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TIINA FREIMANN

Musculoskeletal pain among nurses: prevalence, risk factors, and intervention

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Musculoskeletal pain among nurses: prevalence, risk factors, and intervention

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LIST OF ORIGINAL PUBLICATIONS

The present doctoral thesis is based on the following original articles referred in the text by the Roman numerals:

I Freimann T, Coggon D, Merisalu E, Animägi L, Pääsuke M. Risk factors for musculoskeletal pain amongst nurses in Estonia: cross-sectional study. BMC Musculoskelet Disord. 2013;14:334. Originally published online 1 Dec 2013, doi: 10.1186/1471–2474–14–334.

II Freimann T, Merisalu E. Work-related psychosocial risk factors and mental health problems amongst nurses at a university hospital in Estonia: A cross-sectional study. Scand J Public Health. 2015;43:447–452. Originally published online 7 April 2015, doi: 10.1177/1403494815579477.

III Freimann T, Pääsuke M, Merisalu E. Work-related psychosocial factors and mental health problems associated with musculoskeletal pain in nurses: a cross-sectional study. Pain Res Manag. 2016;3:9361016. Originally published online 12 October 2016, doi: 10.1155/2016/9361016.

IV Freimann T, Merisalu E, Pääsuke M. Effects of a home exercise therapy programme on cervical and lumbar range of motion among nurses with neck and lower back pain: a quasi-experimental study. BMC Sports Sci Med Rehabil. 2015;7:31. Originally published online 4 December 2015, doi: 10.1186/s13102-015-0025-6.

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Paper I: Tiina Freimann participated in the study design of the Estonian version of the international CUPID study, data collection and analysis and interpretation of the collected data; she drafted the manuscript and was responsible for this throughout the review process.

Paper II–IV: Tiina Freimann participated in the study design, data collection, analysis, and interpretation of the collected data. She drafted the manuscripts and was responsible for them throughout the review process.

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ABBREVIATIONS

BMI	Body mass index
CROM	Cervical range of motion
CUPID	Cultural and psychosocial influences on disability
COPSOQ	Copenhagen psychosocial questionnaire
ICU	Intensive care unit
LROM	Lumbar range of motion
MBI	Maslach's Burnout Inventory
MHP	Mental health problems
MSD	Musculoskeletal disorders
MSP	Musculoskeletal pain
NMQ	Nordic musculoskeletal questionnaire
PE	Participatory ergonomics
PS	Psychosocial
ROM	Range of motion
RN	Registered nurses
SROM	Spinal range of motion
TUH	Tartu University Hospital
VAS	Visual analogue scale

1. INTRODUCTION

Musculoskeletal pain (MSP) is a highly prevalent health problem in the working population, which often results in chronic disability. According to Eurostat (2010), musculoskeletal problems constitute the most often reported work-related health problem (60%), followed by stress, depression, and or anxiety (14%). Studies of both MSP and work-related stress have indicated that their source may be interaction between work-related factors and individual characteristics (Leka et al. 2008). Despite a long research history, MSP continues to be an unsolved problem. According to the statistics of the Estonian Health Board for 2015, musculoskeletal disorders accounted for 80% of all occupational diseases in Estonia (Terviseamet 2015).

Around the world nurses constitute an occupational group with a high prevalence of MSP, which results in adverse consequences for individuals, health care institutions, and society. Work-related MSP is the most common cause of work incapacity among nurses, which gives rise to physical, psychological, and social problems. MSP among nurses has a considerable impact on health care institutions because of decreased productivity and work absenteeism. In societies with increasing life expectancy, high rates of chronic MSP have put considerable pressure upon their economies because of the significant amount of health care services and incapacity compensation required. For example, MSD imposed a substantial burden on American society in 2004, with national estimates of $510 billion in direct medical expenditures and $339 billion in lost productivity (Dall et al. 2013).

Rapid changes in the Estonian health care system over the past 20 years have placed extra pressure upon the nursing staff by significantly changing the nature and quality of their work. Nurses have had to adapt to considerably more demanding and technologically complicated working conditions. Previous research findings suggest that changes in the health care system are associated with MSD among nurses (Lipscomb et al. 2004). Following changes at work organizations, the European Agency for Safety and Health at Work and several researchers recommend recourse to surveys to evaluate the psychosocial state of their staff (Rial-González et al. 2005; Bambra et al. 2009; Leka & Jain 2010).

Since the 1970s occupational risk factors have been examined using epidemiological methods (Bernard et al. 1997). A large number of published studies describe the role of work-related risk factors in the development of MSP. However, contradictory information is often justified by the multifactorial nature and independent or interactive effects of MSP risk factors (Leka & Jain 2010). Recent decades have witnessed increasing interest in the interactive effects of physical, psychological and social (including cultural) factors regarding the occurrence of MSP.

While the risk factors of MSP have been in the focus of investigators, little attention has been paid to limitations to the spinal range of motion in

relation to MSP. Although the neck and lower back pain of nurses is often related to the cervical range of motion (CROM) and the lumbar range of motion (LROM) limitations, there is a lack of information on effective intervention methods for improving CROM and LROM among nurses.

The present thesis is based on three empirical studies concerning the prevalence, localization within the body, and risk factors of MSP among registered nurses (RN) at Tartu University Hospital (TUH) (Studies I and II) and the effects of a home exercise therapy programme on the CROM and LROM of intensive care unit (ICU) nurses with neck and or lower back pain (Study III).

2. REVIEW OF THE LITERATURE

2.1. Musculoskeletal pain

Musculoskeletal pain (MSP) is related to the nerves, tendons, muscles, and supporting structures of the body and is perceived within a single or multi-site regions of the body. In the present study MSP refers to any pain at six anatomical sites (lower back, neck, shoulder, elbow, wrist/hand, and knee) lasting for more than a day at least once in the past month and or in the previous 12 months. Multisite pain in this thesis is defined as pain at two or more anatomical body sites and is classified by the number of sites affected (Coggon et al. 2013).

2.2. Prevalence of musculoskeletal pain among nurses

Studies in different countries have shown high prevalence rates of MSP among nurses, ranging from 48–95% (Table 1). The prevalence of MSP varied across studies and countries; MSP at any site was most prevalent in Iran (95%) (Mehrdad et al. 2010), Korea (94%) (Smith et al. 2005), Japan (92%) (Smith et al. 2003a), and New Zealand (91%) (Harcombe et al. 2009). The lowest prevalence of MSP (48%) was recorded in Sweden (Nilsson et al. 2010) although about a decade earlier it had been measured as quite high (84%) (Josephson et al. 1997). Differences in the prevalence of MSP among nurses within the same country have also been found for Japan, with levels fluctuating from 78% to 92% (Smith et al. 2003a, 2003b, 2006).

2.3. Pain localization by anatomical body sites

Among nurses the body sites most often affected by pain, are the lower back (ranging from 23–83%), shoulder (13–75%), knee (16–69%), and neck (15–63%) (Table 1). The comparison between countries demonstrates that lower back pain has been most prevalent in Japan (83%) (Smith et al. 2003a), neck and shoulder pain in Korea (63% and 75% respectively) (Smith et al. 2005), and knee pain in Iran (69%) (Mehrdad et al. 2010). The lowest prevalence of shoulder pain was detected in Niger (13%) (Tinubu et al. 2010) and knee pain in Japan (16%) (Smith et al. 2003b). The lowest prevalence of neck (15%) and lower back pain (23%) was shown for Sweden by Nilsson et al. (2010). Usually the pain is perceived in more than one site of the body and most often as neck-shoulder pain. For example, Alexopoulos et al. (2003) found that 52% of nurses with MSP experienced both neck and shoulder pain.

According to an international CUPID (Cultural and psychosocial influences on disability) survey among 12 195 workers (mostly nurses, office staff, and manual workers) in 18 countries, pain localized to the neck or shoulder

was often related to generalized pain involving neck and shoulder (Sarquis et al 2016). The same study analysed the prevalence of multiple MSP among 47 occupational groups and showed that 47% of the participants experienced MSP in 1–3 body sites, 7% of respondents mentioned pain in 4–5 regions and 5% in 6–10 body parts (Coggon et al. 2013).

Table 1. The prevalence of musculoskeletal pain (%) by different body sites during the preceding 12 months among nurses from studies across countries

Country	N	Mean age	Low back	Neck	Shoulder	Knee	Any site	Authors
China	282	34	56	45	40	n/a	70	Smith et al. 2004a
China	180	30	57	43	39	31	70	Smith et al. 2004b
Greece	351	37	75	47	37	n/a	n/a	Alexopoulus et al. 2003
Iran	641	32	55	36	40	48	84	Choobineh et al. 2006
Iran	317	34	73	46	49	69	95	Mehrdad et al. 2010
India	212	31	48	33	35	29	81	Anap et al. 2013
Japan	247	33	83	37	61	24	92	Smith et al. 2003a
Japan	305	29	59	28	47	16	78	Smith et al. 2003b
Japan	844	33	71	55	72	n/a	86	Smith et al. 2006
Korea	330	n/a	72	63	75	35	94	Smith et al. 2005
New Zealand	181	46	57	52	39	34	91	Harcombe et al. 2009
Niger	118	36	44	28	13	22	78	Tinubu et al. 2010
Poland	237	36	57	34	24	35	n/a	Jarowek et al. 2010
Sweden	278	43	23	15	22	n/a	48	Nilsson et al. 2010
Sweden	565	37	64	53	60	n/a	84	Josephson et al. 1997
Uganda	741	35	62	37	33	37	81	Munabi et al. 2014
United States	1163	45	47	46	35	n/a	73	Trinkoff et al. 2002

n/a – not available.

2.4. Risk factors for musculoskeletal pain

A number of systematic reviews have found evidence of work-related physical (biomechanical) and psychosocial factors, and individual characteristics, which play an important role in the development of MSP among nurses (Sherehiy et al. 2004a, 2004b; Gershon et al. 2007; Lorusso et al. 2007; Long et al. 2012; Bernal et al. 2015). These risk factors (independently or in interaction with each other) may affect the development of musculoskeletal symptoms directly or indirectly as a result of work-related stress (Cox et al. 2000; Bongers et al. 2002). However, their synergic effects may be mediated by cultural factors and health beliefs (Madan et al. 2008; Coggon et al. 2013; Vargas-Prada 2013). Simultaneous exposure to more than one risk factor appears to increase the risk of developing MSP.

2.4.1. Physical risk factors

There is strong evidence that work-related physical factors are important for the development of MSP among nurses, especially in combination with exposure to more than one physical factor (Sherehiy et al. 2004a, 2004b; Lorusso et al. 2007; Long et al. 2012). Physical risk factors depend on the exposure in terms of frequency, duration and intensity (Bernard et al. 1997). Specific patient handling tasks in awkward postures are especially high-risk tasks for MSP among nurses (Smedley et al. 2003; Trinkoff et al. 2003). Table 2 shows the most often reported physical risk factors for MSP among nurses.

Table 2. Physical risk factors for musculoskeletal pain among nurses from epidemiological studies

Category	Physical risk factors	References
Physical load/ demands	High perceived exertion, intensive physical efforts.	Camerino et al. 2001; Alexopoulos et al. 2003; Choobineh et al. 2006; Bos et al. 2007.
	Perceived work overload.	Trinkoff et al. 2003; Tezel 2005.
Work posture	Workplace ergonomics, strenuous or static postures, awkward postures, bending, twisting, stooping.	Alexopoulos et al. 2003; Trinkoff et al. 2003; Luime et al. 2004; Choobineh et al. 2006, 2010; Bos et al. 2007; Anap et al. 2013; Golabadi et al.2013; Munabi et al. 2014.
Work tasks	Patient moving, lifting, transferring and other handling tasks.	Smedley et al. 1995, 1997; Alexopoulos et al. 2003; Smith et al. 2003a, 2005, 2006; Trinkoff et al. 2003; Choobineh et al. 2006; Cameron et al. 2008; Warming et al. 2009; Anap et al. 2013.
	Manual material handling.	Alexopoulos et al. 2003; Choobineh et al. 2010.

2.4.2. Psychosocial risk factors

Recent decades have witnessed an increased interest in the study of work-related psychosocial (PS) risk factors. Psychosocial risks in the workplace have been identified as significant emerging risks for the health and safety of employees (Brun & Milczarek 2007), but there is disagreement as to the magnitude of their impact. The nurses' work is not static and there is a lack of understanding of how personal and workplace factors interact (McVicar 2003). Better psychological assessment tools also are needed to predict the mediating role of stress between PS factors and MSP (Bongers et al. 2002).

