared and reference electrodes were placed according to SENIAM guidelines (Hermens et al., 1999). Using an inter-electrode distance of 20 mm, bipolar surface electrodes were placed according to Cram et al. (2011) and McLean et al. (2003). EMG data were collected at a sampling rate of 1000Hz, raw EMG signals were analogically band-pass filtered with an anti-aliasing filter (signal band-pass 8-500 Hz) and preamplified (gain: 1000, a common-mode rejection ratio CMRR of > 130dB, noise < 1  $\mu$ V). 'Flexion 125°', 'empty can' and 'external 0°' tests (Boettcher et al., 2008) were used for isometric MVC test positions. Each three test were repeated three times, with a rest interval of 30 s between repetitions (Boettcher et al., 2008) and a rest period of 2 min prior to new test. Details of electrode placements and MVC tests are described in Wallius et al. (2016).

### 2.3 Experiment

An aluminium telescopic mop handle and a 60 cm wide mop frame were used. Standardized dampness of the microfiber mop was controlled by dampening the mop with 60 ml of water. In the experiment, the subjects mopped the floor surface of a 20 m long and 1.79 m wide corridor back and forth once. Each subject performed four trials of mopping and each trial consisted of using a different mop handle height (Figure 1) in randomized order. Breaks of 5 min were given between the trials. At the end of each trial, the subjects were asked to verbally rate their level of perceived exertion for shoulder area using CR-10 scale from 0 to 10 (Borg 1990).

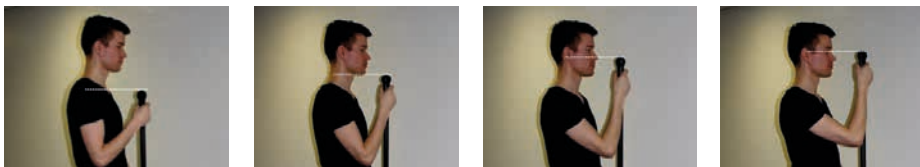


Figure 1. In the experiment, the top of the mop handle was adjusted to four levels as follows: (A) shoulder level: slightly below the lateral border of clavicle, (B) chin level: in line with chin, (C) nose level: in line with the apex of the nose and (D) eye level: in line with the corner of the eye.

### 2.4 EMG data processing and statistical analyses

The EMG signals were band-pass filtered (5th order Butterworth, 20-400 Hz pass-band). Root mean square (RMS) amplitudes were calculated using a window length of 250 ms. EMG data were normalized to a percentage of MVC (%MVC). The muscle activities were assessed by estimating the 10th, 50th and 90th percentiles of the amplitude probability distribution function

(APDF) of the EMG signals. These percentiles were denoted by APDF10, APDF50 and APDF90 and represent static, median and peak activity levels, respectively (Jonsson 1982).

The linear mixed model was used for statistical analysis to examine the differences in the shoulder muscle activities among different mop handle heights. The Sidak method was performed for multiple comparison. The APDF parameters were logarithmically transformed due to the skewness of the distribution. Each logarithmically transformed EMG parameter (APDF10, APDF50 and APDF90) was used as a dependent variable and analysed separately. The mop heights (i.e., shoulder, chin, nose and eye level) and muscles (i.e., UT, IP, MD, AD) were used as fixed factors. The non-parametric Friedman's test was used to examine the differences in perceived exertion among different mop handle heights. A  $p < 0.05$  was considered as significant.

### 3. Results

The analysis revealed that the mop handle height had a statistically significant effect on  $\log(\text{APDF10})$  ( $p < 0.001$ ),  $\log(\text{APDF50})$  ( $p = 0.003$ ) and  $\log(\text{APDF90})$  ( $p = 0.026$ ) parameters. In pairwise comparisons, no statistically significant differences were detected in any of the EMG parameters between shoulder level and chin level.

For static activity level, APDF10 values ranged from 0.2% MVC to 13.7% MVC. In pairwise comparisons,  $\log(\text{APDF10})$  values were significantly higher at eye level mop adjustment as compared to shoulder level ( $p < 0.001$ ) or chin level ( $p = 0.001$ ).

For median activity level, APDF50 values ranged from 0.6% to 21.9% MVC.  $\log(\text{APDF50})$  values were significantly higher when the mop height was adjusted to eye level compared to shoulder level ( $p = 0.006$ ). The muscle activities were also significantly higher at eye level compared to chin level ( $p = 0.012$ ).

For peak activity level, APDF90 values ranged from 1.1% to 31.9% MVC.  $\log(\text{APDF90})$  values were significantly higher for the eye level mop adjustment than for the chin level ( $p = 0.044$ ). However, the difference was not statistically significant between shoulder level and eye level ( $p = 0.054$ ).

For subjective assessments, subjects rated floor mopping exertion as 'very weak' (median 1) for the shoulder area when the mop handle height adjustment was at chin level. Mopping was considered 'weak' (median 2) at shoulder level and 'moderate' (median 3) both at nose level and eye level. The analysis showed that significantly less exertion was found when the mop was adjusted to chin level compared to eye level ( $p = 0.005$ ). In similar, less strain was assessed when the mop was adjusted to chin level compared to nose level ( $p = 0.011$ ).

### 4. Discussion

Results of our study demonstrated that there were differences in shoulder muscle activities and perception of exertion among different mop handle heights. As the height of the mop handle raised, a trend of increasing EMG activities was observed, and muscle activation levels were highest with eye level mop adjustment. One potential explanation for the higher muscle activity levels may be higher elevation angles of the shoulder. Mopping requires large shoulder movements and a large amount of stabilization in the shoulder (Søgaard et al., 1996). Thus, the scapular and deltoid muscles may be more active in order to maintain the position of the arm and scapula with rising abduction levels during continuous movements. Cleaners also rated lower mop heights, the chin level adjustment in particular, as less strenuous for their shoulder area. Lower ratings of exertion can probably be explained by a more convenient posture, because cleaners were able to work with their arms at lower level without lifting their shoulders. However, assessment of postures was not performed.

The static level for the shoulder muscles would be considered high if mopping was performed for prolonged periods of time. Using eye level mop adjustments, the mean muscle activity of the UT, IP and AD exceeded Jonsson's (1982) lower limit (2% MVC) for static load. Whereas shoulder and chin level mop heights led to decreased shoulder muscle activation. The results of earlier studies supported a causal relationship between prolonged static loads and high level of static contractions and neck-shoulder pain (Larsson et al., 2007). Therefore, in order to reduce the muscle demand, lower adjustment of the mop is more recommendable than the higher ones.

One limitation of our study was the small sample size. Therefore, the results must be viewed cautiously. Moreover, we did not evaluate muscle activities in diverse mopping environments. Regardless of these limitations, this study revealed that muscle activity levels were affected by the change in mop handle height. The results can be used as a basis for the selection of appropriate mop handle height in order to reduce risks of work-related upper extremity disorders resulting from overuse of the shoulder muscles. These results could be used by occupational physiotherapists, as well as by cleaning supervisors and managers, who are responsible for ergonomic guidance at work.

In conclusion, increased mop height was associated with higher muscle activity levels. These findings were supported by subjective perceptions of exertion. Therefore, a mop height adjustment between chin and shoulder level may be recommended as a basis for floor mopping with a figure eight method.

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# Working postures and movements - A new WEA Guideline

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*Workplaces in Denmark should be safe, secure and healthy. Awkward working posture and movements are well known risk factors for developing work-related musculo-skeletal disorders (MSD). The Danish Working Environment Authority (DWEA) is currently looking into updating the current WEA-message about working postures and movements. The WEA-message is from 1998 and is antiquated in form and language. A project group has conducted a comprehensive literature search and the literature provides a clear and unambiguous answer to the fact that there is evidence that poor/awkward postures and movements equals a risk of developing MSD. The literature is much less convincing and it is impossible to find specific dosis-response values.*

Keywords: Working postures and movements, musculo-skeletal disorders, WEA guideline, dosis-response values.

## 1. Introduction

According to the strategy for working environment efforts up to 2020, workplaces in Denmark should be safe, secure and healthy. There is extensive documentation that a good safe and healthy working environment leads to a decrease in absenteeism due to sickness, and also results in people staying longer on the labour market. In March 2011 a broad political majority in the Danish Government agreed on an ambitious strategy for working environment efforts up to 2020. The parties agreed to establish a series of objectives and priorities for the working environment effort. The goal is to create a good working environment to help increase the safety and health of employees, and to ensure a long working life for the individual with the least possible absenteeism due to sickness. The parties agreed to focus on the following working environment problems as part of the 2020 working environment efforts:

- Accidents at work
- Psychosocial working environment
- Musculo-skeletal disorders (MSD)

Problems arising from any of these three areas lead to serious health issues, long-term absenteeism due to sickness and incapacity for work resulting in early retirement. Regarding MSD the objective that has been agreed on is that the number of employees who experience musculoskeletal disorders is to be reduced by 20%.

Awkward working posture and movements are well known risk factors for developing work-related MSD. In order to support the prevention of MSD caused by awkward working posture and movements, The Danish Working Environment Authority (DWEA) has a WEA-message about working postures and movements. The WEA-message is from 1998 and it is both antiquated in form and language and the evidential basis is not up to date with the current literature on the topic.

In 2014 DWEA implemented a new guideline concept. The purpose of the guideline concept, is to extend and explain safety regulations in such a way that the rules are simple, easy to understand and as easy to use for the companies as possible. With the new concept the WEA guidelines are therefore structured so that they are shorter and more focused in respect to the rules they represent and explain. The intention is to present the rules for companies in a shorter, more logical and user-friendly way.

A project group within the DWEA consisting mainly of ergonomics professionals from the headquarter and inspectors are looking into the possibility of preparing a draft for a new WEA guideline on working postures and movements. The new guideline may have a holistic prevention as a focal point, on the basis of the general principles of prevention. The main purpose of a new guideline on working postures and movements is to support the prevention of MSD caused by awkward working postures and movements. A new guideline has to be timely, logical and user-friendly, and it also has to be evidence-based. The guideline shall motivate businesses to always assess and try to reduce the load that the employee is exposed to due to awkward working postures and movements.

## **2. Methods**

The project group conducted a comprehensive literature search, which highlights the causality in research that exists between work-related influences - including posture and movement - and the risk of developing MSD. The research literature that underlies the literature analysis is selected by the office for data and analyses (ADA) and the office for ergonomic and psychological work environment (EPA). The Ministry of Employment and research organization (NFA) has approved to this list. After searching the literature with a broad spectrum, the outcome was overwhelming and it was agreed that we needed to narrow our focus. Therefore the literature search was limited to the newest reports, white books, reference documents, meta-analysis, and reviews. ADA and EPA estimated that the literature analysis has sufficient width and academic validity to serve as evidence basis for a new WEA guideline with improved evidential basis.

### **2.2 Criteria for evaluation of evidence**

Evidence for causality is based on consistency of high quality studies. There are no fixed criteria for evidence assessment or evidence modulation. The project group has chosen to use a scale from 1-4 to represent the degree of evidence of each of the included literature:

- + Limited evidence
- ++ Moderate evidence
- ++ (+) Moderate to strong evidence
- +++ Strong evidence

Likewise, the quality level of the literature was assessed on a scale from 1 to 4, where 4 presents the highest quality level, while the quality of each of the reviews has been systematically examined based on the SIGN criteria. Finally there was an overall weighting of quality and evidence where high quality studies contribute more to the overall assessment of the evidence than low quality studies.

### **2.3 Delimitation of the working environment problem**

In the delimitation we chose to follow the literature search approach and the literary division of body areas that we have sought evidence of:

- ❖ The neck/shoulders
- ❖ The elbows/wrists
- ❖ The back
- ❖ The knees

The choice of this division is based on the outcome of an occupational exposure most often related to pain and discomfort in these body areas. Literature regarding ankles and the hip is entirely missing. Therefore these body areas are not included in the evidence analysis.



### 3. Results

As an example, Table 1 shows the results of the literature analysis for the neck and shoulders:

Title	Evidence for							Quality	
	Force	Repetition	Elevated arms	Twisted body	Static work	Neck flexion	Combi-nation		
<b>Neck and shoulder</b>									
<b>Reports and investigations</b>									
Arbetets betydelse för uppkomst av besvär och sjukdomar, Nacken och övre rörelseapparaten, En systematisk litteraturoversikt,	<i>SBU-rapport, 2012</i>	+	+	+	++				<b>GRADE: High (xxxx)</b>
Associations between work-related exposure and the occurrence of rotator cuff disease and / or biceps tendinitis, A reference document	<i>Dr Gareth T Jones, Dr Nirupa Pallawatte et al., udredning for ASK 2007</i>	+	+	++ (+)					<b>High (xxxx)</b>
Hvidbog om risikofaktorer knyttet til fysisk tungt arbejde	<i>2009</i>	+	+	++ (+)					<b>High (xxxx)</b>
Muskuloskeletalt besvær, En rapport til Arbejdstilsynet	<i>Bach, Brauer, Ebbenhøj, Kryger, Mikkelsen et al., Bispebjerg hospital, 2014</i>	+	+	+		+			<b>High (xxxx)</b>
<b>Reviews</b>									
Work relatedness of chronic neck pain with physical findings—a systematic review	<i>Dr Keith Palmer &amp; Dr Julia Smedley 2007</i>	+	+			+	+	++*	<b>SIGN assessment High quality (++)</b>
Associations between work-related factors and specific disorders of the shoulder – a systematic review of the literature	<i>van Rijn RM, Huisstede BMA, Koes BW, Burdorf A, 2010</i>	+	+	+					<b>SIGN assessment High quality (++)</b>
Longitudinal evidence for the association between work-related physical exposures and neck and/or shoulder complaints: a systematic review	<i>Julia Mayer, Thomas Kraus, Elke Ochsmann, 2012</i>		+	++	+				<b>SIGN assessment High quality (++)</b>
<b>Other</b>									
Notat om ændring af erhvervssygdomsfortegnelse punkt C.5 om skuldersygdomme									

#### **4. Discussion**

The literature provides a clear and unambiguous answer to the fact that there is evidence that poor/awkward postures and movements equals a risk of developing MSD. The literature is uncertain and it is impossible to find evidence, when it comes to the question of how factors such as duration, frequency, or how many degrees a joint is bent influence the development of MSD. This is partly due to a marked heterogeneity in how exposure occurs and is measured. There are for example various operationalisations of "repetitive gestures" ranging from 'number of repetitions per minute' to 'proportion of a work day working with repetitive movements'. Furthermore assessment of the exposures is lacking - there is not enough information about the frequency, duration and type of work. This means that it is not possible to compare the results in order to accomplish evidence.

The lack of specific dose-response values is a challenge not only internally in the DWEA but also externally towards companies who in terms of reducing awkward working postures requests limiting values. How can a WEA-guideline present the rules while lacking clear cut dose-response values? Could unnecessary awkward positions and movements be a focal point – both internally and externally? Would it be enough in order to encourage companies to increase safety and health for workers exposed for awkward postures and movements while working? Could it be possible to adapt a more pre-emptive aspect in safety work? Would a greater focus in safety culture and prevention principles be a way to go? A lot of questions remain yet to be answered and we hereby invite you to share your knowledge and experiences in this matter.

# Teaching ergonomics to dental students at the University of Eastern Finland

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*Dental work is mainly static work demanding accuracy and concentration. The work is physically, mentally and socially loading and it causes often musculoskeletal disorders. Dental work contains also physical, chemical and biological risk factors. Workload and risk factors can be diminished by ergonomics. It is very important to learn an ergonomic way to work in the very beginning of a dentist career.*

Keywords: Ergonomics, workload, dental student, dentist

## 1. Introduction

Work can effect physically, mentally and socially. The effect of the workload depends on the load's quality, duration and force, and worker's personal features (Lindström et al., 2005). Workload is not only harmful, with rightly sized load it can support the ability to function (Lindström et al., 2005, Lehtelä et al., 2011).

Physical workload can be divided into heavy dynamic work, manual materials handling, static postural work and repetitive work (Louhevaara et al., 2005). Dental physical workload is static and quite constant in common dental tasks. Although the dental operation changes, there is no significant difference in posture and muscle activity on how the work is done (Valachi et al., 2003, Engström et al., 2005, Murtomaa et al., 2014). In static work blood flow to the muscles decreases which causes a shortage of nutrients and increasing waste products in the muscles (Louhevaara et al., 2011). Static work can cause musculoskeletal disorders (Louhevaara et al., 2005). Common dentist musculoskeletal disorders are in the neck, shoulders, hands and back area (Murtomaa et al., 2003, Murtomaa et al., 2014, Bedi et al., 2015). In a recent meta-analysis, the prevalence of musculoskeletal disorders of dentists were 60-87.2 % (Bedi et al., 2015).

Dentist work can be mentally and socially loading. Intensive work with people can cause workload (Murtomaa et al., 2003, Engström et al., 2005, Hakanen et al., 2011). Especially young dentists are exhausted from work. They suspect their own ability to manage the work and also negative feelings that they may have with patient communication cause workload. A study shows that good work environment reduces emotional workload (Perhoniemi et al., 2011). Especially in public health organisations dentist work contains too high job demands and amount, and a low possibility to influence those. Also unclarity of work roles and low support from the superior can cause workload (Murtomaa et al., 2003, Hakanen et al., 2011).

The pair work of a dentist and dental assistant sets its own challenges to the work. (Engström et al., 2005, Hakanen et al., 2011, Murtomaa et al., 2014). It is important that dentist and the dental assistant can work fluently together, both have good vision to the operation area and communication works (Engström et al., 2005, Murtomaa et al., 2014).

The most common risk factors in dentistry are noise, different kinds of chemicals and contagious diseases (Murtomaa et al., 2014). Noise sources are high-speed drills, ultrasonic scalers

and suction tubes, which can cause hearing loss and can be mentally disturbing (Rytönen 2005). The most allergenic chemical is methacrylate, which is in cavity filling materials (Murtomaa et al., 2003, Jolanki et al., 2005, Henriks-Eckerman 2008). Biological risk factors are different kind of infection diseases (Pääkkönen 2008).

Teaching ergonomics in dental school is commonly limited. However it should start during dental school and continue through professional life so that a dentist would be more healthier and productive worker (Valachi et al., 2003). It is very important that dental students learn and have guidance for adequate postures to work and learn factors of good work environment in clinical practices (Murtomaa et al., 2003, Diaz-Caballero et al., 2010). Workload can be diminished with proper working practice, working postures, tools, work environment and work organizing (Murtomaa et al., 2003, Valachi et al., 2003, Roivainen et al., 2007, Louhevaara et al., 2011, Murtomaa et al., 2014).

The Institute of Dentistry at the University of Eastern Finland has taken into account ergonomics when the new dental clinic was planned. There is unique operational environment. The teaching environment (Figure 1), where dental students train manual skills, is identical to the clinic where the patients are treated in real life. A fully equipped dental unit gives the best opportunity for ergonomics training, where ergonomics teacher gives guidance for an ergonomic way to work. The Institute of Dentistry at the University of Eastern Finland has a teacher who teaches ergonomics to dental students.



Figure 1. Teaching environment of manual skills.

## 2. Objectives

The aim is to present how ergonomics is taught to dental students at the University of Eastern Finland.

## 3. Description of the dental students' ergonomics education

University of Eastern Finland dental student ergonomics education contains teaching of ergonomics from third to fourth year. The teaching contains lectures, guidance in small groups, photographing and video recording of working positions in manual skills training and group tasks of ergonomics.

### 3.1. Ergonomics lectures and group tasks

In the third year of dental school the dental students have a lecture, which contains information of ergonomics, dentists' physical, mental and social workload factors, risk factors, musculoskeletal disorders and how to prevent them. This lecture gives a foundation of the importance of dentists' ergonomics. The fourth year students make group tasks of workload and

risk factors and deepen the knowledge of them. The group tasks are presented to the whole course.

### 3.2. Ergonomics practising

In the third year of dental school the dental students start to train dentist manual skills. They train mostly in pair. In every practise, where it is possible, the ergonomics teacher gives guidance of an ergonomic way to work and photographs students' work with a tablet (Figure 2). Photographing is a very illustrative and quick way to give feedback of the posture. A student can see from the photograph his/her posture, which helps the student to understand how the posture should be improved. After guidance of the working posture and method, a new picture is taken, so that student can see the improvement of those. Ergonomics is also a part of cariology manual skill exam, where working postures are evaluated.



Figure 2. Photographing and video recording of working postures.

The fourth year dental students are video recorded (Figure 2) in the dental clinic where the real patients are treated. The ergonomics teacher video records every student when they are treating a patient and writes down her observations to workload form of the working postures and methods. After the video recording the dental student makes an appointment with the ergonomics teacher where the video is watched. Before the appointment the dental student evaluates his/her work and fills up a workload form. The workload form consists working postures, patient adjustment, working methods, work environment, etc. In the appointment the dental student and ergonomics teacher analyse the video and workload forms and set targets for the development of ergonomics in the future. After everyone has done that, there is a practise session in the operational environment where everyone targets of development are seen in practise.

In the fourth year of dental school the dental students get dental loupes which give better sight of the operation area. With dental loupes the working posture improves because of better vision, but it takes practise before getting used to them. When the dental loupes are given to dental students, there is a manual skill practise where ergonomics is guided (Figure 3).



Figure 3. Dental students' manual skill practise using dental loupes.

#### 4. Discussion

Dental work is loading and causes often musculoskeletal disorders. Dentist work contains many workload factors whose influence is important to diminish. In order to diminish workload and musculoskeletal disorders, workload factors and how personal actions affect those must be understood. It is very important to learn an ergonomic way to work in the very beginning of a dentist career. Thus education of ergonomics to dental students is important. With better understanding of ergonomics and guidance in practise comes a good base to improve ergonomics skills. The University of the Eastern Finland educates dentists who can transfer learned ergonomics skill into practical work and have the ability to develop their own work.

#### Acknowledgements

Photographs by Tanja Toivanen

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## *Session 2C Management, leadership, team work, Part I*

### **Monday 15<sup>th</sup> August**

Marjaana Lahtinen: Good practices and developmental needs in workplace change management

Mira Turunen: Managers need more knowledge about ergonomics

Seppo Tuomivaara: Connections between agile way of working, team coherence and well-being at work

Carolina Souza da Conceição: Developing a framework to transfer knowledge from operations into engineering design projects: understanding the knowledge management challenge



# Good practices and development needs of workplace change management

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*The aim of the case study was to describe and analyse a workplace change process in the context of relocation from an open office to a multi-space office. With respect to the theories of organizational change, the process fulfilled many of the success factors of change management: a shared understanding of the change goal, management commitment, employee participation, and the facilitation of readiness for change. However, real opportunities to influence design solutions and the co-ordination of simultaneous technical, operational and psychosocial processes were criticized. Despite the criticism, 73% of the personnel regarded the new multi-space office as positive.*

Keywords: workplace change management, multi-space office, user experience

## 1. Introduction

Today's social regulations on energy conservation and excessive property expenses are driving organizations to search for cost savings through efficient utilization of space. New multi-space (activity-based) office solutions have been developed to achieve these goals. The objective is to develop a flexible, efficient solution consisting of different spaces for different types of activities and the various phases of work processes: open spaces for team work, silent places for tasks that require concentration, places for undisturbed phone calls, and formal and informal meeting areas. In addition to the savings in property expenses, organizations expect the multi-space concept to promote a new working culture, characterized not only by fluent communication and knowledge transformation between employees, but also by higher creativity and productivity.

In order to achieve these goals, workspaces, ways of working and working culture must be developed simultaneously. However, experience has proven that organizational and workplace change processes seldom proceed concurrently. In practice, they are often developed in different projects with no mutual dialogue. Previous research on multi-space offices has highlighted the importance of participatory workplace design and change management (e.g. Laframboise et al. 2003, Vischer 2008, van der Voordt et al. 2012, Ruohomäki et al. 2016) in workplace change processes. A successful change process is vital when striving for a work environment that promotes well-being and productivity as well as positive changes in the working culture.

## 2. Objective

The aim of the present case study was to describe and analyse a workplace change process, focusing on the success factors of change management in the context of a relocation from an open office to a multi-space office. The case was chosen because it exemplifies the prevailing best practices, and may demonstrate learning points for practitioners and reveal further research needs.

### **3. Material and methods**

The case organization was a government-owned enterprise that provides facility management services. The starting points for the workplace change were the government premises strategy and the case organization's own strategic goals and work environment vision defined by the management. In Finland, the new government premises strategy assigns multi-space offices as the standard way in which to organize office facilities. According to the strategy, the target for renovated office space is 18 m<sup>2</sup>/FTE, and for newly constructed buildings 15 m<sup>2</sup>/FTE. The change aimed to achieve a cost effective space solution and, at the same time, a work environment that supports an interactive working culture and multi-locational, mobile work. The workplace change project was launched in January 2013 and commissioned in January 2015. The case study was implemented 14 months after commissioning.

The research methods comprised a questionnaire study for the personnel of the office (n=191; response rate 57%) and theme interviews of key persons (n=11). Documentary material (e.g. project plan, layouts) was used as complementary qualitative data. The authors of the present article acted in the role of researchers, and did not consult in the workplace change process.

### **3. Results**

#### **3.1. Workplace change process**

The workplace change process (Figure 1) was implemented by a multisectoral project organization. The change process was managed by a steering group that comprised representatives from top and middle management. A workplace management group, made up from representatives from human resources, facility management, the ICT unit, financial administration, and substance departments formed one party responsible for co-ordinating the process. Other working groups managed, for example, communication during the change process, and specialists and architects from a workplace development consultancy also provided support.

The process was divided into four phases: Planning a workplace concept that supports the organization's strategy, architecture and interior design, construction, and finally, commissioning and follow-up (Figure 1). The forums for change management and personnel participation were a workplace survey, key person interviews, various workshops and a seminar for both management and personnel, excursions, and a follow-up survey. Communication was supported by briefings, bulletins and the intranet. The workplace survey and most of the events were organized and facilitated by the workplace development consultancy. In addition, the workplace management group independently arranged some discussion forums and the follow-up survey.

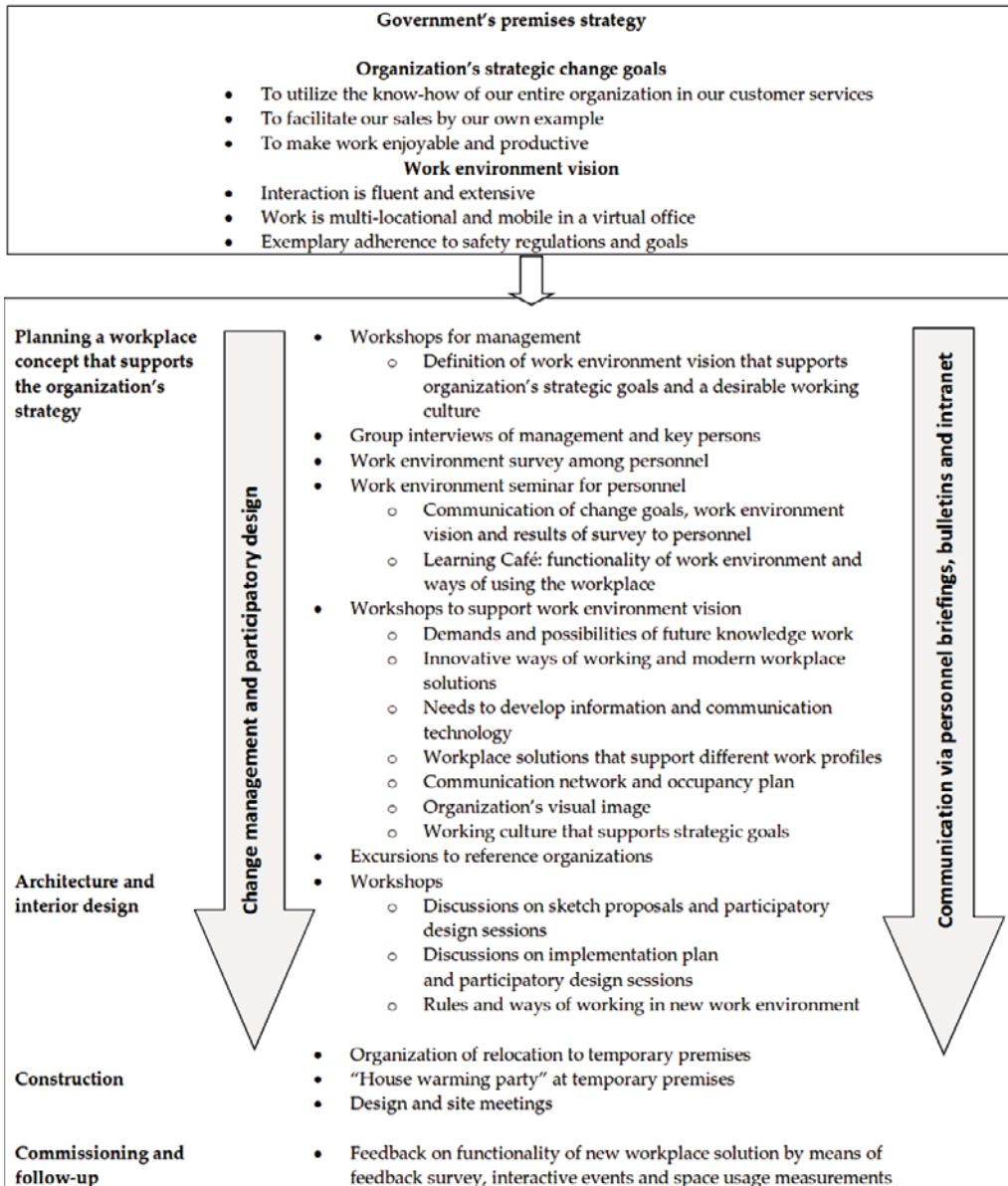


Figure 1. Workplace change process

### 3.2. Users' experiences of the workplace change process

The personnel regarded the workplace change as well-grounded (76%) and logical and easy to understand (81%), and assessed the dissemination of information during the change process as quite positive (Figure 2). In contrast, real opportunities to influence design solutions were somewhat criticized. However, post-occupational evaluation revealed that 63% of the respondents agreed that the functionality of the spaces had improved. All together 73% of the personnel regarded the new multi-space office as positive.

According to the key person interviews, the commitment of the top management to the change goals was strong. The roles and responsibilities of the different working groups in the

project organization were considered quite clear but some of the interviewees strongly criticized the co-ordination and general management of the project as a whole. Lack of co-ordination was seen as having increased confusion and time pressure during the process.

*“Nobody really managed the project. There was no real distinct project leader to co-ordinate the process and lead it from a higher level.”*

Despite the investment in change management and the development of the working culture during the process, some key persons interviewed felt that the change was mainly managed as a technical process, and that the social and psychological perspective was neglected.

*“The main priority was the schedule of the construction project ... it should have been led more from the change management perspective.”*

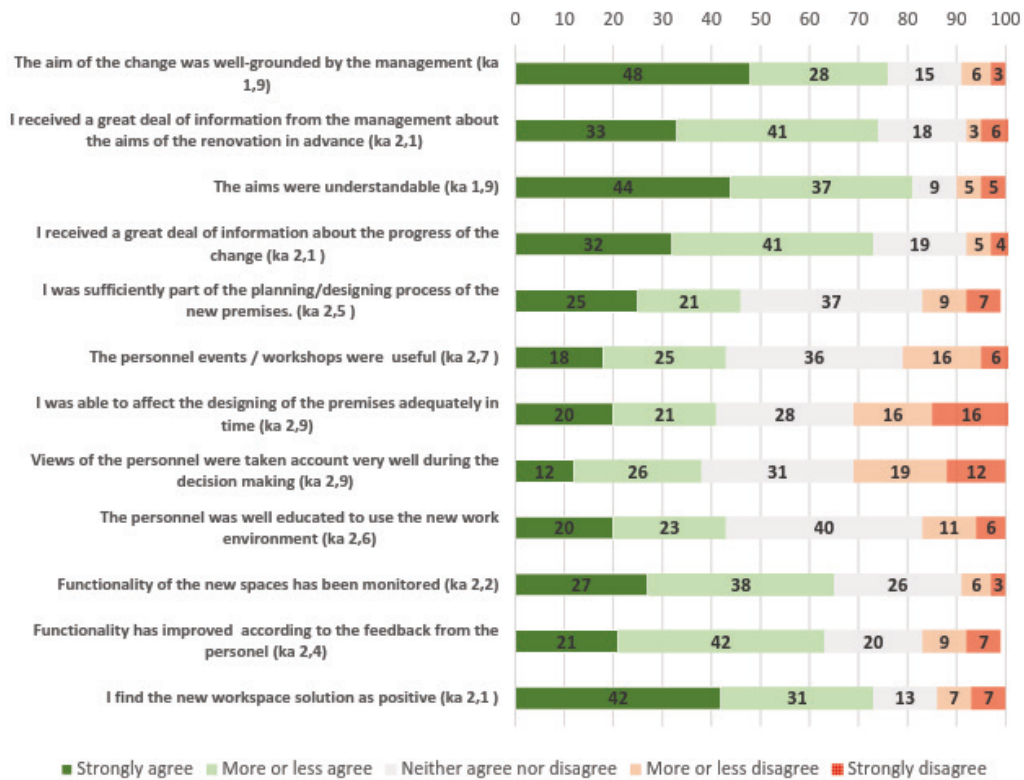


Figure 2. Users' experiences of the workplace change process

### 3.3. Perceived effects of workplace change

The workplace change improved the sense of communality and interaction (69% improved, 22% weakened; scale 1=substantially improved to 5=substantially weakened), which was in accordance with the organization's work environment vision. In addition, it improved the comfort (79% improved/10% weakened) and functionality of the premises (59%/17%). Many of the respondents reported that the effectiveness of their work (40%/11%) and their well-being at work (46%/14%) had improved. Interestingly, assessments concerning privacy were bidirectional, 32% regarded privacy as having deteriorated, whereas 36% estimated that it had improved due to the change. Many of the respondents felt that the workplace change had no impact on them.

#### 4. Discussion and conclusions

The theories of organizational change highlight several success factors as prerequisites for an effective change process: a shared understanding of the goal of the change, management commitment, enhancement of readiness for change, employee empowerment and participation with real decision power, and clearly defined roles (Salminen 2000).

With respect to the theories of organizational change, many of the success factors of change management were fulfilled in the case organization's process, but challenges and needs for development were also recognized. The personnel considered the workplace change well justified, and understandable. The commitment of the top management was strong. In addition, workshops and excursions were organized to facilitate the readiness for change and development of the working culture. Post-occupancy evaluation and other measures to the develop work environment were also carried out. However, although the project organization was well-structured, in practice a number of problems emerged, especially in the co-ordination and management of the process as a whole, and in the transitions between different phases of the process. Furthermore, despite the effort to involve users in the process, the personnel was quite critical about the extent to which they were actually able to influence the design solution. A difficult issue in the development of participative action is how to make the actual opportunities to influence design solutions meet the personnel's expectations.

Although many of the perceived impacts of the workplace change process were considered positive, almost a third of the respondents assessed that privacy had deteriorated. This is a typical problem, referred to also in previous research concerning multi-space offices (e.g. De Been and Beijer 2014). When implementing multi-space offices, the starting point in the design process should be the users' work requirements, and in the case of knowledge-intensive work in particular, attention should be paid to design solutions that improve privacy and the ability to concentrate in addition to communication.

In workplace change, the challenge is to integrate and manage many simultaneous technical and operational, as well as social and psychological processes. There is an obvious need to develop good practices and operational models for change management which unify an organization's strategic and workplace change processes, as well as genuinely utilize user-centric knowledge in the development work.

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# Managers need more knowledge about ergonomics

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*The objective of this study was to describe the ergonomic knowledge of managers working in woodworking industry and describe how the ergonomics has been taken into consideration in the operation of the company. The data was collected by questionnaire and theme interviews and was analysed by using deductive content analysis. According to the data the managers were the most familiar with physical ergonomics. Cognitive ergonomics was seen important due to the increased use of the information technology, but it had been poorly utilised. The advantages of the organisational ergonomics were also identified, but the managers did not have time for developing the cooperation of the work processes.*

Keywords: ergonomics, managers, knowledge of ergonomics

## 1. Introduction

Work and working life are changing continuously. Workplaces are compelled to consider work from a new perspective due to global markets, the development of information and communication technology, changes in the economy and the needs of people (Mäkitalo & Paso 2008, Dul et al. 2012).

International Ergonomics Association, IEA, published a strategy for human factors/ergonomics in 2012. The paper indicated that ergonomics as a comprehensive discipline and profession provides solutions for the challenges business and society faces, but the benefits and opportunities of ergonomics are not known among managers and other decision makers. As a consequence the managers and decision makers do not exhibit a strong demand for ergonomics (Dul et al. 2012).

Mäkinen (2001) found that understanding of ergonomics which is formed during the polytechnic studies is rather constricted. Both building technology and rehabilitation students think that education does not give structured and a broad understanding of ergonomics and its benefits are underestimated during the education of the future experts and developers for the work life (Mäkinen 2001).

Ergonomics focuses on two closely related outcomes, overall system performance and human well-being. Ergonomics can help to design work, environments, organisations, tasks and products in a way that takes into consideration the needs, abilities and limitations of the employees (Koningsveld 2009, Dul et al. 2012). Ergonomics can affect business and financial objectives of organisations, such as sales and profits (Dul & Neumann 2009, Dul et al. 2012).

Ergonomically correct and well-designed system improves productivity, efficiency, quality and profitability. It reduces costs and increases employee's health and safety as well as improves an employee engagement to the company (Koningsveld 2009, Dul et al. 2012). Improved production and product quality, increased flexibility in production, the higher security

of supply, as well as employee and customer satisfaction improves competitiveness. In addition, the company's position in the labour market will be strengthened (Koningsveld 2009).

## **2. Objectives**

The objective of this study was to describe the ergonomic knowledge of managers working in woodworking industry and describe how the ergonomics has been taken into consideration in the operation of the company.

## **3. Methods**

### **3.1 Subjects**

A total of 13 immediate managers of a company in the woodworking industry participated into this study. Their mean age was 50 (range 37-63) years. They had been working in the woodworking industry company on average 18.9 (range 5-47) years. They had been working in managerial duties on average 17.5 (range 5-35) years and they had 28 (range 5-41) subordinates on average.

### **3.2 Questionnaire and theme interviews**

The data was collected by questionnaire and theme interviews. The questionnaire included respondents background information and open questions of perceptions of physical, cognitive and organisational ergonomics as well as how the ergonomics has been taken into consideration in the operation of the company. With the help of a theme interviews the researcher was able to deepen the ergonomic knowledge of managers and find more about their sentiments in ergonomics.

### **3.3 Analysis**

The qualitative data was analysed using deductive qualitative content analysis. The transcribed text was read through several times by the researcher to obtain a sense of the whole data collected. The researcher created themes based on the research questions. After that similarities between the concepts were grouped and combined with the sub-category, which was named for its content descriptive title. Formed sub-categories were abstracted to upper categories and eventually to main categories.

## **4. Results**

According to the results of the study the immediate managers were the most familiar with the physical ergonomics. The physical ergonomics had been taken into consideration in most of the company's operations. Cognitive ergonomics was seen important due to the increased use of the information technology, but it had been poorly utilised in the company. The advantages of the organisational ergonomics were also identified, but lack of employee resources, the organisations did not have time to develop the cooperation and quality of the work processes.

### **4.1 Physical ergonomics**

The immediate managers were the most familiar with the physical ergonomics and it had been taken into consideration in the most of the operations inside the company. On managers opinion physical ergonomics is the reduction of physical load factors by designing work environment, workplace layout, working methods, work equipment/ device and optimal working position. Noise was also considered to be a part of physical ergonomics.



By paying more attention to the physical ergonomics the company had improved safety at work, reduced the amount of manual work and the physical work had become lighter. The role of occupational health care at ergonomics issues was unclear. Managers hope that the use of ergonomics experts increases in the organisation, it would reduce the costs that are caused by sick leaves. Co-operation with the ergonomic experts during planning phase of the operations would reduce the amount of errors. It was also seen that this would reduce the costs caused from changes during operational phase that originated from the planning errors.

#### **4.2 Cognitive ergonomics**

Cognitive ergonomics was seen important among the managers due to the increased use of the information technology, but it had been poorly utilised within the organisation. The concept of cognitive ergonomics was unfamiliar. In managers opinion, cognitive ergonomic is mainly the interaction between human and computer. It was seen as users interface and the usability of electronic devices, user-friendly software, data presentation and processing. Also mental stress was seen as a part of cognitive ergonomics.

The development of cognitive ergonomics has been reflected in increased guidelines, work instructions and increased electronic communication. The usability and ease of use have been an important criterion for the introduction of new IT systems. The respondents believed that cognitive ergonomics opportunities and benefits were poorly utilised. They thought that cognitive ergonomics must be taken into account more in system design. For example, the distribution of information sharing could be further developed.

#### **4.3 Organisational ergonomics**

Organisational ergonomics as a concept was unfamiliar. The advantages of the organisational ergonomics were identified, but lack of employee resources, the organisations did not have time to develop the cooperation and quality of the work processes. Managers saw organisational ergonomics as work design, production and service development, personnel planning and planning of a work shift.

The respondents' experience of the task of designing and the development of work processes, production and services was a challenge, because the company did not have a clear long-term vision and strategy for action. Without vision it was difficult for managers led their subordinates.

### **5. Discussion and conclusions**

According to immediate managers, the physical ergonomics was paying attention to health and safety at work and to reduce the physical load factors. Cognitive ergonomics was an interaction between the information technology systems and the employee. It was the usability of devices and user interfaces and user- friendly as well as the presentation and processing of data related issues, which were also linked to mental load at work. Organisational ergonomics was part of management such as work assignment design, the development of work processes and production, as well as personnel planning and rota planning.

The immediate managers thought that physical ergonomics had been considered the most in the company. On the other hand they thought that there was further development to be done, especially in production lines, where the need of support and amount of sick leaves were high due to musculoskeletal diseases. Cognitive ergonomics has sought to draw attention to the design of information technology systems, but despite this, all systems did not support the best possible

everyday work flow. Issues related to the organisational ergonomics were a central part of the superiors work life. Unclear vision and strategy for the company's operations, as well as limited resources complicated the development of work processes, function modules, and work experience and quality of cooperation.

Overall, the perception of the ergonomics was very concise and it focused on the physical ergonomics. Also the concept of physical ergonomics was familiar, while the cognitive and organisational ergonomics as a concept were unfamiliar. The cognitive and organisational ergonomics contents the managers were familiar with were considered as important issues at work. Co-operation with ergonomic specialists must increase. Using an ergonomics expert at the planning stage reduces the number of errors committed in the design and correction of errors afterwards.

According to the study, the immediate managers were unaware of all advantages and possibilities of ergonomics and therefore they were unable to fully utilise them. Raising awareness requires the networking between ergonomics experts and decision makers such as managers by participating in product or service design process. Also education of ergonomics needs to be increased in universities and polytechnics. Ergonomics would be recommended to at ergonomics into industrial and management discipline. Interdisciplinary research of ergonomics in business would increase the awareness of the impact ergonomics could have on productivity.

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# Connections between agile ways of working, team coherence and well-being at work

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*We investigated how agile ways of working are associated with team coherence and well-being at work. We examined four case organizations in which agile methods had already been in place for some years. The survey conducted concerned perceived agile work, team coherence, and experienced workload. The results indicate that team coherence is associated with perceived agile ways of working in regard to the aspects of continuous improvement and customer relations. They also show that agile ways of working generate sources and potentials for well-being at work from the viewpoint of stressful work, job satisfaction and aspiration.*

Keywords: Agile practices, Team coherence, Workload

## 1. Introduction

Agile work has become particularly popular in modern society. Agile methodologies originate from software process improvement and have gained popularity. They are now also being applied to other types of work. Systematic research on agile methods and well-being at work is scarce. However, a few studies exist on agile methods, stress, motivation, and job satisfaction. In our study we investigated how agile ways of working are associated with team coherence and well-being at work.

The Agile Manifesto (Agile Manifesto 2013) consists of 12 principles that describe agile ways of working. These principles hold many promises in relation to well-being at work, such as: 'promotion of sustainable pace'; 'best results emerge from self-organized teams'; and 'teams regularly consider when and how to make improvements'. However, balancing resources and workload is a labour-intensive and error-prone task, and thus poses a risk of self-intensification and a threat to the work-life balance. The 12 agile principles have been implemented through various practices. The relevance of the principles differs according to applied methods (Känsälä and Tuomivaara 2014).

Like all management practices, it is the way in which the practices are applied that determines the connections between agile methods and well-being at work (see Porschen 2012). Sherehiy (2008) suggests that if management implements agile strategies in a way that positively affects job autonomy, job uncertainty, and employee collaboration, it is more likely that employees will be able to perform their job in an adaptive, flexible way. It has also been shown that an agile team may only attain its flexible way of working through autonomy (Briand and Hodgson 2011).

Sense of Coherence (SOC) is a concept developed by Antonovsky (1987), and is assumed to be useful when explaining successful coping with stressors. SOC consists of three components: comprehensibility, manageability and meaningfulness. Team Coherence (TC) includes an implicit understanding of shared purposes and goals as well as each members' interests and aims. TC is linked to individual goals, a repertoire of team task strategies, and compatible team member

role expectations (Kozlowski et al. 1996). It can be also defined as mutual support, group cohesiveness, trust, responsibility for team goals, and team reciprocity. TC then allows team members to self-manage during periods of intense task engagement. A coherent team is able to adapt and adjust to unexpected changes and uncertainty, and sustain its productive functioning.

We define well-being at work as the meaningfulness of work, optimal strain at work, and fluency of (team) work processes (Tuomivaara et al. 2013). In this study we focused on strain and experiences of meaningfulness and autonomy of work. From the viewpoint of strain, well-being at work means a balance between one's tasks and capabilities (Karasek 1979). Workload is optimal when work matches the worker's capabilities both qualitatively and quantitatively. Job satisfaction and aspiration indicate the positive aspects of work.

Our hypothesis was that when agile principles and practices are experienced by team members, the team's TC will also be high. In addition, we supposed that agile principles and practices would promote the positive aspects of work and decrease the experience of workload and stressful work.

## 2. Material and methods

We examined four case organizations in which agile methods had already been in place for a few years. These organizations represented innovative companies in the front line of digitalized services, products and processes. Teams operating within an agile context are characterized as multifunctional, dynamic, and co-operative. The questionnaire was conducted as a web-based survey, and focused on perceived agile work, team coherence, job satisfaction, aspiration, experienced workload, and the stressfulness of work. Sixty-eight participants answered the survey: 12 female and 56 male. The participants belonged to the following organizations: organization A 15, B 13, C 29, and D 11 participants.

The measurements of the perceived agile ways of working and team coherence are still in progress. The items of agility were based on ideas from the Agile Manifesto and the PAM Scale (see Tuomivaara et al. 2015). The survey contained twenty one statements concerning agile practices, and the response options to statements were on a five-point Likert scale: strongly disagree = 1, to strongly agree = 5. The agile practices observed here represented four dimensions of agile ways of working. The dimensions and examples of the statements are illustrated below.

Continuous orientation practices: "Our team works in short recurrent 1 – 5 weeks periods"; Incrementation: "A working product or its increment is the primary measure for the progress of work"; Continuous improvement: "All team members actively participate in gathering lessons learned about our working methods"; and Customer relations: "The needs and hopes of the customer (internal, external) direct the development process well".

Team coherence included eight items, using a scale of 1 = almost always, to 5 = almost never. Examples of the questions are: "Has it happened that people in your team, on whom you counted, disappointed you?" and "How often do you feel that your work in the team has no clear goals?"

Workload was measured using seven items using the same scale as the agile statements. Examples of the statements are "The amount of work is constantly too big", "My work is too challenging". The stressfulness of work was elicited by one question: "Is your work stressful?", using a scale of 1 = not at all, to 5 = very much.

Job satisfaction and job aspiration were asked by three questions, for example: "How satisfied are you with your work?", using a scale of 1 = very much dissatisfied, to 5 = very much satisfied. Job aspiration was addressed by asking: "Are you enthusiastic about your work?", using a scale of 1 = almost never, to 5 = almost always.

All the measures demonstrated tolerable internal consistency, ranging from 0.63 to 0.86. The connections between agile ways of working, coherence and well-being at work were analysed via hierarchical multiple regression in which the participants' organization, age and gender were controlled in the first step.

### 3. Results

The results are shown here first as correlations between agility, coherence and well-being at work factors, and second, as regression tables indicating the coherence and well-being factors as dependent variables, and agile factors as independent factors.

#### 3.1. Connections between sum factors

As Table 1 shows, the factors for the perceived agile way of working (variables 1–4) had a statistically significant connection to the factors for team coherence and well-being at work (variables 5–9) as follows: incrementation associated with job satisfaction as well as with job aspiration.

When the principle of incrementation emerged, job satisfaction and aspiration were also experienced. Continuous improvement was associated with all the well-being of work factors, and customer relations with job aspiration and the stressfulness of work. Continuous orientation practices were not associated with any of these.

Table 1: Correlations between agile factors, team coherence, job satisfaction, job aspiration, and workload (n = 68)

Variable	M	SD	1	2	3	4	5	6	7	8	9
1. Incrementation	4,0	,63	1	.18	.33	.48	.25	.34	.46	-.20	-.13
2. Continuous orientation	3,0	,45		1	.23	.25	.11	.07	.14	.12	.18
3. Continuous improvement	3,5	,77			1	.44	.42	.56	.49	-.29	.33
4. Customer relation	3,3	,89				1	-.03	.12	.35	-.19	.48
5. Team coherence	3,8	,57					1	.59	.58	-.27	-.34
6. Job satisfaction	3,8	,77						1	.56	-.51	-.27
7. Job aspiration	3,9	,73							1	-.39	-.24
8. Workload	3,0	,85								1	.69
9. Stressfulness of work	2,7	,93									1

Note: On the table, correlation coefficients over .26 are statistically significant at a level of  $p < .05$ .

#### 3.2. Agile dimensions as predictors of team coherence and well-being at work

TC was predicted by agile ways of working, when gender, age and organization were controlled. The dimensions of agile work that statistically significantly predicted TC are the continuous improvement and customer relation dimensions. Active continuous improvement increased TC but strong customer relations decreased it when the effect of continuous improvement was controlled. (Table 2)

Positive experiences of work (satisfaction and aspiration) were also predicted by active continuous improvement. In addition, incrementation was a predictor of job aspiration. (Table 2)

Table 2: Hierarchical regression analysis of controls and agile factors in team coherence, job satisfaction, job aspiration, workload, and stressfulness of work.

Variable	Team Coherence		Job Satisfaction		Job aspiration		Workload		Stressfulness of work	
	$\Delta R^2$	$\beta$	$\Delta R^2$	$\beta$	$\Delta R^2$	$\beta$	$\Delta R^2$	$\beta$	$\Delta R^2$	$\beta$
Step 1: Control	.04		.08		.06		.06		.25*	
Male, dummy		.06		.18		.10		-.22		.06
Age		.04		-.14		-.11		-.03		-.12
Firm 2, dummy		.09		-.16		.02		.04		-.17
Firm 3, dummy		.11		.00		-.16		.38†		.27
Firm 4, dummy		.21		.05		.06		-.10		-.31†
Step 2: Direct effects	.33*		.33*		.32*		.00		.24*	
Continuous orientation		.03		-.09		-.03		.25†		.26†
Continuous improvement		.68*		.63*		.43*		-.24		-.42*
Incrementation		.25		.22		.30†		.09		-.07
Customer relations		-.38†		-.14		-.01		-.16		.51*

Note: \* $p < 0.01$ ; † $p < 0.05$ ; ‡ $p < 0.10$ .

Workload, in contrast, had no statistically functional regression model, even though continuous orientation practices seemed to be statistically significant predictors and increase workload.

The experience of the stressfulness of work can be predicted by continuous orientation, continuous improvement and customer relations. Continuous orientation and customer relations increased the experience of stressful work, whereas continuous improvement decreased it.

#### 4. Conclusions

The results indicate that team coherence is associated with perceived agile ways of working. Thus, this data confirmed our first hypothesis. The results also show that agile ways of working generate sources and potentials for well-being at work. Continuous improvement in particular proved to be important for both team coherence and positive aspects of work (job satisfaction and job aspiration), and diminished the experience of the stressfulness of work. On the other hand, continuous orientation and customer relations seemed to have negative effects on the experience of the stressfulness of work. Thus, our hypothesis that agile ways of working decrease the experience of stress and workload was not supported.

Some limitations of the study were the inadequate number of participants, their different organizational backgrounds, and the way in which they were unevenly divided among the organizations. Even though the organization was controlled in the analysis, some powerful psychosocial aspects of work may have remained. Our qualitative data (interviews in the organizations) suggest that these might be in some cases, limited possibilities to set the appropriate goals for each period by the team, the practice is seen still in early stage, motivating customers to new way of working is challenging or customer is far from one's own job. This, however, requires more research. The measures are also under the construction and can cause some error.

However, these results may be understood as preliminary and references to possible effects of agile ways of working on well-being at work and TC. They also confirm results obtained in previous research. The implications of these results are that continuous improvement practices make teams more coherent and in this way able to self-manage better, and allow them to

experience more job satisfaction and aspiration. At the same time we have to be careful in how we implement continuous orientation practices and form customer relations.

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# Developing a framework to transfer knowledge from operations into engineering design projects: understanding the knowledge management challenge

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*Knowledge from operations offshore is valuable when designing new rigs or optimizing existing ones. But, how to capture operational knowledge and experiences from offshore units, and how to transfer this knowledge to the design of new units and optimization of existing ones? To address these questions, we structured a framework that helps mapping and understanding the existing challenges within knowledge transfer in the oil offshore context. This is the basis for a set of requirements to improve the knowledge transfer process.*

Keywords: Knowledge transfer, Work systems, System ergonomics, Offshore sector

## 1. Introduction

Capturing, generating and distributing qualified knowledge are recurrent challenges in the knowledge transfer process. In geographically dispersed organizational structures, like in the offshore sector, the need for a knowledge transfer system that overcomes the existing communication barriers is reinforced. The highly complex, and sometimes hostile, environment that this sector operates in creates a unique working environment for employees. The difference, both geographical and workwise, between the offshore operators and the onshore staff reinforces the need for a knowledge transfer system that overcomes the existing communication barriers.

Offshore operations are a potential knowledge source to be exploited for optimizing existing and new units in terms of costs, safety and production effectiveness. However, it is acknowledged that there are a number of obstacles to set up efficient knowledge transfer processes (Ranjbarfard et al. 2014). Incidents and accidents of operating rigs have created a focus on constant learning and optimizing risk, health and safety. However, the integration of human factors and ergonomics expertise and knowledge into the design of rigs is poor or missing (Johnsen, 2014). Also, there is a clear gap on the knowledge transfer from offshore to onshore when it comes both to improvements and optimization of design, and on common knowledge derived from action. There is a continuous need for sharing this knowledge on the offshore industry through a coherent and systematized approach.

### 1.1. The challenges of transferring knowledge within the oil drilling industry

The importance and use of knowledge exchange systems increases when employees and managers work across distributed organizational structures as in the offshore oil industry (Gressgård, 2014). But transfer of knowledge from one context to another implies the transformation of both context and knowledge content. Recurrent themes in the literature are the challenges of generating qualified knowledge, capturing and distributing this knowledge, and applying it in order to support the knowledge transfer into R&D in a highly distributed organizational context.



A first theme is related to the positive value of taking the workers' experience into account in the design of future work systems and how to capture the knowledge arising from the work activities. Many problems can be solved by applying existing knowledge from operations, which is valuable when designing new operating units (Conceição et al., 2012). However, there are still serious challenges in capturing operational knowledge and experiences from offshore units and transferring this knowledge to design of new units.

Another main theme relates to the need of transforming and translating the knowledge. Engineering design is a social process, influenced by different groups of people with different perspectives and values. Transfer of knowledge from one context to another implies the transformation of both the target context and knowledge content (Yakhlef, 2007). This transformation takes place through processes of translations, negotiation and bargaining among actors.

A last theme to highlight is regarding the capabilities of knowledge transfer systems. A general challenge is the reliance on the knowledge systems and thus on the capability of these systems. Information technology solutions are not always the best strategy to support knowledge management (Vianello and Ahmed, 2012). But when alternative channels of sharing and transferring knowledge are hindered by geographical distances, the knowledge transfer systems become even more important.

## **1.2. Objectives**

Relating to the challenges identified in the literature and to the analysis of exploratory interviews in an oil drilling company (Conceição et al., 2015), we suggest a framework for knowledge transfer from operations into design. In our framework we consider capturing, transforming and transferring as parts of the whole process of knowledge transfer. This paper focuses on the diagnosis phase and aims to present this framework and how it helped structuring and identifying the challenges and gaps in the process, leading to a set of requirements to face these gaps.

## **2. Conceptual framework for the study**

We base our approach mainly on the notion of work systems and the co-existence of multiple work systems (Alter 2008), and on a systems ergonomics perspective (Wilson, 2014), treating the system as holistic. By work system we mean a system in which human participants and/or machines perform work activities using information, equipment, technology, and other resources to produce products and/or services. We understand that the main is the knowledge transfer between two main different work systems: 1) the offshore work system, meaning the rigs in operation, and 2) the onshore work system, meaning the designing teams. The focus is on the understanding of interactions between people and all other elements within a system, and design in light of this understanding.

Along the research project, we are building up a framework to transfer knowledge from operations into design (Figure 1). A framework provides a general set of variables that can be used to analyse and it helps generating the questions that need to be addressed when conducting the analysis (Ostrom, 2011). In our case, the framework helps in better understanding and addressing the knowledge transfer challenges.

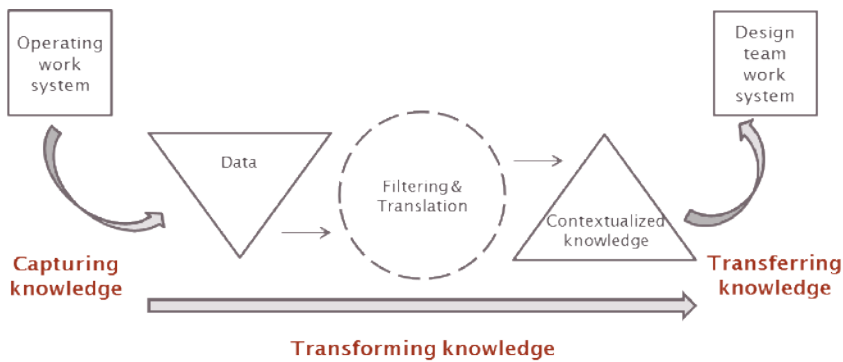


Figure 1. Knowledge transfer framework

The basic concept behind the framework is a three-step process for the knowledge transfer from the source of the knowledge and experiences to the receiver of it: 1) capture, 2) transform, and 3) transfer. The whole system needs a continuous functioning; information has also to be registered and “pushed” into the system to contribute to the full cycle of knowledge transfer.

The aim of the first step is to capture potential knowledge from the experiences of the operators that can be codified afterwards. However, which knowledge to capture? There is a need to account for this “invisible work” part of operating activities and the tacit knowledge embodied in it when codifying and transferring this knowledge; but understanding what to focus on is an important part of this step.

As for the second step, the idea behind is the recognition of knowledge as more complex than a codified piece of information that can be transferred without being transformed. It is not enough to capture knowledge; this knowledge has to be systematized and translated into the design context, making it valuable for improving design solutions.

Beyond the two first steps, there is a need to understand which transfer mechanisms are suitable for the process. Once you target the relevant knowledge receivers, the means this knowledge will arrive to them is paramount and includes storage in a computer-based repository with easy-to-retrieve features. The transformation of the captured knowledge includes its contextualization into the engineering design language.

### 3. Methods

This paper is based on an ongoing study part of a two-year research project on knowledge transfer from the operations of oil rigs into the design and operation optimization of rigs. For this research three researchers work in collaboration with a company working in the drilling sector. The case company has a workforce of about 4.000 people working both on and offshore and with a fleet of over 20 rigs operating in 12 different countries. The geographically dispersed work systems require a focus on the internal knowledge sharing. Through exploratory interviews, document analysis and a survey among employees of different departments, we have collected data about the existing knowledge transfer systems in the company.

The initial analysis focused on the understanding of interactions between people and all other elements within the work systems, and allowed us to identify how the knowledge is being transferred in the company and also which knowledge is being transferred. Besides, with the analysis we also systematized the main challenges in relation to the knowledge transfer domain at the company. We look at how development of oil rigs can retrieve information and learn about existing operations of oil rigs and incorporate this knowledge into the new design to optimize

operations on new rigs. All the analysis served as basis for developing a set of requirements for the knowledge transfer process.

## **4. Results**

The initial result of this research is the use of the framework to identify and systematize the challenges faced on the knowledge transfer process. These challenges lead in the direction of a new broad and functional system to manage knowledge, which is not restricted to IT solutions. Further results include the development of a set of requirements for such a system to address these challenges and structure the knowledge transfer process.

### **4.1. The existing challenges**

The company has well-established knowledge transfer systems and mechanisms. However, there is a gap in relation to operational knowledge to be transferred into design. Taking our framework as a starting point, we could systematize the challenges identified into three main groups: 1) knowledge capture, 2) knowledge transformation, and 3) knowledge transfer.

The capture of knowledge is the first challenge, since it is mostly not design oriented. The IT systems used offshore are designed for performance of operations and incidents tracking, not meant for design purposes. This explains the information being registered in a way not favourable to retrieve it in order to use in projects, which leads to operational information captured and "lost" in the formal systems, not being retrieved or used in projects. In addition, the key performance indicators for the rigs do not encourage this knowledge transfer; the rig crew members working hours directly target the productivity of the unit rather than time spent registering this knowledge.

The lack of transformation of the knowledge registered and captured in the systems is the second challenge. The captured knowledge is not transformed into valuable information to directly input the design process. It is hard to qualify the captured knowledge due to its amount and complexity; besides, the use of different systems between offshore operations and design teams difficult processing this knowledge. What can be found is data, not contextualized information that provide a basis for actions.

Finally, the third challenge is to then transfer the knowledge. When having too many IT systems, retrieving information is difficult. However, more critical is the lack of systems or management strategies for bringing in operational knowledge to the design teams. This leads to the transfer of knowledge relying on personal strategies and not always being taken into account in the early phases of the projects, what disable most of the knowledge to be used in due time.

### **4.2. Developing a set of requirements for a functional system**

A functional system can be seen as a knowledge transfer model that accounts for different elements that should be part of the process. The framework structures these elements: the need to capture, transform and transfer the knowledge originated in the operating rigs, bringing up knowledge that, nowadays, is lost in different channels and underused. The requirements are characteristics such a system should have in order to address the different challenges. The development of a set of requirements is ongoing and is the future result of this research.

## 5. Conclusion

The overall aim of this research project is to generate a new understanding of the knowledge transfer topic by using the analysis of the existing work systems as the basis for the knowledge to be transferred. This knowledge is, many times, registered in different ways; however, not with the goal of using it for design improvements. Managing this knowledge is then the main challenge to be addressed when developing solutions.

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## *Poster Session*

### **Tuesday 16th August**

Akiko Takahashi: Characteristics of older construction workers' risk perception

Anneli Muona: The load of repositioning the supine patient by using draw sheet versus CareCare Transfer Slide Film

Marja Randelin: Ergonomics in theory and practice through the Ergonetti learning program

Jarmo Heikkinen and Marianne Rytönen: The specialist physician training program in occupational health care in Finland

Susanna Järvelin-Pasanen: The further employment and experiences of education among graduates in ergonomics

# Characteristics of older construction workers' risk perception

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*This study experimentally examined the characteristics of older construction workers' risk perception. Twenty-three older male workers and twenty middle-aged male workers took a risk prediction test. Older workers pointed out risk factors less than middle-aged workers for the reasons that "I didn't know it" and "although I knew it, I couldn't recognize it". Regarding the risk evaluation for each factor and the usual performance rate of unsafe acts, significant differences were not recognized for most factors. Therefore, it is important for older workers to train in acquiring knowledge of risk factors and paying attention to them effectively.*

Keywords: older worker, risk perception, risk prediction test

## 1. Introduction

In the Japanese construction industry, older workers have many accidents (Takahashi and Miura, 2015). If a worker can't perceive risk factors in work sites appropriately, the possibility that he has an accident will increase. Takahashi et al. (2013) reported that it was possible that older workers couldn't perceive risk factors as well as younger workers based on the results of measuring the effectiveness of a safety-training tool. However, no study has analyzed the risk perception ability of older workers in detail. This study aims to examine the characteristics of older workers' risk perception by comparing the performance on a risk prediction test between older workers and middle-aged workers.

## 2. Method

A risk prediction test consisting of five static images of work sites was developed (Figure 1). A static image had three to five risk factors (unsafe behaviors and unsafe conditions) involving four kinds of construction work in which many accidents occur (work on a scaffold, work with a stepladder, work with a circular saw, and work with a nail gun) (The Japan Federation of Housing Organizations & National Institute of Occupational Safety and Health, Japan, 2010). The test thus had twenty risk factors in total.

The participants were twenty-three older male workers (age  $62.1 \pm 3.6$ , job tenure (years)  $41.6 \pm 7.5$ ) and twenty middle-aged male workers (age:  $42.8 \pm 2.5$ , job tenure (years):  $21.9 \pm 3.9$ ). After answering a questions about his profile (age, job tenure, occupation category, position), each participant took the risk prediction test. Each was asked to identify risk factors in the static image of the risk prediction test and to evaluate the degree of risk for each risk factor (5-point scale: "not dangerous at all = 1" to "extremely dangerous = 5") and the usual performance rate of each unsafe behavior or work in each unsafe condition involving the risk factor (5-point-scale: "don't do it at all = 1" to "do it every time = 5"). Furthermore, if he didn't point out a risk factor, he was asked to explain why and to evaluate its degree of risk and his usual performance rate of it. The

participant repeated this procedure for the remaining four static images. Finally, he answered the usual frequency of the four kinds of construction work illustrated (3 point-scale: “don’t do the work at all = 1” to “often do the work = 3”).



Figure 1. Image from the risk prediction test (Scene A)

### 3. Results and Discussion

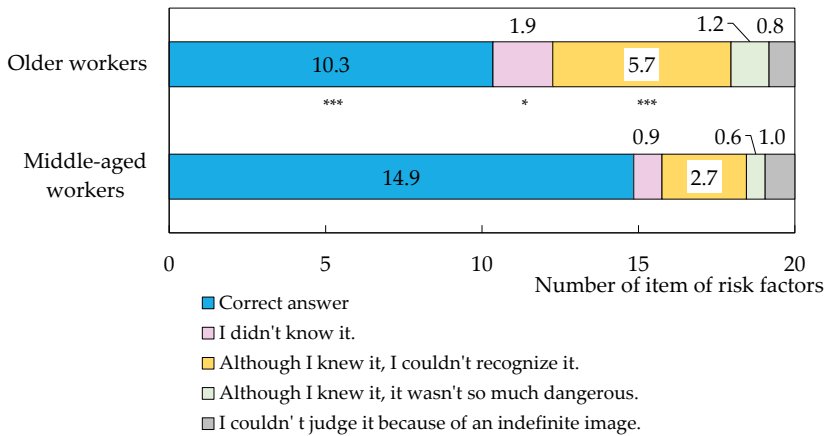
#### 3.1 Number of correct risk factors and the reasons for participants failing to point out risk factors

Figure 2 compares the number of correct risk factors and the reasons for participants failing to point out risk factors between the two age groups.

The number of correct risk factors from older workers was significantly smaller than that of middle-aged workers ( $t(41)=4.90, p<0.001$ ). With respect to the reasons for their failure to point out a risk factor, older workers responded that “I didn’t know it” or “although I knew it, I couldn’t recognize it” more than middle-aged workers (“I didn’t know it”;  $t(34.4)= 2.1, p<0.05$ , “although I knew it, I couldn’t recognize it”;  $t(41)= 4.1, p<0.001$ ). Based on the former reason, it is considered that older workers’ knowledge about risk factors was less than that of middle-aged workers’ in spite of their longer job tenure. In addition, based on the latter reason, older peoples’ attention decline toward the center of the visual field may have affected the result because several risk factors were put in each complex scene (Miura and Ishimatsu, 2005). Older workers may not necessarily show these characteristics in actual work sites because this was the result of a risk prediction test. However, if older workers practice paying attention to risk factors, they will be able to identify risk factors more quickly.

#### 3.2 Risk evaluation for each risk factor and the rate of unsafe act performance

Table 1 compares the risk evaluation for each risk factor and the rate of unsafe act performance between the two age groups.



\*:  $p < 0.05$ , \*\*\*:  $p < 0.001$

Figure 2. Comparison between age groups of the number of correct answers of risk factors and the reasons that participants failed to point out risk factors

The risk evaluation for each risk factor was compared between the age groups. If a participant did not identify a risk, the data was deleted because he could not evaluate the degree of risk of that risk factor. There were no significant differences between the age groups for the risk factors, except for one factor (“A worker is using a nail gun when a man is on the other side of the wall”,  $t(41)=2.48$ ,  $p < 0.05$ ). Regarding the risk factor that did differ between the age groups, middle-aged workers evaluated the degree of risk as being lower than did older workers, which means that middle-aged workers experienced more risk than did older workers. Workers have almost similar subjective risks regardless of age if they have knowledge about the risk factors, and older workers do not tend to disregard risk.

The rate of performing unsafe acts involving a risk factor was compared between age groups. If a participant answered that he usually does not do the kind of work involving the risk factor, for example saying, “I usually don’t work with a nail gun”, or if he did not know a risk factor, the data was deleted because he could not evaluate the rate of performing unsafe acts. No significant differences were recognized between the age groups for the risk factors, except for two factors (“A worker is using a nail gun when a man is on the other side of the wall”,  $t(41)=2.86$ ,  $p < 0.01$ , and “A worker is using a circular saw with materials in his hand”,  $t(41)=2.29$ ,  $p < 0.05$ ). Furthermore, regarding the two risk factors that did show a difference between the age groups, middle-aged workers performed unsafe acts more frequently than older workers, which means that middle-aged workers experienced more risk than did older workers. The workers had similar rates of performing unsafe acts regardless of age if they usually do the kind of work illustrated and have knowledge about the risk factors. Also, older workers do not tend to take risks.

Therefore, it is important for older workers to be trained in acquiring knowledge of risk factors and in paying attention to risk factors effectively rather than reconsidering the risk evaluation for risk factors that they already know.



Table 1. Comparison of the risk evaluation for each risk factor and the rate of performing unsafe acts between older workers and middle-aged workers

Scene	Risk factors	Risk evaluation for each risk factor					Usual performance rate of unsafe acts				
		Older workers		Middle-aged workers		t	Older workers		Middle-aged workers		t
		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
A	1. A worker is using a circular saw with a towel hanging down from his neck.	3.65	0.59	3.61	0.85	0.17	1.15	0.37	1.33	0.49	1.32
	2. A worker is using a circular saw with things scattered on top of the desk.	3.67	0.66	3.45	0.83	0.93	2.33	0.86	2.50	1.00	0.57
	3. A worker is using a nail gun when a man is on the other side of the wall.	4.57	0.51	4.10	0.72	2.48 *	1.26	0.54	1.80	0.70	2.86 **
	4. A worker is using a nail gun without safety glasses.	3.81	0.75	3.85	0.81	0.17	2.48	0.87	2.89	1.10	1.34
B	5. A worker is not using a safety belt in a high place.	4.09	0.75	4.35	0.81	1.07	2.83	1.15	3.00	0.89	0.47
	6. A guardrail of a scaffold is removed.	4.43	0.73	4.53	0.70	0.41	2.11	0.94	2.19	0.66	0.30
	7. A scaffold floor is removed.	4.61	0.50	4.65	0.49	0.27	1.32	0.48	1.47	0.80	0.69
	8. Some material that a worker doesn't use is put on the work floor.	3.83	0.78	3.85	0.81	0.10	2.06	0.80	2.29	0.92	0.82
	9. One worker is working under another worker.	4.00	0.60	4.20	0.77	0.96	2.11	0.74	2.06	0.66	0.20
C	10. A worker is going up a stepladder with something in his hands.	3.42	0.67	3.50	0.99	0.26	3.08	0.51	2.94	0.87	0.50
	11. A worker is using a stepladder with things scattered on the floor.	3.57	0.68	3.95	0.60	1.89	2.52	0.75	2.65	0.93	0.48
	12. A power cable of a circular saw is left plugged into an outlet after use.	3.38	0.89	3.53	1.07	0.45	2.25	1.13	2.53	1.22	0.69
	13. A worker is loading nails into a nail gun with the power cable plugged into an outlet.	3.61	0.85	3.24	1.03	1.18	3.00	0.59	3.29	0.92	1.13
D	14. A worker is using a stepladder with an inappropriate posture.	3.83	0.65	4.15	0.67	1.61	2.35	0.83	2.45	0.69	0.44
	15. A worker is using a circular saw without a safety cover.	4.39	0.58	4.65	0.49	1.56	1.22	0.52	1.30	0.80	0.41
	16. A worker is using a circular saw with materials in his hand.	4.17	0.72	3.75	0.85	1.77	1.91	0.79	2.50	0.89	2.29 *
	17. A worker is walking with a nail gun with an air hose attached.	3.64	0.67	3.33	0.78	0.99	3.09	0.70	3.25	0.87	0.48
E	18. A worker is working on the top step of a stepladder.	4.22	0.80	4.30	0.73	0.35	2.09	0.79	2.50	0.76	1.74
	19. A step of the stepladder is bent.	3.91	0.60	4.05	0.83	0.63	1.09	0.29	1.25	0.72	0.95
	20. A worker has his finger on the trigger of a nail gun after use.	4.48	0.67	4.50	0.69	0.11	1.39	0.72	1.30	0.57	0.45

\*:  $p < 0.05$ , \*\*:  $p < 0.01$

In this study, participants pointed out risk factors on sites from the viewpoint of a co-worker. However, we have to study workers' actual risk perception from the viewpoint of the workers themselves. In the future, we will focus on their own viewpoint and study the process whereby workers learn about risk factors in more detail. For example, what characteristics of potential hazards can workers not determine?

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# The load of repositioning the supine patient by using draw sheet versus CareCare Transfer Slide Film

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*Patient handling tasks are common in healthcare work and cause musculoskeletal complaints among healthcare workers. Physical load of patient handling can possibly be reduced by using assistive devices. The poster presents the methodology and results of a pilot study in which the load of patient handling task was measured while using CareCare Transfer Slide Film (TSF) and draw sheet in patient transfers.*

Keywords: Physical load of patient handling, assistive devices, transferring the patient

## 1. Introduction

The prevalence of musculoskeletal complaints is higher among health care workers (HCWs) than in other occupational groups (Hofmann, Stossel, Michaelis, Nubling & Siegel 2002; Schneider, Lipinski & Schiltewolf 2006). The risk associated with a single personal handling situation is higher than risk in connection with lifting for example a box (Skotte, Essendrop, Hansen & Schibye 2002, 1357). The physical load of patient handling can be reduced by using assistive devices. Patient handling tasks should be performed in a more ergonomic way; activating the patient and with a lower load for HCWs. (Fagerström 2013, 19).

Physically heavy work with frequent bending and twisting is connected with self-reported low back pain disorders (Hyun, Dropkin, Spaeth, Smith & Moline 2011; Qin, Kurowski, Gore & Punnett 2014). There is evidence that moving and helping devices support nurses and decrease physical load on nurses and occurrence of musculoskeletal disorders. (Fagerström 2013, 136). Patient moving and helping skills among Finnish nurses are not in the level of international evidence-based recommendations. Musculoskeletal complaints increase in the practical training in nursing education as 31% of Finnish student nurses have back pain at the beginning of studies and 72% report back pain at the end of nursing studies. In a five year follow-up it was found that nursing increased the risk: 82% of nurses reported back pain (Fagerström 2013, 25). There is evidence that previous low back disorders and previous sick leave, high strain work and high perceived physical exertion in domestic work are associated with high risk of future sick leave due to neck, shoulder and back disorders among health care workers (Horneij, Jensen, Holmström & Ekdahl 2004).

The highest risk for back pain are in situations in which patients are transferred in bed, into bed or out of bed. Use of devices decreases the risk for back pain but in spite of this knowledge nurses do not utilize devices (Engkvist, Wigaeus, Hjelm, Hagberg, Menckel & Ekenvall 1999, 367, 370). The most common reason for not using devices is that there are no

mechanical aids available or the work situation so urgent that there is not time to collect devices. (Byrns, Reeder, Jin & Pachis 2004, 18).

## 2. Objectives

The objective of the study was to measure and compare the physical load of nurses in a patient handling situation where a supine patient is repositioned higher in bed. The assisting tools used were a draw sheet and CareCare TSF.

## 3. Methods

We conducted the study in a laboratory setting. Two voluntary female nurses performed patient-handling tasks using two different devices to transfer two different voluntary "patients". The patient handling task was repositioning of the supine patient towards the head of the bed first using draw sheet and second using the CareCare TSF as assistive device. Prior to performing the task using draw sheet the nurses were asked to handle the patient with the techniques they used during normal patient handling situations without harming oneself. Male patients were voluntaries (first patient 185 cm, 125 kg, the other 178 cm, 90 kg). They were instructed not to offer resistance or help to the nurses. The bed had a design that is typically found in a hospital in Finland, and the height of the bed could be electrically adjusted. The nurses trained to use the new devise CareCare TSF Transfer Slide Film before performing the task with a voluntary "patient" (165 cm, 60 kg).

In repositioning the patient the nurses shifted their weight from the rear foot to the front foot on both sides of the patient. The nurse whose performance was measured at the time was able to control the height of the bed. Ground reaction forces (GRFs) were measured using two force platforms embedded in the floor (model OR6-7MA, AMTI Inc.) on which the nurses were standing with one leg on each platform. The GRFs were measured in three dimensions, vertical direction is perpendicular to the floor and the two horizontal directions lie on the floor. In the analysis, the vertical component is analyzed separately. The two horizontal forces are reduced to a single value by calculating the norm of the horizontal components. Force norm is the magnitude of vertical and horizontal force. The two force platforms measured GRFs under both feet. The legs are called front foot and rear foot, during the tasks weigh was shifted form rear foot to front foot. The forces of both feet were examined trial-by-trial. The sum of forces of the two feet were calculated, these sums (total forces) are used in this paper to quantify the load, see Fig. 1. Maximum values of the total forces were chosen as descriptive variables.

The baseline of the total force was determined in each trial. The baseline force consists of the weight of nurse and the possible contact forces between the nurse and the bed at the initial position. The difference between the baseline force and the maximum force was calculated. This difference describes the maximum force exerted in the task. In addition, the total horizontal force describes the force used in the repositioning. Percentage differences of these two parameters, the maximum force exerted and the total horizontal force are used in comparing conventional draw sheet and CareCare TSF. Other force values, as well as the duration of force exertion are shown in Table 1.

## 4. Results

The GRFs of every task were examined, and the norms of vertical and horizontal components were examined along with the norm of the forces. These forces values during the measurements of nurse 2 repositioning patient 1 are shown in Fig. 1. The maximum force exerted is difference

between the maximum and the baseline of GRF, and this difference is illustrated on the GRF graphs in the third row of Fig. 1.

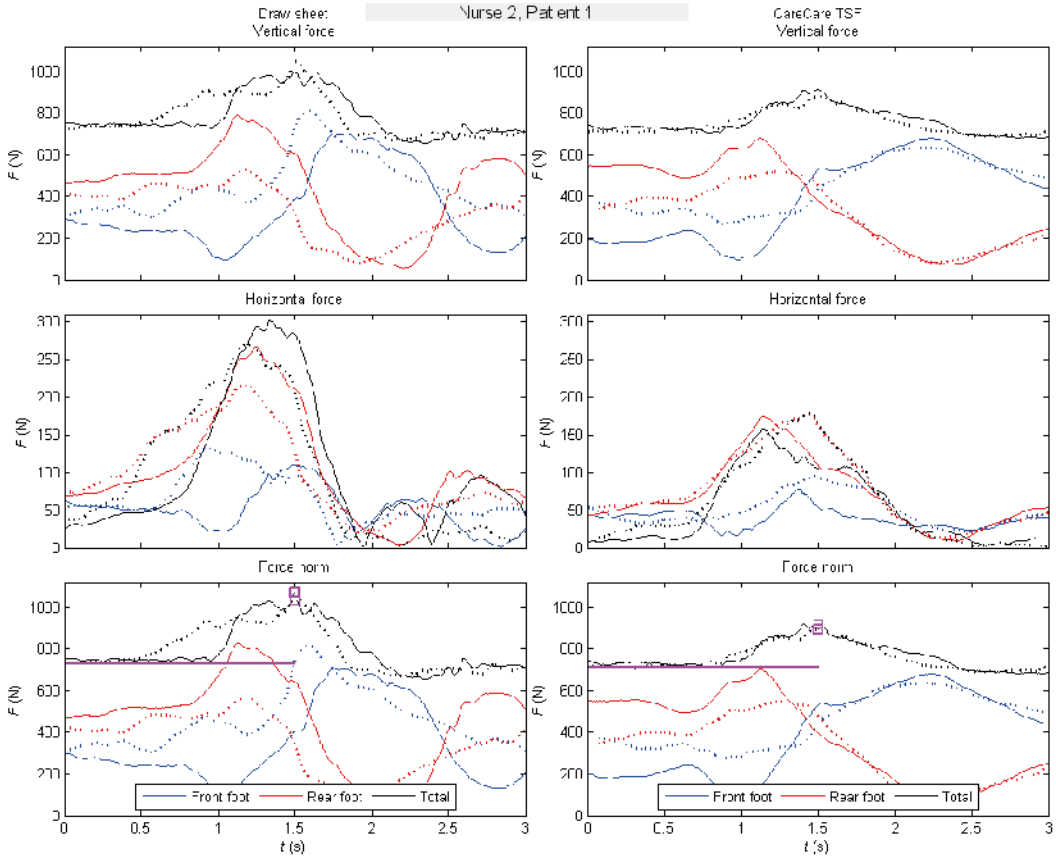


Fig. 1. GRFs during repositioning of the supine patient, measurements of nurse 2 with patient 1. On the left side measurements using draw sheet and on the right CareCare TSF. First row: Vertical component of GRF. Second row: Norm of the two horizontal components of GRF, Third row: the norm of GRF. Solid lines: Nurse working at right side of the patient; left foot at head side (front foot) and right foot at leg side of the bed (rear foot). Dotted lines: Nurse working at left side of the patient; right foot as front foot and left foot as rear foot. Blue and red lines are GRFs of the both feet and black lines are corresponding total GRFs. Pink lines describe baseline of GRF before repositioning. Pink squares show maximum of GRFs.