Although the results concerning work-related PS risk factors are sometimes contradictory, several literature reviews have shown a relationship between PS factors and musculoskeletal problems (Bongers et al. 1993, 2002; Hoogendoorn et al. 2000; Windt et al. 2000; Ariëns et al. 2001). A high perceived work load, time pressure, low job control, and low social support are important risk factors of musculoskeletal symptoms (Camerino et al. 2001; Smedley et al. 2003). The most frequently reported PS risk factors for MSP among the nursing profession are shown in Table 3.

Table 3. Psychosocial risk factors for musculoskeletal pain among nurses from epidemiological studies

Category	Risk factors	References
Job demands	Quantitative demands, work pace, several different work tasks, conflicting demands.	Camerino et al. 2001; Alexopoulos et al. 2003; Smedley et al. 2003; Bos et al. 2007; Choobineh et al. 2010; De Souza Magnago et al. 2010;
	Psychological demands, high mental pressure, job strain, demands for hiding emotions, responsibility.	Camerino et al. 2001; Trinkoff et al. 2003; Smith et al. 2004a, 2004b, 2006; Golabadi et al. 2013.
Job control	Job decision latitude, authority over decisions, insufficient possibility to influence the work situation, discretion, insufficient control over their work.	Smedley et al. 2003; Cameron et al. 2008; Golabadi et al. 2013.
Social relations at work	Lack of social support, role conflicts.	Camerino et al. 2001; Alexopoulos et al. 2003; Smith et al. 2004b.
Work organization	Full-time work, shift work, schedule characteristics, working during leisure time, mandatory overtime.	Choobineh et al. 2010; Lipscomb et al. 2002; Trinkoff et al. 2006; Cameron et al. 2008; Mehrdad et al. 2010.

2.4.3. Individual risk factors

Many studies describe the role of demographic and lifestyle factors regarding the development of MSP among nurses. Traditionally, it has been argued that age, female gender, personality traits, and lifestyle risk factors, such as lack of physical activity, smoking, alcohol and drug abuse are related to MSP among nurses (Camerino et al. 2001; Aleksopoulos et al. 2003; Trinkoff et al. 2003). In addition, perceived poor or moderate general health is an important risk factor for MSP (Aleksopoulos et al. 2003; Luime et al. 2004; Nilsson et al. 2010). A longitudinal study by Smedley et al. (2003) showed a significant relationship between MSP and a previous history of neck and shoulder pain.

Systematic reviews have indicated that MHP, such as low mood, stress, burnout, somatic stress symptoms, and depression are associated with MSP in the nursing profession (Sherehiy et al. 2004b; Long et al. 2012). Some authors have concluded that perceived stress may be an intermediary link between work-related PS factors and MSP (Bongers 1993, 2002; Cox et al. 2000). The individual risk factors for MSP are presented in Table 4.

Table 4. Individual risk factors for musculoskeletal pain among nurses based on epidemiological studies

Category	Individual risk factors	References
Demographic and social factors	Age, gender, personality traits, marital status, number of children, work-home interface.	Aleksopoulos et al. 2003; Warming et al. 2009; Choobineh et al. 2010; Mehrdad et al. 2010; Nilsson et al. 2010.
Lifestyle factors	Physical activity, smoking and alcohol and drug abuse.	Camerino et al. 2001; Aleksopoulos et al. 2003; Trinkoff et al. 2003.
History of employment	Job tenure, work specificity, occupational status.	Choobineh et al. 2006; Mehrdad et al. 2010.
History of MSP	Past exposure to MSP risk factors.	Smedley et al. 2003.
General health	Poor or moderate general health state.	Aleksopoulos et al. 2003; Luime et al. 2004; Nilsson et al. 2010.
Mental health	Stress, burnout, somatic stress symptoms, depression symptoms, sleep quality.	Warming et al. 2009; Jaworek et al. 2010; Mehrdad et al. 2010; Smith et al. 2005, 2006; Nilsson et al. 2010; Solidaki et al. 2010; Matsudaira et al. 2011; Munabi et al. 2014.
Fitness	High body mass index (BMI).	Luime et al. 2004; Choobineh et al. 2010.

The risk factors have been studied from different perspectives. For example, in studies in physiotherapy and rehabilitation medicine MSP has been found to be associated with genetic factors, physical characteristics, the spinal range of motion limitations, and a high body mass index (Kriviskas 1999).

2.4.4. Risk factors for musculoskeletal pain in the different body sites

Risk factors for MSP may differ by body sites (Hoe et al. (2012). Physical factors have been shown to have a high risk for developing lower back, neck and or shoulder pain (Smedley et al. 1995, 1997, 2003; Trinkoff et al. 2003; Smith et al. 2003a; Tezel 2005; Bos et al. 2007). A clear link has been found also between PS factors and regional pain (Linton et al. 2000). The job demands are most frequently associated with back, neck, and shoulder pain (Sherehiy et al. 2004b; Lorusso et al. 2007; Long et al. 2012; Bernal et al. 2015). Low job control, effort-reward imbalance, and low social support were found to be associated with most anatomical sites of body among the nursing profession (Bernal et al. 2015). Other risk factors such as full-time working, work pace, shift work, number of staff and relations with supervisors are also related to back, neck, and shoulder pain (Sherehiy et al. 2004b). Psychosomatic symptoms constitute the most important risk factors for back, neck, and shoulder pain (Sherehiy et al. 2004b; Sarquis et al. 2016; Vargas-Prada et al. 2016).

2.5. Intervention strategies for the prevention and reduction of musculoskeletal pain

Ergonomic and organizational interventions and physical exercise are common approaches for MSP prevention and reduction (Bongers et al. 2006; Hartvigsen et al. 2005; Henchoz & So 2008; Coury et al. 2009). As the development of MSP is often multifactorial, multifactorial interventions are also most likely to be successful in reducing the MSP-related risk factors (Hignett 2003).

2.5.1. Ergonomic interventions

In order to decrease the prevalence of MSP, individual interventions, physical and organizational ergonomic interventions have been suggested (Driessen et al. 2010). Individual interventions involve redesigning of the work place; physical ergonomic interventions are aimed at creating a safer work environment, and organizational ergonomic intervention involves redesigning the work process, counselling and training for employees. Ergonomic interventions in the workplace may have some effect on reducing

musculoskeletal symptoms (Rivilis et al. 2008; Eerd et al 2010), but without physical exercise programmes they may be ineffective in preventing MSP, especially lower back pain (Hartvigsen et al. 2005). Driessen et al. (2011) found that ergonomic intervention did not reduce pain prevalence, intensity, and or duration. The researchers explained this by insufficient or inconsistent implementation of ergonomic practices and incompatibility of the ergonomic interventions with the most important risk factors, such as lifting, physically heavy work, static postures, frequent bending and twisting, repetitive work, and exposure to vibration (Driessen et al. 2011).

2.5.2. Organizational interventions

Nurses are highly exposed to work-related stress caused by physical, psychological, and social factors at work (Moustaka & Constantinidis 2010). Organizational interventions with a focus on work organization issues have the potential to reduce work-related stress and to prevent or reduce MSP symptoms (McVicar 2003; Bongers et al. 2006). Clegg's (2001) literature review refers to stress management interventions in nursing at three levels: primary intervention, to identify and reduce stressors; secondary interventions, include training and health promotion to improve workers' coping strategies and a focus on changing health-related risk behaviour, such as smoking and drinking; tertiary interventions, including support groups and counselling. The most popular coping strategy among nurses according to Lim et al. (2010a, 2010b) is social support from colleagues, family and friends, but nurses also seek support from supervisors, problem solving, and self-control.

2.5.3. Physical exercise

2.5.3.1. Effects of the physical exercise

Physical exercise has beneficial effects across several physical and mental health outcomes, including better functional capacity and emotional moods (Penedo & Dahn 2005). Pedersen & Saltin's (2015) literature review provided evidence of prescribing exercise therapy for 26 different chronic diseases. These are psychiatric diseases (depression, anxiety, stress, schizophrenia), neurological diseases (dementia, Parkinson's disease, multiple sclerosis), metabolic diseases (adiposity, hyperlipidaemia, metabolic syndrome, polycystic ovarian syndrome, types 1 and 2 diabetes), cardiovascular diseases (hypertension, coronary heart disease, heart failure, cerebral apoplexy, and intermittent claudication), pulmonary diseases (chronic obstructive pulmonary disease, asthma, cystic fibrosis), musculoskeletal disorders (osteoarthritis, osteoporosis, back pain, rheumatoid arthritis), and cancer.

Exercise improves cardiopulmonary functions, strengthens the immune system, and reduces psychological stress and depression. Nurses who

exercised regularly experienced less mental, emotional, and physical distress (Feng & Hwang 1999); they had better physical fitness (Yuan et al. 2008). Alexandre et al. (2001) suggested that regular exercise with an emphasis on ergonomics could reduce musculoskeletal symptoms among nursing staff. Physical exercise is an effective preventative intervention method for reducing MSP, especially in the neck and lower back (Linton & Tulder 2001).

Although neck and lower back pain among nurses are often associated with CROM and LROM limitations, there is limited evidence regarding how physical exercise therapy programmes affect CROM and LROM. Generally, the effects of physical exercise programmes on the spinal range of motion (SROM) limitations have been mainly studied among elderly people. Tseng et al. (2006) examined the effects of a simple nurse-led range-of-motion exercise programme on the upper and lower extremities of older people after a stroke and found positive effects regarding the enhancement of physical and psychological functions.

One literature review provides evidence that worksite physical activity programmes are a more effective intervention method than home exercise programmes regarding musculoskeletal disorders (Proper et al. 2003). However, Jakobsen et al. (2012) found that the effects of physical exercise on musculoskeletal pain did not depend on whether the exercises were conducted at the workplace or during leisure time at home. Moreover, Kuukkanen et al. (2007) found that well-supervised home exercises led to reduced lower back pain, and these positive effects persisted for more than five years after the completion of the exercise programme.

2.5.3.2. Use of different methods in exercise therapy programmes for musculoskeletal pain

Some authors have emphasized that in order to be effective, exercise therapy programmes should be conducted with sufficient frequency, intensity, and duration, plus appropriate ergonomic counselling and supervision (Henchoz & So 2008, Coury et al. 2009). For example, the literature review by Coury et al. (2009) provides evidence to support the effectiveness of physical exercise on reducing lower back pain among health care workers when the training periods were longer than 10 weeks and the sessions were supervised.

However, there is no clear evidence whether general or specific exercises are more effective or whether they should be performed at the workplace or at home, or in one-on-one or group sessions (Henchoz & So 2008; Jakobsen et al. 2014). In addition, there continues to be uncertainty about the most effective exercise approach for MSP in specific body sites. A systematic review by Hayden et al. (2005) provides evidence that exercise therapy programmes that include stretching and or strengthening and are delivered with supervision may reduce pain and function with regard to chronic lower back pain. The study by Andersen et al (2008) showed that specific strength

training led to prolonged relief of neck pain, but general fitness training reduced only acute pain to some extent. In this study the participants were allocated to 3 different intervention groups: specific strength training, general fitness training in the form of leg bicycling, and health counselling as a reference group. In the specific strength training group 18 employed women with chronic neck muscle pain were randomly assigned to 10 weeks of specific strength training locally for the affected muscle. Supervised training was performed at a high intensity for 20 minutes 3 times per week.

Cunha et al. found (2008) that conventional stretching and muscle stretching in association with manual therapy were equally effective for reducing pain and improving the range of motion of female patients with chronic neck pain. Thirty-one female patients aged from 35 to 60 years were randomly divided into two groups. The global posture re-education group (n=15) performed muscle chain stretching while the conventional stretching group (n=16) performed conventional static muscle stretching. The treatment programme consisted of two 1-hour individual sessions per week for six weeks.

Some studies have shown that 12 months of stretching is as effective as strengthening exercises or manual therapy for patients with chronic neck pain (Ylinen et al. 2007; Häkkinen et al. 2008). Cleland et al. (2010) found that thoracic spine manipulation together with the cervical range of motion exercises was more beneficial for patients with neck pain than the exercise alone. One hundred and forty patients with a primary report of neck pain were randomly assigned to either 5 sessions of stretching and strengthening exercise (exercise-only group) or 2 sessions of thoracic spine manipulation and cervical range of motion exercise followed by 3 sessions of stretching and strengthening exercise (manipulation + exercise group). Patients in both groups attended physical therapy sessions twice weekly during the first week and then once weekly for the next 3 weeks, for a total of 5 sessions over a 4-week period.

2.5.4. Study rationale

The International Labour Organization (ILO) emphasizes that the workplace and the work environment play a key role in workers' health and well-being (Gabriel & Liimatainen 2000). The European Agency for Safety and Health at Work (Rial-González et al. 2005) recommends the use of surveys to evaluate the possible health consequences following changes at work organizations.