Selected data and calculations in repositioning are shown in Table 1. and percentage differences of measured forces in Table 2. The results of forces and duration of exertion needed in repositioning of patient are shown in Table 1 concerning nurse 1.

Table 1. Selected parameters of nurse 1 measurements.

	Patient 1				Patient 2			
	Draw sheet		CareCare TSF		Draw sheet		CareCare TSF	
	right	left	right	left	right	left	right	left
Horizontal max. force front foot (N)	65	61	69	72	62	68	57	57
Horizontal max. force rear foot (N)	141	158	150	176	126	128	82	76
Horizontal max. force total (N)	153	148	111	180	120	115	75	53
Max. force norm front foot (N)	759	704	751	794	787	759	716	719
Max. force norm rear foot (N)	468	547	524	581	456	476	316	304
Max. force norm total (N)	1047	1060	958	1089	999	966	862	841
Duration of exertion (s)	1.33	1.16	1.21	1.26	1.13	1.37	1.32	1.34
Baseline of force (N)	718.99	705.37	712.86	719.55	724.45	709.59	720.70	710.12
Maximum force exerted (N)	327.55	354.87	245.66	369.53	274.15	256.61	141.77	130.75

Calculated force values show that nurse 1 used less force in horizontal direction than nurse 2. The maximum value of total horizontal force was 302 N and it was measured in the use of draw sheet (nurse 2, patient 1). Similarly, vertical force values show, that in using CareCare TSF nurses needed less force in repositioning the patient compared to using the draw sheet. Duration of exertion was between 1.03 – 2.05 seconds.

The reduction in the measured horizontal total force in repositioning was on average 39.5% (nurse 1) and 45.8% (nurse 2) while using CareCare TSF. The other percentage results of nurse 1 are shown in the Table 2. The reduction in the measured exerted force used in the task was on average 40.8% (nurse 1) and 46.7% (nurse 2).

Table 2. Percentage differences in measured force between the two aiding devices (nurse 1).

	Patient 1		Patient 2		Mean values
	Right side	Left side	Right side	Left side	
Horizontal max. force front foot	4.67	18.84	-6.57	-15.27	-5.73
Horizontal max. force rear foot	6.49	11.96	-34.87	-40.93	-23.10
Horizontal max. force total	-27.13	21.24	-37.25	-54.07	-39.48
Max. force norm front foot	-1.05	12.76	-9.08	-5.28	-5.14
Max. force norm rear foot	12.04	6.15	-30.80	-36.17	-18.31
Max. force norm total	-8.41	2.72	-13.63	-12.97	-11.67
Baseline of force	-0.86	2.01	-0.52	0.07	-0.43
Maximum force exerted	-25.00	4.13	-48.29	-49.05	-40.78

The average percentage differences in maximum exerted force between CareCare TSF and the draw sheet were 43.8%.

Force graphs in Fig. 1. and force values in Tables 1. and 2. show that both nurses with both patients exerted less force while using CareCare TSF than using draw sheet.

## 5. Discussion

The results of this pilot study show that nurses need and use less force in repositioning of supine patient towards the head of the bed in using CareCare TSF compared to using draw sheet. The average percentage 43.8% is remarkable reduction in percentage in the total force. Measurements in experimental laboratory set-up are, however, not as valid as in repositioning of patient in clinical practice. On the hospital wards patients are lying on the bed several hours before the transfer and patients are deep in the mattress. On ward nurses need more force in patient transfer than in our study. In further studies this matter must be taken into account.

In this experimental laboratory set-up whole body motion capture was performed using inertial sensors. In further studies, mechanical load at lumbar spine will be quantified based on motion capture and force plate measurements.

The results are evidence of reduction in load of patient transfers while using a new assistive device. This evidence can be utilized in developing occupational health and ergonomics among healthcare workers.

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# Ergonomics in theory and practice through the Ergonetti learning program

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*This paper presents the Ergonetti learning program and evaluates the Ergonetti as a method for developing well-being at work in different enterprises. The data were gathered using theme interviews and evaluated using inductive content analysis. The interviewees included employees from companies who had completed the Ergonetti studies (n=29) and their co-workers (n=18) who participated in the Ergonetti development activities. The Ergonetti is a practical and efficient way of promoting well-being at work. The Ergonetti projects decreased work-related strain in the workplace and increased work safety, contributing significantly to well-being at work. Successful implementation of the Ergonetti requires the investment of time, resources, commitment, and managerial support.*

Keywords: Education, Ergonomics, Occupational Health, Workplace

## 1. Introduction

In a modern society the nature of work is changing rapidly, and competition in the job market is getting more intense. This requires competence from workers and demands them to update their knowledge, skills, and attitudes in order to remain productive and retain their attractiveness in the job market (Gijbels et al. 2012, Wang et al. 2007). On the other hand, skilful employees are a company's most important competitive assets, and so it is worth training them and looking after their well-being (WHO 2007).

With the help of modern information technology, including e-learning environments, it is possible to support learning by both individuals and organizations and thereby improve companies' effectiveness and profitability. Moreover, internet-based training in workplaces appears to be more lucrative (Toole 2011) and consumes fewer natural resources than training based on contact learning (Barratt 2006).

The Ergonetti is a web-based, basic level learning program in ergonomics and well-being at work developed by the Open University of Eastern Finland. In total, 1828 students have participated in the Ergonetti program since its inauguration in 2000. Approximately one third of this group (642 students) have completed their studies and been awarded a basic diploma in ergonomics (as of the 11th of April, 2016). The Ergonetti learning program consisted of five learning modules: Keys for the development of work (4 ECTS credit points), Work environment (4 ECTS credit points), Work community and competence (7 ECTS credit points), Diverse load and strain at work (7 ECTS credit points), and Summary (3 ECTS credit points) (Figure 1). The



Ergonetti learning modules focus on the diverse loads and strains at work, such as physical and psychological load and strain, work and the work environment, work organization and leadership, and professional competence (Ergonetti 2016).

Each module includes discussion areas and tasks that relate to its topics and goals. A tutor is assigned for all of the modules to provide the students with additional input relating to the tasks. However, students perform practical developmental work in their own workplaces with their co-workers.



Figure 1. The Ergonetti learning modules (modified Pitkänen et al. 2005).

The Ergonetti operations model is the so-called developmental cycle (Figure 2), in which participants study the promotion of occupational well-being in theory and practice. It provides a functional, web-based learning environment that encourages students to develop their working environment.

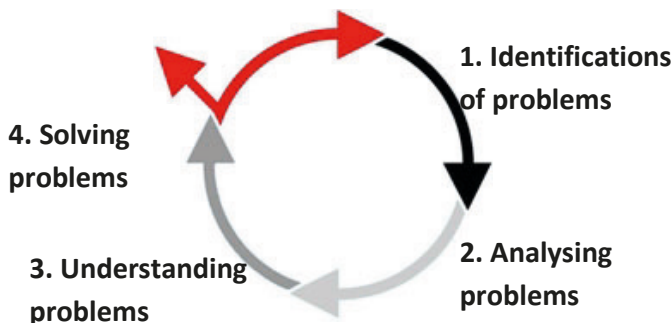


Figure 2. The Ergonetti development cycle.

The developmental process based on the Ergonetti development cycle requires a participatory approach from the work community. The idea is to learn through experience (e.g., Kolb 1984) and on-the-job (e.g., Pohjonen 2002).

## **2. Objectives**

The aim of this paper is to present the Ergonetti learning program and evaluate the program as a method for developing well-being at work.

This research was a qualitative study whose data consisted of theme interviews with Ergonetti students (n=14) and their co-workers (n=18) who worked in small- and medium-sized enterprises and Ergonetti students (n=15) in one large company between 2004 and 2009.

## **3. Methods**

The data gathered in this research was evaluated using qualitative inductive content analysis, which is suitable to the analysis of interviews (Huberman and Miles 1994).

A key research objective was to study the quality of the phenomenon rather than its quantity, and so fewer participants were involved than would have been required in a quantitative study (e.g., Draper, 2004). The interviewees had a high knowledge of the Ergonetti learning program and this improved the relevance of the data (e.g., Endacott 2008).

## **4. Results**

The Ergonetti studies promoted occupational well-being at workplaces. The enterprises benefited from the increased collaboration between workers and positive changes in the attitudes of managers and workers towards the developmental activities. The development projects worked out well and the process-like learning of the Ergonetti learning program, which involves developmental cycles and practical development work proved to be functional and useful. Moreover, it was shown that in practice, the Ergonetti development cycle model is transferable to different work tasks and development subjects.

The positive attitudes of non-student workers and management led to increased support for the students' participation in the Ergonetti program during working hours. Open conversations also provided opportunities for all parties to discuss various problematic issues as they arose.

The development of ergonomic programs in workplaces requires the investment of time, the commitment of all involved parties, and managerial support. With the help of shared discussions, it was possible to obtain input from all affected parties and to utilize the tacit knowledge present in the workplace. Overall, students felt that the developmental solutions implemented while following the Ergonetti learning program were beneficial.

Participation in the Ergonetti learning program increased the students' knowledge, credibility and proficiency (i.e. expertise) regarding ergonomics. Students generally felt that they would be able to continue using their knowledge of ergonomics in the future, and that their studies had beneficial effects on their lives. For example, some reported that the program had prompted them to think about ways of doing housework that would cause less strain than their current methods. Some students also stated that the number of sick leave days taken by employees had declined following the implementation of changes in their working practices to reduce their physical workloads.

Some disadvantages of the Ergonetti learning program were encountered during the development of occupational well-being programs in the students' workplaces. These related primarily to implementation of the Ergonetti learning program, inadequate support from the tutors, and individual problems due to changes in the students' personal situations.

## 5. Discussion

The Ergonetti development cycle model proved to be functional and useful according to students and was even adopted for other tasks within the workplaces. Employees discussed and raised awareness of drawbacks to their current ways of working and learned how to mitigate them. It was possible to establish and embed new information into the organization, reinforcing its learning ability. Shared discussions in the workplace also revealed the opinions of all workers affected by development activities, making it possible to access and exploit the workers' tacit knowledge (e.g., Falconer 2006).

Practical implementation of the Ergonetti tasks promoted the discussion of difficult problems and collaboration between all parties within the workplace partners. This ultimately led to improvements in working conditions.

According to Cheng et al. (2012), managerial and organizational support promotes learning in workplaces. The Ergonetti students were well motivated and their work colleagues and managers were also committed to, and participated in, the development of their projects and supported learning and the implementation of the Ergonetti program.

The results showed that the web-based courses were convenient, and offered flexibility for most of the adult students. A lack of spare time at work and free time at home decreased the students' motivation to continue with the Ergonetti program. Similar problems have been reported previously by van Gog et al. (2010).

The web-based studies are intended to encourage independent learning. However, some students clearly required more individual guidance and instruction than the tutors of the Ergonetti could offer.

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# The specialist physician training program in occupational health care in Finland

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*The article describes the structure, main objectives and pedagogical approach of the 6-year training program of specialist physicians in occupational health (OH) in Finland. There are about 850 specializing physicians (trainees) in OH. The training takes place at work aligned with the goals of the curriculum. The training is about knowledge, skills, attitudes and professional mindset. Tutoring specialist physicians (trainers) at contractual units put these goals into practice. The trainers receive pedagogical training regularly. Special features include e.g. decentralized model of training and diverse university collaboration including the Virtual University in Occupational Health Care.*

Keywords: Specialist training, pedagogics, eLearning, blended-learning

## 1. Introduction to Occupational Health (OH) Service System in Finland

Occupational health care is based on legislation. The principle statutes are Occupational Health Care Act (OHCA 1383/2001) and Government Decree on the principles of good occupational health practice, the content of occupational health care and the educational qualifications required of professionals and experts (GD 708/2013). OH is based on multifaceted, multi-professional and cross-disciplinary approach. OHA obliges all employers to arrange preventive occupational health care for all their employees. Furthermore, of all employers approximately 90% organize curative care. Private medical clinics are the main service providers (over 50%). However, to guarantee the availability of the services the municipalities are obliged to provide the OH services locally for employers who request them.

## 2. Specialist Physicians in OH

A physician working full-time in OH-care must be a specialist physician in OH. In general, the specialist physician can work independently, understands the interactions between work and health, has command of occupational health care systems, is able to act in a multiprofessional and multidisciplinary manner, and can interact with service systems at the workplace and in the society. Also, he/she is able and willing to update his/her professional know-how as many of the aspects of the discipline and work-life are continuously changing. (OHA 2001). The main task of OH-physicians (OHP) is to enhance and support the work ability and working careers. There are approximately 850 specialist OHPs in Finland, while the employed labor force is over 2.4 million persons.

## 3. The Organization of and Objectives of Training

Ministry of Social Affairs and Health Decree on the Training of Specialist Physicians.... (STM 56/2015) states that in general the training contains defined sections working as a physician under tutelage of an assigned trainer and with in-service training, theoretical studies, obligation

to assess own progress and training, and national theoretical examination. Depending on the discipline the training program is either 5 or 6 years in length after graduating a physician (table 1).

In general, Ministry of Health and Social Affairs is responsible for the training program. The five medical universities are responsible for the curriculum. In practice the training takes place working as a physician under tutelage in contractual units. The unit will appoint trainee a personal trainer approved by the university. The trainer is responsible for the implementation of the training program. He/she gives personal tutelage to the trainee two hours a week. He/she also guides the professional growth of the trainee, monitors the implementation of the trainee's compulsory personal specialization plan, and assesses the learning process together with the trainee. However, a personal trainer is not required in clinics.

After the training program the trainee

- knows the interaction between work and health
- can prevent the harmful effects of work on health and promote the work ability of and with the individual employees, work places and multi-professional OH-team
- can asset and support work ability together with the work places, primary and special health care, rehabilitation, social security system and employment authorities
- is able to set goals, justify actions needed and asset the effects of these actions in co-operation with the work places

Table 1. The 6-year training program of specialist physicians in occupational health (OH) in Finland.

<b>Basic qualification training, 2 years</b>		<b>Theoretical courses</b> 100 hours  <b>Management training</b> 10-30 ECTS
<ul style="list-style-type: none"> <li>•Service in municipal health centres and hospital, 9-12 months</li> <li>•Service in occupational health service, 6 months</li> <li>•Other university approved service, 6-9 months</li> </ul>		
<b>Specialized qualification training, 4 years</b>	<b>Evaluation</b>	
<ul style="list-style-type: none"> <li>•Training in occupational health care units, 2 years</li> <li>•Rotation in other relevant clinical disciplines, 1 year</li> <li>•Assessment of work ability and physical rehabilitation, 6 months</li> <li>•Service at the Finnish Institute of Occupational Health, 6 months</li> </ul>	The use of logbook after every 6 months and always at the end of a rotation	
<b>National written exam</b>		

### 3.1. The Basic Qualification Training (24 months)

The overall objective of this section of training is to prepare the physician to work independently as a general practitioner in primary health care. The training must include at least nine months of service in a municipal health care center. At least six months must be served in clinical rotation in a hospital and at most six months may be served at some other university-approved public or private health care unit performing duties of a general practitioner.

### **3.2. The Specialized Qualification Training (48 months)**

This section prepares the trainee for the profession and activities of the OHP. The trainee fills a logbook to document the training received and to reflect his/her training and learning along the whole training program.

#### **3.2.1. Occupational Health Care (24 months)**

After the section the trainee has a thorough understanding of OH-services, processes and multiprofessional activities. The trainee will be able to act as an OH-expert with the workplaces and other relevant entities, in accordance with the good occupational health care practices. This section takes place in a contractual municipal or private OH-care unit. In addition to the personal tutelage the unit will provide the trainee with in-service training of two hours per week. The in-service training consists of clinical meetings, supervised workplace visits, study groups, seminars, reviews of professional journals and literature etc.

#### **3.2.2. Assessment of Work Ability and Rehabilitation (6 months)**

The section improves skills to assess work ability and overall functional ability, and the rehabilitation of working-aged people. Primary training units are the rehabilitation assessment units in major hospitals and the contractual rehabilitation institutes.

#### **3.2.3 Clinical Service (12 months)**

The main goal of this section is to increase the competence to operate with the most important diseases of working-aged people. At the same time the knowledge about the work-related diseases is enhanced. The trainee will participate the in-service training and theoretical seminars and courses for about three hours a week.

Clinical service is completed in at least three acceptable clinics and three months of service is required in each of them. Acceptable clinics are dermatology, internal medicine, neurology, oto-rhino-laryngology, physiatrics, pulmonary diseases, psychiatry and surgery. The emphasis should be on outpatient work.

#### **3.2.4 Finnish Institute of Occupational Health FIOH (6 months)**

This section focuses on occupational medicine, applied research in occupational health care, and introduces the principles of scientific research. The trainee also familiarizes with scientific disciplines supporting OH-care such as toxicology, occupational hygiene, work physiology, work psychology, ergonomics, epidemiology and health economics. There are five local offices of FIOH in Finland.

### **3.3 Theoretical Studies (100 hours) and Management Training (10-30 ECTS)**

Theoretical studies are comprised of multifaceted themes: OHP and the employer organization, OHP and the individual employee, OHP and the society and OHP as a professional.

The training program also includes the multiprofessional management training worth 10 ECTS with the exception in Helsinki University (30 ECTS). The training is organized by the universities.

### 3.4 Evaluation

The trainee shall evaluate the training and the development of his/her competencies together with the trainer at least every 6 months. The evaluation is documented in the logbook, which is approved by the university before graduation. The national exam evaluates the theoretical part of competencies at the end of the training program.

### 4. The Pedagogical Approach

During the sections the trainee works as a physician under tutelage. So, the training takes place at work aligned with the objectives of the curriculum. The pedagogical approach consists of several theories like blended learning. Also, the trainers receive pedagogical training yearly. The objectives of the curriculum are checked and revised every two years by the universities.

### 5. What is specific?

The tasks and objectives of OH-services vary greatly in Europe and the world. In Finland these are defined in legislation and reflected in the training program of the OHPs.

Auditing, evaluation of and research activities on the training program are regularly performed by the universities. The latest auditing report has been published in the series of the Ministry of Social Affairs and Health including an abstract in English (Räsänen et al 2015).

The curriculum is unified nationally, which is not common among the 50 medical disciplines. The training program enables the majority of the training to take place almost anywhere in Finland, not only in the cities with universities or major hospitals. Training can take place in contractual units in the private sector, too. Also, OH is one of the few disciplines to offer pedagogical training for the trainers. The wide collaboration of the five medical faculties has been discussed earlier.

In addition, the Virtual University in Occupational Health Care (VUOHC) is a collaborative result of the five universities. VUOHC offers about 50 courses in Moodle learning environment, varying from tutored eLearning and blended learning to self-study and case-based courses on central topics in OH. Web-based learning is particularly suitable in Finland for scarce population and long distances and for this most decentralized training program. The courses are voluntary and free of charge.

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<http://www.finlex.fi/fi/laki/alkup/2015/20150056?search%5Btype%5D=pika&search%5Bpika%5D=56%2F2015%20>
- Virtual University for Occupational Health Care in Finland. <http://www.tthvyo.fi/web/guest/english/vuohp>

# The further employment and experiences of education among graduates in ergonomics

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*In Finland, it is possible to study ergonomics as a major subject in the University of Eastern Finland. During May 2016, the feedback from graduated students in ergonomics was gathered with a web based questionnaire in order to improve to content of education. The purpose of this paper is to describe the main results of the survey.*

Keywords: Education, Bachelor's degree, Master's degree, Ergonomics

## 1. Introduction

One aim in the strategy for human factors and ergonomics (HFE) for the future, is to promote the education of specialists in ergonomics (Dul et al. 2014). Promoting academic education and research strengthens the application of high-quality HFE.

The University of Eastern Finland (until 2010 University of Kuopio) is the only university where ergonomics can be studied as a major subject, in Finland. The aim in the studies is to educate specialists in ergonomics, who can develop work and work environments based on scientific knowledge (Järvelin 2009). The degree in ergonomics includes bachelor's and master's studies (i.e., Bachelor in health sciences and Master in health sciences). Studies have been available since 1990. A total of 89 students have been graduated, and 12 have completed doctoral degree in the discipline of ergonomics.

The content of education corresponds to the qualification of the European ergonomists set by CREE (Centre for registration of European Ergonomist) (2014). The present bachelor's degree (total of 180 ECTS) includes basic (25 ECTS) and subjects studies (40 ECTS) in ergonomics (ECTS, European Credit Transfer System). In addition, bachelor's degree includes minor studies (e.g., work and organizational psychology, physiology, work and safety technology or studies in occupational health), language and communication skills (10 ECTS), statistics (12 ECTS) and total of 64 ECTS studies in health promotion and health sciences (e.g., epidemiology, health psychology, health politics, and evidence based health care). The master's degree (120 ECTS) includes advanced studies in ergonomics (70 ECTS), statistics and optional studies (50 ECTS) (Fig.1). The basic studies of ergonomics are provided by the Open University of Eastern Finland (Ropponen 2009, Randelin 2013).

Curriculum of Health Promotion Specialization to Promotion of Ergonomics and Well-being at work	
Bachelor in Health Sciences (180 ECTS) (3 years)	Master in Health Sciences (120 ECTS) (2 years)
Studies in health promotion and health sciences, 64 ECTS Academic skills (i.e., statistics, language and communication skills), 26 ECTS Basic and subject studies in ergonomics and well-being at work (incl. Bachelor's thesis), 65 ECTS Minor studies, 25 ECTS	Advanced Studies in ergonomics and well-being at work (incl. Master's thesis), 70 ECTS Statistics, 14 ECTS Minor and Optional studies 36 ECTS

Figure 1. The curriculum of Health Promotion at the University of Eastern Finland

The contents of studies and educational methods have been continuously developed by the feedback collected from students. However, the feedback from graduates have not been enquired before. Thus, the aim of this paper is to describe:

1. the occupations and employment after graduating in ergonomics,
2. the experience of education regarding the demands of present occupations of graduates, and
3. the demands for improving the content of education.

## 2. Methods

The subjects of this study were graduates in ergonomics during years 1990-2015 (n=89). Data was gathered with a web based questionnaire. The announcement and link to the questionnaire was send by postal services to the subjects at the beginning of May 2016. The contact details of the subjects (n=79) were got from the Population Register Centre.

Questionnaire included items on background information, present occupation, the correspondence of present work tasks and education and the significance / relevance of education. A total of 20 questions with 5-point Likert-scale were included. In addition, the questionnaire included open questions. At the end of questionnaire the subjects were asked to express their interest to update their knowledge and to act as a working life contact person to present students.

## 3. Results

The response rate was 30%. The age of subjects varied from 25 to 62 years (mean 57 years, median 52 years).

The most common occupational titles were lecturer/teacher (n=4), well-being/occupational safety manager (n=3), coordinator (n=2), inspector in occupational safety (n=2), work physiotherapist (n=3) and post graduate student/doctoral student (n=2). The other titles were entrepreneur, customer adviser, specialist/consultant, researcher and project manager (Figure 2).



Figure 2. The occupational titles of graduates in ergonomics at the University of Eastern Finland during years 1990-2015, % (n=24).

Most of the subjects (54%) had permanent full-time work. The most common employers were municipalities or federation of municipalities, government and independent organization (Figure 3).

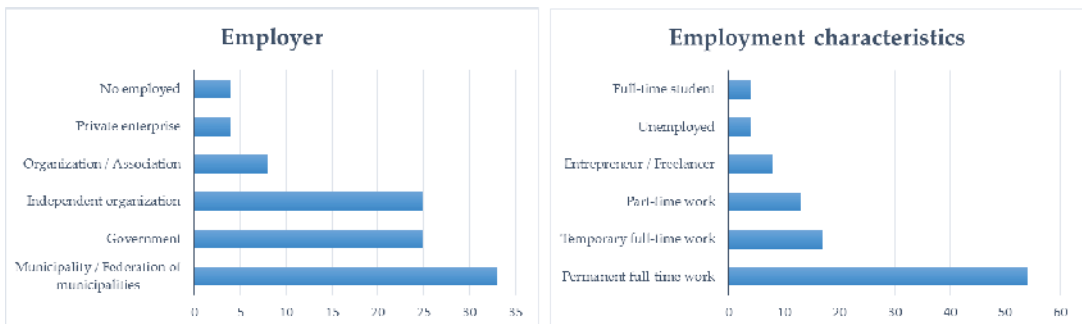


Figure 3. The employer and employment characteristics of graduates in ergonomics at the University of Eastern Finland during years 1990-2015, % (n=24).

The majority of the subjects (79%) were very satisfied or satisfied to their university education and its content regarding to their present occupation's requirements. In addition, the subjects expressed that in their present occupation they can do work independently, and work tasks are diverse and positively challenging. Further, they feel that they can develop their competences. The majority of the subjects (63%) stated that their present occupation required academic degree. In 4 cases (17%) the degree in ergonomics was necessary.

In open question, where the suggestions for improving the content of education was asked, the subjects highlighted the importance of knowledge in project management, leadership, personnel management, financial administration and entrepreneurship.

#### 4. Discussion

The graduates in ergonomics have employed well to the occupations where they can utilize the knowledge from their studies in ergonomics, for example in the field of education or in occupational health and safety. The majority of the graduates (79%) were satisfied to the content of education and they found it valuable regarding to their present occupation and working life requirements. On the other hand, the graduated students highlighted the importance of knowledge in project management, leadership, personnel management, financial administration and entrepreneurship.

The limitation of our study is the low response rate, only every third graduated student responded to our survey.

In conclusion, the degree of master of health sciences in ergonomics meets well the requirements of working life and acting as a specialist in ergonomics. The main challenge is to develop studies regarding to changing requirements of modern working life.

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## *Session 3A Musculo skeletal disorders and prevention, Part II*

### **Tuesday 16<sup>th</sup> August**

Ruth Carlsson: Physical variation at work – a scientific review

Triinu Sirge: Prevalence and localization of musculoskeletal strain in female office workers

Satu Mänttari: Muscular fatigue and recovery after a heavy work bout in the heat: comparison of four recovery interventions on muscle architecture, tone and mechanical properties in firefighters

Kim, Kyungsu: Introduction to R&D for agricultural health & safety management in South Korea

# Physical variation at work – a scientific review

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*Physical variation is generally considered to be an important factor influencing the risk for musculoskeletal disorders in repetitive work, but a comprehensive scientific basis for this assumption has not been available. Thus, the Swedish Work Environment Authority requested the Centre for Musculoskeletal Research at the University of Gävle to review scientific standings regarding physical variation and its effects. In total, 56 articles were included in the review. The results showed that occupationally relevant studies of the effects of physical variation are few, and that the effectiveness of initiatives promoting variation has also been studied to a limited extent. Thus, current research cannot provide a clear answer to what an effective combination would be of work tasks in a job in the context of physical variation, let alone the optimal time distribution of tasks in a short (hours, days) and long (weeks, months, years) perspective. Also, gender aspects of physical variation were considered to a very limited extent. There is a need for more studies of relevant initiatives aiming at creating increased physical variation by changing the contents of work or its temporal structure; including studies placing this issue in a gender perspective.*

Keywords: Ergonomics, Physical variation, Repetitive work, Job rotation

## 1. Introduction

Many professions are characterized by jobs offering limited physical variation (Arbetsmiljöverket 2014a), and current working life may develop towards less variation due to the increased use of information and communication technology development and due to organizational changes including outsourcing. The most prominent examples of jobs with limited variation are those requiring repetitive movements to a large extent, and those performed in constrained postures. Women are exposed to repetitive work to a larger extent than men (Lewis and Mathiassen 2013) and also seem to stay in repetitive and constrained jobs, even in cases where companies and organizations can offer tasks leading to more variation (Nordander et al 1999). The statutes of the Swedish Work Environment Authority (SWEA) require that risks associated with repetitive work must be prevented by initiatives leading to increased physical variation, for example through job rotation, job diversification or breaks. While this may be a warranted initiative, it is unclear how physical loads should then be organized across time to effectively avoid fatigue and musculoskeletal disorders. Therefore, SWEA contracted the Centre for Musculoskeletal Research at the University of Gävle to review scientific standings regarding physical variation and its effects. The researchers were requested to particularly observe whether available studies addressed variation from a gender perspective. The report, authored by Svend Erik Mathiassen and Charlotte Lewis, was published in February 2016 (Mathiassen and Lewis 2016).

Some previous reviews conclude that there is evidence to support that repetitive work can lead to shoulder disorders (National Research Council 2001, Punnett and Wegman 2004, van der Windt et al 2000). Other reviews, however, conclude that the available evidence is not sufficient for concluding that repetitive work causes disorders in neck, and only with some hesitation support that repetitive work may influencing hand and elbow disorders, and then only if force is also involved (SBU 2012). This reluctance to the scientific standings was reflected even in a summary of the literature on effects of job rotation, which concluded that too few studies were available to reach any conclusive evidence (Leider et al 2015). Another recent review on the effects of physical variation on fatigue in occupationally relevant tasks also found that scientific evidence was limited (Luger et al 2014).

In a paper from 2006, Mathiassen suggested that variation can be defined as “the change in exposure across time” (Mathiassen 2006). He also proposed that variation can be described through three aspects: how *much* the load changes across time, how *often* it changes, and to which extent *similar* sequences of load occur during work. These three aspects can change independently of one another (Mathiassen 2006). The physical variation in a job, in turn, can change in one or more of these aspects if individual tasks in the job are manipulated, if tasks are mixed in another way in the job, and if new tasks are brought into the job. For the two latter initiatives to be effective in changing variation, tasks need to be different, or “diverse” (Mathiassen 2006) in terms of physical load.

Effects of variation in physical load, i.e. its time pattern, have been addressed by researchers in decades, most notably in studies investigating effects of breaks on fatigue (Vernon et al, 1924), and then with a dominance of studies of muscle contractions at a constant load and posture (isotonic, isometric contractions), which can be difficult to interpret in an occupational context (Mathiassen and Winkel 1992). However, these basic studies suggest that individuals can continue working for a longer time with pauses than without, and that the total possible amount of work is greater with pauses than without (Björkstén and Jonsson, 1977). Other basic studies show that frequent short pauses lead to a greater reduction of fatigue than longer but less frequent pauses (Mathiassen, 1993). An important question in these studies is whether the effect of breaks is, indeed, an effect of *rest*, or whether it is a result of the variation between different intensities in the task. Some studies suggest the latter explanation to be more valid, i.e. that load variation is more important in determining the outcome than the rest *per se* (Yung et al 2012).

## 2. Objectives

The review set out to examine studies describing the three basic ways mentioned above of changing physical variation in constrained or repetitive jobs, i.e. changing conditions in individual tasks, changing the time-line and proportions of tasks relative to each other, and adding new tasks to the job. Each of these initiatives may alter how much or how often exposure changes, as well as whether similar exposures occur repeatedly, as in repetitive work. All three aspects are known from physiology to be important to relevant outcomes, such as fatigue. Thus, the review examined the available documentation that changed contents of tasks, changed structure of tasks in the job, and changed task composition of the job do, indeed, change physical variation; and the review also addressed available evidence that a changed physical variation influences fatigue and risk for musculoskeletal disorders. The review concentrated on studies dealing with physical variation for the neck, shoulder and arms.



### **3. Methods**

An extensive literature search was performed in PubMed, and identified articles were sorted and examined using standard procedures. In total 56 articles were eventually included in the review.

### **4. Results**

Few studies were available of physical variation in individual tasks and how it is affected by equipment, task contents, and conditions when performing the task. Studies of the effectiveness of such initiatives on fatigue and disorders were also few; they mainly deal with the effects of breaks from productive work and very rarely document whether anything actually happened to physical variation. However, a higher work pace in repetitive work seems to lead to less variation in exposure between work cycles, and this also happens with higher demands on precision. Also, few studies deal with a changed distribution across time of different tasks and they almost all consider breaks in productive work, i.e. the effect of increased break allowances or a changed distribution of breaks across the workday. None of these initiatives appeared to have any particular effect on fatigue or discomfort. There is a lack of studies devoted to redistribution across time of an individual's current productive tasks. As a tentative conclusion, however, the time-line of changes between periods of "high" workload and periods of recovery is probably more important in determining the development of fatigue and disorders than the load level per se.

Few studies actually document how much physical variation changes for an individual taking part in job rotation or job enlargement, even though increased variation is often the major purpose of those initiatives. Available studies of job rotation and job enlargement do not give any firm support for these initiatives leading to less fatigue and disorders. Therefore it is also not clear if women and men are given the same opportunities in a job rotation and if they experience the same results regarding physical variation.

### **5. Conclusions**

Current research cannot provide a clear answer to what an effective combination would be of work tasks (including breaks) in a job, let alone the optimal time distribution of different tasks in a short (hours, days) and long (weeks, months, years) perspective. There is a need for more studies of occupationally relevant initiatives aiming at creating increased physical variation by changing the contents of work or its temporal structure. The studies should document effects both on the physical work load and on the eventual outcomes of interest; this is a remarkable short-coming of the current literature. Also, future research should observe possible gender aspects of organizational and individual initiatives for increased variation.

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# Prevalence and localization of musculoskeletal strain in female office workers

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*Seated working positions as office workers positions are often regarded as a cause of musculoskeletal strain (MSS). The aim of the present study was to assess prevalence and localization of MSS in female office workers (n=61), who worked with computer in sitting position. All participants filled the Nordic Questionnaire, MSS questionnaire, and informative form with questions about workplace ergonomics. Results showed that MSS in the last 6 months localized primarily in low back (57.4%), in neck (50.8%), and in shoulders (44.3%). MSS were localized in last month after normal workday mostly in low back (43.4%).*

Keywords: musculoskeletal strain, office workers, sitting position, workplace ergonomics

## 1. Introduction

Seated working positions as office workers positions are often regarded as a cause of discomfort in the musculoskeletal system. There is substantial evidence that such ergonomic risk factors as awkward body posture, repetitive tasks, stress and force if overcome worker's biomechanical capabilities may lead to musculoskeletal strain (MSS), which is the most prevalent occupational disorder. In Estonia registered occupational diseases are mainly caused by monotonous work tasks and work postures (National, 2016), which means that office workers are also exposed. Monotonous tasks and forced position in work with computer are associated with high prevalence of MSS, particularly in low back, neck, and shoulder (Piranveyseh et al., 2016, Shariat et al., 2016), but also in wrist/hand (Mahmood Khudhir et al., 2015, Piranveyseh et al., 2016).

## 2. Objectives

The aim of the present study was to assess prevalence and localization of musculoskeletal strain in female office workers (n=61) with mean ( $\pm$  SD) age of  $45.8 \pm 11.9$  years and body mass index (BMI) of  $25.1 \pm 4.2$  kg/m<sup>2</sup> (Table 1). All office workers worked with computer in sitting position almost whole 8 hours workday (7.8 hours per day and 35.9 hours per week).

Table 1. The anthropometric and work experience characteristics of participants (n = 61)

	<b>Mean ± SD</b>
<b>Age (years)</b>	45.8 ± 11.9
<b>Body mass index (kg·m<sup>-2</sup>)</b>	25.1 ± 4.2
<b>Years of work experience as an office worker (years)</b>	15.1 ± 11.4
<b>Yeas of work experience in same occupation (years)</b>	11.4 ± 8.4
<b>Total work experience during life (years)</b>	25.2 ± 12.4
<b>Working hours per day with computer (hours per day)</b>	7.8 ± 5.1
<b>Working hours per week with computer (hours per week)</b>	35.9 ± 7.7

Participants had had work experience as an office worker on average 15.1 years, and they have worked in same occupation on average 11.4 years.

### 3. Methods

All participants filled the modified Nordic Questionnaire (NQ) which evaluates the frequency of musculoskeletal symptoms such as pain, tingling and/or numbness in six body regions (low back, neck, shoulder, elbow, wrist/hand, and knee) in two time periods: the previous seven days and the previous six months (Kuorinka et al., 1987); musculoskeletal strain questionnaire, and informative form concerning bio-demographic variables and questions about workplace ergonomics. To evaluate workers physical activity, Baecke Habitual Physical Activity Questionnaire (Baecke et al., 1982) was used. Questionnaires were filled at the workplace or at home. The subjects wrote the values of height and body mass themselves and the body mass index (kg·m<sup>-2</sup>) was calculated. Means and standard derivations (± SD) of mean were calculated. Linear correlations were calculated to observe the relationship between the received characteristics. A level of  $p < 0.05$  was selected to indicate statistical significance.

### 4. Results

The questionnaires were completed by 61 (79%) of the office workers invited to take part in the research. Office workers, who participated in this study worked in the university, in administrative departments, using computer almost whole workday. All computer workstations were designed as seated, so office workers spent their workday mainly in sitting position. Results showed (Figure 1) that MSS in the last 6 months was localized primarily in low back (57.4%), in neck (50.8%), in shoulder (44.3%), and less in knee (27.9%) and in wrist (27.9%). MSS in the last 7 days was localized mainly in neck (34.4%), equally in shoulder (24.6%), and in low back (24.6%), less in knee and wrist region. MSS according to the NQ was lowest in elbow region. Total MSS in office workers was 83.6%, and MSS in the last 7 days was significantly lower in low back ( $p = 0.0002$ ), in shoulder ( $p = 0.02$ ), in wrist/hand ( $p = 0.0045$ ), and in knee ( $p = 0.01$ ) compared to last 6 months data.

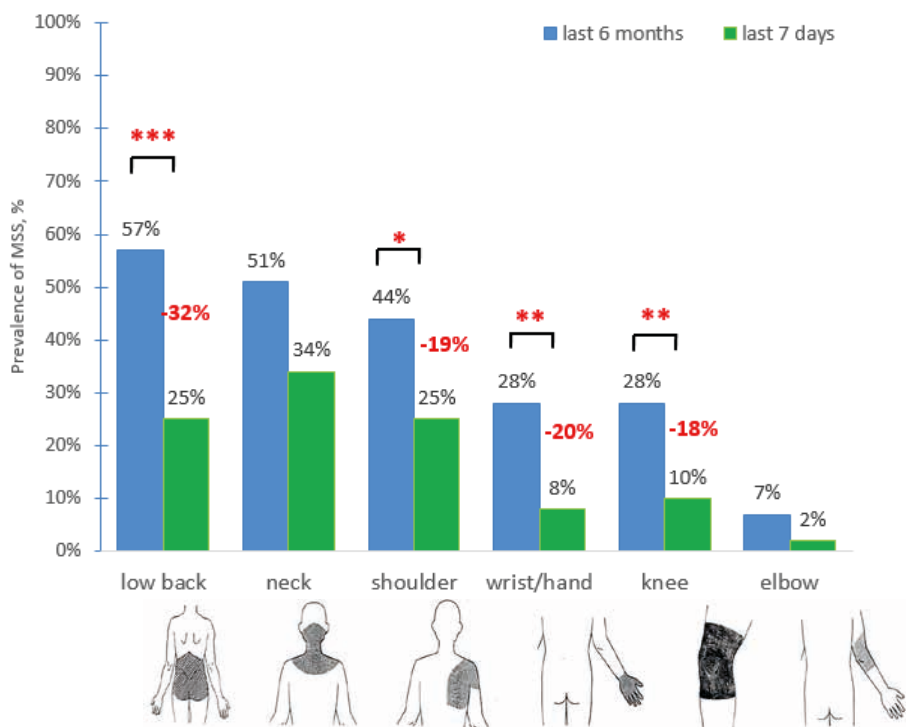


Figure 1. Prevalence of MSS (%) in office workers (n = 61) in different body regions in the last 6 months and in the last 7 days. \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

MSS was localized in last month after normal workday mostly in low back (43.4%), in neck (38.5%), in upper back (34.4%), in top of the right shoulder (34.8%) and in top of the left shoulder (33.2%), in right wrist (24.6%), and less in left wrist (8.6%). Office workers were mainly in right-handed (95%), so their right body side is more affected to musculoskeletal discomfort. Almost quarter (24.2%) of office workers reported MSS in legs. Also, 46.7% of the subjects had reported discomfort in eyes. Almost quarter (24.4%) of female office workers answered that their workplace was designed not ergonomically.

Psychosocial risk factors in the workplace: 60.7% of employees need to rush during the workday, while 55.7% of respondents feel mentally fatigued. 55.7% can have make rest breaks when they want and as often as they wish. Half of them (55.7%) are satisfied with their job. As a positive side, no work accidents have happened with participants.

At least half of office workers (56%) are physically active during free time. Participants practicing sport activities, which are mainly low or moderate intensity (e.g. Nordic walking, aerobics, gymnastics, yoga, running, cycling).

Correlation analyze showed that MSS in different body parts were associated positively. MSS in neck is associated with MSS in right *m.trapezius* ( $r = 0.71$ ,  $p < 0.001$ ), and in left *m.trapezius* ( $r = 0.58$ ,  $p < 0.001$ ), in upper back ( $r = 0.61$ ,  $p < 0.001$ ), in right wrist ( $r = 0.56$ ,  $p < 0.01$ ), in low back ( $r = 0.48$ ,  $p < 0.01$ ), discomfort in eyes ( $r = 0.41$ ,  $p < 0.05$ ).

## 5. Discussion

This study reveals that the prevalence rate of MSS was high (83.6% respondents noted MSS at least in one body part) among office workers. Only 16.4% reported no strain at all during last 6 months and 7 days. This result is better than Malaysia, where 7.2% of office workers reported no musculoskeletal discomfort in 6-months period (Maakip et al., 2015). In this study prevalence rate of MSS is quite high and 44.3% of office workers do not do regular rest breaks. To maintain physical health at workplace is recommended to do regular rest breaks during the workday.

Our study reveals that MSS in upper limb region in the last 7 days was 34% in neck, 25% in shoulder 8% in wrist/hand, and only 2% reported in elbow. These results are better ones, that findings among Malaysia university workers, where prevalence of upper limb disorders during last 7 days was 47% in neck, 44% in shoulder, 37% in wrist/hand, and 16% in elbow (Mahmood Khudhir et al., 2015). While body parts data ratio is the same (neck, shoulder, wrist/hand, and elbow), Malaysia MSS scores are higher, because they participated in their study also drivers and cleaners after administrative stuff and lectures. So drivers and cleaners work tasks are more physical, so they could perceive more MSS, which influence results.

This study finds that prevalence of MSS in office workers is mainly in lower back, neck, and shoulders. These results are similar to previous study of Piranveyseh et al. (2016), where office workers prevalence of regional musculoskeletal disorders in the last 3 months are mainly reported in low back, neck, back, and shoulders. Also Shariat et al. (2016) reported that prevalence of MSS in office workers is mainly in shoulders, neck, and lower back.

Almost quarter of office workers were not satisfied with workplace ergonomics.

This could be one reason of MSS in office workers. To prevent MSS is necessary to set up workplaces ergonomically, so personal ergonomic workplace assessment and training are needed, like suggests Robertson et al. (2009). Also is obligatory to be physically active.

## 6. Conclusions

It was concluded that the highest prevalence rate of musculoskeletal strain in female office workers was found in low back, neck, shoulders and upper back, and also they felt discomfort in eyes. Mainly right-handed office workers perceived more musculoskeletal strain in right body side. At least half of office workers are physically active during free time. The study suggests that a workplace design and exercise recommendations needs to include an individual workstation assessment to be effective in reducing strain.

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# Muscular fatigue and recovery after a heavy work bout in the heat: comparison of four recovery interventions on muscle architecture, tone and mechanical properties in firefighters

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*Firefighting is physically and mentally demanding work including occasional heavy work bouts which require high muscular strength and endurance, and appropriate performance under psychological stress. In this study we assessed the influence of four different interventions on muscle recovery after a task-specific heavy work in warm conditions. Furthermore, 24-h heart rate variability (HRV) was measured and used for evaluating work-related stress and recovery. After the work, pennation angle, elasticity, tone, and stiffness of the forearm muscles were altered. Of the interventions tested, contrast water therapy enhanced muscle recovery most effectively. On average, 24-h HRV measurement included 43 % stress and 34 % recovery.*

Keywords: muscle fatigue, recovery, contrast water therapy, firefighter

## 1. Introduction

Firefighting is physically and mentally demanding occupation including occasional heavy work bouts which require high muscular strength and endurance in difficult environments under time pressure. The combination of strenuous firefighting activity, hazardous conditions, protective equipment and exposure to heat causes an increased physiological and psychological stress (Kivimäki and Lusa 1994, Rissanen et al. 2008, Perroni et al. 2014). Muscular recovery after performing such heavy work bouts until fatigue can take several hours (Oksa et al. 2013).

Adequate recovery from heavy physical work is essential before next strenuous work tasks since especially chronic fatigue is regarded as a precursor for musculoskeletal symptoms and disorders. Furthermore, it also forms a risk for injuries and accidents (Sjøgaard and Sjøgaard 1998, Buckle and Devereaux 1999). To reduce that risk and to improve safety, restoring muscular capacity effectively is important.

In an attempt to accelerate the speed of muscular recovery, four different interventions i.e. caffeine intake, active stretching, cold-water immersion, and contrast water therapy, were used and evaluated after a task-specific heavy work in warm conditions. Furthermore, 24-h heart rate variability (HRV) was measured and used for evaluating work-related stress and recovery.



## 2. Materials and methods

Thirteen firefighters performed a 20-min heavy work bout at 35 °C with 40 % relative humidity while wearing a smoke diving suit (excluding mask and hood). The work consisted of the following components, each lasting 2.5 min:

1. Hammering a 57-kg truck tire with a 7-kg hammer,
2. going under and over a 60-cm high obstacle,
3. ascending and descending 20-cm-high stairs (3 stairs up, 3 stairs down),
4. rolling up a 25-m long hose,
5. walking on a treadmill (velocity 5 km·h<sup>-1</sup>) while carrying 2 hoses, each weighing 13 kg (first minute without hoses).

The hammering was repeated 4 times (after 2, 3, and 4).

To quantify cardiovascular strain and heat stress during the work simulation, heart rate, oxygen consumption (Bodyguard 2, Firstbeat Technologies Ltd., Finland) rectal temperature ( $T_{re}$ ) and skin temperatures ( $T_{sk}$ ) from six different sites (forehead, chest, upper arm, forearm, thigh, calf) were continuously measured. Stress and recovery were objectively measured with The Firstbeat Stress and Recovery Analysis Method (Firstbeat Technologies Ltd., 2014) based on 24-h HRV recordings.

After completing the work, maximal grip force (maximal voluntary contraction, MVC), and structural changes induced by muscular fatigue (muscle circumference, cross-sectional area, thickness, and pennation angle) as well as muscle tone, elasticity, and stiffness (i.e. mechanical properties) were measured using horizontal and vertical ultrasound (Logiq 5 Pro, GE Medical Systems, USA) and MyotonPRO myometer (Myoton AS, Estonia), respectively, and compared to the baseline. The measurements were focused on wrist flexors and/or extensors since the muscular strain of the test battery greatly focuses on the forearm muscles.

The work simulation was followed by a 28-h recovery period, during which four different active recovery interventions and a reference (passive recovery) were used in random order i.e. five follow-ups in total. In the course of recovery, active recovery methods were used at time points 15 min, 1.5 h, and 2.5 h after finishing the work simulation. The active recovery interventions were (1) caffeine (2 mg·kg<sup>-1</sup>, Vitabalans Oy, Finland), (2) dynamic stretching of muscles (three minutes altogether), (3) cold water immersion (CWI, 15 °C, five minutes) for forehead, and (4) contrast water therapy (CWT, alternating cold (15 °C) and warm (38 °C) water immersion, three times for one minute in both temperatures) for forehead. During the recovery, MVC, structural parameters, muscle elasticity, tone and stiffness were measured at six time points.

Statistical analyses were conducted using SPSS 20 statistical software package (SPSS Inc., Chicago, Ill., USA). The normality of the data sets were tested using Shapiro-Wilk test and the data were found to be normally distributed. Repeated measurements general linear model (GLM) was conducted to determine whether any change in fatigue is the result of the intervention over time. The homogeneity of the variances of the differences between conditions were tested with the Mauchly's test of sphericity, and possible violations of sphericity were corrected with the use of Greenhouse-Geisser correction. After the repeated measures ANOVA analysis, significant effects were further analyzed by using post hoc Bonferroni test. Differences in rectal or mean skin temperature between pre- and post-exposure (work and recovery) were assessed using a multiple pairwise Student's t-test with Bonferroni corrections. The difference in MVC before and after

work was tested with Student's t-test. Differences were considered statistically significant at  $p < 0.05$ .

### 3. Results

The average oxygen consumption during the 20-min work bout was  $32.2 \pm 1.5$  ml/kg/min corresponding to  $71.2 \pm 2.3$  %VO<sub>2</sub>max. The work intensity was, thus, high. At the end of the working phase,  $T_{re}$  and  $T_{sk}$  were  $37.9 \pm 0.1$  and  $36.4 \pm 0.2$  °C, respectively ( $p < 0.001$  compared to baseline). After the heavy work bout, maximal grip force decreased by  $8.1 \pm 1.6$  % compared to baseline ( $p < 0.001$ ). Pennation angle ( $\theta$ ) of flexor muscle was significantly affected, i.e.  $\theta$  increased by  $4.4 \pm 0.9^\circ$  ( $p < 0.001$ ) and remained elevated for two hours (Table 1). Significant ( $p < 0.001$ ) difference was observed in recovery of  $\theta$  between different interventions and reference, contrast water therapy being the most efficient ( $p = 0.007$ ).

Table I Flexor carpi radialis muscle architecture before (baseline) and immediately after exhaustive work simulation, and at different time points during the recovery period of 28 h (reference). CIRC; muscle circumference, CSA; cross-sectional area, MT; muscle thickness,  $\theta$ ; pennation angle.

	CIRC (cm)	CSA (cm <sup>2</sup> )	MT (cm)	$\theta$ (°)
Baseline	$8.52 \pm 0.32$	$3.64 \pm 0.22$	$2.14 \pm 0.08$	$11.4 \pm 0.5$
After work simulation	$8.70 \pm 0.25$	$3.74 \pm 0.14$	$2.23 \pm 0.08$	$15.8 \pm 0.8^{***}$
30 min	$8.63 \pm 0.30$	$3.78 \pm 0.16$	$2.19 \pm 0.12$	$14.7 \pm 0.5^{***}$
1 h	$8.35 \pm 0.25$	$3.73 \pm 0.15$	$2.13 \pm 0.06$	$15.7 \pm 0.8^{***}$
2 h	$8.19 \pm 0.25$	$3.71 \pm 0.17$	$2.09 \pm 0.10$	$14.9 \pm 0.9^{**}$
4 h	$8.18 \pm 0.25$	$3.74 \pm 0.16$	$2.13 \pm 0.06$	$12.9 \pm 0.9$
22 h	$8.42 \pm 0.20$	$3.75 \pm 0.11$	$2.07 \pm 0.04$	$12.7 \pm 0.8$
28 h	$8.53 \pm 0.24$	$3.63 \pm 0.13$	$2.10 \pm 0.06$	$12.9 \pm 0.9$

\*\*\*, \*\* Values differ significantly ( $p < 0.001$ ,  $p < 0.01$ , respectively) from the corresponding measurement at rest (baseline).

Immediately after fatiguing exercise, elasticity was reduced in both muscles ( $17.0 \pm 1.8$  % in flexor,  $p < 0.001$ ;  $15.6 \pm 2.7$  % in extensor,  $p < 0.001$ ) compared to baseline. Flexor muscle was hypertonic after work ( $3.0 \pm 1.0$  % increase,  $p < 0.01$ ) with reduced ( $13.0 \pm 1.2$  %,  $p < 0.001$ ) stiffness. Significant ( $p < 0.05$ ) difference was observed in recovery of flexor elasticity between different interventions, contrast water therapy being the most efficient ( $p = 0.002$ ).

On average, the 24-h HRV measurement after the work bout included  $43.3 \pm 2.1$  % of stress and  $33.8 \pm 2.2$  % of recovery. The interventions used had no effect on the stress-recovery balance. There was a negative correlation ( $p = 0.03$ ) between age and the amount of stress.

### 4. Discussion

The results of this study indicate that after a heavy work bout fatigue induces changes in muscle structure, tone, stiffness and elasticity, and several hours is needed for the structural recovery of muscles. Of the interventions tested, contrast water therapy proved to be the most effective method to enhance muscular recovery.

The work simulation used in the present study was adequately demanding to induce marked thermal, cardiovascular and muscular load, and therefore presumably corresponded the firefighting activities in the field. Along with the muscle fatigue, the structure and mechanical properties of the forearm muscles were altered. The internal architecture of a skeletal muscle

plays an essential role in determining the functional features of the muscle. Changes in the architecture are reflected in the force-generating capacity and shortening velocity (Narici 1999). However, we were able to improve the structural recovery of the muscles by using different methods well-known among athletes.

The work-related stress measured was above 40 % in a 24-hour period. The normal amount of stress in a day varies, but is usually approximately 40-60 % in a 24-hour period (Firstbeat Technologies, 2014). The amount of recovery (> 30 %), in addition to a good-quality sleep period, should be sufficient to maintain a good stress-recovery balance. Interestingly, there was a negative correlation between age and the amount of stress reactions indicating the importance of work experience in the occupation of a firefighter. Since the mental load in a simulated situation differs from the actual fire service, additional research on the psychological component related to the work activities is conducted (A project funded by European Social Fund: Co-operation and competence network for promoting occupational health, safety and well-being at work, TyhyverkostoX).

To conclude, these results provide evidence that after a heavy work bout 1) fatigue induces changes in muscle structure and mechanical properties, 2) several hours is needed for the structural recovery of muscles, 3) of the interventions tested, contrast water therapy is the most effective method to enhance muscular recovery, and 4) it is beneficial to take the means of recovery into account in work ability enhancing activities in fire brigades.

Main reason for early retirement of fire fighters is musculoskeletal disorders. Proper recovery is one example of preventive actions taking place during the whole working career. The results of the present work are implemented and distributed through Co-operation and competence network for promoting occupational health, safety and well-being at work –project network.

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# The introduction of R&D for the agricultural health & safety management in South Korea

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*Korean farmers' occupational injury and disease rates are reported to be higher than those in other industries. Health and safety for most Korean farmers (usually small-scale and owner-operator farmers), excluded from national industrial safety and health protection, has been mainly managed by agricultural and forestry agencies since the mid-2000s. Rural Development Administration (RDA) has conducted various studies and extensive preventive activities for agricultural health and safety as follows: Farmers' occupational injury and disease survey, proposing relevant legal and policy systems, evaluation of agricultural health hazards, development of ergonomic convenience equipment and protective gears, etc.*

Keywords: Agriculture, Safety, Health, Korea

## 1. Introduction

The development of agricultural technologies has gradually relied on supplementary supports for agricultural labor including agricultural machines and agricultural chemicals, due to intensified outflow of agricultural manpower related with the industrial modernization in Korea. The increase in the use of such supplementary support for agricultural labour has become a major risk factor of injuries among farmers.

Despite a high risk of injury for Korean farmers, the farmers have been in the dead zone of national occupational safety and health management. Because national workers' compensation and safety management are carried out by the Ministry of Employment and Labor, only certain scale of agricultural worksites' farming workers are included in the system. Small scale owner-operator farmers excluded from the Labor Ministry's worker's compensation and injury control are about 98% of total farmers.

Government agencies related with agriculture and forestry (mainly RDA) has started to play a leading role in solving the safety and health problems of such owner-operator farmers since the 2000s. Until the 2000s, RDA has carried out research and projects for farmers' work convenience. Since the 2000s, RDA has put its efforts into identifying the condition of agricultural injuries and diseases and managing it systematically on the national level.

## 2. Objectives

The objective of this study is to describe the status of Korean farmers' safety and health, efforts for legalization of farmers' safety insurance and safety management, and various safety and health research and prevention activities.

### 3. Methods

This study consists of literature study and data review. The literature and data are comprised of the following three areas: 1) Statistical data on the status of farmers' injuries and disease, 2) Status of legal and administrative management, 3) Relevant organizations' roles and activities. These data have been arranged by examining the concerned agencies' business activity plans, reports and academic presentation results. The statistical data of farmers are surveyed and produced by RDA, and the statistical data have been official data that gained the Statistics Korea's approval. The statistical data were collected through the questionnaire survey by visit of 10,000 farm houses, which are standard samples nationwide.

### 4. Results

#### 1) Status of farmers' injuries and diseases

##### (1) Statistics of workers' compensation (Statistics Korea 2014)

As a result workers' compensation statistics managed by the Ministry of Employment and Labour, the farm workers' occupational injuries and diseases occurrence rate is reported to be about 1.5 times higher than that of the workers in the entire industries (Figure 1, 2). The farm workers in the data are those who have subscribed to the industrial accident compensation insurance, which includes only 2.2% of the total 2.75 million of Korean farm population (Ministry of Agriculture, Food and Rural Affairs, 2014). The occupational injury and diseases rate for farmers is estimated higher in the case of most small scale and owner-operator farmers who do not subscribe to the insurance.

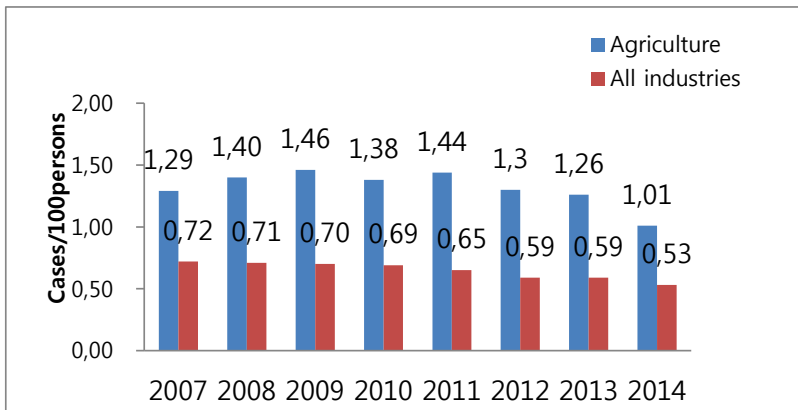


Figure 1. Occupational injury and disease rates, Worker's Compensation Statistics (Cases of death or 4 days of convalescence and over)

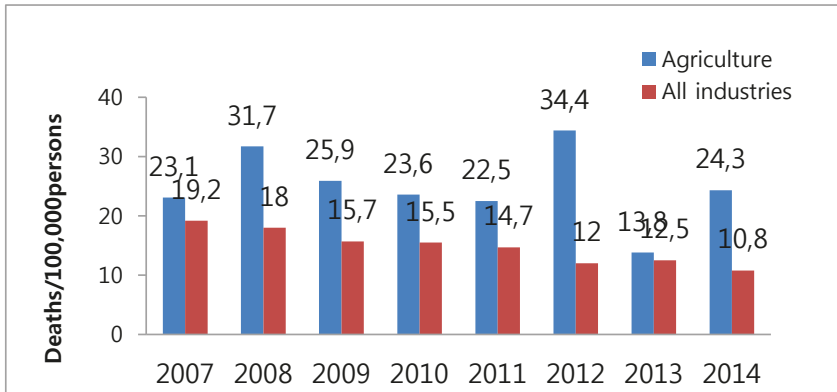


Figure 2. Occupational death rates, Worker's Compensation Statistics

(2) Survey statistics of occupational injuries and diseases for farmers  
(Statistics Korea, 2014; RDA, 2013)

As a statistical result of a sample questionnaire survey of farmers carried out by RDA, the rates of occupational injury and disease prevalence (one day convalescence and over) were 3.0~3.2 and 4.8~5.7 farmers/100 farmers, respectively during 2009~2014 (Figure 3).

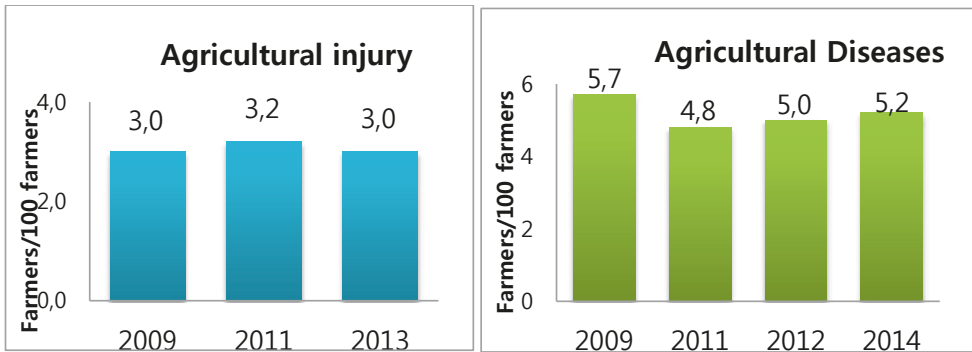


Figure 3. Occupational injury and disease rates among farmers (Cases of 1 day convalescence and over)

## 2) Legal basis on agricultural health and safety

(National Law Information Center, 2016)

(1) The Act on 『Farmer's and Fisherman's Quality of Life Improvement and Farming & Fishing Village Development』

As this Special Act was executed in 2004, the term of farmer's occupational injury was included in the law clause for the first time in Korea, and national support began to be partially offered for farmers' and fishermen's disease prevention and treatment. Based on such a special act, six of Agricultural Safety and Health Centers by theme began to be designated to university hospitals in order to research farmers' diseases from 2013.

\* Article 14 (Support of Farmer's and Fisherman's Disease Prevention and Treatment)  
and Article 15 (Support of Farmers and Fishermen who Suffered from Occupational Injuries)

\* Article 15.2 (Support of Facilities for Farmers' and Fishermen's Disease Prevention)

(2) The Act on 『Farmers and Fishermen’ Safety Insurance and Injury & Disease Prevention』 This law was executed in 2016, while the bill was presented during the three national assembly terms. According to this law, the Ministry of Agriculture, Food and Rural Affairs has to operate farmers’ safety insurance, and RDA has to conduct farmers’ safety accident prevention research and activities.

Major prevention services of RDA designated in the law include a survey and research on agricultural injury and disease, a preventive education and PR of agricultural safety and health, and other works that Minister of Agriculture, Food and Rural Affairs acknowledged as necessary.

### **3) Relevant organizations’ role and activities for agricultural safety and health**

#### **(1) Rural Development Administration (RDA)**

As a national agency that aims to develop and diffuse agricultural technologies, RDA is in charge of research, education and diffusion projects related to farmers’ health and safety. Major research fields related with agricultural safety and health are as follows: The survey of farmers’ occupational diseases and injuries (national statistics), an evaluation of exposure to farming work hazards, an investigation of injury causes, a development of a variety of preventive technologies including ergonomic tools and personal protective equipment, and dissemination of safety knowledge and protective equipments.

#### **(2) Local governments**

The Agricultural Research & Extension Service Institute in each of nine provinces, and a total of 165 Information Centers of Agricultural Technologies nationwide (one center in each city or county) are performing their duties under the direction of each local government head. Major duties are agricultural technology dissemination, education, and operation of demonstrative projects for prevention of agricultural injuries. The size of preventive projects is about KRW 10 billion annually, and national support is offered. As the Act on the Safety Insurance and Safety Accident Prevention for Farmers and Fishermen was executed in 2016, and legal framework was laid to expand farm work preventive projects.

#### **(3) Ministry of Agriculture, Food and Rural Affairs**

The ministry leads agricultural policies, carries forward the legislation of the policies, and is in charge of enforcement of laws described above. The ministry plans, manages, and oversights farmers’ safety insurance as its main policy project, and operates six Agricultural Safety and Health Centers in each province by designating them to university hospitals.

#### **(4) National Agricultural Cooperative Federation (Nonghyup)**

Nonghyup carries out economic and financial projects. Nonghyup operates “Farmers’ Safety Insurance” and “Agricultural Produce Insurance” being commissioned by the Ministry of Agriculture, Food and Rural Affairs. The Farmers’ Safety Insurance is a policy insurance that the government pays 50% of the insurance premium, but it is sold as a private insurance type by Nonghyup. The Farmers’ Safety Insurance still takes on voluntary subscription type, and therefore many farmers and their family members do not receive national support. In the future, an improvement to retain social security characteristics should be made by expanding the scope of benefit of the Farmers’ Safety Insurance and converting it into statutory subscription.

## 5. Discussion/conclusions

The safety and health management for farmers that started in the mid-2000s has achieved remarkable results including the production of agricultural injury statistics, enactment of relevant laws, and expansion of relevant research and service. Efforts to build a systematic, effective, and national management system encompassing the law, system, research and preventive projects are being made. To make an optimum national management system in line with Korean farmers' circumstances and Korean social security system, Korea refers to the best practices of foreign countries including Europe, and endeavors to develop a creative type through relevant stakeholders in Korea. For the effective advancement of these efforts and practical compliance with ILO's relevant regulations, more active international exchange and cooperation are needed.

## Acknowledgement

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## *Session 3B Management, leadership, team work, Part II*

### **Tuesday 16<sup>th</sup> August**

Kasper Edwards: Some key issues in the development of ergonomic intervention tools

Hans Comtet: UX in the Shipping Industry

Minke Wersäll: Does the organisation make a difference? – An evaluation of Women's Work Environment Programme

Mirja Johansson: Accessible work environment. Government Assignment 2011-2016 for The Swedish Work Environment Authority

# Some key issues in the development of ergonomic intervention tools

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*Literature reviews suggest that tools facilitating the ergonomic intervention processes should be integrated into rationalization tools, particular if such tools are participative. Such a tool has recently been developed as an add-in module to the Lean tool “Value Stream Mapping” (VSM). However, in the investigated context this module seems not to have any direct impact on the generation of proposals with ergonomic consideration. Contextual factors of importance seem to be e.g. allocation of sufficient resources and if work environment issues are generally accepted as part of the VSM methodology.*

## 1. Introduction

Mapping ergonomic risk factors is a key issue in ergonomic research. The number of available methods is large (e.g. Winkel & Mathiassen 1994; Takala et al. 2010), but no single one is suitable for all purposes – different approaches are needed for different goals. Quantification and exactness in the assessments are important e.g. in ergonomic epidemiology, for safety inspections and when making compensability decisions for injured workers. However, exact information on the risk factors does not ensure that proper interventions are developed, implemented and sustained (Westgaard & Winkel 1997). This demands engagement of the employees through participation in the generation and implementation of solutions (e.g. Punnett et al 2013; Westgaard & Winkel 2011). Participation also seems to increase the ownership to the solutions, thus increasing intervention sustainability (e.g. Vink et al 2006; Westgaard & Winkel 1997).

However, in a systematic review by Westgaard and Winkel (2011) it was concluded that most ergonomic intervention studies seem to have limited health effects in a long-range perspective. They also concluded that health issues are generally remedied in isolation from ongoing business and organizational activities. The review presented evidence for work intensification as a common result of rationalization (“the Ergonomic Pitfall”, Winkel & Westgaard 1996). This suggests that tools facilitating the ergonomic intervention processes should be integrated into rationalization tools, particular if such tools are participative.

On this background, an appropriate ergonomic intervention tool may be one that highlights significant ergonomic risk factors in such a way that the employees will be able to consider these when engaged in the running rationalization processes in their organization. Such a tool has recently been developed (Jarebrant et al. 2010). It is based on the Lean tool Value Stream

Mapping (VSM) (Rother & Shook, 2009) and aims to develop more sustainable patient flows at hospitals by integrating ergonomic risk factors in the change process (Winkel et al, 2015a). The tool (ErgoVSM) aims to catch ergonomic risk factors in a semi-quantitative way. This is time demanding and should only be accepted if more sustainable proposals are generated compared to those obtained by using VSM. However, no support has been found in the literature showing that quantitative compared to qualitative information on risk factors facilitates a participative change process.

In the present paper we present some Danish experiences on this issue.

## 2. Ergonomic Value Stream Mapping (ErgoVSM)

ErgoVSM is basically an ergonomic complement to VSM that guides the user through ergonomic assessments of all the activities identified in the VSM. The ErgoVSM process starts by identifying a value stream. All occupational groups involved in the value stream participate. They map the process by identifying tasks and activities. Each activity is written on a post-it note and placed on an overall timeline defining start and end of the value stream.

All activities are then analyzed regarding ergonomics, i.e. duration of the task (for an average patient), physical ergonomics and work content. Physical ergonomics and work content are “quantified” for each activity by using rating scales. The assessments are written on a post-it note for the activity (e.g. Figure 1).

Assess and give score to each work task with respect to work postures (WP)

Description	Score	Comments
Strongly twisted and at the same time bent work posture, extreme angles in the hands, elbow or shoulder joints, hands above the height of the shoulder or far outside the forearm's length (sitting) or ¾ arm length (standing), kneeling.	10 9	
Strongly bent or twisted work postures, hands below the hips (standing), hands outside the forearm's length (sitting) or outside ¾ arm length (standing), uneven surface and insufficient room for the legs (standing).	8 7 6 5	
Bent or twisted work posture, hands partly outside the forearm's length (sitting) or outside ¾ arm length (standing) with a possibility of relieving the load, some possibility to adapt the work posture to the individual and work task.	4 3 2	
Unlimited possibilities to choose comfortable and varied work postures. Adaptation to the individual and work task. Sufficient room, possibilities for free movements, even surface, support for legs and back, relieving the load on the arms.	1	

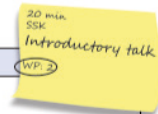


Figure 1: Rating scale for posture assessment used by the ErgoVSM tool (cf. Jarebrant et al. 2010).

ErgoVSM provides ‘physical ergonomics’ rating scales for: 1) work posture, 2) weight/force, 3) physical ergonomic potential, 4) physical porosity, 5) physical variation; for ‘work content’ rating scales are used for 1) control / influence, 2) communication, 3) potential in the work content, 4) demands, 5) mental porosity, 6) variation in work content. ErgoVSM also provides scoring sheets for documenting, calculating and summarizing scores.

The work group then identifies problems in the value stream and develops suggestions for improvements. The suggestions are used to describe a desired value stream – a future state. The future state is now analyzed by using the same rating scales once more. The assessments are compared with the initial assessments and potential problems are addressed. The future state is finally implemented.

## 3. Material and Methods

ErgoVSM has been used at three Danish hospital wards. ErgoVSM was used as part of a normal lean intervention where VSM was used to analyze a process. VSM was facilitated by a lean

specialist employed at the hospital. The ErgoVSM analyses using the rating scales were facilitated by the first author.

The workshops were audio and video recorded and each workshop lasted a full work day (7,5 hours). The ErgoVSM analyses at the workshops lasted about 1 hour each. Value streams were photo documented and the ergonomic ratings were collected during the workshops. The workshops were performed at:

- an orthopedic bed ward by a work group consisting of 6 employees including the head nurse;
- a neurologic rehabilitation center by a work group consisting of 8 first line managers (ward nurses, head of physio and ergo therapy, and porter etc.) and the head of department;
- a geriatric ward by a work group consisting of 12 employees including the head nurse and head physician.

In all cases we followed the project from start to end. Action plans were developed and their implementation was followed and documented.

#### **4. Results**

All workshops performed a value stream mapping of the process and analyzed the process. All ergonomic ratings from using the ErgoVSM tool were performed and discussed. All workshops produced an action plan based on the value stream analyses. However, no action plan proposals regarding changes in the process were generated as a direct consequence of these discussions. Thus, in those cases where the ratings suggested needs for improvements no immediate proposals for improved ergonomics were observed.

#### **5. Discussion**

The present observations suggest that the ErgoVSM tool facilitates ergonomic considerations by initiating discussions on ergonomic issues. However, in the present context, generation of proposals considering not only efficiency but also ergonomics, seemed mainly to be facilitated by the well-established and broadly accepted VSM routines at the investigated hospital; these routines included first line manager support and engagement, allocation of sufficient resources, work environment issues as part of the VSM methodology and VSM routines that were well-established and broadly accepted (Winkel et al, 2015b).

However, when the ErgoVSM tool has been used in Sweden and Iceland at hospitals without such a focus, it seemed to facilitate the process (Jarebrant et al, 2014; Winkel et al 2015b). The use of the ErgoVSM tool is time-consuming and should therefore only be used if it contributes to the inclusion of ergonomics in the action plan proposals. A further development and simplification of the ErgoVSM tool is therefore suggested.

#### **6. Conclusion**

The ErgoVSM tool: Our observations suggest that the ErgoVSM tool as used in the present context put focus on ergonomic issues. But this seems not to have any direct impact on the generation of action plan proposals with ergonomic consideration.

At hospitals using VSM: They may initially consider their VSM routines regarding e.g. first line manager support and engagement, allocation of sufficient resources, work environment issues as part of the VSM methodology and if ergonomic issues are considered. If ergonomics is not considered we suggest the use of the ErgoVSM tool.

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# UX in the Shipping Industry

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*The shipping industry takes more and more interest in the efficiency-enhancing potential of IT technologies. As an experienced software vendor, Dataloy wishes to be a driving force within this development. This paper is about how we developed a prototype for tactical fleet and tonnage planning. In most shipping companies, fleet scheduling is usually performed using spreadsheets. The result is sub-optimal fleet utilisation, much downtime, sailing without cargo, and high fuel consumption. In addition, the manual tonnage planning requires much cognitive capacity of the user and often results in double work. In short, this type of fleet scheduling limits optimisation opportunities. Throughout its development and upon completion, the prototype will be continuously evaluated by users – thereby ensuring that design meets requirements: delivering a simple solution to a complex fleet scheduling challenge.*

Keywords: Software, Engineering, Development, Shipping

## 1. Background

### 1.1 Scrum

Scrum is an agile project method, which is used in this project. This means short development cycles done by a cross-functional team, in which the user is involved to validate if requirements are met. This approach ensures user participation from the early beginning. It also ensures enough flexibility, so that changes have a limited impact on project goals.

### 1.2 User-Centered Design

The project follows a user-centered design process, which is divided into understanding and specifying the context of use, specifying requirements, producing design solutions, and evaluating if the design meets the requirements. By being user-centered we were able to constantly keep a user focus, as well as use design methods to unlock user insights. Those insights help to define user needs employed to design and develop our prototype.

## 2. Introduction

The shipping industry adopts more and more interest in the efficiency-enhancing potential of IT technologies and the need to be better informed.

As an experienced software vendor, we wish to be a driving force within this development. We want to deliver user-friendly solutions, which both serve business and user needs.

This paper is about how we developed a prototype for tactical fleet and tonnage planning, i.e. to allocate vessels and cargoes and to calculate optimised fleet plans.

### **3. Challenges**

Tonnage planning in most shipping companies is done manually by using spread-sheets and thereby limiting optimisation opportunities. The result is a suboptimal fleet utilisation, much downtime, sailing without cargo, and high fuel consumption. In addition, the manual tonnage planning requires a high degree of cognitive capacity from the user and often results in double work.

### **4. Methods**

#### **4.1 Domain Knowledge and Project Objective**

This project originally began as a research based project to create the optimal cost efficient schedule. Through our workshops we discovered that our users didn't see this as the highest priority for delivering what they needed in their business. More critical was the need to deliver operational solutions that worked and this as fast and efficiently as possible.

This has fundamentally changed the business case from the original research project and gives us the basis on which we will commercialise this tool for the client base it is designed to serve. Our goal in this project was therefore to deliver a simple solution that everybody could understand and therefore actually use.

The next step was to build a conceptual framework.

#### **4.2 Conceptual Framework**

In our user workshops we met clients who are serving different markets and are faced with different challenges. We built up a requirements document, which was analysed.

We discovered that although our clients are very different, they all follow the same process. Without our user-centered design approach we would not have discovered this success factor in our project.

Being able to summarise the users workflows of our different clients into common task models gave us a conceptual framework that we could base our development on.

In the next phase we had to prioritise requirements.

#### **4.3 Prioritise requirements**

There is currently no other Fleet scheduling application in use in the shipping industry today. As such we had no benchmark by which to prioritise the requirements we gathered since no other product exists in the market. By reviewing the requirements against the task flow models and attaching them directly to the process we were able to immediately see the priorities in the functional areas without being influenced by only one or two stakeholders. Thereby retaining a user focus and limiting risk of serving only one or two user groups.

We were then able to start the development of our design prototype.

#### **4.4 Prototype design**

We have developed a prototype. Our focus on basic manual and semi-automatic optimisation requirements on a vessel/voyage level has made it possible for the main actor of the system to get an overview over the processes involved. Getting an overview is together with tight integration with operational data some of the key factors of user adoption.

#### **4.5 Evaluating with users**

In our on-going work we will improve our prototype in a second phase, by continuing to involve users during the development, thereby ensuring that the design meets the requirements and delivering a simple solution to a complex fleet scheduling challenge.

#### **5. Conclusion**

By using an Agile and User-Centered Design approach, we were able to discover that whilst different user groups may have varied parameters and differing challenges to their businesses they all follow the same basic processes, which gave us a generic conceptual framework on which the solution development was based. This was not something we had necessarily expected to discover before we began this process. Our user-centered approach has allowed us to validate the business needs whilst seeing synergies between the different user groups.

Developing an overall UX navigation overview helped us to accommodate user flows for the actors supporting the role of the Scheduler. The complete UX navigation was then validated and prioritised by our users.

The success of this project was listening to our users and acknowledging their work processes and using this to map the requirements. Thereby taking a simplified approach to solving the complex task of fleet planning.

This has also been one of the first initiatives to bring user-centered design to the shipping industry and a success in terms of approach, commitment, and user involvement.



# **Does the organisation make a difference? - An evaluation of Women's Work Environment Programme**

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*The Swedish Work Environment Authority had a special commission by the Swedish government to visualise women's health in working life and prevent early retirement from work due to restrictions in the work environment. The programme named "Women's work environment" was organised in two projects 2011-2014. During 2015 - 2016 the authority has received a new commission to evaluate effects of the programme and deal with dissemination of the results and conclusions. Results show that most of the changes are reported on an individual level.*

Keywords: Evaluation, Supervision, Gender, Women's work environment

## **1. Introduction**

From 2011-2014 the Swedish Work Environment Authority (SWEA) had a special commission from the Swedish government to develop and implement directed initiatives aiming at preventing the exclusion of women from working life due to factors in the work environment, with an emphasis on conditions related to musculoskeletal health and ergonomics. The programme was divided into two projects. One with the emphasis on conditions related to musculoskeletal health and ergonomics. The other with emphasis on workload and comparing prerequisites for a healthy work environment in male and female dominated sectors. All together more than four thousand organisations and enterprises were supervised. (Arbetsmiljöverket, 2015). For 2015-2016 the authority received a new assignment to deal with the dissemination and development of the results and conclusions that the project has resulted in. Within the framework of the new commission five areas are covered: state of knowledge compilation with focus on organisational and social factors, communication, updating of skills, inspection and evaluation of the impact of the project on the authority as well as evaluation of the inspections done during the programme 2011-2014.

The evaluation started in order to study the effects achieved at workplaces and to learn from these for the future. The project aims for innovation, updating of skills and development oriented learning. Sustainability of made improvements thanks to a learning organisation is achieved when knowledge and understanding can be seen on all levels; the individual level, group- or department level and at an organisational level. Follow up and ongoing evaluation within the authority show that the program has led to a number of results, among these some long term effects (Sjöberg Forssberg and Svensson, 2015).

## 2. Objectives

The aim of the evaluation is to see what effect the inspections 2011-2014 have had on the organisations in terms of gender perspective and assessment of risks for musculoskeletal disorders. Have the inspections and other activities from SWEA led to activities at the workplaces? What effects have the inspections led to at the workplaces studied? Are the effects sustainable? What can explain present and absent effects? Which lessons did the authority learn from the projects? Also whether there have been effects which are difficult to perceive and visualise, especially if the effects are unintended or surprising? We want to try to track, understand, and discuss the effects of this kind.

## 3. Methods

The evaluation will take place February – October 2016. The evaluation is carried out through interviews with employers and safety representatives from organisations where inspections took place during the programme. We will carry out interviews by phone with representatives from about 30 work places. At 5 work places we will carry out about 10 personal interviews as well as a seminar where participants (employers and safety representatives) can discuss the preliminary results from the 10 interviews.