Unfortunately, despite the rapid changes in the Estonian health care system affecting nurses' work, there are no studies of MSP- and MSP-related risk factors in the nursing profession. In addition, there is lack of evidence-based knowledge of effective intervention programmes for nurses with MSP. The present study identifies the prevalence of MSP by body localization among nurses; studies a wide range of possible risk factors for MSP, as well as evaluates the effects of an intervention method on the cervical and lumbar range of motion in order to reduce MSP among nurses.

3. THEORETICAL FRAMEWORK

There are several theoretical models describing the multifactorial aetiology of MSP. The framework of this thesis is based on the conceptual models devised by Bongers et al. (2002) and Cox et al. (2000). The model worked out by Bongers et al. (2002) incorporates and integrates physical and PS risk factors and individual characteristics with regard to the development of MSP (Figure 1). For this reason, it was considered useful for the study of nurses.

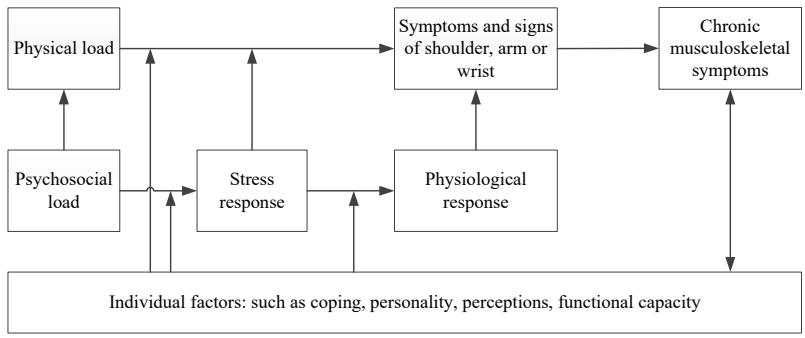

Figure 1. Relationships between risk factors and musculoskeletal symptoms (Bongers et al. 2002)

Based on the model of Cox et al. (2000) the present study also took into account the direct and indirect impact of work-related risk factors on workers' health (Figure 2).

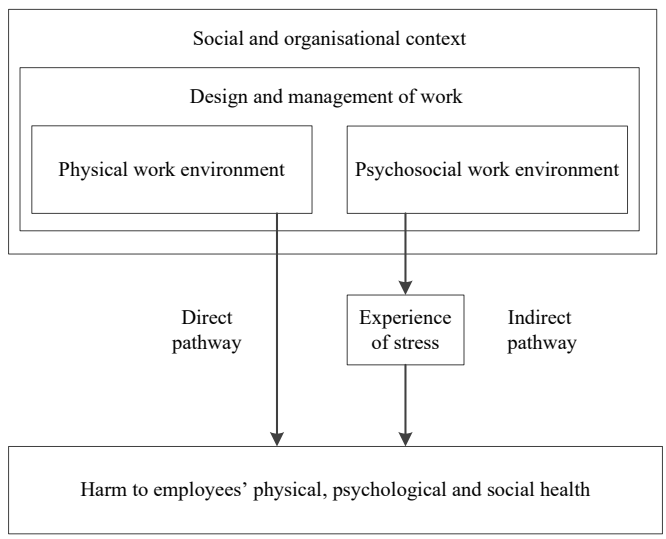

Figure 2. The dual pathway of work-related risk factors adapted from Cox et al. (2000) (Leka & Jain 2010)

4. AIMS OF STUDY

The main aim of the three empirical studies was to identify the prevalence, body localization, and determinants of musculoskeletal pain among nurses and to evaluate the effects of a home exercise therapy programme on the cervical and lumbar range of motion of nurses with neck and lower back pain.

The specific aims of the research were as follows:

1. to investigate the prevalence, body localization, and determinants of musculoskeletal pain among nurses (Paper I);
2. to examine psychosocial work factors and their relationships with the mental health of nurses (Paper II);
3. to analyse the associations between work-related psychosocial factors and mental health problems on the occurrence of musculoskeletal pain (Paper III);
4. to evaluate the effects of a home exercise therapy programme on the cervical and lumbar range of motion of nurses with neck and lower back pain. (Paper IV).

5. SUBJECTS AND METHODS

5.1. Overview of the study

Three empirical studies among registered nurses (RN) working at Tartu University Hospital (TUH) were conducted in 2008–2011 (Table 5). The target population was related to TUH because the DoRa Action 3 Program was aimed at supporting such doctoral studies where research is carried out by the university in close cooperation with partner institutions to create a more favourable environment for innovative solutions in the partner institutions of the university.

Table 5. The empirical studies, their time periods, samples, and the related research papers

Studies	Time period	Sample	Objectives	Papers
I	2008–2009 5 months	221 female nurses	To investigate the prevalence, body localization, and determinants of MSP among nurses.	I
II	2011 2 months	404 nurses; 397 female and 7 male	To examine PS work factors and their relationships with the mental health of nurses.	II
			To analyse the associations of work-related PS factors and MHP on the occurrence of musculoskeletal pain.	III
III	2011 3 months	24 female nurses	To evaluate the effects of a home exercise therapy programme on the cervical and lumbar range of motion of nurses with neck and lower back pain.	IV

Study I was part of the international survey "Cultural and Psychosocial Influences on Disability" (CUPID) conducted by the University of Southampton (United Kingdom) in collaboration with 18 countries (Coggon et al. 2012). In Estonia, the baseline data was collected from October 2008 to February 2009. Study II is a cross-sectional electronic survey, which was performed during April and May 2011. Study III was based on a quasi-experimental (case control series) model conducted between May and July 2011.

5.2. Subjects

5.2.1. Study I

Study I comprised 416 individuals randomly selected from 869 full-time RN employed at the hospital. The inclusion criteria were as follows: age range 20–59 years and working in current job for at least one year. The questionnaire was completed by 237 nurses (response rate of 57%) who were invited to take part in the study. However, 16 respondents were excluded because they had worked in their current job for less than a year or were over 59 years of age. In total, 221 female nurses were included in the analysis.

5.2.2. Study II

All the full-time working RN who had been employed at the hospital for at least one year, were invited to participate in Study II. In Study II, 409 of 906 nurses completed the questionnaire (the response rate being 45%), but after checking for compliance with the criteria, five respondents were excluded because they had worked in their current job for less than a year. In total, the analysis is based on 404 participants, including 397 female and 7 male nurses.

5.2.3. Study III

In Study III, all 96 full-time working nurses from three different intensive care units (ICUs) were invited to take part in the study. A positive response was received from 40 female nurses from three ICUs.

The inclusion criteria for the experimental group were as follows: full-time employment for at least a year in the ICU, under 40 years of age, body mass index less than 32, and experience of mild to moderate pain in the cervical and or lumbar regions during the previous six months. The criterion for body mass index (<32) depended on the intensity and severity of the exercise programme. The inclusion criteria for the control group were as follows: under 40 years of age, body mass index less than 32, and lack of MSP during the previous six months. The exclusion criteria for both groups were acute orthopaedic and or neurological diseases and pregnancy.

Twenty-two nurses fulfilled the eligibility criteria for the experimental group, but only thirteen completed the 8-week home exercise therapy programme. The other nine participants failed to complete the programme due to health reasons, change of residence, or a lack of time. Eleven nurses met the eligibility criteria for the control group. Figure 3 shows the participant flow chart.

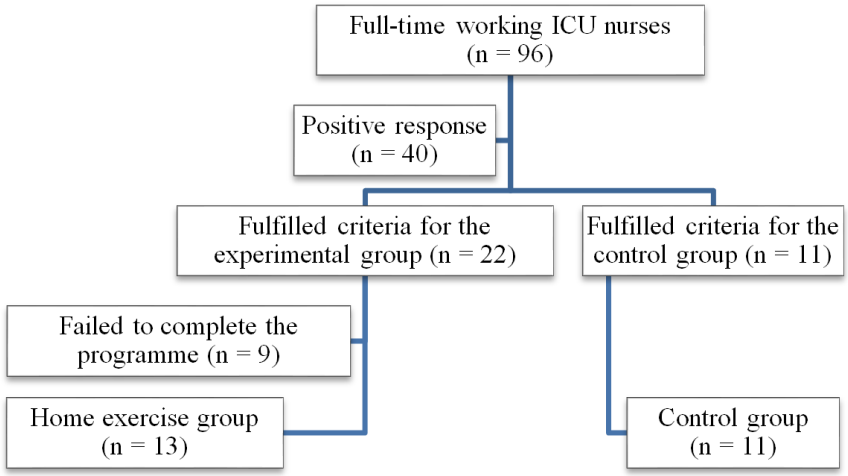

Figure 3. Participant flow chart

The age range of the experimental and control groups were 23–37 (n = 13) and 22–39 (n = 11) years, respectively. Both groups were homogeneous ($p>0.05$) for age and the anthropometric variables measured (Table 6).

Table 6. Age and anthropometric parameters of the experimental and control groups

Parameters	Experimental group (n = 13)		Control group (n = 11)		
	Mean	SD	Mean	SD	p
Age (years)	29.2	5.1	31.1	5.1	0.414
Height (cm)	165.6	4.8	167.5	3.6	0.191
Weight (kg)	66.5	2.4	67.8	3.0	0.885
BMI (kg/m^2)	24.2	0.9	24.2	1.1	0.977

5.2.4. Ethics

All three studies were approved by the Research Ethics Committee of the University of Tartu (Study I – N° 173/T-14 18.08.2008; Studies II and III – N° 202/T-19 14.03.2011) and conducted in accordance with the Helsinki Declaration. Written informed consent for participation in Studies I and III was obtained from all the participants. For Study II, the voluntary nature of participation was emphasized in the letter of invitation, as well as in verbal communication. All the members of the research group and subjects were informed about the purpose and content of the studies.

5.3. Methods

5.3.1. Standardized questionnaires

5.3.1.1. Cultural and psychosocial influences on disability

To explore the prevalence, body localization, and the determinants of MSP for Study I, the baseline self-assessment questionnaire of the CUPID (Coggon et al. 2012) study was used, with supplementary questions added about self-rated health and burnout. Maslach's Burnout Inventory (MBI) (Maslach et al. 1996) was used to assess burnout indicators. The CUPID questionnaire contained several relevant indices from widely used standardized questionnaires, such as the Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka et al. 1987), the Brief Symptom Inventory (BSI) (Derogatis & Melisaratos 1983), and the Short Form-36 questionnaire (SF-36) (Ware 1989). Questions about time pressure at work were based on Karasek's (1979) model. The CUPID questionnaire was used as a tool in the 18 countries that participated in the joint international study to compare the prevalence and determinants of MSP between office workers, nurses, and industrial workers (Harcombe et al. 2009; Solidaki et al. 2010; Matsudaira et al. 2011; Coggon et al. 2012).

5.3.1.2. Copenhagen Psychosocial Questionnaire version II

To evaluate work-related PS risk factors and mental health problems as possible risk factors for MSP, the Copenhagen Psychosocial Questionnaire version II (COPSOQ II) was used in Study II (Kristensen et al. 2005). COPSOQ II is a multidimensional instrument that measures a broad variety of PS workplace factors that may impact upon the health and well-being of employees (Tabanelli et al. 2008; Kristensen 2010; Pejtersen et al. 2010; Arsalani et al. 2011). The COPSOQ II has been validated in Estonia (Seppo et al. 2010) and several other countries and evaluated as a suitable instrument for measuring work-related PS factors and the health and well-being of nurses (Aust et al. 2007; Arsalani et al. 2011). The earlier version, COPSOQ I, had been previously used in some countries to examine the PS work environment of nurses (Li et al. 2010; Malloy & Penprase 2010; Nübling et al. 2010). In the present study, COPSOQ II was translated by a licensed translator, and Cronbach's alphas were calculated to assess the internal consistency of the scales.

5.3.1.3. Other questionnaires

A structured questionnaire was designed for the selection of potential participants for Study III and to record their basic information, including age, height, weight, working hours, general health and physical activity. Questions from the standardized tools NMQ and the 11-point VAS (Visual Analogue Scale) (Scott & Huskisson 1979) were used to measure pain localization and

intensity. VAS has been regarded as a reliable self-reporting instrument in other self-assessment studies (Huskisson 1974; Downie et al. 1978).

5.3.2. Measurement of the cervical and lumbar range of motion

A digital goniometer (Acumar TM Digital Inclinometer, Version 5.0) was used to study the effects of a home exercise therapy programme on the cervical and lumbar range of motion in Study III. This method has been found to be objective and reliable (Fitzgerald et al. 1983; Youdas et al. 1991; Saur et al. 1996, De Koning et al. 2008) and is recommended by international clinical guidelines (Childs et al. 2008; Delitto et al. 2012). CROM in flexion, extension, lateral flexion and rotation, and LROM in flexion, extension and lateral flexion, were measured in ICU nurses.