On the basis of this data there will be an analysis of how the SWEA can continuously improve the work for equal opportunities for good work environment conditions for both women and men.

## 4. Preliminary results

So far we can from interviews see achieved effects and absent effects. These are described separately for the two projects.

### 4.1 Inspections with emphasis on conditions related to musculoskeletal health and ergonomics

The inspections are carried out in various sectors, with the common feature that women have working conditions that could affect musculoskeletal health.

The inspections have mainly led to improvements in ergonomics, and not increased gender awareness. Actions undertaken are for example job rotation, improved cooperation with the safety representatives, increased use of occupational health services. The employer has also got an increased understanding to include physical ergonomics in the systematic work environment management. However, the effects are mainly achieved at workplaces where a majority of the work force are women.

The achieved effects are probably sustainable. It is likely that a workplace who started using for example lifting equipment will continue doing so over time.

Explanations used when effects were identified:

- Inspectors used good and appropriate tools for measuring the physical work load
- Requirements are made regarding improved ergonomics
- Even penalty payment is used when needed
- There was already a functioning work environment management system at the workplace when the inspection took place

Explanations of the absence of effects:

- Control and management philosophy and / or policies that create illness

#### **4.2 Inspections with emphasis on workloads, resources, support and goals**

The inspections were carried out in technical departments (i.e. property management) and social departments (home care) organised by municipalities.

The inspections have mainly led to increased awareness at the individual level, understanding that there are gender related differences between departments within a municipality. When there were ongoing activities to connect to, the inspections have been a trigger, and in that sense positive changes within the organisations have been strengthened.

The achieved effects are probably not sustainable. We can see several explanations to this:

- The impact has mainly affected the individual level
- The municipalities are to a large extent depending on political decisions and decisions taken "over the head" of the affected persons
- It is complex and difficult to implement a gender perspective on systematic work environment management
- There are major shortcomings in the ownership and steering of the systematic work environment management

Explanations given when effects are presented:

- The project layout with two inspectors having different expertise, the focus on several levels / many people's perspective, the feedback to politicians, and that questions were asked about gender equality

Explanations given in case of the absence of effects:

- In the regulations on systematic work environment management we lack the gender perspective
- No active work for gender equality in general at the workplace
- Lack of skills for change management at the workplace
- Control and management philosophy and / or policies that create illness
- Cutbacks without a gender analysis
- Large turnover of managers and other employees

#### **5. Discussion**

Is it possible for the organisations to develop in the desired direction without first having a functioning systematic work environment management system?

It is important that the organisation takes into account what gender means in work environment management. The results show that a gender perspective is needed on an organizational level in order to become sustainable, which means an active ownership of the gender perspective and management asking for results. A learning organisation has to visualise, compare and reflect in order to take effective preventive measures for a sustainable work environment. The evaluation contributes to the learning within our organisation. Especially the importance of management asking for results appears to be a critical success factor.

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# Accessible work environment Government assignment 2011-2016 for The Swedish Work Environment Authority

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*Everyone should be able to participate in working life. It is important to prevent and remove obstacles by changing the environment and surroundings. In this presentation, the Swedish Work Environment Authority (SWEA) wishes to draw attention to the efforts contributing to accessible work environment for all employees.*

Keywords: work environment, accessibility, disability, government assignment, inspection

## 1. Introduction

This is a presentation of the Swedish Work Environment Authority's (SWEA) work in contributing to accessible work environment for all employees. It is based on a government assignment given autumn 2011. The final report was in March 2016.

The fundamental principle of the assignment has been that everyone should be able to participate in society and take part of human rights. Here, the state authorities have a specific responsibility. Twenty-two strategic authorities have received the task of setting up goals within their respective activity areas, and following up the development each year. The effects of these efforts should be measurable.

SWEA has had a specific responsibility for the work environment area and has worked towards six goals. These have been about increasing competence within accessibility, integrating the disability perspective and accessibility into our regulations, communications, and inspection. It has also been about increasing the authority's own accessibility. In this presentation, we primarily describe the work within inspection.

One of the core activities of SWEA is to promote a good work environment by inspecting workplaces. This aims at preventing risks of the employees being affected by ill health and accidents.

## 2. Objective and goals

The aim has been to increase knowledge and competence about accessibility questions among inspectors and at the workplaces we inspect. Accessibility has been taken up in connection with supervision activities such as inspections, follow-ups and information campaigns. We have worked towards the goal of carrying out at least one annual regional or national supervisory activity where the accessibility perspective is included.

We operationalized the goal through six sub-goals:

1. The inspectors to be educated in accessibility during 2013 and 2014
2. The inspectors to register every occasion where they have included accessibility in their supervision

3. During 2013, a regional pilot project will be carried out with inspections within the recycling sector, with a focus on accessibility
4. Experiences from the inspections during 2013 to be evaluated and used in the planning of 2014's inspection activities (information, communication, inspection, regulation support)
5. Accessibility is an integrated part of the coming inspection within schools 2014 and 2015
6. All inspections integrate accessibility with two inspections during spring 2015 within any sector

### **3. Methods**

In 2012 we did baseline measurements for the goals. We broke the goals down into sub-goals in order to identify development areas, and to concretise the goals ahead of the following years' activities.

We have followed up the work towards the goals, both quantitatively and qualitatively. We have counted the number of ordinances within inspections and information campaigns. We have used questionnaires and interviews for the evaluation of experiences and material. Furthermore, we have carried out and followed up the education campaigns.

Measurement of goal attainment has been done through the follow up of statistics, questions to the inspection district and the development of inspection methods.

The zero position in 2012 shows that accessibility is present very seldom or never in supervision. We do not either have any systematic follow up of the number of inspections that encompass accessibility.

### **4. Results**

#### **4.1. What did we do?**

We began with education. Our starting point was that it is important that all inspectors have the same approach and basic knowledge.

The common approach is based on the UN Convention on the Rights of Persons with Disabilities (2006). That, in its turn, builds upon the understanding that it is possible to prevent and remove functional obstacles through changing the environment and surroundings. The SWEA should work with minimizing obstacles in the work environment for everyone. This can be done, firstly by designing universal solutions that work for everyone. Sometimes special individually designed solutions are needed as a complement. The aim is to achieve participation and equality.

Our message is that which is good for everyone can be necessary for persons with disabilities. There is no them and us, but there is us and us because health and thereby life situations can suddenly change for us all. Further, the work environment encompasses several aspects such as social, emotional, cognitive, organisational and physical.

#### **4.2. What have we achieved?**

We have achieved all the sub-goals. We started with a regional pilot project in 2013 in the recycling sector. A limited group of inspectors received training, and participated in developing inspection support. We then evaluated the efforts and developed the inspection support. In 2014, we broadened this regional pilot project to a national supervision activity in the recycling sector.

The next step was the national supervision in schools (compulsory school and upper secondary schools), which started in 2013 and is on going until and including 2016. During all

inspections in schools we have brought up the question about accessibility in connection with systematic work environment management. In 2015, all inspectors carried out two information drives in any sector, where they integrated accessibility in all inspections.

#### **4.3. Accessibility integrated in the organisation, including supervision**

During the zero measurement in 2012, accessibility was seldom or never mentioned. During 2015 this made up 2 per cent of all inspections, during 2014 and 2015, the proportion was 6 per cent. Organisational measures have also given the questions a more central position where accessibility is centrally integrated in the authority's planning and follow up, which all departments work for.

We have, during the years 2013 – 2015, visited 3634 employers with supervision activities where we have taken up functional obstacles and accessibility. More than half of the inspection activities are in the school sector. Examples of other visited sectors are recycling, commerce, manufacturing, public administration and defence.

The inspectors place demands on the employers who do not follow the Work Environment Act and its provisions. The demands placed within recycling have primarily been organisational. One example that has often occurred is accessible introduction and instruction, in order to increase safety. Within the schools we have placed demands within all work environment areas.

### **5. Discussion**

#### **5.1. Discussion – inspection**

##### **5.1.1. Broadened perspective on accessibility**

The education and supervision campaigns have given many inspectors basic knowledge and a broader perspective of accessibility. Partly through the insight that it is possible to change the work environment so that disability is not an obstacle in a working situation. Partly that accessibility, over and above the physical aspects, also encompasses social, mental and cognitive aspects. This has also been an insight for many employers.

Several inspectors today include invisible obstacles in dialogue with employers. It can be about the importance of supplementing written instructions with images, pictograms or films. The inspectors have also taken up the digital work environment and the significance of having user-friendly and accessible systems and computer programs.

Today inspectors can reveal and have dialogue about functional limitations and accessibility in work environment and, where necessary, make demands. For many inspectors it is obvious to take up questions connected to gender and accessibility.

We assess that we have come a long way in the work with accessibility. In connection with inspections, many employers have said they have received an increased insight that accessibility is good for everyone, and that they can prevent obstacles in working life.

##### **5.1.2. Lessons learned from inspections**

We have seen that it can be difficult to see the whole picture around the employees' work environment. A number of employers make adaptations when it comes to working hours, workload and working tasks for persons with mental ill health. But they can miss the ergonomic risks for example that one does not use lifting equipment. Several inspectors have mentioned that it is unclear where the responsibility for a good work environment lies for those persons who participate in labour market policy programmes.

We have given attention to respiratory allergies being a widespread work environment problem within many sectors. In schools due to deficient cleaning, and within the manufacturing

industry due to insufficient ventilation and also air contamination. Also within commerce in the form of chemicals in the clothes, demolition dust within construction, and chemicals within the hairdressing profession and the beauty sector.

An important conclusion is that employers need to reveal accessibility questions in the systematic work environment work, and work preventively. This can be about the employers needing to produce procedures for how they must work with accessibility, or that they need to investigate the risks in the work environment. They also need to consider that the risks can be within all work environment areas. New premises and equipment should be accessible to all, and technology need not mean unnecessary obstacles.

### **5.1.3. Good examples**

We have come across good examples, among other things within the processing industry. People from many countries work there, and it has therefore become more common to have instruction films. They watch the films together with the staff, and have apps with film clips for smart phones. Furthermore, we have met company management who formulate IT and telephone policy in order to reduce workload. Policy about how quickly one has to reply to mail or answer the telephone, and what applies when it comes to weekends and holidays.

## **5.2. Discussion –the whole assignment**

Our reflections from our work with accessibility are that the questions permeate our entire organisation, obvious in many ways but also difficult to grasp. It takes time and must be allowed time to find the way to tackle it. To be sustainable in our work has been important.

Over and above the work within inspection, all the other departments have worked with accessibility. Some examples of the results are that all our staff have received fundamental knowledge, common concepts and a common attitude that accessibility concerns us all, and is integrated into our mission.

We have strengthened our possibility to create rules that more can embrace. In the process we use to create provisions, we have introduced accessibility as an aspect that should be taken into consideration. We have developed tools as well as information about accessibility, rewritten several brochures in order to make them easier to read, and worked with the accessibility of our website.

SWEA work environment survey, which will be presented in spring 2016, contains questions about functional obstacles in the work environment. This contributes to a more nuanced picture of disabilities that cause obstacles in working life in Sweden.

We have increased the authority's own accessibility through, for example, working more actively with IT accessibility, procurement and physical accessibility. We also place demands on accessibility during the procurement of premises and the acquisition of goods and services.

### **5.3. Discussion - challenges**

We have challenges ahead of us. One is the authority's work with regulation renewal 2016 – 2018. This should achieve a modern and forward-looking regulatory framework that is accessible, clear and relevant for employers and others. Knowledge and experiences from the work with accessibility can be valuable in this work.

SWEA should monitor whether the accessibility perspective is taken into consideration in the reformation work of the EU Work Environment Directive. And similarly, follow the negotiations that have begun regarding the proposal for the European Accessibility Act.

We see a challenge in the change of working life to being more abstract, and more cognitively, emotionally, and socially demanding. We assess that the work with increasing

cognitive accessibility is of great importance in future work environment management. It is essential to take advantage of the possibilities within digital development.

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## *Session 4A Interventions*

### **Tuesday 16<sup>th</sup> August**

Kasper Edwards: Accounting for effect modifiers in ergonomic intervention research

Pia Sirola: How suitable are multispace-offices for university work?

Sanna Lohilahti: Field study investigating gear shifter usability in car rental scenario

Kristiina Hellsten: Implementation and impact of an ergonomic intervention in elderly care

Veli-Matti Tuure: Comprehensive improving of well-being and productivity in SME's at forestry and health care sectors

# Accounting for effect modifiers in ergonomic intervention research

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*The impact of ergonomic interventions may be offset by other changes at the work place, primarily rationalizations. These have previously been shown to imply a dominant negative effect on health and risk factors, thus causing effect modification. We present a method identifying potential effect modifiers in ergonomic intervention studies.*

*Keywords: Ergonomic intervention, Effect modifiers, Method*

## 1. Introduction

In a systematic review by Westgaard and Winkel (2011) it was concluded that most ergonomic intervention studies seem to have limited health effects in a long-range perspective. They also concluded that health issues are generally remedied in isolation from ongoing business and organizational activities. The review presented evidence for work intensification as a common result of rationalization, thus modifying a potential positive impact of ergonomic interventions (“the ergonomic pitfall”, Winkel and Westgaard 1996). Poor knowledge on potential modifiers often hampers inference regarding impact of an investigated ergonomic intervention and may lead to false conclusions.

This paper presents a newly developed method to identify potential effect modifiers in occupational health intervention research.

## 2. Material and Method

### 2.1 The Method

The method is a type of group interview including 3-6 participants representing all occupational groups in the investigated organization. For the investigated period, the participants identify events perceived as having significant impact on their work and work situation. Each employee writes each event on a separate post-it note without any group discussions. The process is guided by 3 questions focusing (1) events in general, (2) work processes and equipment and (3) working environment. The post-it notes are then collected and, in co-operation with the group, placed on a timeline (e.g. on a whiteboard) according to occurrence (Figure 1). The respondents are interviewed about background to each event and impact on their work environment and performance (positive, no or negative impact). At the end of the workshop it is assessed if the

events are part of the intervention (yes/no). The workshop is audio-recorded and transcribed and the timeline photographed for later quality control and analyses.

Following the workshop all assessments are triangulated and reassessed by 2 researchers and entered into a database. Triangulation is based on scientific evidence, researcher knowledge, reading the transcribed audio recorded workshop and other local sources.

The method aims to capture both the individual and collective account of all significant events that may have caused a significant impact in relation to the specific aim of the investigated intervention. The method is inspired by the 'chronicle workshop' procedure (Limborg and Hvenegaard, 2011).

## 2.2 Case Study

The method was tested at a Danish hospital ward using their own local version (Winkel et al, 2015a) of the Lean method "Value Stream Mapping" (VSM) (Rother and Shook, 2009), supplemented by an ergonomic module (Jarebrant et al, 2010). The intervention was initiated and run by the hospital. The purpose was to create a more efficient care process for a specific patient group without impairing (or even improving) the work environment for the employees (Winkel et al., 2015a, b).

A nurse, a physiotherapist and an assistant nurse participated in the workshop, which was facilitated by the first author.

## 3. Results

In total 47 events were identified. Of these, 30 were modifiers. Figure 1 shows a time-line including the first 22 post-it notes. From Table 1 it appears that most of the modifier events cause negative impact on the work environment.



Figure 4: Illustration of part of a time-line according to occurrence of each event. Each post-it note indicates an event perceived to cause a significant impact on their work and work situation.

The intervention project resulted in almost equal amount of events with positive and negative impact on the work environment. However, 83% of all identified modifiers were assessed to cause negative impact on the work environment (Table 1).

Table 1 Distribution of events according to impact on work environment (WE) and origin of event (implemented intervention or modifier). A majority of the events are due to modifiers with negative impact on WE.

Type of event	# events	WE-	WE0	WE+	Total
Intervention	18	47%	12%	41%	100%
Modifiers	31	83%	10%	7%	100%

Modifiers were then pooled into larger groups as appears from Table 2. Cutbacks (i.e. Downsizing) implied that the same amount of patients should be treated with less resources leading to perceived work intensification as shown in Table 2. Cutbacks, in turn, led to personal turnover, which further amplified work intensification. The reallocation created uncertainty among staff. This resulted in overall negative perceptions of the work environment at the investigated wards.

Table 2 Modifier and intervention events pooled into major groups. Each of the 10 groups showed either positive or negative perceived impact on the work environment. No mixed results within any of the groups.

<b>Modifiers</b>	<b>#events</b>	<b>Interventions</b>	<b>#events</b>
Cutbacks (WE-)	14	Better collaboration (WE+)	3
Personal turnover (WE-)	5	New care concept (WE+)	3
Merger: better professional collaboration (WE+)	2	Better role and function of team leaders (WE+)	1
Merger: Relocation (WE-)	2	Less dialog with management (WE-)	3
Miscellaneous (WE-) -less care continuity -More sick leave -Negative atmosphere -Unclear management agenda	4	Miscellaneous (WE-) -less time for rest -Miss care plan meeting -Restructuring from lean -Lean not visible -Evaluating lean	5
Disregarded (WE0)	3	Disregarded (WE0)	2
<b>Total</b>	<b>30 (64%)</b>		<b>17 (36%)</b>

## 4. Discussion

### 4.1. General discussion of Case Study results

The presented case study illustrates that the investigated intervention would have been misinterpreted if no modifier analyses had been performed. A main group of modifiers seem to be related to downsizing imposed by hospital management and not to the investigated intervention at the ward.

The workshop revealed that 70% of the identified events in the investigated period were assessed to cause negative impact on the work environment. The majority of the events were due to modifiers.

The workshop identified work intensification and uncertainty for staff. Without accounting for modifiers it appears that the investigated intervention would have been assessed as a failure due to impaired work environment. However, when accounting for modifiers, a more detailed picture emerges. Most of the identified events (53%) were negative effect modifiers. The intervention alone had almost equal positive and negative impact on the work environment. This tempts a conclusion that the intervention was not a failure as the patient care process was optimized without a general negative impact on the work environment.

#### **4.2 Methodological considerations**

The method uses a combination of individual and collective responses to capture and validate events. Individuals write the events on the post-it notes without prior group discussion followed by comments from the other participants. If the event is not recognized by the other participants this is a strong indication that the event may not have taken place or is an individual experience with limited modifier effect. Such events should be removed during the workshop.

An "event" is here defined as a change that is out of the ordinary in the investigated organization. For this reason, respondents should have sufficient experience in the organization prior to the investigated period and be affected by the investigated intervention. A key issue is if the participants' assessments of "events" and their impact on the work environment correspond to the perception by the majority of the employees in the investigated organization. The assessments should also correspond to other sources of information. In order to cope with this, a triangulation procedure is used.

The modifiers are assessed in terms of numbers and not in terms of expected impact. Due to this, an additional preliminary scrutinizing procedure of the modifier events is suggested. In the presented case the events were categorized in 5 major groups. One of these, 'cutbacks' (i.e. downsizing), seems to have caused major negative impact on the work environment. Other modifiers, such as better professional collaboration, may only influence a few of the employees i.e. employees part of the quality group. Thus, additional modifier analyses may be important in order to estimate a potential impact of an investigated intervention.

In conclusion, the presented method seems to identify potential modifiers and subsequent effects on the working environment. However, further validation of the method is suggested.

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# How suitable are multi-space offices for university work?

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*Multi-space offices have been developed to achieve space efficiency and to encourage collaboration. Research on the functioning of multi-space offices in universities is scarce. The aim of this survey study was to compare university staff's experiences of multi-space offices in four different types of university work. The new workplace solutions were assessed most positively by those in administrative, expert and customer service tasks that included continuous interaction. Teachers and researchers, whose work tasks required more total concentration, reviewed the premises most negatively. Thus, designers of multi-space offices should consider different groups of employees and their job requirements.*

Keywords: Work environment, multi-space office, functionality, job content, university, collaboration, user-experience

## 1. Introduction and objectives

New ways of working, digitalization, and space and energy-efficiency requirements challenge traditional learning and research environments. Multi-space offices, which have been developed to meet these requirements, as well as to encourage knowledge-sharing and co-operation, have been applied to universities. However, their suitability for universities has not yet been studied. In Finland, university campuses have been actively developed in recent years (Built Environment Innovations (RYM SHOK) Indoor Environment Program 2015).

Multi-space concepts were originally developed for multi-locational and mobile knowledge work. Their objective is to develop a flexible, efficient solution, with different spaces for different phases of work processes: open spaces for team work, silent places for tasks that require concentration, and places for undisturbed phone calls. According to previous research, the perceived positive aspects of the multi-space offices have been the overall appearance of premises, knowledge transformation and interaction, and an improved sense of community. The problems, on the other hand, have mostly been related to concentration difficulties due to interruptions, and inadequate working/storage facilities, information and communication technology (ICT). (Vos & van der Voordt 2001; Bjerrum & Bodker 2003; van der Voordt 2004; McElroy & Morrow 2010; de Been et al. 2015). Parking et al. (2011) studied how two different academic office environments supported collaboration and privacy. They found that combi-offices (desks located in individual offices and shared work settings that were accessible to occupants) were associated with higher satisfaction than open-plan offices (desks located in shared areas and shared work settings that were accessible to occupants).

In addition, the typical problem is that work processes are not considered in the design processes (Vos et al. 2001; Bjerrum et al. 2003). This survey study compares university staff's experiences of the functionality of multi-space offices for four different types of university work. We also studied environmental satisfaction and the perceived effects of the workplace change

from individual rooms to multi-space offices. The specific research questions were: What is the content of university work and how did the job contents of different tasks vary? How satisfied were university staff with their work environment? How did the users find the functionality of the multi-space offices and did their experiences differ according to their tasks? What were the perceived impacts of the workplace change?

## 2. Materials and Methods

The study was carried out at a Finnish university that had refurbished its facilities in the Faculties of Social Sciences, Theology and Premises and Property Services. The facilities were located in six buildings and had been renovated in 2011–2014. The study participants had worked in the new premises for at least one year. The online questionnaire (Ruohomäki, Lahtinen et al. 2013) was tailored for the present study and made available to the personnel (N=332) in May 2015, using Digium software. A total of 57% (n=190) completed the questionnaire. The chosen participants were personnel who worked in the multi-space offices. The final sample was 118 people, of whom 66% were women (mean age 43, range 25–82).

The data was classified into four groups according to the content of tasks performed every day or almost every day: (1) Teaching and / research tasks (n=47), (2) administrative tasks (n=26), (3) customer service tasks (face to face, by telephone or virtual, n=50), and (4) expert service tasks (n=59). A cross-sectional survey design was used. Data was analysed using SPSS (IBM Statistics for Windows 20). Kruskal Wallis and Mann Whitney-*U* tests were used for statistical differences. The level of statistical difference was set to  $p < .05$ .

## 3. Results

### 3.1. Job contents and differences between tasks

University work mainly contained periods requiring total concentration (altogether 77%, great extent to very great extent included), problem-solving (73%), co-ordination and organization (70%), and creation and planning of new ideas and things (67%). In the preliminary analysis (Kruskal Wallis test,  $p < .05$ , scale 1=not at all to 5=very great extent), statistically significant differences were found between the job contents of teaching and research (A), administrative tasks (B), customer service tasks (C) and expert service tasks (D). A further examination using the Mann-Whitney-*U* test showed that teaching and research tasks were characterized by being able to schedule the work (A mean 4,56 vs B mean 3,92,  $p = .003$ ; A vs C mean 3,62,  $p < .001$ ; A vs D mean 4,02,  $p < .001$ ) and to perform it independently and freely (A mean 4,72 vs B mean 4,00, C mean 3,86 and D mean 4,09,  $p < .001$ ). Teaching and research tasks also involved the creation and planning of new ideas and things (A mean 4,13 vs B mean 3,60,  $p = .020$ ; A vs C mean 3,41,  $p = .001$ ; A vs D mean 3,78,  $p = .029$ ), required more periods of total concentration (A mean 4,83 vs B mean 4,04, C mean 3,84 and D mean 4,08,  $p < .001$ ), and involved more problem-solving (A mean 4,17 vs B mean 3,81,  $p = .032$ ; A vs C mean 3,72,  $p = .011$ ; A vs D mean 3,93,  $p = .049$ ) than other groups. Administrative, customer service and expert tasks were characterized by continuous interaction with other employees (A mean 2,56 vs B mean 3,81, C mean 3,80 and D mean 3,78,  $p < .001$ ) and customers (A mean 1,38 vs B mean 3,04, C mean 3,66 and D mean 3,17,  $p < .001$ ), managing several tasks at a time (A mean 3,92 vs B mean 4,58,  $p = .003$ ; A vs C mean 4,36,  $p = .013$ ; A vs D mean 4,46,  $p = .002$ ), and co-ordination and organization (A mean 3,23 vs B mean 3,88,  $p = .014$ ; A vs C mean 3,66,  $p = .042$ ; A vs D mean 3,88,  $p = .002$ ).



### 3.2. Environmental satisfaction with and functionality of multi-space offices

University staff (n=118) were mostly satisfied with their work environment as a whole (73%, scale 5–7 combined, 1=very dissatisfied – 7=very satisfied). The facilities were mainly evaluated as relevant and appropriate for carrying out work tasks (72% agreed strongly or more or less strongly, scale 1=strongly agree to 5=strongly disagree). The staff were also able to work quite effectively in these offices (65% agreed, 14% disagreed). The proximity of co-workers (85%/12%), smooth co-operation (71%/12%) and the feeling of security were regarded as positive (89%/2%). The majority of the respondents estimated that they had enough work space (73%/22%) and quite many felt they had enough storage space at their desks (66%), while 26% disagreed. Over half of the respondents were satisfied with their ability to adjust their furniture (60%, although almost third (26%) disagreed). The adjustability of the work premises as a whole (21% agreed, 53% disagreed), the availability of ICT regardless of where one is working (57%/26%), and how well the workspaces promoted virtual interaction and collaboration (45%/20%), were assessed more negatively. Moreover, being able to move to a quieter place to work if one could not concentrate was estimated critically (63% disagreed).

In the preliminary analysis (Kruskal Wallis test,  $p < .05$ ), statistically significant differences were found between the experiences of the functionality of multi-space offices according to work tasks. Further analysis showed (Table 1) that the experiences of how well the new work premises supported interaction between individuals, how easy it was to contact one's colleagues, and how co-operative the workplace spirit was were assessed the most negatively by those who worked in teaching and research tasks.

Table 1. Experiences of functionality of multi-space offices according to work tasks (Mann Whitney –U - test: mean, median, scale 1 = strongly agree – 5 = strongly disagree)

		A=teaching/ research (n=47)	B=administrative (n=26)	C=customer service (n=50)	D=expert (n=59)
My work premises support interaction between individuals.	mean	3,02	2,00	2,02	2,05
	median	3,00	2,00	2,00	2,00
	<i>Mann</i>		A vs B $p < 0,001$	B vs C $p = 0,680$	
	<i>Whitney</i>		A vs C $p < 0,001$	B vs D $p = 0,642$	
			A vs D $p < 0,001$	C vs D $p = 0,924$	
It is easy to contact one's colleagues in this environment.	mean	2,50	1,73	1,64	1,71
	median	2,00	2,00	2,00	2,00
	<i>Mann</i>		A vs B $p = 0,002$	B vs C $p = 0,766$	
	<i>Whitney</i>		A vs C $p < 0,001$	B vs D $p = 0,962$	
			A vs D $p < 0,001$	C vs D $p = 0,752$	
The workplace is characterised by a co-operative spirit.	mean	2,63	1,96	1,96	2,10
	median	2,00	2,00	2,00	2,00
	<i>Mann</i>		A vs B $p = 0,010$	B vs C $p = 0,961$	
	<i>Whitney</i>		A vs C $p = 0,001$	B vs D $p = 0,519$	
			A vs D $p = 0,012$	C vs D $p = 0,393$	

### **3.3. Perceived effects of workplace change**

Workplace change from individual rooms to a multi-space office (n=118, scale 1=substantially improved to 5=substantially weakened) improved the sense of communality and interaction (60% improved, 24% weakened), increased the comfortableness of facilities (51%/22%), and increased space efficiency (62%/16%). However, peace and quiet in which to work was estimated as having deteriorated (65% weakened, 13% improved). Over half of the respondents reported that the change had no effect on well-being at work (53%), work productivity (59%) or the fluency of work processes (51%). Inadequate soundproofing in quiet rooms and talking at nearby desks were considered the most distracting issues.

## **4. Discussion and conclusions**

This study compared the functionality of multi-space offices from the perspective of teaching and research tasks, administrative tasks, customer service tasks, and expert service tasks. University staff were satisfied with the work environment as a whole. The facilities were evaluated as appropriate for carrying out work tasks in general. The workplace change improved the sense of community and interaction, and increased the comfort of the facilities. The results were closely aligned with previous research on office environments. As in earlier studies, the main developmental target was the improvement of privacy (Vos et al. 2001; Bjerrum et al. 2003; van der Voordt 2004; McElroy et al. 2010; de Been et al. 2015). However, the adjustability of the work premises as a whole, and the availability of ICT systems regardless of where one is working were assessed more negatively. Unlike in previous studies, the majority of the respondents estimated that they had enough work space, and quite many assessed that they had enough storage space at their desks. (Bjerrum et al. 2003; McElroy et al. 2010).

This study showed that the experiences of the university staff regarding the functionality of multi-space office varied according to work tasks. New workplace solutions were assessed most positively in administrative, expert and customer service tasks which included continuous interaction. In contrast, for teachers and researchers whose work tasks required more total concentration, multi-space solutions did not support the interactive and co-operative needs of their work tasks so well. Differences between buildings do not seem to explain the differences between the various groups in this study, since teaching and research staff were positioned in the newest facilities, the renovations of which had been based on the latest information on functional solutions. On the other hand, some of the employees who had previously worked in the same premises were positioned on different floors in the multi-space offices. This may also have affected some of the experiences of co-operation and interaction.

Designers of multi-space offices should take into account different groups of employees, their job contents and job requirements. It is important to pay attention to the factors that contribute to concentration in workplace facilities, such as an adequate number of quiet rooms and their sufficient soundproofing. It is equally important that those requiring total concentration at work should not, in principle, be placed in the same space as those whose work involves more interaction. ICT that supports multi-locational work, as well as the adjustability of the premises and work desks, are also important factors in flexible work environments. Multi-space offices may not be suitable for all tasks, as was shown in the university context.

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# Field study investigating gear shifter usability in car rental scenario

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*Shift-by-wire technology enables new gear shifter designs in cars. Highly innovative gear shifter designs might confuse drivers and have a negative impact on usability. However, new designs might also be more intuitive and easy to use. The purpose of the study was to identify possible usability profits and concerns with different types of gear shifters with shift-by-wire technology during natural interaction, as in a car rental scenario. Four gear shifter types were tested: a button, rotary, joystick, and a stalk shifter, from a usability perspective. The joystick shifter was the most preferred shifter, it felt familiar. The button shifter was the easiest to understand and use. The rotary shifter had also high ease of use apart from one task, the activation of the manual driving mode. The stalk shifter was the least preferred and also the most difficult to use.*

*Keywords: Shift-by-wire, gear shifter, usability, field study*

## 1. Introduction

Shift-by-wire technology, with electromechanical linkage between the vehicle and the gear shifter, enables new and innovative designs of gear shifters. A new design might improve intuitivity and ease of use. However, highly innovative gear shifter designs might also result in solutions that are confusing and distracting to the driver. The problem with variation of gear shifter designs is not new. In 1968, National Highway Traffic Safety Administration (NHTSA), US, introduced a legislation regarding shift lever sequence. The purpose was to make vehicles more standardised and hence prevent shifter errors in unfamiliar vehicles (Tarbet, 2004). The introduction of shift-by-wire technology has raised the concern again and a new legislation might be needed. The variation of shifter concepts are particularly of concern during first encounter or infrequent use, as in a car rental situation. The usability of design may also affect the usage for more experienced drivers (Shinar et al., 1998), especially during distraction or during stress (Harley et al., 2008). Harvey et al. (2011) suggests that infrequently used functions in the vehicle, such as the manual drive mode, should have good memorability. Since driving a car consists of over 1700 tasks (Walker et al., 2001), the driver is able to process only a restricted amount of information at the same time, but is exposed to many different stimuli and needs to make decisions more or less quickly. Adding complexity to relatively simple tasks, such as shifting drive modes, is in that respect unnecessary. McIlroy et al. (2014) points out the importance of careful consideration when adding information in the vehicle. They argue that the interface design could have great impact on driver distraction as well as impact the driver behaviour and user acceptance. Harley et al. (2008) suggests that the kinesthetic feedback in gear shifter is of relevance and that the end positions is particularly useful. For likability aspects of the gear shifter, other aspects as design and ergonomics are of importance as well (Lindner & Tille, 2010). Most

studies on gear shifter usability concern traditional mechanical joysticks. Shift-by-wire technology (SBW) has enabled other shifter types, including buttons, rotary devices and stalk shifters. The movement patterns have also been evolved; previously, the movement patterns had stable positions (polystable) but SBW does also enable monostable patterns, i.e. the shifter falls back into one stable position. These new features might decrease or increase usability. The purpose of this study was to identify possible usability profits and concerns with different and modern types of gear shifters with shift-by-wire technology during natural interaction, as in a car rental scenario.

## 2. Method

### 2.1. Participants

Eight participants (n=8), four males and four females, in the ages 19-65 (M = 40,8; SD = 17,9) volunteered in the study. All participants had a driving license and former experience of cars with automatic transmission but no previous experience of the gear shifters tested in the study.

### 2.2. Concepts and equipment

Four different types of automatic gear shifter types were tested in the study: a button shifter (Kongsberg Automotive concept car,) a polystable rotary shifter with stalk paddles for manual mode (Jaguar XF Sportbrake), a monostable joystick shifter (BMW 320d) and a monostable stalk shifter (Mercedes E-class). The shifter concepts are illustrated in Figure 1. For data collection, two Microsoft Live webcams, one MacBook Air computer with windows 8.1 and the Software iSpy64 was used.

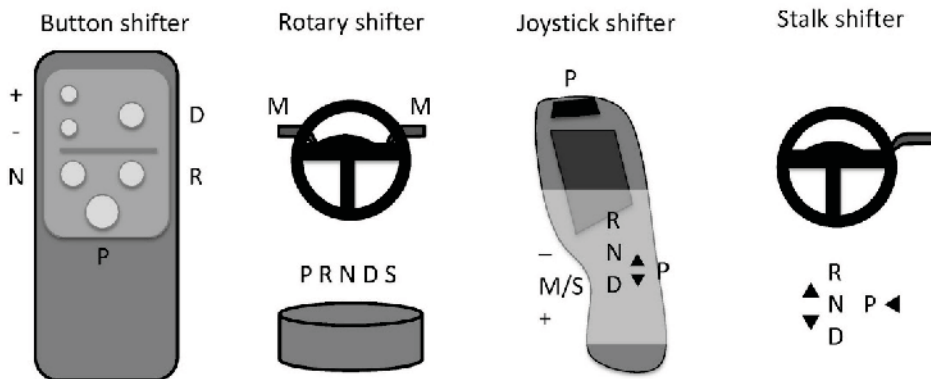


Figure 1. Schematic illustrations of the gear shifters used in the study.

### 2.3. Measures

Usability was measured as the effectiveness, efficiency, and satisfaction (ISO 9241-210). Effectiveness was measured as task success, i.e. the number of instruction free drives, and number of errors, i.e. the number of wrong drive mode selections. Perceived efficiency was captured through interviews and measured by using the perceived ease of use part of the Technology Acceptance Model (TAM; Davis, 1993). Perceived satisfaction was captured through interviews and measured by subjective preferability ratings, from least to most preferred shifter.

## 2.4. Procedure and study design

Each participant interacted with all four concepts in a counterbalanced order (within-subjects design, Latin square) while driving between cones at an empty parking area. The driving tasks were: 1: Select Drive (D), 2: Select Reverse (R), 3: Select Manual (M) mode and increase gears one step (+), 4: Select Neutral (N) and then select Drive (D), and 5: Select Park (P). The tasks were held constant between cars. The participant was asked to comment on the shifter design before receiving tasks, thereafter the first driving task instruction was given. After each driving task, the participant was interviewed. Each gear shifter session ended with interview questions and a questionnaire (TAM). The participants finished the test by rating the gear shifters.

## 2.5. Analyses

Statistical analyses were conducted with SPSS and repeated measures ANOVA with a significance level of .05. Tukey's LCD was used for post hoc tests. The video recorded interviews were transcribed verbatim. The answers were coded as positive or negative and if they related to effectiveness, efficiency or satisfaction. The most descriptive arguments and explanations were summarized.

## 3. Results

### 3.1. Effectiveness

**Task success.** There was a significant difference in guessability, in terms of completing the task without instructions ( $F(3,21) = 3.154, p = .046$ ). The highest amount of instruction free task drives (Max = 5) was found with the button shifter ( $M = 4,88; SD = 0,35$ ), it was significantly easier to understand than both the rotary shifter ( $M = 4,38; SD = 0,52; p = .033$ ), the joystick shifter ( $M = 4,25; SD = 0,71; p = .011$ ), and the stalk shifter ( $M = 3,75; SD = 1,58; p = .038$ ). The problems with the button and rotary shifter were all related to the task of finding and selecting the manual driving mode (M), Figure 2.

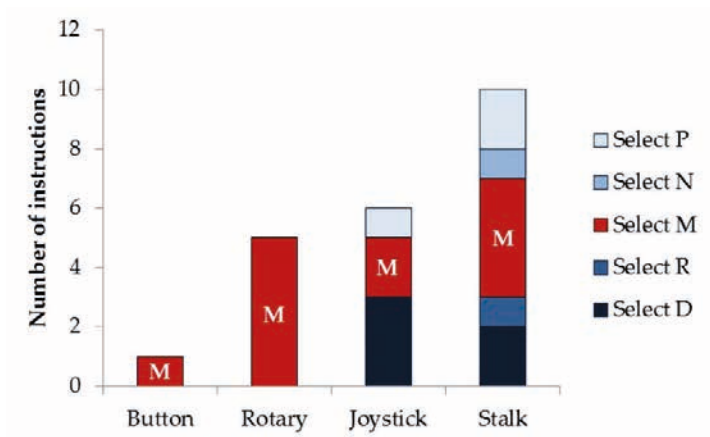


Figure 2. The tasks that needed instructions.

**Errors.** Significant differences were found in error frequency between the gear shifters ( $F(3) = 3,07, p = .05$ ). The amount of selection errors were significantly more frequent with the joystick shifter ( $M = 2,63; SD = 2,39; p = ,049$ ) and the stalk shifter ( $M = 2,38; SD = 1,77; p = ,03$ ) than with the button shifter ( $M = 0,50; SD = 0,76$ ). No difference was found between the rotary shifter ( $M = 1,25; SD = 1,39$ ) and the other shifters.

### 3.2. Efficiency

**Technology Acceptance Model.** No significant differences could be found between the gear shifters regarding ease of use when measured with the Technology Acceptance Model questionnaire, ( $F(3,21) = 0.719, p = .055$ ).

**Interview comments.** The button shifter was overall expressed as easy to use, plain and clear, but three participants were negative about having to look down at the buttons during the driving session. All participants had difficulties finding Manual mode with the rotary shifter. Two participants mistook the Sport mode for the Manual mode. Two participants thought it was inconvenient to move through several positions when shifting from Parking to Drive and when shifting from Manual to Drive since Neutral needed to be activated first. Overall the rotary device was described as easy to use and plain. The joystick was described as quite easy to use, a bit messy, both clear and unclear. Five participants were uncertain about how to start and select Drive with the joystick. The stalk shifter was described as difficult to learn but easy to use or at least not very difficult to use. The shifter felt a bit hidden and easy to mix up with the windshield wipers. The unfamiliar design of the stalk shifter made it difficult for all the participants to locate the gear shifter. Two of the participants needed extensive help from the displays and the test leader to start the car and change to Drive mode.

### 3.3. Satisfaction

**Preferability ranking.** The joystick shifter was selected as the most preferred shifter by several participants (four), followed by the rotary shifter and the button shifter. The stalk shifter was the least preferred shifter.

**Interview comments.** The button shifter was described as awkward and plastic. Someone did not like the feel of the feedback, it was not sensitive enough. The rotary shifter felt new, modern, different and fun. They thought it had a good feeling of quality, was comfortable and nice-looking. The joystick shifter was described as normal, familiar, modern, nice-looking and robust with good feedback, good ergonomics and clear positions. They also thought it was a bit plastic and too heavy. The stalk shifter was described as different, available, distinct and fun - with a racing feeling. But they did not like the feedback (i.e. haptic feedback) and that it jumped back to a middle point (i.e. monostable).

## 4. Discussion

It was feared that new gear shifter designs would violate usability. The results in this study indicate that unfamiliarity could in fact make gear shifters difficult to use. This was exemplified by the stalk shifter that was difficult to understand, hard to use and easy to misuse - the *visibility*, *monostable pattern* and *haptic feedback* was blamed. However, the results regarding familiarity were not unidirectional. All shifters were new to some extent, and the button shifter and the rotary shifter created few errors, which indicates high *intuitivity* in the designs. The combination of a rotary device and paddles were problematic though, *proximity* between related functions were suggested. Furthermore, it could be expected that the premium gear shifters would get higher

usability than a concept gear shifter. This was not the case in this study. The only concept gear shifter, the button shifter, was in fact easier to understand than all of the other premium production shifters, although the overall satisfaction was low (plastic, bad feedback). The buttons made the driver modes easy to identify and provided direct *access* to functions. One could argue that they did not add cognitive demand as a more *complex* interaction pattern might do. The stalk shifter and joystick shifter had both more complex monostable patterns. These patterns do not have a fixed number of steps and stable end positions, hence they might inhibit the building of *mental models* and reduce *memorability*, which might have caused the higher amount of errors. However, the absence of a movement pattern in the button shifter was also a problem, it reduced the possibility of building a mental model and hence use the gear shifter without taking the eyes of road. When it came to preferability, factors such as *familiarity*, *ergonomics* and *feedback* seemed to be important. Even though satisfaction was high with the rotary shifter, the joystick shifter was still the most preferred. Clearly, the participants did not value effectiveness as the most important factor for their own shifter preferences. In summary, several factors including the complexity, accessibility, visibility, intuitivity, proximity, mental model, memorability, familiarity, ergonomics, haptic feedback and stability (mono- vs poly stability) were some possible usability concerns identified in this study worth further studies. It would also be valuable to compare novel shifter concepts with more traditional shifters, i.e. a polystable joystick.

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# Implementation and impact of an ergonomic intervention in elderly care

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*Work in elderly 24-hour care units is both physically and psychologically demanding. In addition, the elderly care sector is not exactly the most attempting. This paper presents what kind of measures and means of management are likely to reduce nurses' physical strain and to ascertain the impact of an ergonomic intervention designed for the work in elderly care.*

Keywords: Ergonomics, Patient handling, Physical stress, Psychological stress, Elderly care, Ergonomic intervention

## 1. Introduction

Care-Institutions and service homes are the living environments for approximately 40 000 Finnish people, aged 75 or above. The work in elderly 24-hour care units is both physically and psychologically demanding (Freitag 2014, Gropelli et al, 2011, Hellstén 2014, Pekkarinen et al., 2013). Nursing facilities, assistive devices and nurses' skills do not meet the needs of patients (Tamminen-Peter 2007).

Shortage of nursing personnel is a problem in all western countries and it is expected to worsen, especially in elderly care (Ministry of social affairs and health, 2013). Therefore, strategies must be put in place to reduce physical strain and improve workers' well-being in nursing of the elderly (Hignett et al, 2014).

In the city of Turku, Finland, the amount of the population that is aged 75 or over is increasing rapidly. It was decided to carry out a two-year ergonomic intervention related to the development of social and health care services for the elderly. (Berthelette et al, 2012, Missar et al., 2012.)

## 2. Implementation of an ergonomic intervention

The two-year intervention study focused on 24-hour elderly care working units (n = 47) and their employees in the city of Turku, Finland from 2010 to 2012. 24-hour care in long-term hospital care, a home for the elderly or a service home were the options when living at home is impossible even with assistive services. The clients were mostly over the age of 75.

The intervention included knowledge management, ergonomic training, monitoring the implementation of the measures and the success of the project evaluation. Patient assistive transfer devices and ergonomic furniture purchase was designed to support the success of the intervention. During the intervention training and education was provided for the first-line managers. (Dellve et al., 2007, Fagerström 2013.)

The core of the intervention was the introduction of the Management Model for Physical Risks in Care Work created in 2010 by The Finnish Institute of Occupational Health (Tamminen-

Peter et al., 2010). The management model is based on the Occupational Health and Safety Assessment System (OHSAS 18001: fi). The model helps to assess and manage physical risks in workplaces (Fagerström et al., 2011).

Introduction and implementation of the new ergonomic working method can be supported by establishing an ergo-coach system in the work units. The ergo-coaches support the managers to develop ergonomic work practices and guide and help colleagues to implement commonly agreed safe working practices.

Turku city elderly care sector established the ergo-coach system in 2010 as part of this ergonomic intervention. Every unit named one ergo-coach and they had a supporting occupational physiotherapist. Ergo-coaches were chosen from among health care professionals interested in ergonomics and rehabilitative care work.

Ergo-coaches' activities were supported e.g. by the Ergonomic patient handling card® -scheme. The Ergonomic patient handling card® -training is standardized in Finland since 2009. It is intended for all social and health professionals, students in the social and health care sectors as well as all who assist others in moving.

### **3. Objective**

The aim of the study was to gather information on the work-related physical and psychological demands and risks among nurses working in 24-hour elderly care units, to determine what measures and management means are likely to reduce nurses' physical strain and to ascertain the impact of an ergonomic intervention designed for work in elderly care.

### **4. Material and methods**

The baseline measurements were carried out in 2010 and the follow-up measurements in 2012. In 2011, a survey was conducted as a part of the intervention on first-line managers and ergo-coaches to establish the actions accomplished, the role of ergo-coaches in promote ergonomic measures and the follow-up plans of units. In spring of 2015, a follow-up survey on ergo-coaches was made to study the successfulness of the ergo-coach system.

The data was collected from clients, nursing staff, first-line managers and ergo-coaches by questionnaires, interviews and statistics.

Clients' mobility was measured with the RAVA™ Index. Nurses' physical load and risks associated with nursing care were estimated with the Care Thermometer™ method and a nursing staff questionnaire was conducted for perceived job workload, job satisfaction, workability and musculoskeletal disorders. The Patient Handling Organizational Question set (PHOQS) method was used the first-line management to detect the state of the safety culture of the work unit. Information generated by the Finnish 10-Town Study (n=120 units) was used to survey changes in management, staff well-being, sick leaves and the work community. (Figure 1)

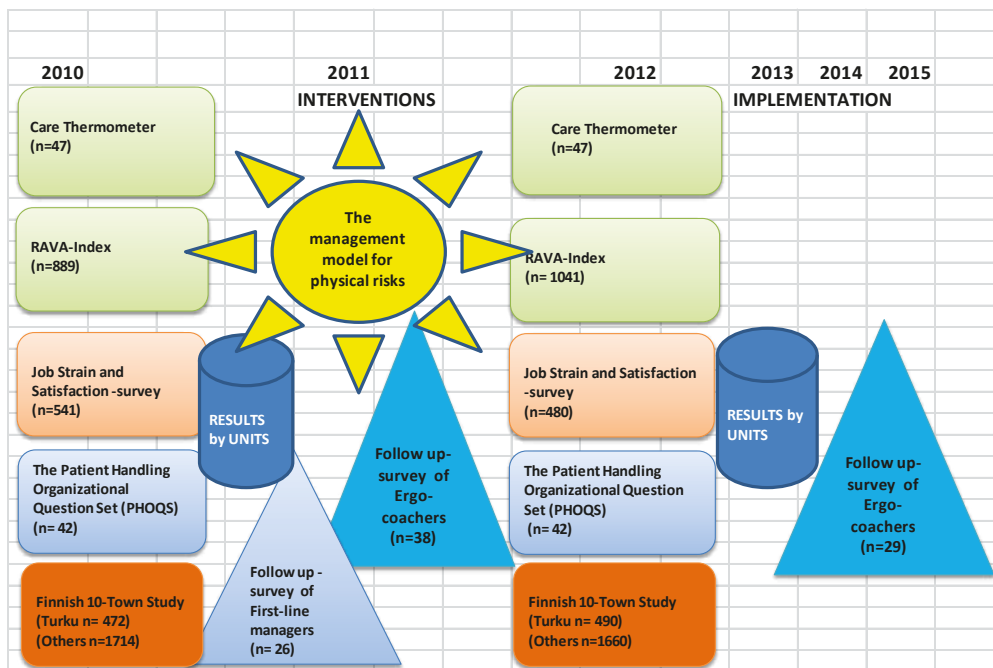


Figure1. The whole study setting

The intervention was diverse and complex. The success of the implementation and impact assessment was difficult, especially when many other changes were taking place at the same time in the organization. The intervention was reported comprehensively and transparently. As criteria for reporting the development and evaluation of complex interventions in healthcare (CReDESI) (Möhler et al., 2012) was used.

## 5. Results

In the 2010 baseline, the Care Thermometer key findings showed that guidelines were followed in many patient handling situations, but too heavy patients were still lifted manually. Neither was lifting devices used with clients needing full assistance nor was they adequately utilized partly assisted clients. The hygiene care with clients in a sitting position was strenuous.

The follow-up measurements in 2012 showed that the working level of safety had increased from 56% to 71.5%. High-risk tasks had been reduced from 22.5% to 13.9%. Assisting devices remained inadequately utilized with partly assisted patients. The guidelines for the quality development of the care were to further intensify the use of lifting equipment and that hygiene care in sitting positions ought to be used for all, except E-types patients.

There were significant differences of perceived physical and psychological stress, by activities and professions. In the long-term hospital care, perceived physical stress was highest. Psychological stress increased most in service homes. Licenced practical nurses experienced their work as physically most stressful while psychologically less stressful than registered nurses' work.

Both physical stress and psychological stress increased, but physical stress increased less than psychological stress. Ergonomic training seemed to have the strongest statistical significance of physical load decrease. Good workability had a positive and dissatisfaction with work a

negative impact on perceived stress. Ergonomic training had the strongest statistical significance of physical load decrease.

The correlation between age of the employees, RAVA™ Index, the Care Thermometer™ and PHOQS-audit and changes in perceived stress was not statistically significant.

The 2015 follow-up survey shows that the ergo-coach system is well established and positive impacts are visible. Activities of the ergo-coaches were most supported by their own knowledge, skills and competence, particularly Ergonomic patient handling card® -scheme and first-line managers. Lack of time to implement a broad remit, attitudes and old stubborn work methods hampered their work most.

## 6. Conclusions

The effectiveness of the interventions was contradictory. Both physical stress and psychological stress increased, but physical stress less than psychological stress. It can be assumed that the interventions in this study had a positive impact on physical stress but the impact on psychological stress was marginal. Additional tests are needed to explain more about the differences between physical and psychological stress and what kind of measures and management means can best reduce the physical strain of employees.

The Management Model for Physical Risks in Care Work and the Care Thermometer™ method systematically supported the assessment and management of physical risks in elderly care workplaces. The establishment of an ergo-coach system supported the achievements of the objectives, too.

The goal was to achieve permanent changes and to establish a better understanding of the management of physical risks. This two-year intervention, therefore, was too short a time to embrace this kind of strategy.

The decrease of physical and psychological stress and the promotion of safe work would require long-time intervention and good management, in particular with regard to the first-line management.

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# Comprehensive improving of well-being and productivity in SME's at forestry and health care sectors

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*Many small and medium-size enterprises (SME's) have recognized the need to improve productivity and the quality of working life. However, there are often short of resources to solve problems, develop operations and thus improve productivity. So, there is a great need for comprehensive development of processes, productivity and well-being of workers in SME's. The project aims to improve well-being and productivity in SME's at forestry and health care sectors, which both have many changes in their operational environments in Finland. In the study a participatory approach is combined with a work place development approach. Both the organizational level and the individual level are in the focus. Special attention is paid to prolong the career of ageing workers. Based on comprehensive development processes in five forestry and five health care SME's as well as joint workshops, a new multidisciplinary course of action will be developed, described and distributed. The study will serve entrepreneurs in their development processes and help them to take the workers along to cooperate in comprehensive work design.*

Keywords: Well-being, Productivity, SME's, Participatory approach, Work place development

## 1. Introduction

Nowadays there are many changes in forestry as well as in social and health care sectors in Finland. These effect powerfully on actions in private small and medium-size wood harvesting and health care enterprises. At the same time many small and medium-size enterprises (SME's) have recognized the need to improve productivity and the quality of working life. However, there is often lack of resources to solve problems, develop operations and thus improve productivity. So, there is a great need to develop processes, productivity and well-being of workers in a comprehensive way in SME's at forestry and health care sectors.

It has been shown that work organisation has a significant impact on the relationship between health and safety at work and productivity (Hesapro 2013). Thus, it is obvious that productivity and well-being issues ought to be integrated in the workplace development programmes based on a participatory approach.

The study is carried out in 2015–2017 by Helsinki Metropolia University of Applied Sciences and Work Efficiency Institute (TTS). It is supported financially by the European Social Fund.

## **2. Objectives**

The project aims to improve well-being and productivity in SME's at forestry and health care sectors. Both the organizational level and the individual level are in the focus. Special attention is paid to prolong the career of ageing workers (+54 years). A new generic model for the promotion of well-being and productivity in SME's will be designed. The model will be used by enterprises with the help of a facilitator.

## **3. Methods**

In the study the participatory approach is combined with work place development approach. Based on comprehensive development processes in five forestry and five health care SME's as well as joint workshops, a new multidisciplinary course of action will be developed, described and disseminated to promote well-being and productivity in work places. In June 2016 the project is going on in seven enterprises – four from health care sector (8–48 persons) and three from forestry sector (4–19 persons).

### **3.1. Enterprise specific development process**

In each enterprise a development group has been nominated. The group consist of 3–6 persons representing the whole staff of the enterprise. It plans the timetable and makes decisions concerning the development process. The researchers act as facilitators and produce data for the development group.

In the beginning of the process every person in the enterprise was asked to give his/her self-evaluation of well-being at work by the Personal radar inquiry (Ilmarinen et al. 2011). The inquiry consists of 23 questions, which have been formulated according to the framework and dimensions of the Work Ability House (Ilmarinen 2006). Following dimensions are included: health and functional capacities; competence; values, attitudes and motivation; work, working conditions, work community and management; family and close community. The inquiry will be repeated in the end of the enterprise specific development process.

There are two workshops for the whole staff in each enterprise specific development process. Based on the results from the initial inquiry the most essential topics were gathered for the first workshop. There were both weaknesses and strengths among the identified topics. The aim of the workshop was to describe and define more precisely the factors which impact the topics. These well-being and productivity factors were then classified into individual, work community and work related factors.

After the first workshop more information were gathered by focus group interviews and work studies. Special attention was paid to elderly people who were interviewed as a separate group. Work processes, labour time consumption, stress factors, hazards and good practises were described with the help of a work study. The work study was carried out during one normal working day in each enterprise.

In the second workshop solutions were composed: how to improve the recognized weaknesses and how to s reinforce the strengths. The factors which came up most often were emphasized.

### **3.2. Joint workshops**

Joint workshops between enterprises are arranged especially for the development group members so that they can share their experiences with people from other organizations. The idea is to offer a forum for a discussion about the development process as well as challenges and

solutions that have been met. The workshops are arranged also for a wider interest group to spread out the results and experiences.

### **3.2. Summary study**

In the third part of the project the data from the enterprise specific development projects as well as from the joint workshops will be gathered together in order to evaluate and design a generic model for SME's. One target for the summary study is to introduce the project and spread the results. The main weight of the summary study is dated during the end of the project.

## **4. Results**

All the enterprise specific development processes started so far are still going on. Thus only preliminary results are available. Seven enterprise specific case studies are carried out; two of the enterprises have already had their second workshops and development measures are underway. Focus group interviews and work studies have been done in four enterprises. In this paper the results of the Personal radar from seven enterprises (4–48 persons/enterprise) are presented as well as some results from the first workshops, work studies and the first joint workshop.

### **4.1. Personal radar**

In seven SME's altogether 81 persons (23 persons from forestry SME's and 58 persons from health care SME's) answered to the Personal radar inquiry. Among the questions that got the lowest mean values both from forestry and health care persons were the "feedback from the manager", "the support from the manager" and "the sufficiency of time and personal resources for friends and hobbies". There were not statistically significant differences between the answers of forestry and health care persons. There were also relative low values in "the sufficiency of training" both in forestry sector and health care sector. Among the health care persons these values were lower than among the forestry persons. Other topics which should be taken into account in the development process are "experienced valuation" and "fair treatment" in the forestry SME's, and "work arrangements" in the health care SME's.

Among the questions that received the highest mean values in the Personal radar were "commitment to work", "motivation to work" and "the ability to work during the next two years" in self-evaluations of both forestry persons and health care persons. There was not any difference in "the ability to work during the next two years" between forestry persons and health care persons, but "the commitment" and "motivation to work" were statistically significantly higher among forestry persons. The forestry persons gave highest values also for "flexibility in working hours", "support from work community" and "sufficiency of personal resources" – all higher than among health care persons. Correspondingly, the health care persons gave highest values for "personal health" and "performance ability". These, however, did not differ from the level of estimates among forestry persons.

### **4.2. Enterprise specific workshops**

In the first enterprise specific workshops the whole staff defines the topics which came up in the Personal radar inquiry of the enterprise. According to first four workshops (three health care enterprises and one forestry enterprise) the personnel appreciates the support from co-workers and the flexibility in working hours. These are regarded as strengths in the workplaces. Co-workers help and support, give positive feedback and are ready to be flexible when needed. Flexibility in working hours means good possibilities to influence the rota planning and the planning of holidays. It also means that work is not done with hurry.



Issues which should be improved are communication, feedback, rules and work arrangements. There are challenges in communication both inside and outside the enterprise – among staff and with partners. In practise this means that information needed is not always available, is not reported, comes too late or is defective. Fair, straight and also positive feedback is hoped especially from the manager and foremen. Because the rules are often lacking the big picture is unclear, tasks to be done are picked and some tasks are done overlapping by several persons; processes are not running and responsibility is unclear. In work arrangements more effort has to be put on planning. In the process all the phases have to be in balance, the previous phase has to be in order before the next phase. Instruments and the machinery have to keep in order; it is important that the maintenance has been planned and is proactive.

#### **4.3. Work studies**

In each enterprise specific development process the work study is carried out by two or three researchers during one (typical) working day. The researchers make observations of activities (activity sampling; observation period 1 min), stress factors and hazards as well as good practises in the work place. Not only workers are observed but also – particularly in the forest work – the machinery. When possible photographing and video recording are used to help the development group to recognise situations in which measures are needed.

The labour time consumption showed the tasks which took most time during the day. According to the first four work studies on average one third of the tasks took 80 % of the working time. Attention should be paid especially to these the tasks. In addition various types of disturbances caused occasional elements which should be removed or at least minimised.

Many recognised stress factors were related to manual lifting or poor working postures. In most cases harmful stress can be at least decreased by careful planning, suitable tools and by using worktops.

Stress factors and accident risks were recognised by the development group from the video recordings. A participative video-based method Vidar (Forsman et al. 2006) was used to activate the persons to give comments concerning their work. However, in health care enterprises it was unfortunately not possible to use video recording method because of the privacy of clients and patients. Most of the factors recognised in forestry work concerned accident risk and environmental factors (noise, vibration, thermal environment, chemicals).

#### **4.4. Joint workshop**

The first joint workshop was arranged in April 2016. Persons from four enterprises took part in the workshop. Some of the enterprises had just started the project. The main target of the joint workshop was to get to know each other and discuss about challenges and experiences in the developing process. The challenges/experiences recognised were following:

- how to make people in the enterprise understand that the operational environment is changing; especially SME's have to be active and client oriented
- the measured results from the study the model for promotion of well-being and productivity and experiences from other enterprises help to recognise developing issues; these also increase assertiveness in the development process
- how to activate personnel and business executives to improve processes and workplaces; the role of the development group gives an operating model
- peer support: both common workshops and workshops targeted only for employees and foremen / only for employers/managers are needed

- interesting topics for the upcoming joint workshops are rota planning and changes in the operational environment.

## 5. Conclusions

Enterprise specific development processes have started actively. The enterprises involved in the project are motivated, willing to co-operate and self-imposed to carry out improvements. The improvements can be technical, organisational or related to working method; some of which can be done fast and without cost. The study will serve entrepreneurs in their development processes and help them to take the workers along to cooperate in comprehensive work design.

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## *Session 4B Occupational health*

### **Tuesday 16<sup>th</sup> August**

Pirjo Hakkarainen: People with Type 1 Diabetes in work – Good practices for workplaces in commercial sector

Ulla Møller Hansen: Type 1 diabetes in work life – a matter of containment?

Constantinos Mamas: Ergonomics of Tele-Cytology for remote Pap-smear Evaluation integrated with Big Data Analytics and computing to optimize prevention of cervical cancer in developing countries

Marjatta Teirilä: Musicians' opinions on prevention activities against occupational symptoms

Annika Vänje: Core competencies in Ergonomics –Do master programs in ergonomics correspond to the requirements in practice? (Abstract available)

# People with Type 1 Diabetes in work – Good practices for workplaces in commercial sector

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*In Finland, there are 30 000 currently working aged individuals with type 1 diabetes and that number is increasing. This paper describes the good practices developed in workplaces in the commercial sector. This study was a so-called action research. One occupational health clinic participated in this project with two client workplaces in the commercial sector. The workshops developed four good practices: 1) increase the awareness of diabetes, 2) adoption of work rotation and 3) work breaks, and 4) first aid instructions that should contain details about how best to support workers with a chronic disease and facilitate safer working conditions.*

*Keywords: Type 1 diabetes, Work, Action research, Good practices, Occupational health*

## 1. Introduction

In Finland, there are about 30 000 individuals with type 1 diabetes who are currently of working age, in fact, their number is increasing (Diabetes in Finland 2011). Approximately 95% of the management of diabetes is self-management (Diabetes UK 2009). Managing type 1 diabetes can be complex; there is evidence that self-management is necessary to avoid both hypo- or hyperglycaemia and detrimental long-term outcomes such as cardiovascular diseases (National Clinical Guideline Centre (UK) 2016).

Individuals with diabetes cope relatively well in working life, but if their diabetes is not stable, it can cause acute and chronic problems in their work ability (Hakkarainen et al., 2016a). Thus, type 1 diabetes requires special attention in working life.

We carried out a multidisciplinary research project entitled “People with Type 1 Diabetes in Work – the Development of Good Practices” in 2013–2014. The overall objective of the project was to promote the work ability of workers with type 1 diabetes and to ensure their well-being at work. A total of six workplaces from different lines of business developed 14 good practices (Hakkarainen et al., 2014). This paper focus on four of these good practices developed in commercial sector workplaces.

## 2. Objective

To develop good practices for improving opportunities to self-manage diabetes at work, and for advancing work ability, safety and well-being of workers with type 1 diabetes in workplaces in commercial sector.

### 3. Methods

We adopted an action research approach and conducted the study in the period 1.1.2013-31.12.2014. One occupational health clinic participated in this research and development project with two client workplaces in the commercial sector (groups 1 and 2). In both workplaces, one salesperson with type 1 diabetes, his or her immediate supervisor, representatives of the occupational health care unit and the occupational safety personnel, and a researcher made up the team. A total of 11 persons participated in this project.

All participants were invited to the Opening seminar. Subsequently, the groups attended workshops arranged in their workplaces (Fig. 1). The study included workshops (5 times) with focus group discussions, a meeting in the diabetes clinic, and seminars for all of the participants (3 times), as well as meetings with professionals from an occupational health care unit and a diabetes clinic. The good practices were brainstormed, developed and assessed by utilizing shared expertise in workshops, and later piloted in the workplaces. The groups requested comments on their good practices from other participants attending the Halfway seminar and presented the finalized practices in the Closing seminar organized in November 2014.

The Research Ethics Committee of the Northern Savo Hospital District reviewed and approved the research protocol (6/2012).

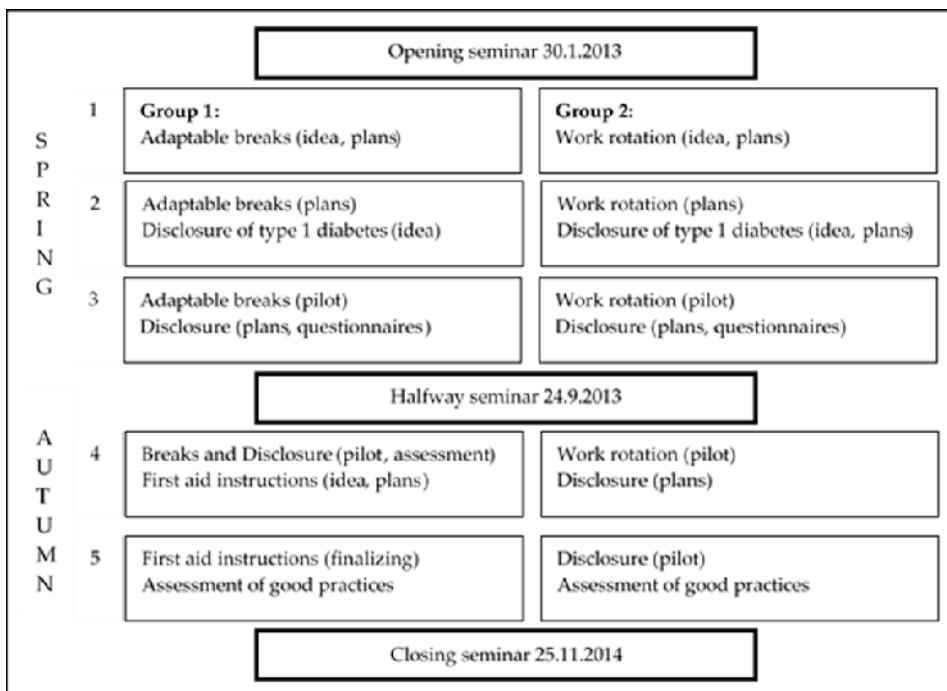


Figure 1. Development processes of good practices for workers with type 1 diabetes in workplaces in commercial sector.

### 4. Results

The work groups from the commercial sector developed four good practices. A method was devised for spreading the awareness of diabetes and subsequently how this should best be discussed within the work community. Both salespersons with type 1 diabetes were willing to disclose their condition to their own work community. A good practice was that the salespersons

asked in writing their colleagues what kind of knowledge of diabetes was needed in their work community and described this in a meeting. The work community needed general information of type 1 diabetes and how diabetes might affect work. In addition, the workmates were not aware of the symptoms associated with type 1 diabetes and how should they act if these become apparent. Many workmates even suggested injecting insulin as a treatment for hypoglycemia - a potentially life-threatening misconception. The work community was very satisfied to obtain this new information.

Another good practice was that management and supervisors should be encouraged to implement work rotation. In one enterprise, a work rotation schedule was arranged with worker undertaking 3-6 week's cycles in the bakery section, dairy section, processed food section and cash-handling section. The work community was informed about the work rotation. As a result, both the physical and mental workload of a worker with type 1 diabetes became diversified; the employer enjoyed the benefit of having a contented, motivated and multiple-skilled worker in the workforce.

The third good practice developed was the adoption of appropriate work breaks. Initially a salesperson with type 1 diabetes was working 7 hours daily including one coffee break (duration - 20 minutes). Subsequently, a total of 30 unpaid minutes was added to the length of working day. Thus, this individual was able to take a 30 minute lunch break and two 10 minute coffee breaks spaced at about two hour intervals during the working day. The worker stated that she felt more active and better without hypoglycemic events. Her immediate supervisor and colleagues were also satisfied with the new schedule.

Finally, first aid instructions for type 1 diabetes more suitable for workplaces were developed. Although some first aid information was already available, the work group found that they included too many details and were printed in a very small font size. In an emergency situation, it would be difficult to absorb the necessary information quickly. It was proposed that readily accessible text and informative pictures would be much better. This idea with proposals about the text and illustrations was forwarded to The Finnish Diabetes Association.

## **5. Discussion**

Type 1 diabetes should be taken into consideration when a career is being chosen. Individuals with diabetes can work in physically demanding jobs, but in such cases, special consideration should be given to allow them opportunities for self-managing their diabetes during the workday. Usually, only simple accommodations are needed. (Varekamp and Dijk 2010, Hakkarainen et al., 2014, Hakkarainen et al., 2016a). The good practices developed in this project can be exemplars of how to support workers with type 1 diabetes and perhaps also those with other chronic diseases, and to facilitate safer working conditions.

Two workplaces in the commercial sector developed good practices for workers with type 1 diabetes and their work communities in workshops. Both participating groups stated that it would be a good practice that the employee could make his/her workmates aware that he/she has type 1 diabetes. There is evidence from Finland that only a slight majority of workers with type 1 diabetes had fully-disclosed their condition to their colleagues and less than 30% to their line manager (Hakkarainen et al., 2016b). Previous studies have reported that workers with type 1 diabetes would be more likely to disclose their condition if they needed work accommodations for self-management and improving their safety at work (Patel 2011). However, some workers have not disclosed their diabetes at work because of fear of discrimination (Bose 2013) and unfair treatment (Ruston et al., 2013). Clearly, it is a personal decision whether or not to disclose to the work community that he/she has diabetes.

Group 1 devised a simple way to help workers with diabetes to self-manage their condition, this could be achieved by organizing a few more work breaks. Workers with type 1 diabetes need breaks for routine blood glucose monitoring, estimation of carbohydrate intake and administration of the correct insulin dose to avoid not only hypo- or hyperglycaemia but also long-term outcomes such as cardiovascular diseases (National Clinical Guideline Centre (UK) 2016). In this project, Group 2 recommended job rotation, which equalized the work load as well as enhancing the worker's job satisfaction. Different job rotation types have been developed, implemented and evaluated (Leider et al., 2015, Jeon et al., 2016). Job rotation has been found to be especially beneficial in preventing work-related musculoskeletal disorders (Comper and Padula 2014, Jeon et al., 2016). It might be valuable to implement job rotation also among workers with type 1 diabetes as well as those with other chronic illnesses. However, both participating groups highlighted the importance of informing all colleagues about workplace innovations such as work rotation or a new system of breaks to avoid misunderstandings, even jealousy, in the work community.

In conclusion, good practices for improving well-being at work among workers with type 1 diabetes can be developed by adopting the practice of sharing expertise. Well-being and safety at work, as well as the functionality and the efficiency of the work community can be improved by increasing the general awareness of type 1 diabetes.

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# Type 1 diabetes in work life: A matter of containment?

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*In this qualitative study illness behaviour in work life is articulated using the theoretical concept of containment, as coined by the sociologist Alonzo (1979). The empirical material consists of in-depth interviews with 40 people with type 1 diabetes from Denmark. As a result of an abductive analysis a local theory of containment is developed suggesting that containment processes unfold at two levels; at an operational level daily containment actions refer to the practical efforts of managing the daily fluctuation of type 1 diabetes, while containment logics refer to a strategic level governing the daily and future containment actions.*

Keywords: Type 1 diabetes, Self-management, Containment, Interviews, Denmark

## 1. Introduction

As the working population with type 1 diabetes spends one third of their time at work, diabetes management in work life significantly impacts the overall care and quality of life with diabetes. So far, however, little attention has been paid to the challenges of balancing the demands of routinized diabetes management with the demands of work life.

## 2. Objectives

The aim of this qualitative study is to explore how people with type 1 diabetes negotiate the interplay between illness and work life.

## 3. Methods

In tune with symbolic interactionism (Blumer, 1969) as the overarching methodology we focus on the meaning making and practices of people with type 1 diabetes in exploring the aim. As a consequence interviews were chosen as method of inquiry to evoke the object of study through the personal accounts of experiences of the interplay between illness and work life.

### 3.2 Interviews

Gaining access to possible interviewees happened through passive recruitment on the basis of a recruitment message in the clinic at Steno Diabetes Center as well as on the homepage of the Danish Diabetes Association and on the Facebook page of an independent type 1 diabetes interest group. The following three inclusion criteria were set up: 1) Having type 1 diabetes, 2) Aged 18-70 years, 3) Job market experience.

In total 40 interviews were conducted between May and December 2015 (table 1). Eight interviews were conducted at the interviewee's work place, 12 interviews took place in the interviewee's private home, in 19 cases the interview took place at Steno Diabetes Center and one interview was conducted in the interviewers' home. In the interviews we asked people about the activities they were involved in at work and about the role of diabetes and self-management at

work. The interviews lasted approximately one hour and they were audio-recorded with the verbal consent of the participants. All interviews were transcribed ad verbatim by the first author and two assistants and hereby turned into material that could be analysed. All personally identifiable data was anonymised.

Table 1. Participant characteristics

Characteristics	Number
Sex	
Men	17
Women	23
Age - Mean 49 [23-69]	
18-30	3
31-50	17
51-70	20
Diabetes duration - Mean 31 [9-60]	
0-20	12
21-40	17
41-60	11
Education	
Long higher education	14
Medium higher education	9
Short higher education/Vocational school or Upper secondary school/Primary school	17
Current employment status	
Employed full time	28
Self-employed	3
Under education	2
Retired	3
Sickness leave/flexijob	4

### 3.3 Analysis

In accordance with abductive reasoning (Tavory and Timmermans, 2014), we used theory as a way to open up the material. Against a background of existing sociological theories, we saw some links between the insights from the interviews and the concept of containment (Alonzo, 1979). On this basis we decided to proceed with containment as a sensitizing concept (Blumer, 1969). According to Alonzo containment involves maintaining proper situational involvement while keeping bodily derelictions at the level of a side-involvement (Alonzo, 1979, p.399).

In brief, the analysis was divided into four phases. In the first phase, we explored the applicability of the containment concept while conducting the last half of the interviews and reading through all the transcripts. In the second phase, we identified some dominant categories of containment processes across the cases. In the third phase, we refined the analysis by re-reading the transcripts and identifying some distinct differences across as well as within the cases pertaining to the situational fit between the concept of containment and the empirical data. As a consequence, we introduced two distinct levels of containment processes. Finally, the categories pertaining to each level were revised and refined in terms of wording as well as content on the basis of feedback from peers.

## 4. Results

As a result of the abductive analysis, a local theory of containment of type 1 diabetes in work life is developed.

The theory suggests that containment processes unfold at two levels; at an operational level daily containment actions refer to the practical efforts of managing the daily fluctuation of type 1 diabetes, while containment logics refer to a strategic level governing the daily and future containment actions.

## **5. Conclusion**

The study shows that containment of type 1 diabetes calls for continuous day-to-day negotiations in the context of work life in order for people with type 1 diabetes to stretch available resources to appear as 'good workers' while sustaining themselves as 'good patients'.

Articulating the psychosocial and behavioural challenges specific to diabetes management in work life as a matter of containment evokes a hidden burden of disease in work life. Further research is needed to map the size and character of the burden and develop adequate supportive measures.

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# **Ergonomics of Tele-Cytology for remote Pap-smear evaluation integrated with Big Data analytics and computing to optimize prevention of cervical cancer in developing countries**

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*Cervical cancer (CC) is the second most common cancer world-wide and the leading cause of cancer related deaths among women in developing countries (DC). Ergonomics of Digital Microscopy based Tele-Cytological evaluation of the Pap-smear and integration with Big Data analytics and computing within remote, specialized, multidisciplinary, holistic and personalized prevention operations to optimize prevention of CC in DC on a global level, are analysed.*

Keywords: Pap-smear, Tele-cytology, Virtual Slide, Big-Data analytics

## **1. Introduction**

Cervical cancer (CC) is the second most common cancer world-wide and the leading cause of cancer related deaths among women in developing countries (DC) (Stewart and Wild 2014). Among aetiologies are the low percentage of women undertaking Pap-test (ranging from 5-10% of women and the lack of cytologists in DC). Mobile Transportation Units (MTU) have been utilized for CC mass screening. The Digital Microscopy (DM) has a significant ergonomic impact enabling the Tele-cytological (TCE) evaluation of the Pap-smear (Roberson et al., 2013).

## **2. Objectives**

Ergonomics of DM based TCE: a. Of the Pap-smear, and b. Integrated with Big Data analytics and computing, to optimize prevention of CC in DC, are analysed.

### 3. Methods

The method of MTU to visit neglected populations for local specialized, multidisciplinary, holistic and personalized secondary prevention operations and the remote diagnosis of the collected pap-smears applying DM based TCE of the Pap-smear for remote tertiary prevention of CC in DC, is the base of our ergonomic study. In this context we took into consideration the previous results of our simulating ergonomic research about the mode of the applied DM (Ghaznavi et al., 2013). Classically an MTU has enough space for Pap-smear preparation, fixation and staining and contains DM infrastructure. Its personnel consists a driver, a physician, a nurse and a cytotechnologist who travel all over the area of responsibility for the population's screening. The principle followed by the MTU personnel pursuing the screening of CC was to obtain a Pap-smear from the cervix and endocervix of each examined woman, which was fixed and stained locally and diagnosed remotely via internet from the DM of the MTU to a connected health care centre, by an expert cytologist.

#### 3.1. Ergonomics of the MTU based Specialized, Multidisciplinary, Holistic and Personalized Prevention Operation for diabetes related complications and CC in Vreses village of Chania, on Crete

Following the aforementioned principle the personnel of a MTU travelled from Athens to Crete by boat and then approached the municipality of Apokoronas to Vreses village near Chania city on 05/02/2016 for the purpose of a specialized, multidisciplinary, holistic and personalized official diabetes related complication secondary locally and tertiary remotely prevention program including CC and the remote evaluation of the Pap-smear samples. In technological terms to achieve the abovementioned prevention operation a new architecture based on MUT, integrated with DM and with tele-communication networks for Tele-medicine constructed (Figure 1.).

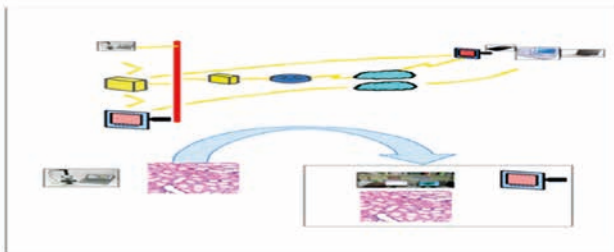


Figure 1: The DM on TS for TCE of the Pap-smear between the personnel of the MTU in the periphery (left part) and the cytologist in the tertiary healthcare centre over four different Electronic Spaces (on the top at right) after digitalization: The cytologist in the tertiary health care centre (in the right lower box) examines the females microscopic digital images digitalized by Virtual Slide (yellow box in the middle behind the firewall (red line) in left) in the periphery (yellow box and red/blue box in left behind the red wall).

If a tertiary prevention examination indicated, that would proceed remotely by instant tele-medicine based connection with the tertiary health care centre. In this context the medical data of the examined diabetics could be shared in a static or dynamic way between the personnel of the MUT and that of the tertiary health care centre. Out of 30 participants in Vreses village prevention operation, 8 were diabetics and according to the prevention protocol only them examined locally for diabetes related complications, while the females could undertake Pap-test

for CC screening. One more non diabetic patient also examined. Focusing on the female diabetic who undertook the Pap-test locally, the digital medical record, the cervical macroscopic and the Pap-smear microscopic digital images that obtained locally then evaluated remotely by an expert cytologist in cooperation with a tertiary health care centre in Athens.

### 3.2. Human factor Engineering of the simulating VS DM TS based TPE and TCE

By experimental simulation, we had analysed the ergonomic impact of VS and that of the electronic space (ES) of TS in terms of the ergonomics of DM in TPE and TCE of the vaginal histologic and cervical cytological samples respectively, for microscopic inflammatory and/or neoplastic lesions. Simulating experimentation included: a. The Development of an OTE-TS similar Experimental Telemedicine System (Exp.-TS) (Mammas 2001, Karavatselou et al.,2001) (Table 1). b. Integration of the Exp.-TS with the VS for digitalization for TPE or TCE applying DM. (Table 1.), c. Simulation of static or dynamic TPE and TCE for microscopic diagnosis of inflammatory or neoplastic lesions (Figure 1.), (Fónyad† et al.,2012).

Table 1: Comparison of the Modules between the OTE-TS and Exp.-TS.

MODULES	OTE-TS	Exp.-TS
Medical record process	+	+
Examinations results.	+	+
Capture/ imaging.	+	+
DICOM and PACS	+	+
Real-time tele-conference	+	+
Chat and whiteboard	+	+
Application sharing.	+	+
Tele-secretary facilities.	+	+
Tele-Mentoring facilities	+	+
Telecommunication net	ISDN based	Internet based
Virtual Slide integration	-	+

## 4. Results

### 4.1. The simulating static VS DM TS based TPE experimental trial

Ergonomics of DM based on VS digitalization of microscopic images for TPE in the Exp.-TS, on simulating trial with a total 208 human vaginal tissues microscopic Digital Medical Images (DMI) had shown feasibility and 100% diagnostic reliability which however elaborated best on the ES of a Desktop, followed by a Lap-Top, a Tablet and a Mobile Phone ( $p<.001$ ) (Table 2.).