All the CROM and LROM measurements in the experimental group were taken before and after the 8-week exercise therapy programme. Because of the asymptomatic population in the control group, the measurements of the control group were taken only once – concurrently with the second measurements of the experimental group. All the measurements were made by the same physical therapist and researcher to achieve a high reliability of measurements (Youdas 1991). The maximum score of three performances was used for each flexion, extension, and rotation measurement. The CROM and LROM measurements are presented in Figures 4 and 5.

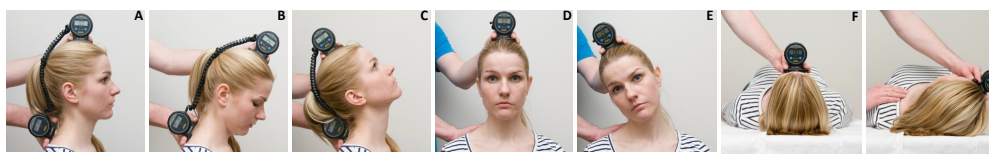

Figure 4. Measurements of the cervical range of motion. Photos by Andreas Annama. A – 0-position for B & C; B – CROM in flexion; C – CROM in extension; D – 0-position for E; E – CROM in lateral flexion to the right; F – 0-position for G; G – CROM in rotation to the right (top down).

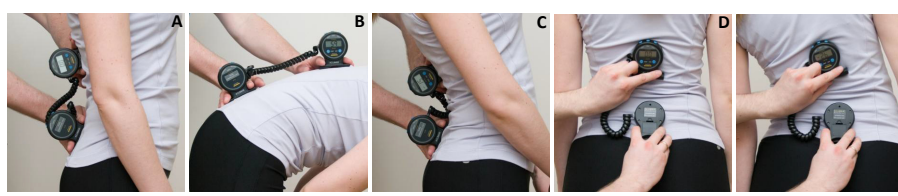

Figure 5. Measurements of the lumbar range of motion. Photos by Andreas Annama. A – 0-position for B & C; B – LROM in flexion; C – LROM in extension; D – 0-position for E; E – LROM in lateral flexion to the right.

5.3.3. Home exercise therapy programme to improve the cervical and lumbar range of motion

To investigate the effects of a home exercise therapy programme on the cervical and lumbar range of motion among ICU nurses with neck and lower back pain, in Study III the experimental group underwent 8 weeks of exercise therapy, with the frequency and intensity of the exercises increasing every two weeks. The training load progressively increased according to the principle of the gradual rising of loads (Kraemer et al. 2002). Based on previous studies, effective stretching and strengthening exercises for the cervical and lumbar region were included in the exercise therapy programme (Hayden et al. 2005, Häkkinen et al. 2008; Page 2012) (Fig. 6).

Figure 6. Examples of the stretching and strengthening exercises that formed the home exercise therapy programme. Photos by Andreas Annama.

The exercises that were added to the programme were designed to increase CROM and LROM and to stretch and strengthen the relevant muscles. The participants were asked to perform the exercises in one to three sets (with the number of sets increasing over the weeks) with 8–10 repetitions. Exercises 4a, 4b, and 12 (both feet) were performed with 2–3 repetitions per set. The goal was to perform the exercises once a day, six days a week, for 8 weeks. Each session lasted from 20 minutes during the first two weeks to 60 minutes during the last two weeks. The control group was asked to continue their normal lifestyle.

5.4. Data analysis

Statistical analysis was performed using PASW Statistics for Windows Version 18.0 (SPSS Inc., Chicago, USA) and IBM SPSS Statistics for Windows Version 24.0 (IBM Corp., Armonk, NY). Descriptive statistics were used to describe the frequency of MSP among the nurses in Studies I and II. The main measurements were pain at any of the six anatomical sites (low back, neck, shoulder, elbow, wrist/hand, and knee), and in Study I, multi-site pain (defined as pain at more than one site) in the past year and past month. In Study I binary logistic regression was used to analyse associations between individual and work-related risk factors and regional and multi-site pain; the results were summarized as odds ratios (ORs) with 95% confidence intervals (CIs). For each analysis, the reference category consisted of nurses who did not have the outcome under consideration.

In Study II mean scores and 95% confidence intervals were calculated for PS factors and MHP. For the analysis all the items of PS factors and MHP were scored from 0 to 100 points (the five response options were 0, 25, 50, 75, and 100, and the four response options were 0, 33.3, 66.7, and 100) to make the scoring on the different scales comparable (Pejtersen et al. 2010). The total score on a scale was the mean of the scores of the individual items.

In Study II associations between PS factors and MHP and MSP were analysed by binary logistic regression, and the results were summarized as ORs with 95% CIs. Pearson's correlation with sequential Bonferroni correction was used to analyse the correlations between PS factors and MHP. Holm's sequential Bonferroni correction was used to account for multiple testing problems in the analyses (Holm 1979). The significance level was set at $p<0.05$. Cronbach's alpha was calculated to assess the internal consistency of the scales of the PS factors and MHP. The majority of the scales showed a satisfactory Cronbach's alpha, ranging from 0.71 to 0.89. The following four scales had coefficients of less than 0.70: social support from colleagues (0.67); social inclusiveness (0.65); somatic stress symptoms (0.61); demands for hiding emotions (0.50).

In Study III descriptive statistics were calculated to show the means and standard deviations for the ages, anthropometric parameters, and CROM and

LROM measurements of the participants. A paired t-test was used to compare the CROM and LROM measurements before and after the completion of the home exercise therapy programme. A Student's t-test was used to examine any differences between the experimental and control groups. The significance level for all tests was set at $p<0.05$.

6. RESULTS

6.1. Prevalence and body localization of musculoskeletal pain among nurses

Descriptive statistics were performed to measure MSP at each of the six anatomical sites (lower back, neck, shoulder, elbow, wrist/hand, and knee) and multi-site pain (at ≥2 anatomical sites) during the past month and or previous 12 months in Studies I and II. Table 7 shows the prevalence of MSP at the six anatomical sites and the number of sites where nurses experienced pain. In Study I 84% of the participants reported having MSP in at least one body site lasting longer than a day in the past year and 69% reported having MSP in the past month. In Study II 70% of the participants experienced MSP in at least one body site during the past year and 64% had experienced pain in the past month.

In both studies the lower back and the neck were most often affected by pain. Neck pain (52% and 56% in Studies I and II, respectively) was almost as prevalent as lower back pain (56% and 57%) while one-third of nurses reported knee pain (33% and 31%) during the past year. MSP at ≥2 anatomical sites had been experienced by 60% and 39% of the participants during the past year and the past month in Study I and 61% and 46% of the nurses in Study II.

Table 7. Prevalence (%) of musculoskeletal pain in Studies I and II

Pain localization area	Study I (n = 221)		Study II (n = 404)	
	Past year	Past month	Past year	Past month
Lower back	56.1	39.8	56.9	39.4
Neck	52.0	38.9	55.7	43.1
Shoulder	21.3	17.2	30.9	26.2
Elbow	11.3	6.8	12.4	9.9
Wrist/hand	27.1	17.2	20.0	16.1
Knee	32.6	19.5	31.2	23.0
MSP at any site	83.7	68.8	70.0	63.6
Number of body sites with pain				
0	16.3	30.8	20.3	30.4
1	23.5	25.8	18.9	24.1
2	24.4	19.0	23.1	20.9
3	19.9	12.2	17.5	13.0
4	12.2	5.9	11.3	6.8
5	2.3	0.5	6.8	3.8
6	1.4	1.4	2.3	1.1

In Study III pain localization and intensity were measured for the selection of potential participants in the experimental group. Eight nurses in the experimental group had experienced both neck and lower back pain, two of them only neck pain, and three only lower back pain. The mean pain intensity score (using the 11-point VAS) over the previous six months was 4.1 (SD 2.5).

6.2. Possible risk factors for musculoskeletal pain

Descriptive statistics were calculated as numbers (N), percentages (%), mean scores (Mean), standard deviations (SD), and 95% confidence intervals (CI) for the possible risk factors for MSP in Studies I and II. In Study I, all the participants were female with the mean age 39.9 years (SD 11.5) (Table 8).

Table 8. Prevalence of possible risk factors for musculoskeletal pain among nurses in Study I

Variable	N	%
Age (23–59 years)	221	100.0
Self-rated health		
Quite good and very good	130	59.1
Very poor to moderate	90	40.9
Mood		
Good	38	17.2
Medium	155	70.5
Poor	27	12.3
Emotional exhaustion		
Low	34	15.4
Medium	154	69.7
High	33	14.9
Depersonalisation		
Low	30	13.6
Medium	150	67.9
High	41	18.5
Distressing somatic symptoms (moderate to extremely)		
Faintness or dizziness	44	20.2
Pain in the heart or chest	35	16.2
Nausea or upset stomach	34	15.5
Trouble with breathing	20	9.3
Numbness or tingling in parts of the body	37	17.0
Prevalence of activities in an average working day		
Using a computer keyboard >4 hr	63	28.8
Other repeated wrist/hand movements >4 hr	149	67.7
Repeated elbow bending >1 hr	155	70.8
Hands above shoulders >1 hr	47	21.4
Lifting ≥25 kg by hand	84	38.2
Climbing up/down >1 hr	133	61.3
Kneeling/squatting >1 hr	41	18.7

Variable	N	%
Time pressure at work		
Work pace with a number of tasks to be completed in a day	4	1.8
Number of tasks to be completed in a day	39	17.8
Payment of a bonus if an agreed number of tasks is completed in a day	14	6.4
Working under pressure to complete tasks by a fixed time	146	67.0

Most had held their job for longer than five years. The mean number of working hours per week was 40.5 (SD 6.7). Forty-one percent of the participants rated their general health as very poor, poor, or moderate. Medium or high level of emotional exhaustion occurred in 85% and depersonalization in 86% of nurses. Sixty-three percent of nurses reported two or more distressing somatic symptoms during the previous week. The most frequent distressing somatic symptoms among the participants were fainting or dizziness, pain in the heart or chest, nausea or upset stomach, and numbness or tingling in parts of the body.

The most prevalent work-related physical risk factors was repeated bending and straightening of the elbow (71%), followed by repeated movement of the wrist and fingers (68%). Lifting weights of 25 kg or more by hand was a daily occurrence in 38% of nurses, and working with one's hands above shoulder height for ≥ 1 hour total of a working day in 21% nurses. Sixty-seven percent of nurses reported time pressure in the form of a target number of tasks to be completed in a day or working to complete tasks by a fixed time as a source of stress.

In Study II most of the participants were female (98.3%) with the mean age 40.2 years (SD 10.8). More than half of them had held their job for more than ten years and one-fifth were employed as nursing managers (Table 9). The mean number of working hours per week was 40.5 (SD 6.7); 17% of nurses worked more than 40 hours per week. Among the participants, 51% of the nurses used pain medicine for MSP more than once a month. Twenty percent of participants were current smokers, and 25% of nurses used alcohol once or more times per month (8% used alcohol once or more per week). About half of the nurses characterized their normal life style as including light physical activity outside of work for 2–4 hours per week. Moderate physical activity (fast walking, cycling, gardening for more than 4 hours) or physical exercise for 2–4 hours per week was practised by 38% of the nurses. High physical load in terms of regular strenuous physical exercise or training several times per week was reported by 11% of the nurses.

Table 10 presents the mean scores and 95% confidence intervals for PS risk factors and MHP among nurses in Study II. The meaning of the work, role clarity, demands for hiding one's emotions, social relationships at work and mutual trust between employees were the PS factors that had the highest mean scores on the 100-point scale. The lowest mean scores were recorded

for job insecurity, workload, influence on work organization, role conflicts, and work-family conflicts. The mean scores for MHP (stress, somatic stress symptoms, cognitive stress symptoms, depression symptoms, sleeping trouble, and burnout) ranged from 26.6 to 45.1. Stress and burnout had the highest mean scores among the mental health indicators. The mean score for self-rated general health on the 100-point scale was 49.5 (SD 20.7).