Table 2: Simulated VS based TPE of the UG after retrieval based on the size of the four electronic spaces (A=Desktop, B=Exp.-TS, C=Tablet, D=Mobile Phone)

Lesion	N1	A vs B	A vs C	A vs D	B vs C	B vs D	C vs D	
A. Inflammation	94	<.001	<.001	<.001	<.001	<.001	<.001	P
B. Neoplasm	94	.002	<.001	<.001	<.001	<.001	<.001	P

### 4.2. The simulating static VS DM TS based TCE experimental trial

Another VS based TCE simulating trial upon Exp.-TS for Pap-smear remote diagnosis on 20 patients, depended on the abovementioned four ES, had proved low diagnostic reliability i.e only 15 out 20 anatomic sections were diagnosable by the two cytologists (75%) which is considered unacceptable (Romero et al.,2013, Allen 2014, Mammias 2015). The analysis of the rest 15 diagnosable digital anatomic sections by the cytologists showed that the TCE of the Pap-smear depends also on the size of ES and on the type of the disease (inflammatory or pre-neoplastic) elaborated best on the ES of a Desktop, followed by a Lap-Top, a Tablet and a Mobile Phone ( $p<.001$ ) (Tables 2.,3.).

Table 3: Simulated VS based TCE of the Pap-smear of the vagina is based on the size of the four applied ES (A=Desktop, B=Exp.-TS, C=Tablet, D=Mobile Phone)

Lesion	N2	A vs B	A vs C	A vs D	B vs C	B vs D	C vs D	
A. Inflammation	15	<.564	<.102	<.011	<.083	<.011	<.0017	P
B. Neoplasm	5	.046	<.001	<.001	<.008	<.002	<.001	P

### 4.3. The simulating dynamic VS DM TS based TCE clinical trial

We had examined the low reliability of the VS digitalization based TCE of the Pap-smear more as a technological issue than as a training problem of the cytologists and changed the visualization standards in the TCE -from the MTU or the medical offices in the periphery- so as to improve outcomes and build a reliably integrated service. Thus, by shifting from the VS based digitalization of the anatomic sections for microscopic remote visualization- which realizes the static TCE - to the dynamic TCE that prerequisites the real-time projection (RTP) for TCE, by a trial which simulated RTP based TCE between the "Aretaieion" University Hospital and "Agios Savvas" Anticancer Hospital of Athens on 22/10/2015. In this experimentation we managed to

up-grade the diagnostic reliability of the TCE of the Pap-smear for about 25% i.e. a high TCE based diagnostic reliability to the level of 100% (Mammas 2015).

#### **4.4. Human factors engineering of the clinical MTU dynamic DM TS based TCE in Vreses Village**

The abovementioned ergonomic process for TCE was applied after preparation for the clinical TCE of the Pap-smear of the examined diabetic in the Vreses village of Crete retrospectively by a cytologist who diagnosed the stained anatomic section after dynamic projection by the Exp.-TS based DM from a laboratory of the Demokritos Research Centre. The results showed also a diagnostic accuracy on the level of 100% (Allen 2014).

### **5. Discussion/Conclusion**

#### **5.1. Human factors Engineering of the MTU DM TS based TCE of the Pap-smear**

The role of human factors in the design of medical devices and medical information systems is the topic of a growing number of published articles. The need for user needs analysis in the discovery phase of device and information system design is analyzed and by which then several methods for assessing usability of information technology in healthcare are proposed (ILO and IEA 2010). On the other hand several studies proved the positive impact of human factors engineering on the design of medical devices and information systems, providing evidence of better usability, reduced errors, and reduced mental workload in a system designed using structured and well-studied processes (ILO and IEA 2010, Allen 2014). In fact when human factors engineering is not considered in the design of information systems, the user needs and their existing problems are rarely identified and hence not properly addressed. Unfortunately, when this occurs, many information systems in healthcare solve the wrong problem or do not address the error in a usable manner. At best, the computer does nothing to eliminate errors. By simulating DM on TS for TCE of the Pap-smear sampled from the MTU in a specialized, multidisciplinary, holistic and personalized diabetes related complications locally secondary and remotely tertiary prevention operation including CC screening, we found that only the RTP design is ergonomically reliable which however elaborated best on the ES of a Desktop, followed by a Lap-Top, a Tablet and a Mobile Phone.

#### **5.2. Human factors Engineering of the DM TS based TCE of the Pap-smear for Big Data analytics and computing for optimizing CC prevention in DC**

On a global level the ergonomic integration of the abovementioned technological DM on TS for TCE in DC with Big Data analytics and computing infrastructure, prerequisites that the results of every and everywhere RTP remote diagnosis and consultation upon the Pap-smears- sampled during the specialized, multidisciplinary, holistic (in the framework of diabetes related complications prevention) and personalized prevention operations (both by MTU and by the medical offices)- have to be stored after their RTP in the cloud- from where they could be recalled by the analysts- for management, prediction and decision making about the value of new strategies for optimizing CC screening and vaccination operations in DCs (Panahiazar† 2014).



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# Musicians' opinions on prevention activities against occupational symptoms

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*Musicians' work is not just one profession, but includes a large variety of expertise with different work ability demands. Therefore, it is a demanding task to design activities for maintenance of work ability to all musicians. The main aim of this study was to find out the musicians' own choice of three different alternatives for preventive activities. The most popular was the alternative which was concentrated on supporting the instrument specific abilities. The less popular was the alternative that was common to all employees and organised by the employer.*

Keywords: Ergonomics, Music, Work ability, Rehabilitation, Occupational health care

## 1. Introduction

To take care of musicians' ergonomics is a demanding task. Musicians' work is not just one profession with its' uniform ability demands, common to all musicians. Instead, it has a large variety of demands depending on an instrument played (Paarup et.al.2011) Therefore, a huge amount of knowledge is needed when activities to prevent occupational symptoms are arranged to support musicians' work ability.

Musicians' work has been characterised atypical in many ways in former studies (Rasilainen 2008, Blum & Peltomaa 2002, Teirilä & Salorinne 1990). Continuous concentration is needed in front of the audience during the entire musical performance. The timing of motor control and coordination must be controlled in sub-second resolution. Some instruments are heavy to carry and support. Some of them are even held above the cardiac level. Singers and wind-instrument players have to control their breathing consciously over the autonomic regulation (Teirilä 1998). The working hours in pop/jazz music are comparable with shift work – without shifts.

The maintenance of work ability, if it is meant to be successful, cannot be organised uniform with preventive activities for regular work. However, the laws and regulations mandate musicians' employers to organise occupational health care and in co-operations with it and employees to take care of the work ability maintenance (A708/2013). The problem is, how it should be designed, and by whom.

## 2. Aims

The aims of the study were to find out:

- 1) how and by whom the preventive activities for musicians should be organised according to musicians' opinions;
- 2) what kind of knowledge about musicians' work the preventive activities are based on now; and
- 3) what kind of information of the diversity of musicians' work should be gained and is needed to create preventive activities against musicians' occupational symptoms as well as to maintain their work ability successfully.

## 3. Methods

### 3.1. Participants and data collected

An e-mail questionnaire was sent to the teachers of two conservatoires; Helsinki and Turku. First, from three alternative arrangements for maintenance musicians' work ability, the participants were asked to select their personal favourites. The alternatives were as follows:

A. Usual preventive activities, common to all employees;

B. Individual preventive activities based on the demands of musicians' instruments and duties;

C. Individual preventive activities, planned by musicians themselves.

To reveal the need of updated information of musicians' work, especially for occupational health care, an open question was included in the questionnaire. The participants were asked to tell, if they had any experiences of situations when more detailed knowledge of musicians' work would have been necessary to health care professionals. They were also asked to describe the situations freely. In order to gather more material of musicians experiences by snowball sample, the participants were asked to forward the questionnaire to those musicians who possibly had something important or interesting to tell on the item.

A complementary interview was accomplished after the data acquired by the questionnaire was analysed. The interviewees were asked only one question: "If you want to be well understood and treated by the health care, what or importance about your work should you tell to the health care professionals?"

The ages, genders and instruments of the participants were asked for background information.

### 3.2 Data analysis

The sample was not randomised. Therefore, no calculations of confidence intervals, nor imputation procedures for missing data were made. Instead, in order to get reliable information, the participants were asked only to answer those questions they actually had knowledge of, or an opinion on. The open questions were at first analysed qualitatively. When saturated, the data of the lacking knowledge of health care was picked up, classified and analysed numerically.

The choices between three alternatives were analysed numerically. Statistic analysis was only descriptive. The frequency distributions were calculated of the choices of preventive activities and for experiences of lack of knowledge in health care. Correlations were calculated and cross tabulations were made between different groups in the classified data.

Finally, the data acquired from the complementary interview was, after qualitative analysis, processed numerically and compared with the results gained from the questionnaire and the former reports in the literature.

## 4. Results

### 4.1. The participants

Via the e-mail questionnaire 170 musicians (93 females, 55% and 77 males, 45%) told their choices from three alternatives of preventive activities. The age distribution of participants ranged between 19 and 68 years and was classified in 10 year intervals. The mode class was 46-55 years of age in both genders. The musicians also answered the open question about their experiences in the health care and what kind of lack of knowledge was then revealed.

Two groups participated in the complementary interview. The first group of interviewees consisted of 26 students (16 females, 62% and 10 males, 38%). Students' age distribution ranged between 19 and 28 years. Adult students (over 30 years of age) were not counted in. The mean age was 21.5 years (mode 21 years). The second group consisted 10 conservatory teachers (4 females, 40% and 6 males, 60%) with age distribution from 34 to 63 years, mean 48.2 years. The groups were dealt as one.

The participants were either singers or instrumentalists: pianists, organists, guitarists, bowed string players, wind instrumentalists, percussionists, harpists and accordionists. While smaller groups combined the instrumental groups were as follows: pianists, combined group of instrumentalists, bowed string players, wind instrument players, singers and organists, the latter in the questionnaire only.

### 4.2. The questionnaire and the interviews

*Musicians' choices between alternative approaches to work ability maintenance.* The alternative B was most popular among participants. However, there was obvious difference between genders. The answers were divided between three options as follows: A 12, 7% (9 females, 9% and 3 males (4%)); B 96, 57% (59 females, 63% and 37, 48%); and C 62, 37% (25 females, 27% and 37 males, 48%). Musicians' choices between alternatives A, B and C were the dependent variables of the study. Their distribution according to participants' experiences in health care, and the distribution of their choices according to their instruments, ages and genders were examined as explanatory variables.

*Musicians' choices in different instrumental groups.* Alternative B was very popular among all instrumentalists and singers. A small difference in the choices revealed in pianists and organists in comparison with other musicians. None of the organists chose the alternative A. Organists' favourite was C (60%). Pianists favoured A (20%) slightly more than the others. Participants' instruments did not seem to explain the choices.

*Musicians ages and choices.* Consistent change in favour of alternatives C and B can be observed in relation to participants' age. The strong correlations (B -0,74 and C 0,83) show the relationship between choices and age. The correlations are even stronger when those working while retired are counted out from the calculations, as seen in Figure 1.

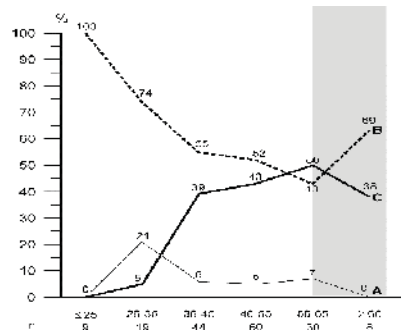


Figure 1: The popularity of options A, B and C was different in different age groups of musicians. A, a typical model of preventive activities common to all employees was favoured less in all age groups. Instead, B an individual preventive activities model based on the demands of musicians' instruments and duties was most popular among younger musicians, while older groups preferred C, an individual preventive activities model planned by musicians themselves. The grey area marks the typical age of retirement.

*More information needed - musicians' experiences as clients in health care.* The prior question was if the musicians had experiences in health care of lack of knowledge about important features of musicians' work. Such experiences described 119 professional musicians out of 170 (70%), 75 females (81%) and 44 males (57%). The musicians had discovered the need for information, 1) particularly as concerns the musicians' work as a profession, and, more detailed; 2) the instrument-specific musculoskeletal ability and motor control demands; 3) mental, physical and social strain associated with musicianship; 4) the slowly developing problems not in plain view such as dental and other intraoral problems; and 5) the importance of the sense organs functioning. Initially, the interviewees complained that it was difficult to decide which would be important to tell. When finally answered the distribution of the comments were tabulated in these categories to be compared to the distribution of answers from the e-mail questionnaire, as seen in Table 1:

Table 1: Proportional distribution of comments about necessary knowledge of musicianship (explanations for categories 1 to 5 see text above).

Categories Participants n	1) % (n)	2) % (n)	3) % (n)	4) % (n)	5) % (n)	Total number of comments % (n)
Questionnaire 170	42 (87)	17 (35)	18 (37)	13 (27)	9 (19)	100 (205)
Interview 36	30 (18)	26 (16)	20 (12)	7 (4)	18 (11)	101 (61)

The fourth category was more weighted in the answers of singers and wind instrument players than of the rest of the participants. The proportional representation of the singers' comments was in the questionnaire 32% and as interviewees 50%, and wind-instrumentalists' representatively 23% and 43%.

## 5. Conclusions

Answers to the research questions seem to be as follows: 1) the preventive activities for musicians should be organised by health care in co-operation with musicians themselves and supported by employers; 2) the preventive activities have until now been designed mostly by employers or health care or the both together, but far too often not based on musicians' expertise; and 3) for both the basis of preventive activity design and to assess the need for sick leaves and rehabilitation, the uncompromising performance requirements of each instrument and singing should be familiar to the health care professionals working with musicians.

The choices between the alternatives of prevention designs tell the story of their own about the development of musicians' confidence in health care professionals' and employers' knowledge of the details of musicians' work with age. Year by year they seem to be more and more ready to take care of their work ability maintenance more independently until the age of retirement. However, the problem is how health care professionals should be informed when, according to the results of the interviews, musicians are not very well prepared to describe their needs. Research on musicians' ergonomics made by musicians with cooperation with health care is a good and important way, but far too slow. Instead, instant solution could be using the GAS-method (Sukula & Vainiemi 2015), not only for planning rehabilitation for severely disabled but, also, as an aid in health care for designing individual prevention activities against musicians' occupational symptoms .

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# Core competencies in Ergonomics – Do master programs in ergonomics correspond to the requirements in practice?

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## Abstract

The first aim of this paper is to explore what kind of knowledge that is taught in master programs in ergonomics and safety and health. The second aim is to identify what competence needs OSH professionals have, and find out if today's teaching in ergonomics (on master level) correspond to practice and modern work organisations. The focus is on the manufacturing industry, and the research questions are;

- (i) What core competencies are taught in today's master programs in ergonomics, in the UK and in Sweden?
- (ii) Do these master programs in ergonomics correspond to OSH professional's perceived demands and knowledge needs?

The sociotechnical framework can serve as a tool for understanding the nature of ergonomics. The dimensions people, culture and processes are representing unpredictable aspects relying on human's behavior according to physical, psychological and social conditions, including organisational cultures. Translated into ergonomics it means that the knowledge areas of ergonomics are both softer skills on peoples acting due to the specific context and harder skills as design of the physical work environment or physical artefacts for optimal use.

Results from two parallel case studies will be presented. The first study comprises four master program's in ergonomics (two in the UK and two in Sweden). The data here represents course plans and modules as well as semi-structured interviews with seven key actors. The second case study is conducted in Sweden with an action oriented approach, its aim is to identify and develop OSH professional's skills. Data from six network meetings with 11 professional actors will be presented. The analyses of the interviews and the network meetings (based on transcriptions) are thematic, and conducted with NVivo software package.

When comparing the four master programs the knowledge areas are to some extent overlapping each other, at the same time as the concept ergonomics itself is to a certain degree contested. The professional network has highlighted themes as; profession in practice, safety and health strategies, working in a system, regulations and OSH providers. In the paper we will explore these themes further and put them into the context of the master programs' learning outcomes.

The conclusions from this paper will serve as an input to the ongoing discussion on the concept of ergonomics and what competencies today's working life requires.

# *Work Shops*

## **Tuesday 16th August**

Work shop I: Integrating ergonomics into process redesign – cases from lean and ergonomics in healthcare in Denmark and Finland”.

- Elina Parviainen: An introduction to Lean and Ergonomics (No abstract available)
- Jori Reijula: Assessing implementation of Lean Thinking into two Finnish University Hospitals
- Kasper Edwards: Experiences with integrating ergonomics into lean at a Danish hospital” (No abstract available)

Work shop II: Heavy manual handling. Are there reasons to re-visit the basics for regulation and guidelines?

- Jakob Ugelvig Christiansen (Abstract available)



# Assessing implementation of Lean thinking into two Finnish University Hospitals

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Keywords – Lean thinking, hospitals, work processes, work environment, facility design

## 1. Background

Today's healthcare (HC) processes and work environment design are both in need of improvement and pressure exists to develop them. Lean thinking has shown potential in eliminating waste from work processes and improving HC efficiency in hospitals. Lately, Lean has been also utilized in HC facility design (FD). Lean has thus become a global phenomenon. Finnish University hospitals have been actively attempting to incorporate Lean into work processes and FD. This study focuses on the implementation endeavors of two Finnish University hospitals.

## 2. Material & Methods

The study targets comprise Kuopio (H1) and Turku University (H2) hospitals. Both hospitals have recently engaged in Lean thinking. In this study, semi-structured interviews (n=14) were conducted in both hospitals. Also questionnaires (n=222) were conducted in H1. The aim of the interviews and questionnaires was to assess the staff's perception of the work environment, work processes and the utilization of Lean. Moreover, research data assessing the target hospitals' use of Lean were utilized.

## 3. Results

According to the interviews, emphasis on participatory, user-centric design approach and integrating Lean as a main part of the operational FD process have proven to be beneficial. The clinicians must be thoroughly oriented to the new work environment and processes. Lean tools, such as value stream mapping and patient flow charts had been utilized in work process and FD planning. Moreover, 5S and A3 problem solving tools were also commonly utilized. Improvement needs existed, including hospital hierarchy, bureaucracy, communication, ICT technology, logistics, safety, teamwork, personnel structure and outsourcing.

The questionnaire response rate was 32%. According to the questionnaire results, an increasing number of hospital staff members understood what Lean thinking meant, and wished it would be capitalized more in the hospital work. Addedly, a majority of the staff did not know whether Lean thinking was utilized in the hospital.

#### **4. Discussion**

Although several improvement needs existed in the target hospitals, the HC professionals seemed keen to address these needs. Some needs were difficult to fulfill but gradual improvement to enhance most areas of the FD process was apparent.

A participatory approach to FD had proven beneficial for both target hospitals. Empowering hospital employees to participate in the FD process had helped emphasize the user's point of view in the hospital design. Lean thinking had made the FD process more systematic and standardized procedures had been used. In H2, this included e.g. using Lean experts from within the hospital to enlighten hospital employees partaking in the FD phase about Lean tools and methods.

Even though several Lean tools were used in the target hospitals, a significant number of the staff were unsure they were in fact Lean tools. Thus a question arises, whether implementation of Lean and Lean training and education courses in H1 had been systematic enough to cover the entire employee base.

#### **5. Conclusions**

Although both target hospitals had experience with quality-driven management systems, Lean required a new mindset. The greatest challenge in implementing Lean seemed to be getting everyone on board with the Lean ideology. The support from the highest level of management as well as using experienced Lean consultants were crucial and reinforced the proposed Lean initiatives. Although the process is still in its early stages, the initial response to Lean – and also the results – have been mostly positive.

# **Heavy manual handling - Are there reasons to re-visit the basics for regulation and guidelines?**

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## **Abstract**

This presentation will raise 17 professional questions addressing the fact that prevention and prevention principles are based on data and decisions often around 50 years old. It is a fact that the incidence of MSD have not shown any significant lowering in the same period; - and often the opposite. It is a fact that reviews and other state of the science documents i.e. in Holland and Denmark have shown that there are only limited evidence for a dose-response relation leading to scientific and useful guidelines for heavy manual handling leading to possibilities to prevent MSD.

The presented observations and questions are meant to create a platform for debate and for taking relevant steps in future guidelines, models and science.

## *Session 5A Psychosocial strain, occupational stress and mental health*

### **Wednesday 17<sup>th</sup> August**

Randi Mork: How does direct glare and psychological stress affect young women during computer work?

Riitta Kärkkäinen: Predictors of return to work (RTW) in professional burnout: A systematic review

Knut Inge Fostervold: Self-perceived health and the impact of psychosocial work factors

Rafaël Weissbrodt: Preventing psychosocial risks at work: A realist synthesis of labour inspection interventions

# How does direct glare and psychological stress affect young women during computer work?

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*In the present study 44 young, healthy women with normal binocular vision worked on a computer in four 10-minutes sessions with different exposure; low stress, direct glare, psychological stress and both visual and psychological stress. Muscle activity and muscle blood flow in trapezius, muscle blood flow in orbicularis oculi, symptom development, affect states, blood pressure, heart rate and postural angles were recorded to investigate how the stressors affected the subjects during the computer work sessions. Preliminary results will be presented at NES 2016.*

Keywords: Computer work, Orbicularis oculi, Trapezius, Visual stress, Glare, Psychological stress

## 1. Introduction

Visually unfavourable conditions during computer work are related to both eyestrain and increased tension in stabilizing muscles in the neck and shoulder area (Anshel 2007, Helland et al. 2008, Richter et al. 2011a, Richter et al. 2011b, Zetterberg et al. 2013). Exposure to glare during computer work is visually demanding and may lead to visual discomfort and development of eye symptoms (Wolska and Switula 1999, Thorud et al. 2012, Mork et al. 2016). In line with this, glare have been linked to decreased reading performance (Glimne et al. 2015) and alternations in fixation disparity (Glimne et al. 2013). Further, In a previous study we showed connections between direct glare exposure and increased muscle blood flow in m. trapezius (Mork et al. 2016).

To further elucidate the effect of direct glare, we wanted to examine how exposure to visual stress (direct glare) and psychological stress affects m. orbicularis oculi and m. trapezius during computer work. Psychological stress is previously shown to increase muscle blood flow and -activity in m. trapezius (Larsson et al. 1995, Lundberg et al. 2002) and in facial muscles (Hidaka et al. 2004, Vassend and Knardahl 2005).

## 2. Objective

The present study investigated how visual stress, introduced as direct glare, and psychological stress, influenced on m. orbicularis oculi, m. trapezius and symptom development in young, healthy women during computer work.

## 3. Methods

Forty-four healthy, young women ( $21 \pm 2$  years, mean  $\pm$  SD) with normal binocular vision were included in the study. All subjects had a visual examination before testing.

All testing was carried out at the same optimized computer work place. It was used a counterbalanced design and each subject were exposed to four different computer work sessions. The subjects were exposed to different stressors during the sessions:

1. Low stress (LS)
2. Visual stress (VS)
3. Psychological stress (PS)
4. Visual and psychological stress (VPS)

The visual stress in VS and VPS was induced as direct glare. The psychological stress in PS and VPS was induced as time and efficiency pressure, a video camera was turned on to film them through the conditions, and the subjects were told that they would be asked questions from the text after the conditions.

The assignment in all four conditions was proofreading using a regular mouse as input device. Each session lasted for 10 minutes with  $13.8 \pm 2.1$  minutes (mean  $\pm$  SD) break in-between. Muscle activity and muscle blood flow in dominant m. trapezius and muscle blood flow in m. orbicularis oculi (dominant eye) were measured continuously during computer work and rest recordings. Muscle blood flow and muscle activity were measured using photoplethysmography (PPG) and electromyography (EMG), respectively.

Sitting posture was continuously registered using inclinometers on the head and upper back. Blood pressure and heart rate were also registered, both before, during and after each computer session. Subjective symptoms and psychological stress indicators, such as affect states, were recorded using VAS-scales before and after each condition. Horizontal fixation disparity was recorded immediately after each condition using Sheedys disparometer.

Overall differences between the conditions and overall temporal changes were tested by repeated measures ANOVA. If significance was indicated, differences at each time point were tested by Paired-Samples t-test or Independent-samples t-test. Pearson correlation was used to examine correlations between different variables. A statistical difference was accepted at  $P < 0.05$  (two-tailed). Statistical analyses was performed in PASW Statistics 17.0 (SPSS Inc., US).

#### 4. Results

The data collection was done in two different periods; the first 24 subjects were tested in the spring 2015, the last 20 subjects were tested in the springtime 2016. There was a presentation of the results from the first data collection on NES 2015. The present abstract present extended results from the whole dataset.

Preliminary results will be presented at NES 2016 and will introduce potential effects seen from the visual and psychological stress exposure on muscle activity, muscle blood flow and symptoms among other factors.

The study was supported by grant from the Norwegian Extra Foundation for Health and Rehabilitation / Spine Association Norway.

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# Predictors of return to work (RTW) in professional burnout. A systematic review

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*This systematic review aims to identify factors predicting return to work (RTW) in professional burnout. Quantitative and mixed-method follow-up studies published in 2005–2015 were searched in seven databases followed by a manual search. Out of the 1,345 articles initially identified, one experimental study and four observational studies involving 536 employees were included. The results suggest that individual psychopathology and burnout rehabilitation predict RTW. In conclusion, burnout employees might benefit from burnout rehabilitation, and RTW may precede full recovery from burnout related symptoms. Further research on predictors of RTW in professional burnout is recommended.*

Keywords: professional burnout; occupational stress; sick leave; return to work; workplace; intervention

## 1. Introduction

Burnout is a work-stress induced syndrome (Maslach et al., 2001), which may cause prolonged sick leave (Borritz et al., 2010) and even permanent work disability (Ahola et al., 2009). The rehabilitation and reintegration of disabled employees due to burnout poses a major challenge in the European labour market, warranting actions promoting RTW (EU-OSHA, 2014).

The aim of this review was to identify predictors of RTW from sick leave in burnout cases, based on quantitative literature. Knowledge of the factors that either promote or prevent RTW in burnout guides workplace actors to provide adequate support and to prevent permanent work disability. Many factors other than interventions were expected to impact on the outcomes. The research question was: What factors predict RTW from sick leave for professional burnout?

## 2. Method

A systematic database search was conducted in ARTO, CINAHL (EBSCO), Medic, PsycINFO (ProQuest), PubMed, Scopus and Web of Science. Combinations of key words and synonyms were used to identify original, peer-reviewed studies in English and Finnish, published January 2005–October 2015. Furthermore, the reference lists of the full-text retrieved articles were screened. Related articles from PubMed, and grey literature from Google Scholar database were searched.

The following inclusion criteria were chosen: (i) quantitative or mixed method follow-up studies with control group (ii) participants as employed people with burnout (iii) burnout was identified with a valid burnout measure (iv) degree of RTW or degree of sick leave was measured



as the outcome (v) not less than 60% of participants with burnout (to accept maximum 40% potential misclassification).

The methodological quality of the studies was assessed with the critical appraisal checklists of the Joanna Briggs Institute (the Joanna Briggs Institute, 2014).

### **3. Results**

A total 1,345 articles were initially identified. A title search reduced their number to 510, and an abstract search to 191. Fifty-four articles remained after removing 137 duplicates. Seven studies were assessed for quality, of which five studies were eligible for analysis.

#### **3.1. Description of the included studies and participants**

One experimental study and four observational studies were included in the analysis of which three were Swedish and two Dutch. The follow-up period was from 6 months to 2 years. The participants (n=536) were female (n=360) and male (n=176), aged 40.9–49.9 years (mean), and had primary/secondary or university level education. There was mental comorbidity and varied use of medication among the participants. The length of the sick leave in the baseline, either full or partial, varied.

#### **3.2. Predictors of RTW in burnout**

Individual psychopathology and burnout rehabilitation were identified to predict RTW.

##### **3.2.1. Individual psychopathology**

*Level of burnout and mental comorbidity.* Despite significant recovery and work involvement, the burnout patients still experienced more psychological symptoms, including depressive symptoms, compared to healthy controls (van Dam et al., 2012). Although the participants who received treatment with both Cognitively oriented Behavioral Rehabilitation (CBR) and Qigong reported more reduced burnout symptoms compared to participants who received Qigong only, there were no difference in RTW rates (Stenlund et al., 2009).

*Level of cognitive impairment.* The extent of RTW was not related to the cognitive performance among former patients with work-stress-related exhaustion, and there were signs of attention deficit, despite considerable recovery and RTW (Österberg et al., 2014). However, van Dam et al. (2012) found that the cognitive performance among patients who returned to work was similar to healthy controls, and of that of those who did not return to work was significantly impaired compared to healthy controls.

*Sleep improvement promoted RTW* (Sonnenschein et al. 2008), yet the sleep was still impaired compared to the healthy controls.

*Psychopathology related to work behavior* such as experienced low control at work and covert coping strategies towards supervisor and/or workmates predicted higher risk of not reducing sick leave after rehabilitation for burnout, whereas high overcommitment seemed to be associated with reduced sick leave level (Nordlund et al. 2011).

*Length of the sick leave* taken whilst at work was related to future sick leave. Of the patients, who had been on sick leave for more than 6 months at randomization, 88% were on full-time sick leave at 12-month follow-up after 1-year rehabilitation (Stenlund et al., 2009).

### 3.2.2. Burnout rehabilitation

Rehabilitation with CBR and Qigong was compared with rehabilitation with Qigong only (Stenlund et al., 2009). Both rehabilitations showed significantly reduced sick leave rates at follow-up.

## 4. Discussion/Conclusions

Based on this review, few studies explore predictors of RTW in burnout. They focus mainly on burnout individual-related factors. Significant recovery from psychopathology such as burnout, mental co-morbidity, and sleep problems associated with RTW was found, yet they fell short of healthy levels (van Dam., 2012; Sonnenschein et al., 2008; Stenlund et al., 2009). The relation of cognitive performance and RTW remains unclear, since in one study (Österberg, et al., 2014) the participants who returned to work still had minor attention deficit, and in another study the participants did not differ from the healthy controls (van Dam., 2012). The length of the sick leave describes the duration of the psychopathology from the moment the symptoms and the severity of the symptoms were recognized by a physician.

Experienced lack of control at work, and covert coping towards the supervisor and/or workmates and high overcommitment to work (Nordlund et al., 2011) signal burnout related behavioural psychopathology. Changing this behavior with cognitive approach might support RTW. The effect of burnout rehabilitation, however, is based on only one study.

A strength of this review is that due to a comprehensive search, the likelihood of publication bias remains small. However, potential selection bias arises from the restricted languages and publication year chosen. Only studies with all the participants with clinical burnout met all the inclusion criterion. Although there were varied degree and duration of the previous sick leave, misclassification is assumed not to bias the results.

Because of the predominance of females in this review, the participants may not be representative of burnout employees as a whole. On the other hand there was heterogeneity in education which increases generalisability. The length of the follow-up period was too short in one of the studies. The main limitation of this review is that the results are based on only five studies. The studies are locally distributed and generalising the results to other populations requires caution.

The results suggest that, first, (i) significant, yet not full, recovery from burnout and burnout related symptoms, (ii) burnout rehabilitation, and (iii) high overcommitment to work, predict reduced sick leave level. Second, (i) low control at work, (ii) covert coping towards supervisors or workmates, or both, and (iii) over 6 months sick leave, predict an unchanged level of sick leave. In conclusion, work place actors, such as Occupational Health Care (OHC), might support burnout employees to achieve sufficient symptom recovery for RTW, eventually through burnout rehabilitation, and urge RTW despite the persistence of the symptoms. The evidence base on this review remains limited due to the shortage of published studies; further research on factors related to RTW in professional burnout is needed.

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# Self-perceived health and the impact of psychosocial work factors

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*Self-perceived health (SPH) has received increasing attention in the discussion of employee health and sickness absence. The present study investigated how psychosocial work related factors influence SPH. The study utilized structural equation modelling (SEM) to analyse a large cross sectional questionnaire survey in the educational sector in Norway. The results support the assumption that SPH is influenced by psychosocial work factors. High job demands seem to indicate improved SPH while high stress aggravates SPH the most.*

Keywords: self-perceived health, psychosocial work environment, sickness absence

## 1. Introduction

Employee health and sickness absence are prominent issues in today's working life. Research seems to agree that adverse psychosocial work-environments are prone to affect individual health and thereby also sickness absence (Semmer 2006). However, consensus about the causality, which factors that have most effect, and how strong the effects actually are, seems to be lacking (Darr and Johns 2008, Rugulies et al. 2007).

Moreover, the understanding of the terms health and sickness absence are not unambiguous. Health' can be construed in many ways, depending on one's chosen theoretical orientation and practical approach. Within the biomedical model, health has traditionally been defined as "the absence of disease." In contrast, more psychological focused perspectives emphasize people's subjective experience and level of functioning. Summarized in one statement: people are healthy if they feel well and is able to act in a social context (Vuori, 1993). Sickness absence is by definition absence from work due to illness. The term, however, should not be used indiscriminately. Sickness and sickness absence is complex and multidimensional phenomena that in addition to actual disease or injury can be explained by a number of other factors such as attitudes, family relationships, absence culture and politics (Melchior, Berkman, Niedhammer, Chea, and Goldberg 2003).

Self-perceived health (SPH) (also denoted self-assessed or self-rated health) has received increasing attention in this discussion. The assessment of self-perceived health (SPH) is not based on any formal criteria. The informants are instead instructed to provide a free overall estimate of their own health status (Jylhä 2009). SPH estimates are nevertheless not merely a health information summary process. The evaluation process is obviously also influenced by contextual cues, individual information and judgement processing factors, such as cognitive schemas, mental models, and heuristics (Huisman and Deeg 2010, Jylhä 2009).

Poor self-perceived health has shown to increase the risk of future disease and mortality (Halford et al. 2012). In addition, self-perceived health seems to influence people's feelings of quality of life, including motivations to engage in social activities and jobs (Pikhart et al. 2001).

Not surprisingly, studies also point towards an association between self-perceived health and sickness absence (Melchior et al. 2003).

Summarizing the literature it appears that a range of important work related factors, such as job demands, job autonomy, social support, role conflict, and role clarity, may influence individual assessment of self-perceived health (Karasek and Theorell 1990, Bakker and Demerouti 2007). The same factors have previously shown to influence important work related factors like motivation, job satisfaction, and job involvement, which again is associated with workers' health experience (Pahkin et al. 2008, Bakker and Demerouti 2007). The aim of the present study was to investigate how important factors in the psychosocial work environment influence individuals' perception of their own health.

## 2. Methods

Based on previous research and theoretical considerations a tentative theoretical model of the relationships between work-related predictor variables and SPH were developed. A schematic figure depicting the hypothesised relations is shown in figure 1.

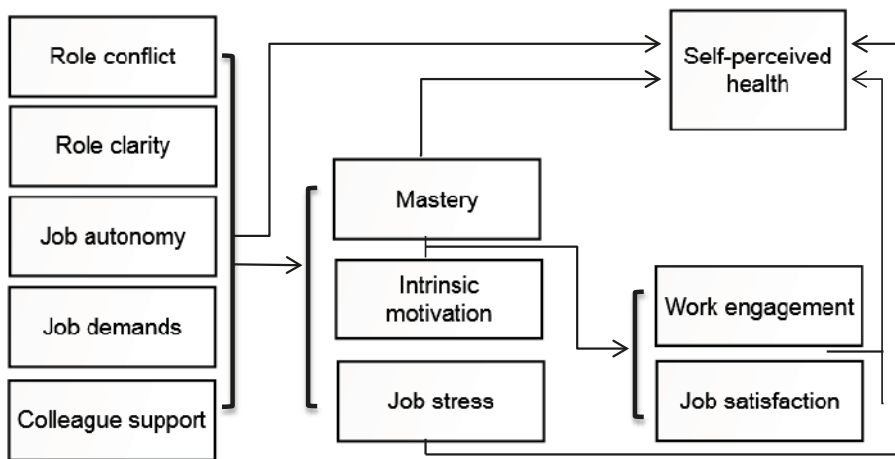


Figure 1. Schematic tentative theoretical model of probable relationships between work-related predictor variables and self-perceived health.

### 2.1 Design and participants

The study was based on a cross sectional employee survey. Individual data were collected from 3581 respondents (4688 invited) working within the educational sector in a large county in Norway. Females accounted for 59.1 % of the sample and 58.6 % worked as active teachers.

## 2.2 Questionnaire

Work related predictor variables and SPH were assessed by means of a questionnaire based validated and known scales. Scales assessing Role clarity (3 items), Role conflict (3 items), Job demands (Quantitative demands (3 items), Decision demands (3 items), and Learning demands (3 items)), Job stress (single item), and Mastery at work (4 items) were taken from the QPS-Nordic (Lindström et al. 2000). Colleague support (3 items), Job autonomy (3 items), Job satisfaction (2 items), and Internal motivation (4 items) were assessed by scales taken from Kuvaas and Dysvik (2012). Work engagement was measured by means of the Utrecht Work Engagement Scale (Uwes) (Schaufeli, Salanova, González-romá, and Bakker 2002). The scale is a second order construct that includes the sub-constructs Vigor (3 items), Dedication (3 items), and Absorption (3 items).

The criteria variable SPH was measured by two items developed by one of the authors. The two items were rated on a five-point bipolar scale with semantic descriptors ranging from 1 = Bad to 5= Very good, and summed into a self-perceived health index.

All scales showed satisfactory coefficient alpha (.60 – .91) compared to previous findings (Kuvaas and Dysvik 2012, Lindström et al. 2000, Schaufeli et al. 2002).

## 2.3 Statistics

Goodness of fit of latent models was investigated using Structural Equation Modelling (SEM) with maximum likelihood (ML) parameter estimation. The analyses were conducted with AMOS version 22. The goodness of fit measures included the model Chi-square ( $\chi^2_M$ ), including its degrees of freedom and p value, the Comparative fit index (CFI), the Root mean square error of approximation (RMSEA), including the high and low values of the 90 % confidence interval values for RMSEA, and the Standardized Root Mean Square Residual (SRMR) (Kline 2016).

Missing data were imputed using the Expectation Maximization algorithm (EM) (Enders 2001). To counter potential bias due to systematic missing, 228 participants showing 20% or more missing were deleted before imputation.

## 3. Results

Role clarity, Role conflict, Colleague support, Job autonomy and Job demands were entered as exogenous variables in the model according to figure 1. Mastery, Internal motivation, Job stress, Work engagement and Job satisfaction were entered as endogenous predictor variables. Hypothesized causal paths were drawn between each predictor variable and SPH. In addition, hypothesized causal paths were drawn between exogenous and endogenous predictors indicating mediated relationships between exogenous variables and SPH. Analysis of the tentative theoretical model revealed a unsatisfactory fit between the model and the data ( $\chi^2(8249) = 12683,62, p < .001$ ) (CFI = .86), (RMSEA=.066, 90% CI [.065, .067]), (SRMR = .13).

### 3.1 Model revision

Inspection of the parameter estimates revealed that several of the hypothesized paths were weak although significant. However, given the sample size and the statistical power, significance itself should not be considered as sole inclusion criteria.

A model revision was consequently conducted to develop a more parsimonious model with weak paths ( $\beta < .10$ ) constrained to zero. Comparative nested models may have fairly similar goodness of fit. Revisions of the model were therefore introduced one at a time and tested by the Delta chi-square ( $\Delta\chi^2$ ). After revision, Job satisfaction was no longer retained in the model. The revised model, explaining 23 % of the variance in respondents' self-perceived health, showed good or close fit with the data ( $\chi^2(745) = 7333,800, p < .001$ ), (CFI = .91), (RMSEA = .051, 90% CI

[.031, .061]), (SRMR = .07). A significant Chi-square was expected due to the large sample size and therefore not considered critical.

The results showed that five predictor variables affect SPH directly: Job demands ( $\beta = .28$ ), Role conflict ( $\beta = -.12$ ), Job stress ( $\beta = -.35$ ), Mastery ( $\beta = .22$ ), and Work engagement ( $\beta = .17$ ). Further, the results showed that Job demands ( $\beta = -.62$ ), Job autonomy, ( $\beta = .24$ ), Role conflict ( $\beta = .22$ ), Role clarity ( $\beta = .20$ ), and Colleague support ( $\beta = .10$ ), all affect Mastery, which in turn was associated with both Intrinsic motivation ( $\beta = .30$ ) and Work engagement ( $\beta = .23$ ). Colleague support ( $\beta = .15$ ) and Job autonomy ( $\beta = .27$ ) both affect Intrinsic motivation, which is associated with Job engagement ( $\beta = .65$ ). Job demands ( $\beta = .68$ ) and Job autonomy ( $\beta = -.21$ ) were the only variables showing a direct association with Job stress. All standardized beta weights were significant ( $p < .001$ ).

#### 4. Discussion

The results indicate that high job demands and high stress levels affect self-perceived health the most, but in opposite direction. As expected, high perceived stress signifies poor SPH. Job autonomy or individual control over the work-situation and participative decision-making seem all to partly mitigate the negative effect of stress on SPH. Somewhat surprising, job demands seem to affect self-perceived health positively. A possible explanation could be the relationship between job demands and job resources. According to the JD-R model (Bakker and Demerouti 2007), job demands do not necessarily have negative consequences. If the employee feels that enough resources are available to handle the demands, the situation could instead be perceived as motivational and foster personal growth, learning and development. Manageable job demands could thus increase feelings of mastery and competence, and thereby affect self-perceived health positively.

The results corroborate previous findings showing that job autonomy, social support, role clarity and role conflict affect self-perceived health indirectly, mediated by one or more of the variables, mastery/coping, intrinsic motivation and work engagement (Bakker and Demerouti 2007, Schrijvers, van de Mheen, Stronks, and Mackenbach 1998).

The direct and indirect effect of role conflict on SPH showed an opposing pattern. The direct effect revealed that high role conflict predicts poor SPH. The indirect effect, mediated through mastery, on the other hand seems to improve SPH. A possible explanation might be that most teachers are accustomed to handle a diversity of roles during a normal working day. A good teacher should not only ensure students' academic development, but should also act as an authority, role model, engage in social work, etc. Thus, when feeling competent to handle a multitude of roles, a high degree of role conflict is not necessarily something negative. On the contrary it may help to increase a sense of mastery and coping.

The study does not support previous results showing an association between job satisfaction and self-perceived health (Faragher, Cass, and Cooper 2005, Molarius et al. 2007). One possible explanation may be that meaning ascribed to items assessing job satisfaction overlap substantially with items assessing work engagement and intrinsic motivation. Considering the zero order correlation found between job satisfaction and work engagement ( $r = .58$ ) and intrinsic motivation ( $r = .50$ ), the unique contribution of job satisfaction may be low, as observed in the present study.

Overall, the study supports the assumption that self-perceived health is influenced by more than just the absence of disease. This knowledge should be included in efforts to prevent disease and promote good health in the workplace.

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# Preventing psychosocial risks at work: A realist synthesis of labour inspection interventions

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*Little research exists on the effectiveness of workplace visits by labour inspectors in relation with psychosocial risk. We conducted a systematic literature review grounded in a realist approach, in order to highlight the factors influencing inspection outcomes. It yielded a programme theory relating public intervention measures, mechanisms of action, outcomes, and contexts. Publications indicated positive outcomes in 4 out of 25 cases, possibly positive results in 2, mixed outcomes in 4, and no or poor effects in 10. The synthesis suggests the possibility of positive outcomes in supportive contexts and with appropriate training and resources. More evaluation studies remain necessary.*

Keywords: Labour inspection, Psychosocial risks, Psychosocial work environment, Realist synthesis, Literature review, Systematic review

## 1. Introduction

Workplace visits by labour inspectors are an important tool to enhance compliance with occupational health and safety (OHS) regulations. Labour inspectors are responsible for monitoring the implementation efforts in workplaces. The integration of organisational and psychosocial issues in their scope of intervention has challenged their roles and activities.

In the last decade, there have been an increasing number of publications on psychosocial risk policies. They often present descriptive accounts of national or international policies, perspectives on the challenges for regulators, and suggestions for the future (e.g. Leka et al., 2015). Some other studies focus on an operational level, exploring how labour inspectors consider psychosocial risks in their daily practices. Two previous systematic reviews addressed the impact of labour inspections (MacEachen et al., 2016; Mischke et al., 2013). However, they measured outcomes in terms of injuries and occupational diseases, and not in terms of psychosocial health; little research exists on the effectiveness of workplace visits in relation with this growing issue.

## 2. Objectives

The study aimed at providing a systematic review of the publications dealing with the inclusion of psychosocial risks in the strategies and actions of labour inspectorates. We strived to produce a coherent and transferable evidence based programme theory, in order to assist authorities in the definition of intervention strategies. For this purpose, we sought to answer two questions. First, which inspection practices have been developed in industrialised countries? Secondly, what has been their impact, in which contexts, and by which mechanisms? We studied these questions through a realist synthesis approach.

### 3. Methods

Our initial exploratory scoping and contacts with other researchers revealed that very few – if any – studies have been conducted on our review topic using (quasi-) experimental designs, or even collecting quantitative data. Moreover, it appeared that publications exist that describe state intervention measures, their contexts, and sometimes their mechanisms of action. Some papers give indications on outcomes. It also turned out that a sound understanding of the socio-political context of a given country is necessary to evaluate the outcomes of policy interventions toward psychosocial risks.

For these reasons, a realist synthesis seemed an appropriate method. Realist syntheses try to answer the question “What works for whom under what circumstances, how and why” (Wong et al., 2013). They aim to unveil interactions between contexts, generative mechanisms and outcomes; these interactions are called CMO configurations. Realist syntheses are particularly well-suited for the review of complex interventions (Rycroft-Malone et al., 2012).

Following the realist approach, we developed a rough initial programme theory to structure the literature search and review. It included six dimensions: regulatory contexts, socioeconomic contexts, workplace characteristics, state interventions towards psychosocial risks, generative mechanisms, and employers’ preventive actions. The main search took place in the Web of Science Core Collection, MEDLINE, and Psycinfo, for the years 2000-2015. We developed a list of search terms for each database. We completed the process by a systematic hand-search in specialised OHS journals, and by an iterative purposive search.

### 4. Results

In sum, 25 publications contributed to the review; 17 were peer-reviewed papers. Almost half of the publications originated in Scandinavian countries, and a third from other European countries. Some papers came from Australia and Québec. Publications indicated positive outcomes in 4 cases; 2 suggested the possibility of positive results, 2 delivered mixed outcomes, and 10 showed no or poor effects. We extracted 30 configurations of contexts, mechanisms, and outcomes. In order to assess which dimensions could enable or impede inspectors’ action, and to ease the interpretation of the results despite their large heterogeneity, we chose to illustrate the programme theory with two particularly exemplary CMO configurations, one with positive outcomes (Hansen et al., 2015) and the other not (Walters et al., 2011). Both were extracted out of international books on labour inspection.

Hansen et al. (2015) provide rather encouraging results in Scandinavia, especially through evaluation studies from Denmark and Norway. They report on inspection activities based on dialogue, group interviews, and a combination of repeated visits with other communication channels. There is a high degree of worker participation. Workplaces must have health and safety representatives, and the social partners may conclude agreements on the work environment. According to the general duty provisions, employers must assess psychosocial risks, develop an action plan, and call in experts if they lack knowledge. Specific provisions on the psychosocial work environment and on bullying complement the regulatory framework. On the other hand, there is no legal definition of the psychosocial work environment, nor specific regulation on some key risk factors (such as workload, time pressure or emotional demands). Psychosocial topics are priority areas in Nordic countries. Intervention strategies are based on a risk-factor approach. Every country has practices on violence and threatening behaviour, bullying and sexual harassment, and lack of training. Risk factors related to the organisation of work or relational matters are often included in the inspection of other factors or in an overall assessment.

Authorities may issue improvement notices on these issues. Some other dimensions, such as working hours and schedules, are not inspected in several countries. Inspection purposes and methods vary across countries, but in any case, industries at high risks, such as social and healthcare, education, or public administration, are inspected in priority. Most countries offer a basic training including psychosocial issues for new inspectors, on-the-job training, and continuing training activities. Specialised inspectors support their less experienced colleagues; they are sometimes organised in skills networks. Authorities develop tools and methods such as guidelines, checklists, structured interviews with employees, and survey questionnaires. Despite all these initiatives, only 1-16% of improvement notices specifically address the psychosocial work environment.

On the opposite, Walters et al. (2011) provide a critical assessment of OHS public policies in Australia, France, Québec, Sweden and the UK. Policy-mixes encompass inspection visits, promotion of OHS management systems (including psychosocial risks), and alternative methods for companies that are difficult to reach with conventional workplace visits. Enlightenment is a core principle and the threat of sanctions is marginal. Case studies demonstrate the importance of workplace inspections in systematic approaches to health and safety. However, there is little evidence for the effectiveness of the other policy instruments, such as promotional strategies and initiatives towards hard-to-reach companies. Besides, the mainstream “management system” approach of OHS – and of the prevention of psychosocial risks – has not been proven clearly effective. Actually, growing precariousness, increasingly contingent work arrangements, and a neo-liberal climate have eroded the economic and social drivers of OHS regulation. Authorities have not developed clear strategies and sufficient resources to implement the process regulation approach, to increase worker participation, and to deal with the consequences of the changing world of work; there is an increased focus on procedural issues rather than on substance. Finally, the authors highlight that a systematic OHS management requires a never-ending investment from workplaces, which is a significant hindrance for policy effectiveness.

## 5. Discussion

The synthesis resulted in an enriched programme theory relating public intervention measures (such as inspection visits), mechanisms of action, outcomes, and contexts (workplace characteristics, socioeconomic context, policies, standards and regulation). This model is described in Weissbrodt and Giaque (2016). One of its core features is the importance of national contexts. There are strong differences between countries, e.g. regarding the legal provisions on psychosocial risks, the intervention strategies and practices, and the relationships between social partners. However, most countries under study are confronted with similar challenges on the roles and resources of labour inspectors in the area of mental health at work. Studies from Nordic countries described some positive outcomes of global inspection activities basing on dialogue with employers and group interviews with employees, repeated visits and combination of inspection visits with other communication and information channels, in a context characterised by highly organised labour markets. Conversely, other studies highlighted the limitations of intervention strategies relying on an “enlightenment” principle, in a context of increasingly precarious and flexible work situations. Many publications report on limited resources for inspectorates to make direct and repeated contact with companies.

According to the realist logic, interventions do not directly cause outcomes. They are mediated by generative mechanisms, which are a function of the context. This review showed that enlightenment, advice, and dialogue are by far the most frequent strategies used by inspectorates to address psychosocial risks and foster compliance. No author mentioned

deterrence as a common approach, but some consider that it remains a necessary ingredient for an efficient intervention of labour inspectors.

Finally, a striking feature regarding the effectiveness of psychosocial inspections is the very small quantitative evidence on this topic. Few publications reported on quantitative results, and even fewer were primary research. Furthermore, only five publications specifically aimed to evaluate outcomes of interventions.

## 6. Conclusion

The synthesis suggests the possibility of positive outcomes of inspectors' interventions on psychosocial risks in supportive contexts and with appropriate training and resources. It seems that inspectors may be rather successful at a micro-level, convincing employers during their inspection duties. By contrast, policies at a macro-level seem to fall short of their objectives. A possible explanation would be that inspectors are only able to inspect a fraction of workplaces, and maybe not the worst ones. However, strong evidence is lacking and more evaluation studies are needed. The realist approach might be an adequate approach to evaluate such a complex topic. Indeed, it would not aim at determining "if" inspection has an effect on the psychosocial work environment – which could be somewhat disappointing – but "where", "in which situations", and "how". Identifying such success factors would allow inspectorates to make informed decisions about the focus of their actions.

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## *Session 5B Safety at work*

### **Wednesday 17<sup>th</sup> August**

Rauno Hanhela: The Occupational Safety Card (Työturvallisuuskortti®) for improved occupational safety in the shared workplaces

Arto Reiman: Occupational safety at rail transport – personnel's view for improving work

Hillevi Hemphälä: A risk assessment method for visual ergonomics (Abstract available)

Akihiro Ohnishi: Relation between dynamic coefficient of friction and subjective slipperiness in footwear soles

# **The Occupational Safety Card (Työturvallisuuskortti®) for improved occupational safety in shared workplaces**

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*Various kinds of safety passport schemes have been developed in many countries to provide a way for ensuring that employees have basic knowledge of occupational safety and health and to complete the basic training in safety and health at work. The target populations of these Voluntary Safety Cards are employees and supervisors of companies and public agencies. In Finland the Occupational Safety Card (in Finnish “Työturvallisuuskortti®”) has been developed by Finnish industry mainly for improving occupational safety in shared workplaces. The card and the entire training system is organised and coordinated by the Centre for Occupational Safety.*

Keywords: Occupational safety, Shared workplace, Training, Safety card

## **1. Introduction**

Many accidents occur in shared workplaces. When there are employees under more than one employer, all working in the same premises or on the same site, practical coordination problems can emerge. There are a lot of questions to be solved: How can an employer know that today the work carried out by employees can possibly cause danger to others? Have they been informed about the third employer’s work from which employees should be protected? Has anyone planned how this work will be coordinated with regard to time and location? How can it be ensured that all employees are familiar with occupational safety and health issues that may appear in this shared workplace?

## **2. Responsibilities**

The employer exercising the main authority in the shared workplace is responsible for taking up measures on the arrangement of joint action in the shared workplace. In this context the employer exercising the main authority can be a client or building developer (person or organisation that undertakes a construction project or manages or oversees the construction project) or project supervisor (the main contractor or employer who has the main authority appointed by the building developer).

A supplier refers to an employer in the shared workplace whose services are charged to the client. This can also be a contractor and a subcontractor working for the supplier. The concept of supplier also covers self-employed persons.

The client is responsible for the coordination of work in the shared workplace. Coordination ensures that suppliers working at the same time or one after another on the same worksite will not put each other in danger or cause problems. The client draws up guidelines for work, mobility and significant hazards. These apply to everyone in the shared workplace and include its common practices as well as regulations for avoiding risks.

The supplier is responsible for the occupational health and safety of its own employees also when working on the client's premises. The supplier is responsible for its employees' qualifications as well as orientation and occupational guidance concerning the job, the job site and its hazards. The supplier is also responsible for the supervision of work as regards its own employees.

A temporary employee works on the premises of the occupant company and under its management and supervision, so the occupant company must comply with the provisions of the Occupational Safety and Health Act regarding the employer. A temporary work agency must also comply with the provisions of the Occupational Safety and Health Act as the employee's employer.

Although each company is responsible for its actions and employees, the purchasing company has the obligation to require that the safety regulations and good practises be followed. This is important in the shared workplace because every company operating there affects the activities of the workplace. Everyone should make sure their actions do not put others working there in danger.

Due to the joint responsibilities, cooperation between client, suppliers, subcontractors and temporary work agencies is important in occupational safety issues. When negotiating client contracts, the parties must always clarify the occupational safety issues and responsibilities concerning the work. It is also very important that all those working on the same site have a good understanding of occupational safety and health risks concerning the ongoing work.

### **The Occupational Safety Card in Finland**

To ensure the success of the cooperation discussed above, training relating to the Occupational Safety Card has been developed by Finnish industry together with labour market organisations, the Finnish insurance industry and training organisations. Occupational Safety Card training provides basic information about the risks and hazards of the work environment as well as implementation of occupational health and safety in the shared workplace.

The training was designed first and foremost for the manufacturing industry, but it is equally applicable to fields such as the construction industry, shipbuilding and public sector. The card was implemented extensively in 2003, but the first regional version was already established in 1997.

Occupational Safety Card issuance at the workplace is a voluntary procedure decided by the employer. In addition to Occupational Safety Card training, the employer is legally required to provide orientation to all new employees on the site. The orientation should be specific to the workplace and job.

In Finland, the Occupational Safety Card has become a popular way to complete the basic training in safety and health at work. The system covers the entire country, and more and more companies are interested in becoming involved. They see the card as a competitive advantage indicating better safety standards. Many big companies require the card for everyone who wants to access the industrial or company area.

Although implementation is voluntary, so far more than 1 115 000 Occupational Safety Cards have been granted since the card was launched extensively in 2003. At the moment 750 000 cards are in force. The number of Occupational Safety Card trainers (about 3 000) and courses (more than 10 000 per year) reflects the extent of the system.

Occupational Safety Card courses are held by course leaders qualified through specific trainer training. The quality of the training is monitored to ensure uniform practice and quality. Occupational safety cards are issued following the certified completion of the training and

successful passing of the written exam. The card is valid for five years. The renewal of the card requires the passing of a new course.

The course material and worksheet were renewed this year. The following topics are covered by the new training content: Zero Incident Vision, Safety at Shared Workplaces, Job Orientation, Risk Management, Workload Identification, Hazard Identification.

The Occupational Safety Card provides basic information about occupational health and safety and arouses interest in and motivation for occupational safety skills among all personnel in client and supplier companies as well as in temporary work agencies. The education related to the card also enhances practical collaboration between employers and contractors, supports job orientation in shared workplaces and reduces overlapping training provided by different employers.

The aim of the scheme is that those who have passed the Occupational Safety Card course have basic knowledge about the cooperation and general hazards of the shared workplace, knowledge about the key principles and good practices of occupational safety and basic preparedness to also adopt workplace and job-specific orientation.

### **International aspect**

Global challenges in working life necessitate global cooperation also in occupational health and safety. Aspects such as migration, multinational corporations and free movement of labour have an increasingly important role to play in health and safety. This means that we should have a shared understanding and knowledge of occupational safety and health and the risks arising at work.

To create mutual understanding we would need the mutual certification of safety passport schemes of different countries. There is currently no system for the mutual recognition of different safety cards.

The European Network of Safety and Health Professional Organizations (ENSHPO) has taken up this challenge to develop a European-wide recognition system for certification of safety passport schemes. The objective of the ENSHPO Safety Card Certification Scheme is to certify that those holding a card which has received ENSHPO certification know and are able to apply the basic elements of workplace safety based on harmonised criteria throughout Europe. The goal is that those holding an ENSHPO-approved safety card do not have to repeat the basic training if they move from one employer, contractor or country to another.

In Finland the card material has been translated into English, Swedish, Russian and Estonian. The translated material is currently based on the old content, and the new content will be translated later this year. With these translations, the Centre for Occupational Safety will try to help companies train their employees who are going to work in Finland. In Finland, we also have agreed on cooperation with the Swedish Entre card, which means that companies can accept the cards mutually in both countries.



# Occupational safety at rail transport – personnel’s views for improving work

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*A large questionnaire was sent to a Finnish railway company personnel (n=9404). In the questionnaire, an open question was posed: “Tell us your own ideas how to improve occupational health and safety in your company”. In total 1087 persons (11.6%) answered the open question. All in all over 2100 ideas were expressed. Researchers identified ten categories from the answers and classified the answers relatively. The categories were: “attitude”, “instructions”, “training and guidance”, “working time”, “work equipment”, “working conditions”, “communication”, “working methods”, “management” and “safety observations”. This study shows how large amount of development ideas can be collected through a simple open question.*

Keywords: Improvement, Occupational safety, Questionnaire, Rail transport

## 1. Introduction

Work at rail transport includes various types of tasks, such as catering, driving, maintenance, shunting, loading, and ticketing (European Agency for Safety and Health at Work 2011). Variety in tasks poses challenges to occupational health and safety (OHS) management and practices, as also a wide variety of different types of accident and health risks exist. Environmental hazards, technical dysfunctions, lack of work organization, lack of knowledge and other human factors have been identified by Chau et al. (2007) as main contributing factors to accidents at the rail transport sector.

In addition to risks for accidents and health hazards employees are also exposed to different kinds of loads that have an effect on their ability to work. Load factors such as organizational changes and outsourcing, lone work, working time issues, long-distance transports, deficiencies in ergonomics and workplace design and climatic conditions have been identified (European Agency for Safety and Health at Work 2011).

This study is a sub study from an AseMa project (2012-2014), which was a study on OHS at Finnish rail transport (Jounila et al. 2015). Safety indicators show positive history and trends in

the company's safety performance during current years. Despite the good progress, the company is willing to in-depth their OHS knowledge and abilities. The project aimed at providing further in-depth information. As a part of this study, a diploma thesis was written by Lindholm (2015). This study provides in-depth analyses derived from the thesis and project material.

## **2. Objectives**

The objective of this study is to analyse and categorize the development ideas that were collected by the open question "Express your ideas how to improve occupational safety" as a part of a larger questionnaire.

## **3. Methods and material**

A questionnaire (via e-mail and mail) was used as a data collection measure. The questionnaire was sent to the whole personnel (n=9 404) in early 2014. Altogether 3 042 persons responded to the questionnaire (response rate 32.3 %). The questionnaire consisted of 71 statements, seven comparison questions and one open question. This study focuses on the analyses of the answers to the open question.

In the open question ideas for improving the occupational safety in the subject company were asked: *"Tell us your own ideas how to improve occupational safety in your company"*. In total 1 087 person of the total of 3 042 respondents answered the open question, thus the response rate for the open question was 11.6%. Due to the phrasing of the question answers were mixed; from general comments regarding OHS into very specific technical improvement ideas. Each answer included one or more ideas, thus over 2 100 ideas and comments were collected.

In total 659 (60.6 %) of the respondents were employees and 415 (38.2 %) acted as experts or at the management (foremen to top management) level. In total thirteen respondents didn't denote information about their work status. The respondents were rather experienced, as nearly 90% of the respondents stated that they have more than six years of work experience.

The material in this study is qualitative and interpretative in nature. The analysis of the material was conducted by applying open coding and axial coding (Strauss & Corbin 1998). In the first phase of the analysis, the researcher read through the answers and sought themes that were repeated. As a result of the first phase analysis researcher sketched in total 37 tentative themes. In the second analysis round the researcher read through the answers again and merged the tentative themes into ten more extensive categories.

## **4. Results**

In total over 2 100 comments and ideas how to improve OHS were collected through the questionnaire. These were categorised into ten categories. The categories and some examples are presented in Table 1.

Table 1. Ten categories based on 2 100 comments and ideas and some examples of the first phase analysis and on the comments and ideas expressed in the answers.

Category	Examples of the themes included (first phase)	Examples of the ideas and comments*
I. Attitude	Management's/supervisor's attitudes, Employees' attitudes	"Think before you act", "Attitude training to foremen and employees", "Each one is responsible to act safely", "Common Safety attitude campaign"
II. Communications	Communication practices, Ability to listen, Participation	"Informing of the accidents more systematic", "Short infos on topical issues", "Notebook on most typical risks"
III. Instructions	Availability and clarity of the instructions	"Instructions in one domain where they are easily found", "More emphasis on the contents of the instructions", "Positive view on informing"
IV. Management	Management practices, Management visits to the work sites	"Management/foremen's ability to act as an example and take a hand on hazardous working manners is crucial"
V. Safety observations	Observation processing practices, Observation making processes	"Improvements on the sharing of safety observations", "Ease safety observation reporting processes", "Regular time for weekly safety meetings", "More information on accidents and root causes"
VI. Training and guidance	Sharing of in-depth information, Amount of training, Training skills	"Accidents should be discussed in trainings", "Concrete examples of accidents in trainings", "Enough time for orientation and ensuring that the issues are understood"
VII. Working conditions	Physical work environment, Technical issues related to trains, Security issues	"Improvements in train brakes", "Snow problems in the wintertime", "More security personnel in the evening and night time trains during the weekends"
VIII. Work equipment	Protective equipment, Technical issues related to trains	"Usability and compatibility of personal protective equipment", "Sliding prevention equipment on winter boots", "Improvements on tool maintenance and replacement"
IX. Working methods	Working alone, Working in pairs, Encouragement, Sanction processes, Planning issues,	"Working in pairs and not alone in trains", "Ergonomics development needs on train maintenance activities"
X. Working Hours	Breaks, Working in hurry	"Working in hurry complicates the sharing of information"

\*Not direct quotations. Answers only in Finnish.

There were differences how employees and others (managers, foremen, experts) answers were divided into the categories, see Figure 1.

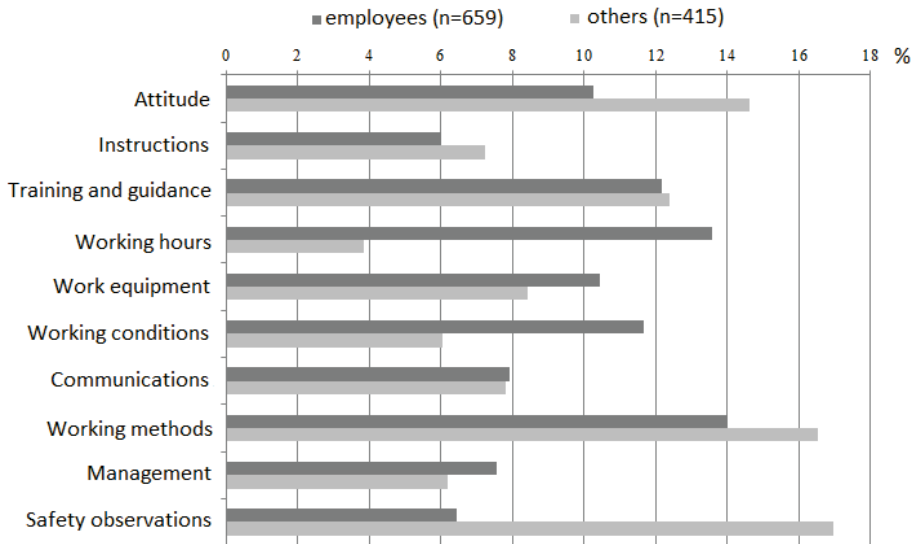


Figure 1. Ideas and comments divided into ten categories by the position of the respondent (employees vs. others) as a percentage of the answers by the respondent group.

## 5. Discussion and conclusions

Personnel's ideas and general comments how to improve OHS in the company served as a material in this study. Altogether over 2 100 ideas and comments were gathered through a questionnaire by one open question. The answers were categorised in ten categories: "attitude", "communications", "instructions", "management", "safety observations", "training and guidance", "working conditions", "work equipment", "working methods" and "working hours". Differences on what kinds of ideas were expressed can be identified on the basis of the respondent's position.

Personnel participation is highly topical both in current OHS research and in practical OHS processes. This study shows how large amount of development ideas can be collected through a simple open question. As the amount of ideas is large they should be processed and analyzed in order to find out the most essential improvement lines.

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# A risk assessment method for visual ergonomics

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## Abstract

The visual environment can affect our wellbeing in many ways. Insufficient visual ability can lead to increased workload and contribute to eyestrain and musculoskeletal discomfort that in turn could lead to sick leave. Non-visual effects, such as flicker from luminaires can cause eyestrain or headache/migraine.

Glare from luminaires or windows within the visual field can cause disability glare or discomfort glare. Glare while performing computer tasks causes visual fatigue and leads to strabismus measured with fixation disparity (harder for the eyes to focus). Strabismus leads to eyestrain, and eyestrain can lead to musculoskeletal discomfort.

Although the relation between eyestrain and musculoskeletal discomfort is not fully understood, studies have shown that straining the eyes increases the musculoskeletal activity in the neck and shoulders (muscle trapezius); associations between visually demanding work, eye problems, headaches and/or muscle problems have also been found.

The aim of this project is to develop a practical, easy-to-use, and time efficient risk assessment method for visual ergonomics. With this method, risk factors in the visual environment can be detected, and interventions implemented to reduce the prevalence of symptoms related to poor visual ergonomics among workers.

The developed visual ergonomics risk analysis method has been used at several work places by ergonomists that have been educated in visual ergonomics. The results from the subjective part of the method show that many individuals report eyestrain and headache. This can be caused by many different factors such as wrong power in lenses, glare, flickering lights etc. Therefore it is essential that if you have a visually demanding work (such as computer work) you have to do eye examinations every other year to make sure that your vision is at its best. But the lighting situation at workplaces is also a key factor to consider in a good visual environment, to increase the level of performance.

To increase wellbeing at work and reduce sick leave the visual environment needs to be good, with sufficient illuminance, a good luminance ratio, no glare from luminaires or windows, no flicker, and a good visibility of the work task. Education in risk analysis of the visual environment is essential for many different occupations such as lighting designers, ergonomists, working life inspectors, optometrists, to ensure a better understanding of the impact on wellbeing that the visual environment have.

The researchers behind this study will have a finished visual ergonomics risk analysis method by the year of 2017.

# Relation between dynamic coefficient of friction and subjective slipperiness in footwear soles

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*The purpose of this study was to examine the validity of the slip-resistance standard in Japan which was 0.2 or higher dynamic coefficient of friction (DCOF) through a ramp test and a rapid stepping task under a slippery floor. Nineteen young males participated in the study. As a result, slip-occurrence angles for both walking up and down significantly differed from each footwear in the ramp test. Subjective slipperiness from the stepping task significantly differed between the DCOF of 0.12 and others, 0.21 through 0.64. This study concluded that the slip-resistance standard was suitable, additionally, the DCOF of 0.64 will be higher-rank-standard of slip resistance.*

Keywords: Fall, Slip-resistance property, Dynamic coefficient of friction (DCOF), Subjective evaluation

## 1. Introduction

Protective footwear are shoes that adheres to Japanese Industrial Standard JIS T 8101 (Japan Industrial Standard Committee, 2006). According to JIS, the F-label (F stands for friction) is given as certification of the slip resistance if the dynamic coefficient of friction (DCOF) from testing is 0.2 or higher. Regarding the relation between the DCOF and a human slipping while walking (as opposed to using a testing apparatus), the previous study reported that on an inclined surface that was slippery owing to soapy water wherein the probability of slipping was 50%, the coefficient of friction (COF) was 0.16; a coefficient of 0.39 was required to reduce this probability to 5% (Hanson et al., 1999). However, the relation between the COF obtained by the JIS testing apparatus and slip-resistance in actual situations is unclear.

This study examined the validity of the F-label for protective footwear by JIS. Firstly, we analysed the relation between the DCOF obtained by the JIS testing machine and angle of slip-occurrence for a human walking on an inclined slippery flooring. Furthermore, a rapid stepping task on the same level was conducted under slippery conditions.

## 2. Method

### 2.1. Participants

Nineteen males with no orthopaedic medical history in the past year (Age:  $29.5 \pm 8.1$  years, Height:  $170.4 \pm 4.5$  cm, Weight:  $62.9 \pm 9.1$  kg, Shoe size:  $25.6 \pm 0.9$  cm) participated in this study. Prior to the measurement, informed consent was obtained both verbally and through written documentation. As a safety consideration for conducting measurements, participants were asked to wear harness-type safety belts attached to a rope that was fixed to a rail suspended from the ceiling. This procedure was to prevent them from falling over when a slip occurred. Also the participants asked to wear a helmet along with protectors for their elbows and knees. This study

was approved by the research ethics committee of the National Institute of Occupational Safety and Health, Japan.

## 2.2. Slip-Occurrence Angle on an Inclined Flooring (Ramp Test)

We used five types of experimental footwear from the JIS slip-resistance test, with DCOF ranging from 0.12 to 0.64 (Table 1). The ramp-test method was based on the DIN Standard (German Institute for Standardization, 2014). For a floor surface condition similar to that used for the JIS slip-resistance test, a 90% concentration of glycerine was applied to a stainless-steel board. The participants were asked to continue a stepping task with a walking stride-length on the inclined surface, and the floor angle was gradually increased. The DIN testing only used “walking down”, however, we additionally evaluated “walking up”. Both tasks were measured the slip-occurrence angle three times per footwear.

For determining the footwear factors, one-way repeated measures of analysis of variance (ANOVA) was used separately for walking up and down. A Bonferroni correction was used for multiple comparisons between the footwear types. Also, for comparing walking up and walking down using the same footwear, we conducted a paired t-test.

Table 1 Mean  $\pm$  standard deviation of dynamic coefficient of friction (DCOF) for left and right foot soles using five types of testing footwear.

	A	B	C	D	E
Right	0.12 $\pm$ 0.01	0.21 $\pm$ 0.01	0.29 $\pm$ 0.01	0.41 $\pm$ 0.02	0.66 $\pm$ 0.05
Left	0.12 $\pm$ 0.01	0.20 $\pm$ 0.01	0.29 $\pm$ 0.01	0.41 $\pm$ 0.02	0.62 $\pm$ 0.07
Mean	0.12 $\pm$ 0.01	0.21 $\pm$ 0.01	0.29 $\pm$ 0.01	0.41 $\pm$ 0.02	0.64 $\pm$ 0.06

## 2.3. Subjective Evaluations via a Stepping Task

Using the same experimental footwear as in the ramp test, we asked the participants to carry out a stepping task on the same level where they need to conduct three times in a row facing forward with both feet with 2.5 times the sole length of each footwear. To create the same condition as for the JIS, a 90% concentration of glycerine was applied to a stainless steel board. Furthermore, the stepping tempo was regulated to 140 bpm using a digital metronome so that there was no difference in the stepping way, e.g., as a strategy for preventing a slip or a fall. A total of 15 trials were conducted, three trials for each type of footwear.

To evaluate the subjective slipperiness, we first asked the participants to carry out the stepping task once before applying glycerine to the stainless-steel board. We explained that this condition would be their reference point for “non-slip.” Next, immediately after conducting the actual stepping task. Participants were asked to intuitively evaluate how much they were slipping as compared to the reference point during the task using a visual analog scale (VAS). A similar evaluation was conducted for the “sense of fear” that participants felt when conducting the stepping. One-way repeated measures ANOVA was used to evaluate the differences both the slipperiness and the sense of fear.

## 3. Results

### 3.1. Ramp Test

For both walking up and the walking down tasks, the slip-occurrence angles significantly differed; a difference of footwear types corresponded to an inclination angle from 1.9° to 3.8° (Fig.



1). Also, when comparing walking up and walking down, the angle for walking down was significantly smaller by around 2° for footwear B, C, and D.

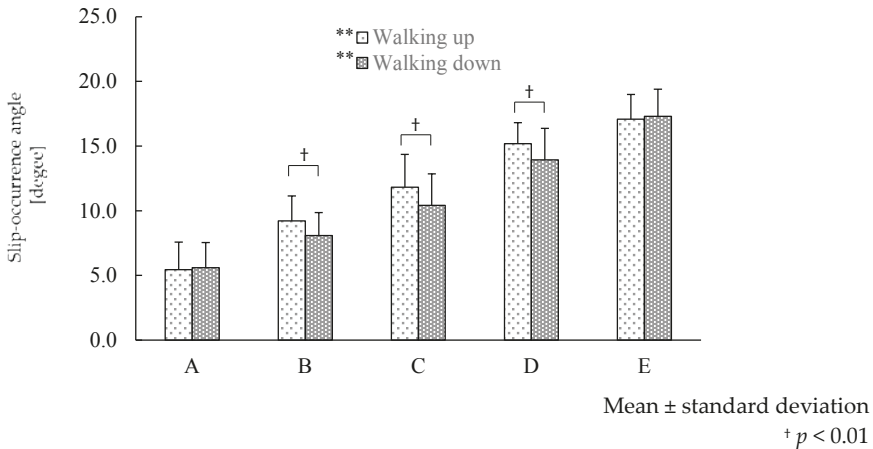


Figure 1 Ramp test results for "walking up" and "walking down" in each footwear  
 "Significant differences were observed at between all other groups for both walking up and walking down.

### 3.2. Stepping Task

The VAS scores regarding slipperiness for A which was not given the F-label were extremely low, at approximately 10. On the contrary, the score for B considerably increased to approximately 50. The increase in the four types, up to E, was gradual. A significant difference was recognized between A and others, B through E (Fig. 2).

Also, participants' sense of fear observed was similar to that observed for the slipperiness. A difference could be observed between A, with the lowest DCOF, and the other footwear but no difference was recognized between B and E (Fig. 3).

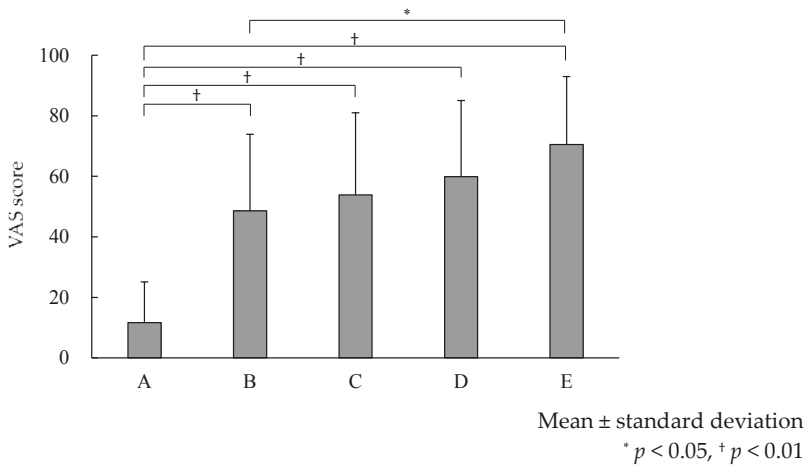


Figure 2. Subjective slipperiness during conducting a stepping task in each footwear

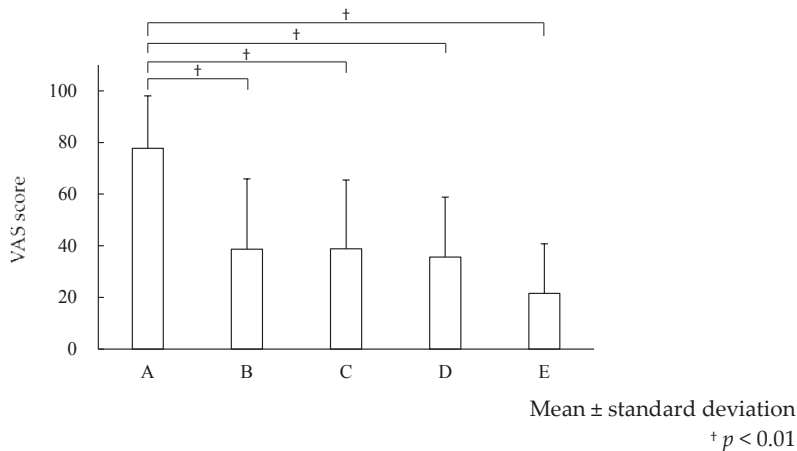


Figure 3. "Sense of fear" during conducting a stepping task in each footwear

## Discussion

### 4.1. Ramp Test

Comparing walking up and walking down, the angles for walking down were smaller for the three types of footwear. Therefore, since this study focused on slipping during different phases of the gait cycle, the acceleration phase used the forefoot for walking up and the heel-contact phase for walking down. However, for both walking up and walking down, the slip-occurrence angle proportionally increased to an increase in the DCOF. These results suggested that it was possible for JIS test values to be interchangeably used with the slip-occurrence angles for a human gait on an inclined flooring. For example, in the case of footwear that did not slip on an incline of  $10^\circ$ , it could be judged that these footwear had a suitable slip resistant.

However, the DIN ramp test only targeted walking down, primarily evaluating the reduction of vertical force (against the floor reaction force) during the heel-contact phase, which tended to cause slipping. In addition, slipping occurred more readily when walking down a slope. Therefore, prioritizing the evaluation for walking down was considered important.

### 4.2. Stepping Task

As for the subjective slipperiness, the VAS score for A (0.12) was around 10, whereas the score for B (0.21) increased drastically to around 50. It was suggested that the level of DCOF in footwear B enable greater control of the slipping. Hanson et al. presented an approximate formula using a logistic function for slip occurrence (Hanson et al., 1999). The VAS score obtained from the subjective evaluations in the present study showed a similar trend with this approximation formula, this result indicated that the slip resistance standard of JIS was an appropriate standard that reflected not only the phenomenon of slipping but also a sense of slipping.

With regard to validity of higher DCOF than the previous slip-resistance standards, there was a significant difference between B (0.21) and E (0.64). Taking into account the fact that this difference was recognized despite a trend where clear differences in evaluating slipping were less apparent compared with the ramp test; also, in the ramp test, E had a slip-occurrence angle significantly greater than D (0.41). These results indicated that a DCOF of approximately 0.64 could become a higher-rank slip resistance standard.

As for “sense of fear,” the trend was similar to the VAS scores for “slipping,” with E receiving an evaluation of “least sense of fear” out of the five footwear types. From the above reasons, the DCOF of 0.64 will be reasonable as the higher-rank slip resistance standard.

## **5. Future Issue**

To evaluate the JIS slip-resistance test, we examined the relationship between the DCOF of footwear sole (the indicator for degree-of-control over slipping action) and the subjective slipperiness. The DCOF plays a role in slip controllings, however, because the occurrence of slipping depends on the static coefficient of friction (SCOF), this factor may influence the subjective evaluations. In the future, measuring SCOF for all five types of footwear will be required to further examine conformity with human senses.

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## SUSANNA JÄRVELIN-PASANEN (ED.)

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*NES2016 conference gathers together researchers and practitioners with an interest in the field of ergonomics and human factors and occupational health. This facilitates sharing the experiences and results that help the development of research, work and ideas, the formation of networks as well as increasing the quality of the joint fields of ergonomics and human factors and occupational health.*

*This book contains the proceedings of the 48th annual conference of Nordic Ergonomics and Human Factors Society (NES) "NES2016 - Ergonomics in Theory and practice" held in Kuopio, Finland, August 14-17, 2016.*



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