Table 9. Prevalence of possible risk factors for musculoskeletal pain among nurses in Study II

Variable	N	%
Age (23–69 years)	404	100.0
Gender		
Female	397	98.3
Male	7	1.7
Occupation		
Nursing	323	79.9
Nursing management	81	20.1
Work tenure (years)		
<5	80	19.8
5–10	96	23.8
>10	228	56.4
BMI (kg/m^2)		
≤24.9	207	51.2
≥25.0	197	48.8
Taking pain medicine during the past 3 months		
Never	60	14.9
Seldom	140	34.6
One to several times a month	115	28.5
One to several times a week	73	18.0
Every day	16	4.0
Smoking		
Never or ex-smoker	322	79.7
Current smoker	82	20.3
Alcohol use during the past 3 months		
Never	95	23.5
Seldom	176	43.6
One to several times a month	101	25.0
One to several times a week	25	6.2
Every day	7	1.7
Physical activity		
Mostly physically inactive or light activity for < 2 h per week	85	21.0
Light activity for 2–4 h per week	206	51.0
Light activity for >4 h or physical exercise 2–4 h per week	153	37.9
Regular physical exercise or training several times per week	43	10.6

Table 10. Mean scores and 95% confidence intervals (95% CI) for work-related psychosocial risk factors and mental health problems among nurses in Study II

PS factors (scales)	[a] Items	Mean	95% CI
Work demands			
Quantitative demands (workload)	4	32.2	30.5–33.9
Work pace	3	66.3	64.8–68.0
Cognitive demands	4	67.2	65.6–68.7
Demands for hiding emotions	3	73.3	71.6–75.1
Emotional demands	4	57.1	55.3–58.8
Work organization and job content			
Influence on work organization	4	33.3	31.3–35.4
Possibilities for development	4	68.6	67.1–70.2
Meaning of the work	3	80.2	78.7–81.7
Commitment to the work	4	63.7	61.7–65.6
Interpersonal relationships and leadership			
Access to information	2	63.2	61.2–65.3
Rewards (recognition)	3	57.6	55.5–59.7
Role clarity	3	78.9	77.5–80.2
Role conflicts	4	35.9	34.0–37.8
Quality of leadership	4	59.6	57.4–61.9
Social support from colleagues	3	59.9	57.8–62.0
Social support from the supervisor	3	57.8	55.2–60.5
Social relationships at work	3	71.4	69.5–73.4
Work-individual interface			
Job insecurity	4	18.4	16.4–20.3
Job satisfaction	4	65.5	64.0–66.9
Work-family conflict	4	43.5	40.9–46.0
Values in the workplace			
Mutual trust between employees	3	71.1	69.2–73.0
Trust regarding the management	4	63.7	62.3–65.2
Justice and respect	4	49.3	46.8–51.9
Social inclusiveness	4	61.3	59.8–62.9
Mental health problems during the past 4 weeks			
Stress	4	41.2	39.5–42.8
Somatic stress symptoms	4	30.8	29.3–32.3
Cognitive stress symptoms	4	26.6	25.0–28.1
Depression symptoms	4	30.9	29.3–32.5
Sleeping trouble	4	32.7	30.7–34.6
Burnout	4	45.1	43.4–46.7

[a] Items – number of the questions in a scale.

6.3. Associations between risk factors and musculoskeletal pain

In Study I, binary logistic regression was used to assess possible associations between individual and work-related risk factors and MSP at each of the six anatomical sites during the previous year and multi-site pain in the past year and past month.

MSP in the past 12 months tended to be more frequent among older nurses and those with higher emotional exhaustion (Appendix I, Table 1; Appendix II, Table 2). After adjustment for the other risk factors under consideration, older age, especially for the age group 50–59 years, was significantly associated with lower back, shoulder, and elbow pain; and for the age group 40–49 years with shoulder pain. Emotional exhaustion associated significantly with lower back and wrist/hand pain, and depersonalization with neck pain. Poor self-rated health significantly correlated with shoulder and knee pain, distressing somatic symptoms (≥2 symptoms) with lower back and neck pain, and a low mood with lower back pain. The physical risk factor of lifting weights ≥25 kg was associated with lower back pain and working with one's hands above the shoulders with shoulder pain. Time pressure significantly correlated with the occurrence of elbow pain among the nurses. Significant correlations with MSP were not found for occupation, work tenure, working hours per week, and smoking. After adjustment for the other risk factors, multi-site pain was significantly correlated with older age and a tendency to somatise (Table 11).

Table 11. Associations of multi-site pain (≥2 anatomical sites) with risk factors and health indicators in Study I

Risk factors	Multi-site pain in past year			Multi-site pain in past month		
	N	[a]OR (95% CI)	[b]OR (95% CI)	N	[a]OR (95% CI)	[b]OR (95% CI)
Age groups (years)						
23–29	25	1	1	14	1	1
30–39	42	1.2 (0.5-2.5)	1.3 (0.6-2.8)	27	1.4 (0.6-3.0)	1.3 (0.6-3.0)
40–49	34	2.0 (0.8-4.4)	1.9 (0.8-4.8)	24	2.3 (1.0-5.2)	2.2 (0.9-5.4)
50–59	32	4.2 (1.7-11.3)	6.3 (2.1-22.7)	23	3.6 (1.5-8.6)	3.7 (1.4-9.9)
Self-rated health						
Good	64	1	1	38	1	1
Poor	69	3.2 (1.8-5.9)	1.5 (0.7-3.0)	50	2.6 (1.5-4.6)	1.6 (0.8-3.1)
Number of distressing somatic symptoms						
0	62	1	1	36	1	1
1	33	2.1 (1.0-4.3)	1.7 (0.8-3.6)	25	2.5 (1.2-5.0)	2.0 (1.0-4.2)
≥2	38	6.5 (2.7-18.2)	7.3 (2.5-27.2)	27	4.2 (2.0-8.9)	3.1 (1.3-7.0)
Emotional exhaustion						
Low	14	1	1	10	1	1
Medium	90	1.9 (0.9-4.3)	1.8 (0.8-4.5)	57	1.4 (0.6-3.4)	1.2 (0.5-2.8)
High	24	3.6 (1.3-11.0)	2.9 (0.9-10.5)	18	2.7 (0.9-7.7)	1.8 (0.6-5.6)

Risk factors	Multi-site pain in past year			Multi-site pain in past month		
	N	[a]OR (95% CI)	[b]OR (95% CI)	N	[a]OR (95% CI)	[b]OR (95% CI)
Physical load						
Low	72	1	1	47	1	1
High	60	1.8 (1.0-3.2)	1.3 (0.7-2.6)	40	1.7 (0.9-3.0)	1.2 (0.7-2.3)

[a] Without adjustment.
[b] Adjusted for all risk factors in the table.

Binary logistic regression analysis was used to assess the associations between PS factors, mental health problems, and MSP in Study II. Mental health problems and most significantly somatic stress symptoms were positively associated with the occurrence of MSP in the past year and past month (Table 12).

Table 12. Associations between psychosocial factors, mental health problems and musculoskeletal pain among nurses in the past year and month in Study II

Psychosocial factors (scales)	MSP in the past year	MSP in the past month
	[a] OR (95% CI)	[a] OR (95% CI)
Work demands		
Quantitative demands (workload)	1.13 (1.02–1.25)	1.09 (1.00–1.20)
Work pace	1.14 (0.99–1.31)	1.17 (1.04–1.32)
Cognitive demands	1.12 (1.01–1.25)	1.08 (0.99–1.19)
Emotional demands	1.10 (1.00–1.24)	1.17 (1.08–1.28)
Demands for hiding emotions	1.06 (0.95–1.20)	1.06 (0.95–1.17)
Work organization and job content		
Influence on work organization	0.88 (0.81–0.96)	0.92 (0.85–0.99)
Possibilities for development	1.01 (0.91–1.12)	1.01 (0.92–1.11)
Meaning of the work	1.02 (0.89–1.17)	1.01 (0.90–1.15)
Commitment to the work	0.96 (0.88–1.05)	0.98 (0.91–1.06)
Interpersonal relationships and leadership		
Access to information	0.92 (0.78–1.08)	0.89 (0.77–1.03)
Rewards (recognition)	0.92 (0.82–1.03)	0.92 (0.84–1.01)
Role clarity	0.99 (0.85–1.15)	0.96 (0.85–1.10)
Role conflicts	1.09 (1.00–1.19)	1.09 (1.01–1.17)
Quality of leadership	0.94 (0.87–1.02)	0.98 (0.92–1.05)
Social support from colleagues	0.85 (0.76–0.95)	0.96 (0.88–1.06)
Social support from the supervisor	0.94 (0.86–1.02)	1.01 (0.94–1.08)
Social relationships at work	0.89 (0.78–1.02)	0.90 (0.81–1.01)
Work-individual interface		
Job insecurity	1.01 (0.92–1.11)	0.97 (0.89–1.05)
Job dissatisfaction	1.19 (1.02–1.39)	1.16 (1.01–1.33)
Work-family conflict	1.14 (1.03–1.25)	1.17 (1.07–1.27)
Values in the workplace		
Lack of trust between employees	1.20 (1.05–1.38)	1.09 (0.98–1.22)

Psychosocial factors (scales)	MSP in the past year	MSP in the past month
	[a] OR (95% CI)	[a] OR (95% CI)
Lack of trust regarding the management	1.16 (1.05–1.28)	1.08 (0.99–1.18)
Low justice and respect	1.18 (1.08–1.30)	1.11 (1.03–1.19)
Low social inclusiveness	1.02 (0.92–1.12)	1.07 (0.98–1.16)
Mental health problems		
Sleeping troubles	1.21 (1.09–1.34)	1.16 (1.06–1.27)
Burnout	1.23 (1.10–1.39)	1.32 (1.18–1.48)
Stress	1.35 (1.20–1.53)	1.34 (1.20–1.49)
Depression symptoms	1.19 (1.06–1.33)	1.23 (1.11–1.37)
Somatic stress symptoms	1.71 (1.44–2.02)	1.51 (1.32–1.73)
Cognitive stress symptoms	1.19 (1.06–1.34)	1.14 (1.03–1.25)

[a] Adjusted for age and self-rated health. MSP in the past year or MSP in the past month was used as a binary dependent variable and the psychosocial factors, age, and self-rated health as independent variables in the logistic regression model.

Work-individual interface factors, such as job dissatisfaction and work-family conflicts, were also significantly associated with MSP, as well as such work-related PS factors as low justice and respect in the workplace, influence on work organization, role conflicts, and high work demands.

Taking into account the relationships between mental health problems and MSP, Pearson's r correlation with sequential Bonferroni correction (Holm 1979) was used to assess the cross-sectional correlations between work-related PS risk factors and mental health problems in Study II. After sequential Bonferroni correction, most of the 24 PS factors statistically significantly correlated with self-rated stress and burnout (15 and 16 correlations, respectively) (Table 13). Most significant positive correlations were revealed between quantitative demands and stress, burnout and depression symptoms, work pace and burnout, emotional demands and burnout. Most significant negative correlations occurred between rewards and burnout and social relationships at work and stress.

Table 13. Associations between psychosocial factors and mental health problems among nurses in Study II

Psychosocial factors (scales)	Stress	Somatic symptoms	Depression symptoms	Burnout
Work demands				
Quantitative demands (workload)	0.38*	0.25*	0.34*	0.38*
Work pace	0.21*	0.08	0.03	0.33*
Cognitive demands	0.10	0.04	0.08	0.19*
Demands for hiding emotions	0.06	0.05	0.06	0.20*
Emotional demands	0.27*	0.19*	0.25*	0.31*

Psychosocial factors (scales)	Stress	Somatic symptoms	Depression symptoms	Burnout
Work organization and job content				
Influence	-0.12	-0.09	0.04	-0.19*
Possibilities for development	-0.13	-0.14	-0.10	-0.04
Meaning of the work	-0.17*	-0.09	-0.25*	-0.13*
Commitment to the workplace	-0.03	-0.02	-0.01	0.01
Interpersonal relationships and leadership				
Role conflicts	0.18*	0.14	0.17*	0.18*
Role clarity	-0.14*	-0.08	-0.23*	-0.08
Predictability	-0.24*	-0.16*	-0.15*	-0.21*
Rewards	-0.24*	-0.19*	-0.16*	-0.30*
Quality of leadership	-0.20*	-0.14	-0.12	-0.20*
Social support from colleagues	-0.19*	-0.17*	-0.13	-0.17*
Social support from supervisors	-0.18*	-0.13	-0.10	-0.19*
Social relationships at work	-0.30*	-0.23*	-0.22*	-0.29*
Values at the workplace				
Mutual trust between employees	-0.16*	-0.14	-0.13*	-0.12
Trust regarding the management	-0.20*	-0.21*	-0.16*	-0.25*
Justice and respect	-0.25*	-0.19*	-0.12	-0.25*
Social inclusiveness	-0.10	-0.14	-0.02	-0.04

* Statistically significant p-values after sequential Bonferroni correction ($p<0.05$).

6.4. Effects of the home exercise therapy programme on the cervical and lumbar range of motion

After the exercise therapy programme in Study III, statistically significant differences were found for the CROM values of the experimental group before and after therapy (Table 14). There was a significant increase in cervical flexion (26%; p=0.000), extension (18%; p=0.002), right lateral flexion (15%; p=0.002), left lateral flexion (14%; p=0.012), right rotation (10%; p=0.002), and left rotation (9%; p=0.010). After therapy CROM in flexion was significantly higher in the experimental group compared to the control group (11%; p=0.004). Significant increases in lumbar right lateral flexion (20%; p=0.003) and left lateral flexion (17%; p=0.009) after therapy were also found in the experimental group. After the programme, six participants were completely pain-free; mean pain intensity in the neck and lower back of the other seven participants was significantly lower than before.

Table 14. Mean values of the cervical and lumbar range of motion in the experimental and control groups and p-values for intra-group and inter-group comparisons in Study III

Indicator	Experimental group					Control group			
	Before therapy		After therapy						
	Mean	SD	Mean	SD	p	Mean	SD	p^a	p^b
Cervical ROM (deg)									
Flexion	42.3	8.1	57.0	7.0	0.000	50.5	7.6	0.109	0.004
Extension	49.5	10.7	60.2	9.2	0.002	58.4	13.5	0.080	0.704
Lateral flexion (right)	34.8	4.5	40.8	5.5	0.002	37.6	6.2	0.133	0.203
Lateral flexion (left)	35.5	6.6	41.4	7.8	0.012	39.9	7.1	0.107	0.634
Rotation (right)	75.7	8.7	84.2	6.4	0.002	83.2	7.3	0.323	0.731
Rotation (left)	78.4	8.8	85.8	7.6	0.010	84.8	6.1	0.354	0.766
Lumbar ROM (deg)									
Flexion	62.2	9.8	61.2	7.2	0.698	60.0	7.9	0.275	0.691
Extension	22.4	7.9	23.6	5.9	0.528	28.2	7.6	0.090	0.113
Lateral flexion (right)	21.9	4.7	27.4	2.2	0.003	27.2	7.4	0.045	0.925
Lateral flexion (left)	24.5	6.0	29.6	3.6	0.009	27.6	5.4	0.142	0.272

[a] Experimental subjects before the therapy compared to the controls; [b] experimental subjects after the therapy compared to the controls.

7. DISCUSSION

The aim of the three empirical studies was to obtain evidence on the prevalence, body localisation and risk factors of MSP among nurses, and the effects of a home exercise therapy programme on the CROM and LROM of nurses with neck and lower back pain.

7.1. Main findings and comparison with earlier studies

7.1.1. Prevalence and localization of musculoskeletal pain

The studies indicate that MSP is highly prevalent among TUH nurses. Although MSP has not been investigated in other Estonian hospitals, one can suppose that the high prevalence of MSP is a common health problem among nurses also in other hospitals. This may be because of the similar nature of the work performed by nurses regardless of the hospital. The TUH nurses observed in Study II represent 7% of the population of hospital nurses (n=5742) in Estonia.

The prevalence of MSP among nurses varies across studies and countries (Table 1). Farioli et al. (2014) proposed that the variation in the prevalence of MSP in European countries could be explained by socio-economic differences between the countries. However, the results of the international CUPID study (Coggon et al. 2012) show that socio-economically different countries such as Iran, Korea, Japan, and New Zealand have similarly high MSP prevalence. It could well be that the high prevalence of MSP is attributable, among other things, to culturally determined health beliefs and expectations, a hypothesis which was addressed in the CUPID study (Madan et al. 2008; Coggon et al. 2013; Vargas-Prada 2013) of which this survey formed a part. The findings of the CUPID study among factory and office workers support this hypothesis (Madan et al. 2008).

A different prevalence of MSP was also revealed in two Swedish studies (Josephson et al. 1997; Nilsson et al. 2010). According to Nilsson et al. (2010), the prevalence of MSP among Swedish nurses was significantly lower compared to an earlier study by Josephson et al. (1997). A difference in the prevalence of MSP among nurses in the same country was also found in Japan (Smith et al 2003a, 2003b, 2006), where the studies were carried out over shorter time intervals.

The prevalence of MSP also varied in the present studies (84% and 70%, respectively, for Studies I and II) (Freimann et al. 2013, 2015, 2016). There could be several reasons for this variation. The higher prevalence of MSP in the rather small sample size of Study I could be explained by the fact that the subjects with pain could have been more interested in participation. Another reason may have been the seasons during which the data were collected. While Study I was performed from October 2008 to February 2009

(autumn/winter), Study II was carried out in April and May 2011 (spring). The seasonal effects on the occurrence of MSP have received insufficient attention in the scientific literature.

According to the CUPID study in Estonia, the 12-month prevalence of MSP among nurses, nursing aids, and office workers is similarly high, but the localization of pain varies by occupational groups (Merisalu et al. 2016). For example, lower back pain is significantly more prevalent among nursing aids followed by nurses and office workers. Wrist and hand pain is more prevalent among office workers. This variability can be explained by the different nature of the job. Lower back pain in nurses and nursing aids is caused by work-related physical risk factors including patient moving, lifting, transferring, and other handling tasks. Wrist and hand pain in office workers may be related to physical overload of this body site as a result of using of keyboard.

As in Estonia, lower back pain was most prevalent in all other countries for which data is available (Table 1). However, the prevalence of neck and shoulder pain varied across studies and countries. The highest occurrence of neck pain was found in Korea (63%) (Smith et al. 2005) and shoulder pain in Korea (75%) (Smith et al. 2005) and Japan (72%) (Smith et al. 2006).

Comparison of the prevalence of lower back pain among nurses between other countries in the CUPID study (Coggon et al. 2012) showed similar results for Costa Rica (56%), the UK (59%), and Japan (59%). Several countries (Brazil, Lebanon, Australia, Nicaragua, New Zealand, Iran, Italy, Spain, and Greece) had higher prevalence of lower back pain (ranging from 62–83%) than the TUH nurses. Italy (76%), Spain (73%), and Greece (62%) were the countries with the highest prevalence of neck pain in the CUPID study (Coggon et al. 2012).

7.1.2. Possible risk factors for musculoskeletal pain

The prevalence of possible risk factors of MSP among nurses has been investigated in many countries. However, the results are very different and difficult to compare due to differences in the study designs, the instruments applied, and the work-related risk factors taken into account.

When comparing the prevalence of physical risk factors for the nursing profession between the countries involved in the CUPID study, work-related stressful physical activities were more prevalent in the average working day of Estonian nurses (TUH) than in the United Kingdom (Coggon et al. 2012) (Paper I). For example, it concerns repeated bending and straightening of the elbow for >1 hour (71% for Estonia and 55% for the UK), repeated movement of the wrist and hand for >4 hours (68% and 44%), lifting weights of 25 kg or more (38% and 28%), and working with one's hands above shoulder height for >1 hour (21% and 9%).

Comparison of the prevalence of work-related PS risk factors with previous COPSOQ (Kristensen et al. 2005) studies showed that the TUH

nurses scored lower than Danish and US nurses for quantitative demands (perceived workload) and role conflicts (Aust et al. 2007; Malloy & Penprase 2010) (Papers II & III). The reason for the lower scores for quantitative demands of Estonian nurses could be related to different cultural attitudes towards workloads and a more equitable division of tasks and responsibilities between nurses and physicians, especially in intensive care units. However, according to COPSOQ II (Kristensen et al. 2005), the quantitative demand scores for nurses were higher than for other salaried workers in Estonia (32 and 24, respectively) (Seppo et al. 2010). A low influence upon work organization seems to be a common problem among nurses in Estonia, Denmark, and the USA (Aust et al. 2007; Malloy & Penprase 2010) (Papers II and III). Low influence on work organization means that that nurses often have no choice in deciding on the amount of work and how or what to do at work.

As for emotional demands and work pace, TUH nurses scored considerably higher than other salaried workers in Estonia (Seppo et al. 2010). At the same time justice and respect scored considerably lower than in other salaried workers in Estonia (Seppo et al. 2010). A low level of justice and respect has not been mentioned as a risk factor in earlier studies, but it was found to be associated with the occurrence of MSP in the present study.

Similar to earlier studies, more advanced age (≥40 years) was found to be an important individual risk factor for MSP among nurses (Aleksopoulos et al. 2003; Trinkoff et al. 2003) (Paper I). In the international CUPID study, the prevalence of participants in the age range of 40–59 years was 42% in TUH and 38% in the United Kingdom (Coggon et al. 2012). This age group was most prevalent in Ecuador (75%) and New Zealand (70%).

In the present study, MHP stress and burnout had the highest mean scores among the psychological factors. As measured by COPSOQ II (Kristensen et al. 2005), the mean scores of stress and burnout were similar to US nurses (Malloy & Penprase 2010) and other salaried workers in Estonia (Seppo et al. 2010) (Paper II). The similarity of MHP between Estonian and US nurses could be explained by the similar nature of the work performed by nurses regardless of the country. Distressing somatic symptoms were more prevalent among Estonian nurses than US nurses. According to the CUPID study, the somatising tendency varied markedly among nurses in different countries (Coggon et al. 2016). For example, high rates of somatic symptoms were detected for nurses in Costa Rica, Nicaragua, Ecuador, and Iran while the lowest rates were observed in Australia, the UK, Pakistan, and New Zealand.

7.1.3. Associations between risk factors and musculoskeletal pain

The present study and previous studies concluded that work-related physical risk factors constituted an important risk factor for MSP in nurses (Smedley et al 1995; Alexopoulos et al. 2003; Smith et al 2003b). The findings of the present study showed that among stressful physical activities, lifting weights of ≥25 kg was significantly associated with lower back pain and working with one's hands above shoulder height with shoulder pain; physical load (three or more stressful physical activities) was associated with multisite pain (≥2 anatomical sites). One previous study also suggested that the risk factors for MSP differ according to body sites (Hoe et al. 2012).

The present study found that most of the studied work-related PS factors were statistically significantly correlated with MHP (Paper II) and fewer of them were related to MSP (Paper III). Most of the 24 PS factors observed were statistically significantly correlated with stress and burnout (Paper II). Work demands including emotional and quantitative demands (workload) and work pace had the most significant positive correlations with MHP.

Work-individual interface factors, such as job dissatisfaction and work-family conflicts, were significantly associated with MSP, as well as such work-related PS factors as low justice and respect in the workplace, role conflicts, and high work demands. Justice and respect in the workplace were scored quite low (49.3 on a 100-point scale) and considerably lower than in other salaried workers in Estonia (64.9) (Seppo et al. 2010). The low level of justice and respect has not been mentioned as a risk factor in earlier studies.

There are a number of strategies that could be used to improve PS work environment of hospital nurses. However, more objective methodological approaches for assessing relationships between psychosocial risk factors and MSP are needed in future studies.

Surprisingly, most of the demographic and lifestyle factors (physical activity, smoking, and alcohol and drug abuse) were not associated with MSP among TUH nurses, as they were found to be risk factors in previous studies (Camerino et al. 2001; Aleksopoulos et al. 2003; Trinkoff et al. 2003). Similarly to the present study, several earlier studies found that older age and perceived poor health were important risk factors for the occurrence of MSP in nurses (Aleksopoulos et al. 2003; Nilsson et al. 2010; Long et al. 2012).

7.1.4. Associations between mental health problems and musculoskeletal pain

MHP as individual psychological factors were positively associated with the occurrence of MSP (Table 12) (Paper III). As in earlier studies, the most significant positive association was observed between somatic stress symptoms and MSP (Solidaki et al. 2010; Matsudaira et al. 2011). A somatising tendency was also the strongest predictor of the MSP symptoms in other CUPID studies (Carugno et al. 2012; Coggon et al. 2013; Coggon et al. 2016). Similarly to the present study, psychosomatic symptoms have been found as the most important risk for neck and back pain in earlier studies (Sherehiy et al. 2004b).

As MHP were significantly related to MSP in the present study, the risk factors for MHP should be taken into account by changing nurses' working conditions. It is important to monitor nurses' quantitative and emotional job demands and work pace, analyse work roles; develop leadership qualities, and improve interpersonal relationships and the sharing of rewards. As stress and burnout of nurses seemed to be related to interpersonal relationships and values, fair and respectful relationships between colleagues and supervisors should be maintained.

7.1.5. Effects of the home exercise therapy programme

Study III evaluated the effects of an 8-week home exercise therapy programme on the CROM and LROM of ICU nurses (Paper IV). A significant increase in cervical flexion, extension, lateral flexion and rotation, and lumbar lateral flexion was found after therapy (Freimann et al. 2016). The largest increase in the range of motion was found for cervical flexion; after 8 weeks this value approached the age-specific normal CROM value of 58–60° (Swinkels & Swinkels 2014). The study results suggest that this home exercise therapy programme may improve CROM and LROM and reduce musculoskeletal pain among intensive care nurses. The exercise therapy programme had a more significant effect on CROM compared to LROM. Therefore, the types of exercises needed to achieve better results in both CROM and LROM within a single therapy programme should be explored further. Future studies are needed to develop this simple but effective home exercise therapy programme and to help motivate nurses to perform such exercises regularly.

The present study results are difficult to compare with previous findings because of differences in study designs, exercise therapy programmes, and the outcomes measured. Only in some previous studies CROM and or LROM were compared before and after an exercise therapy programme. Tseng et al. (2006) examined the effects of range-of-motion exercise on the upper and lower extremities and found positive effects regarding enhancing

the physical and psychological functions of older people after a stroke. More evidence is available concerning the positive effects of regular exercise on musculoskeletal symptoms (Skargren & Oberg 1996; Alexandre et al. 2001; Yuan et al. 2008). In this study, after the exercise therapy programme six participants were completely pain-free, and the mean pain intensity of the other seven participants was significantly lower in the neck and lower back than before.

Our intervention study was limited to investigating only the effects of a home exercise therapy programme on CROM and LROM. Other intervention strategies that could increase the effectiveness of any programme should also be taken into consideration (Hignett 2003). As the aetiology of cervical and lumbar disorders is multifactorial, a combination of intervention programmes for intensive care nurses should be studied in the future. However, as the cost-effectiveness of any intervention method is an important consideration, it would be ideal to find low-cost effective interventions (Palmer et al. 2012).

7.2. Study findings in relation to the theoretical framework

The present study showed a significant correlation between physical, psychosocial, and individual risk factors and MSP. The research findings allowed addition of some important aspects to the model of Bongers et al. (2002) (Fig. 1), such as the development of SROM limitations and physical exercise intervention to prevent and reduce SROM limitations (Fig. 7). Physical exercise can help nurses cope with acute MSP and prevent chronic MSP. Individual characteristics can play a significant role in coping with the physical load of the job and PS factors, as well as with stress and its consequences.

In the present study only a few of the work-related PS factors directly correlated with MSP. This result is in accordance with the theoretical model of Cox et al. (2000), which explains the difference between direct and indirect effects of PS factors with the occurrence of MSP (Figure 2). Based on the theoretical models (Bongers et al. 2002; Cox et al. 2000), one might suspect that health and mental status could play an intervening role in the associations between PS risk factors and MSP. This has been confirmed by studies examining the intermediary role of stress, burnout, and work-home interference factors between PS work factors and MSP (Heijden et al. 2008; Leka & Jain 2010). However, it is possible that MSP can affect health and mental status and in turn affect the scores of PS risk factors. The hypothesis of the intervening role of MHP between PS risk factors and MSP requires further investigation. The present study provides evidence that physical exercise intervention reduces SROM limitations among nurses with neck and lower back pain.

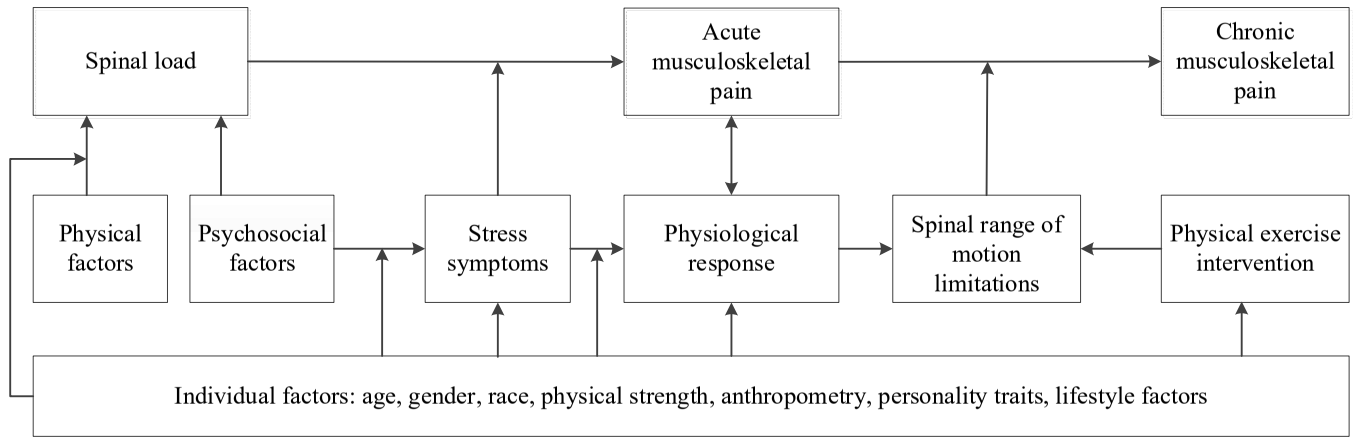

Figure 7. The interaction model of risk factors and the intervention method in relation to MSP (adapted from Bongers et al. 2002)

7.3. Main practical implications

In the context of the present state of national and international scientific knowledge, this study provides additional information for scientists, managers, and nurses about MSP prevalence, related risk factors, and intervention strategies. The present study has important practical value because several risk factors that correlate with MSP can be potentially decreased by future preventive activities. The evidence-based knowledge of work-related and individual risk factors helps to change the working conditions and health behaviour in order to prevent and reduce the occurrence of MSP among nurses.

The results of the present study showed that work-related psychosocial risk factors (higher quantitative and emotional demands, work pace, low justice and respect in the workplace, influence on work organization, and role conflicts) are significantly associated with the occurrence of MSP among nurses. These findings suggest that it is important to monitor quantitative and emotional job demands and work pace, to analyse work roles, to develop work organization, and to improve interpersonal relationships.

As justice and respect in the present study was scored lower than for other salaried workers in Estonia, it is important to ensure that the nurses' work tasks should be assigned on an equal footing and conflicts at the workplace would be resolved in a fair way. All the suggestions made by nurses should be treated more seriously by the management and the nurses should be appreciated when they have done a good job. Nurses should have a work environment where they would be able to express their views and feelings and they are allowed to do their work independently and provided with sufficient and reliable information.

According to the positive relationship between MSP and MHP in the present study, the MHP risk factors should be taken into account by corrective activities. A number of strategies could be used to improve the working conditions and to help prevent MHP among nurses. The findings of the present study suggest that it is important to monitor quantitative and emotional job demands and work pace; to analyse work roles, to develop leadership qualities, to improve interpersonal relationships and the sharing of rewards. Because all the risk factors cannot be eliminated, one could suggest the use of common coping strategies, including problem-solving, seeking social support, and training in self-control and relaxation techniques (Lim et al. 2010).

The research findings of the present study could also be used to improve awareness of the importance of physical exercise to prevent and reduce MSP among nurses. The study results support home-exercise therapy as a useful method to improve the cervical and lumbar range of motion among nurses with MSP. However, one could recommend randomized controlled trials to investigate the effects of exercise therapy programmes on CROM and LROM in larger samples and more clinically rigorous outcome measures.

7.4. Limitations of the study

Study I used baseline data from a longitudinal study (Paper I). The data of the follow-up study of this investigation were not usable due to the small sample size. As studies I and II were cross-sectional, it cannot be excluded that some of the observed correlations with risk factors reflected reverse causation (Papers I–III). The cross-sectional design of the study leaves some uncertainty about any causal relationships between the dependent and independent variables. Reverse causation may have contributed in particular to psychological risk factors (David 2005). For example, MSP may lower one's mood or increase perceived stress and burnout among nurses, especially if they experienced acute pain. However, Armon et al. (2010) found that the possibility of reverse causation, which means that MSP predicts elevations of burnout levels among healthy employees, is not supported. Regardless of the limitations, a cross-sectional method is practical due to its capacity, versatility, generality, and the low cost level.

In the present study MSP was not assessed with a diagnostic tool but by self-reporting using the NMQ (Kuorinka et al. 1987). Because self-reported measurements were used for both the explanatory and outcome variables, a common method bias may exist (Podsakoff et al. 2003). However, self-reported assessments can be used to collect data on workplace exposure to both physical and PS factors. In the present study self-reported questionnaires were used for work-related risk factors.

Another constraint was the modest sample size of Studies I and II, which limited the power with which some possible risk factors could be examined. The modest response rate in Study II could be explained by the fact that it is easy to ignore a web-based survey. However, there is no reason to call into question the reliability of the research results, because the sample size of Study II was representative of the occupational group that was being investigated.

The main limitations of Study III were related to the quasi-experimental design and the number of subjects of the study (Paper IV). A quasi-experimental design was used to examine the effects of physical exercise interventions. In quasi-experimental designs, participants are assigned to intervention and comparison groups without random assignment. Randomized controlled trials are often used to examine the effects of ergonomic or physical exercise intervention on musculoskeletal symptoms (Dawson et al. 2007; Coury et al. 2009; Driessen et al. 2010) and also on the spinal range of motion (Tseng et al. 2006). The aim of randomization is to avoid confounding and selection bias by creating comparable groups. Due to the small population of volunteering ICU nurses, it was difficult to find a sufficient sample size of subjects with suitable characteristics for randomization in Study III. In general, a major problem of quasi-experimental designs is that the experimental and the control group might not be similar in terms of the demographic parameters selected for intervention and comparison. However,

the experimental and control group in Study III were homogeneous for anthropometric measurements and BMI.

Because of the insufficient recruitment number of the control group was formed from the population without symptoms. Further research could be required to complete larger samples, and select the control group with musculoskeletal symptoms.

According to the training diaries, nine experimental subjects participated in other types of aerobic training (cycling, running, walking, swimming, rollerblading, and rowing) on average twice a week. Aerobic training outside of the exercise therapy programme was negatively associated with CROM. This association might show possible overtraining and or physical overload in the cervical spine, which may have influenced the effectiveness of the programme. In the future, randomized controlled trials are recommended to investigate the effects of exercise therapy programmes on CROM and LROM with and without other types of aerobic training.

8. CONCLUSIONS

1. Musculoskeletal pain is highly prevalent among TUH nurses while lower back and neck are the most prevalent body sites. Individual risk factors such as older age, poor self-rated health, and physical overload are associated with the occurrence of MSP at one or more anatomical body sites. Psychological risk factors such as low mood, emotional exhaustion, depersonalization, and psychosomatic symptoms have an important impact on MSP among nurses.
2. Work demands such as quantitative and emotional demands and work pace have significant positive relationships with MHP in nurses and may contribute to high levels of stress and burnout among nurses.
3. Work-related psychosocial risk factors and MHP have an important impact on the occurrence of MSP among nurses.
4. An 8-week intensive home-exercise therapy programme improves the cervical and lumbar range of motion among nurses with neck and lower back pain.

REFERENCES

Alexandre NMC, de Moraes MAA, Correa Filho HR, Jorge SA. Evaluation of a programme to reduce back pain in nursing personnel. *Rev Saude Publica.* 2001; 35:356–61.

Alexopoulos EC, Burdorf A, Kalokerinou A. Risk factors for musculoskeletal disorders amongst nursing personnel in Greek hospitals. *Int Arch Occup Environ Health.* 2003;76:289–94.

Anap DP, Iyer C, Rao K. Work related musculoskeletal disorders among hospital nurses in rural Maharashtra, India: a multicentre survey. *Int J Res Med Sci.* 2013;1:101–7.

Andersen LL, Kjaer M, Søgaard K, Hansen L, Kryger AI, Sjøgaard G. Effect of two contrasting types of physical exercise on chronic neck muscle pain. *Arthritis Rheum.* 2008;59:84–91.

Ariëns GA, van Mechelen W, Bongers PM, Bouter LM, van der Wal G. Psychosocial risk factors for neck pain: a systematic review. *Am J Ind Med.* 2001; 39:180–93.

Armon G, Melamed A, Shirom A, Shapira I. Elevated burnout predicts the onset of musculoskeletal pain among apparently healthy employees. *J Occup Health Psych.* 2010;15:399–408.

Arsalani N, Fallahi-Khoshknab M, Ghaffari M, Josephson M Lagerstrom M. Adaptation of questionnaire measuring working conditions and health problems among Iranian nursing personnel. *Asian Nurs Res.* 2011;5:177–82.

Aust B, Rugulies R, Skakon J, Scherzer T, Jensen C. Psychosocial work environment of hospital workers: Validation of a comprehensive assessment scale. *Int J Nurs Stud.* 2007;44:814–25.

Bambra C, Gibson M, Sowden AJ, Wright K, Whitehead M, Petticrew M. Working for health? Evidence from systematic reviews on the effects on health and health inequalities of organisational changes to the psychosocial work environment. *Prev Med.* 2009;48:454–61.

Bernal D, Campos–Serna J, Tobias A, Vargas–Prada Sergio, Benavides FG, Serra C. Work-related psychosocial risk factors and musculoskeletal disorders in hospital nurses and nursing aides: A systematic review and meta-analysis. *Int J Nurs Stud.* 2015;52:635:48.

Bernard B, Putz-Anderson V, Burt S. Musculoskeletal disorders and workplace factors. National Institute for Occupational Safety and Health. *DHHS Publication.* 1997;97–141:7–11.

Bongers PM, Winter CR de, Kompier MAJ, Hildebrandt VH. Psychosocial factors at work and musculoskeletal disease. *Scand J Work Environ Health.* 1993; 19:297–312.

Bongers PM, Kremer AM, Laak J. Are psychosocial factors, risk factors for symptoms and signs of the shoulder, elbow, or hand/wrist?: A review of the epidemiological literature. *Am J Ind Med.* 2002;41:315–42.

Bos E, Krol B, Star L, Groothoff J. Risk factors and musculoskeletal complaints in non–specialized nurses, IC nurses, operation room nurses, and X-ray technologists. *Int Arch Occup Environ Health.* 2007;80:198–206.

Brun E & Milczarek M. Expert forecast on emerging psychosocial risks related to occupational safety and health. European risk observatory report. European

Agency for Safety and Health at Work. *Luxembourg: Office for Official Publications of the European Communities*, 2007.
Camerino D, Molteni G, Vito GD, Evaristi C, Latocca R, Cesana GC. Job strain and musculoskeletal disorders of Italian nurses. *Occup. Ergon.* 2001;2:215–23.
Cameron SJ, Armstrong–Stassen M, Kane D, Moro FBD. Musculoskeletal problems experienced by older nurses in hospital settings. *Nurs Forum.* 2008;43:2.
Carugno M, Pesatori AC, Ferrario MM, Ferrari AL, Silva FJ, Martins AC, Felli VE, Coggon D, Bonzini M. Physical and psychosocial risk factors for musculoskeletal disorders in Brazilian and Italian nurses. *Cad Saude Publica.* 2012;28: 1632–42.
Childs J, Cleland J, Elliott J, Teyhen DS, Wainner RS, Whitman JM, et al. NP: clinical practice guidelines linked to the international classification of functioning, disability, and health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther.* 2008;38:A1–34.
Choobineh A, Rajaeefard A, Neghab M. Association between perceived demands and musculoskeletal disorders amongst hospital nurses of Shiraz University of Medical Sciences: a questionnaire survey. *Int J Occup Saf Ergon.* 2006;12:409–16.
Choobineh A, Movahed M, Tabatabaie SH, Kumashiro M. Perceived demands and disorders in operating room nurses of Shiraz city hospitals. *Ind Health.* 2010;48: 74–84.
Clegg A. Occupational stress in nursing: a review of the literature. *J Nurs Manag.* 2001;9:101–6.
Cleland JA, Mintken PE, Carpenter K, Fritz JM, Glynn P, Whitman J, et al. Examination of a clinical prediction rule to identify patients with neck pain likely to benefit from thoracic spine thrust manipulation and a general cervical range of motion exercise: multi–center randomized clinical trial. *Phys Ther.* 2010;90: 1239–50.
Coggon D, Ntani G, Palmer KT, Felli VE, Harari R, et al. The CUPID (Cultural and Psychosocial Influences on Disability) study: methods of data collection and characteristics of study sample. *PLoS ONE.* 2012;7:e39820.
Coggon D, Ntani G, Palmer KT, Felli VE, Harari R, et al. Patterns of multisite pain and associations with risk factors. *Pain.* 2013;154:1769–77.
Coggon D, Vargas-Prada S, Ntani G, Walker-Bone K, Palmer KT, et al. Descriptive epidemiology of somatising tendency: findings from the CUPID study. *Plos One.* 2016.
Costa BR, Vieira ER. Risk factors for Work-related musculoskeletal disorders: a systematic review of recent longitudinal studies. *Am J Ind Med.* 2010;53:285–323.
Coury HJCG, Moreira RFC, Dias NB. Evaluation of the effectiveness of workplace exercise in controlling cervical, shoulder and lumbar pain: a systematic review. *Rev Bras Physioter.* 2009;13:461–79.
Cox T, Griffths A, Rial-Gonzales E. Research on work related stress. *Office for Official Publications of the European Communities.* 2000.
Cunha ACV, Burke TN, França FJR, Marques AP. Effect of global posture re-education and of static stretching on pain, range of motion, and quality of life in women with chronic neck pain: a randomised clinical trial. *Clinics.* 2008; 63:763–70.

Dall TM, Gallo P, Koenig L, Gu Q, Ruiz D. Modelling the indirect economic implications of musculoskeletal disorders and treatment. *BMC Cost Eff Resour Alloc.* 2013;11:5.

David GC. Ergonomic methods for assessing exposure to risk factors for Work-related musculoskeletal disorders. *Occup Med.* 2005;55:190–9.

Dawson AP, McLennan SN, Schiller SD, Jull GA, Hodges PW, Stewart S. Experimentals to prevent back pain and back injury in nurses: a systematic review. *Occup Environ Med.* 2007;64:642–50.

De Koning CH, van den Heuvel SP, Staal JB, et al. Clinimetric evaluation of active range of motion measures in patients with non-specific neck pain: a systematic review. *Eur Spine J.* 2008;17:905–21.

De Souza Magnago TS, Lisboa MT, Griep RH, Kirchhof AL, De Azevedo Guido L. Psychosocial aspects of work and musculoskeletal disorders in nursing workers. *Rev. Lat. Am. Enfermagem.* 2010;18:429–35.

Delitto A, George SZ, Van Dillen L, Whitman JM, Sowa G, Shekelle P, Denninger TR, Godges JJ. LBP clinical practice guidelines linked to the international classification of functioning, disability, and health from the orthopaedic section of the American Physical Therapy Association. *J Orthop Sports Phys Ther.* 2012;42:A1–57.

Derogatis LR, Melisaratos N. The Brief Symptom Inventory: an introductory report. *Psychol Med.* 1983;13:595–605.

Downie WW, Leatham PA, Rhind VM, Wright V, Branco JA, Anderson JA. Studies with pain rating scales. *Ann Rheum Dis.* 1978;37:378–81.

Driessen MT, Proper KI, van Tulder MW, Anema JR, Bongers PM, van der Beek AJ. The effectiveness of physical and organisational ergonomic interventions on low back pain and neck pain: a systematic review. *Occup Environ Med.* 2010; 67:277–85.

Driessen MT, Proper KI, Anema JR, Knol DL, Bongers PM, van der Beek AJ. The effectiveness of participatory ergonomics to prevent low back and neck pain: results of a cluster randomized controlled trial. *Scand J Work Environ Health.* 2011;37:383–93.

Eerd D, Cole D, Irvin E, Mahood Q, Keown K, Theberge N, Village J, St-Vincent M, Cullen K, Widdrington H. Report on process and implementation of participatory ergonomic interventions: a systematic review. Toronto: Institute for Work & Health, 2008.

Eurostat. Health and safety at work in Europe (1999–2007). A statistical portrait. *Eurostat statistical books.* European Commission. Luxembourg: Publications Office of the European Union, 2010.

Farioli A, Mattioli S, Quaglieri A, Curti S, Violante FS, Coggon, D. Musculoskeletal pain in Europe: role of personal, occupational and social risk factors. *Scand J Work Environ Health. 2014;40:36–46.*

Feng CK & Hwang JT. Risk factors for musculoskeletal symptoms in the back, lower limbs and shoulder among nurses: result of a questionnaire survey. *Chinese Journal Occupational Medicine.* 1999;6:249–60.

Fitzgerald GK, Wynveen KJ, Rheault W, et al. Objective assessment with establishment of normal values for lumbar spinal range of motion. *Phys Ther.* 1983;63: 1776–81.

Freimann T, Coggon D, Merisalu E, Animägi L, Pääsuke M. Risk factors for musculoskeletal pain amongst nurses in Estonia: cross-sectional study. *BMC Musculoskelet Disord.* 2013;14:334.

Freimann T, Merisalu E. Work-related psychosocial risk factors and mental health problems amongst nurses at a university hospital in Estonia: A cross-sectional study. *Scand J Public Health*. 2015;43:447–52.

Freimann T, Pääsuke M, Merisalu E. Work-related psychosocial risk factors and mental health problems associated with musculoskeletal pain in nurses: A cross-sectional study. *Pain Res Manag.* 2016;3:9361016.

Freimann T, Merisalu E, Pääsuke M. Effects of a home exercise therapy programme on cervical and lumbar range of motion among nurses with neck and lower back pain: a quasi-experimental study. *BMC Sports Sci Med Rehabil.* 2015;7:31.

Gabriel P, Liimatainen M-R. Mental health in the workplace. *Introduction executive summaries.* International Labour Organization, 2000.

Gershon R, Stone P, Zeltser M, Faucett J, MacDavitt K, Chou SS. Organizational climate and nurse health outcomes in the United States: a systematic review. *Industrial Health.* 2007;45:622–36.

Gillen M, Yen IH, Trupin L, Swig L, Rugulies R, Mullen K, et al. The association of socioeconomic status and psychosocial and physical workplace factors with musculoskeletal injury in hospital workers. *Am J Ind Med.* 2007;50:245–60.

Golabadi M, Attarachi M, Raeisi S, Namvar M. Effects of psychosocial strain on back symptoms in Tehran general hospital nursing personnel. *Arh Hig Rada Toksikol.* 2013;64:505–11.

Harcombe H, McBride D. Prevalence and impact of musculoskeletal disorders in New Zealand nurses, postal workers and office workers. *Aust N Z J Public Health.* 2009;33:437–41.

Harcombe H, McBride D, Derrett S, Gray A. Physical and psychosocial risk factors for musculoskeletal disorders in New Zealand nurses, postal workers and office workers. *Inj Prev.* 2010;16:96–100.

Hartvigsen J, Lauritzen S, Lings S, Lauritzen T. Intensive education combined with low tech ergonomic intervention does not prevent low back pain in nurses. *Br Med J.* 2005;62:13–7.

Hayden JA, van Tulder MW, Tomlinson G: Systematic review. Strategies for using exercise therapy to improve outcomes in chronic low back pain. *Ann Intern Med.* 2005;142:776–85.

Heijden BIJM, Demerouti E, Bakker AB. The NEXT Study Group coordinated by Hans-Martin Hasselhorn. Work-home interference among nurses: reciprocal relationships with job demands and health. *J Adv Nurs.* 2008;62:572–584.

Henchoz Y, So AKL. Exercise and nonspecific low back pain: a literature review. *Joint Bone Spine.* 2008;75:533–9.

Hignett S. Intervention strategies to reduce musculoskeletal injuries associated with handling patients: a systematic review. *Occup Environ Med.* 2003;60.

Hoe VCW, Kelsall HL, Urquhart DM, Sim MR, et al. Risk factors for musculoskeletal symptoms of the neck or shoulder alone or neck and shoulder among hospital nurses. *Occup Environ Med.* 2012;69:198–204.

Hoogendoorn WE, Poppel MNM van, Bongers PM, Koes BW, Bouter LM. Systematic review of psychosocial factors at work and private life as risk factors for back pain. *Spine.* 2000;25:2114–25.

Holm S. A simple sequentially rejective multiple test procedure. *Scand. J. Stat.* 1979;6:65–70.

Huskisson EC. Measurement of pain. *Lancet.* 1974;2:1127–31.

Häkkinen A, Kautiainen H, Hannonen P, Ylinen J. Strength training and stretching versus stretching only in the treatment of patients with chronic NP: a randomised one-year follow-up study. *Clin Rehabil.* 2008;22:592–600.

Jakobsen MD, Sundstrup E, Brandt M, Kristensen AZ, Jay K, Stelter R, Lavendt E, Aagaard P, Andersen LL. Effect of workplace – versus home-based physical exercise on pain in healthcare workers: study protocol for a single blinded cluster randomized controlled trial. *BMC Musculoskelet Disord.* 2014;15:119.

Jaworek M, Marek T, Karwowski W, Andrzejczak C, Genaidy AM. Burnout syndrome as a mediator for the effect of Work-related factors on musculoskeletal complaints among hospital nurses. *Int J Ind Ergonom.* 2010;40:368–75.

Josephson M, Larger strom M, Hagberg M, Hjelm EW. Musculoskeletal symptoms and job strain among nursing personnel: a study over a three-year period. *Occup Environ Med.* 1997;52:47–57.

Karasek R. Job demands, job decision latitude, and mental strain: Implication for job redesign. *Admin Sci Quart.* 1979;24:285–308.

Kraemer WJ, Adams K, Cafarelli E, Dudley GA, Dooly C, Feigenbaum MS, et al. American College of Sports Medicine position stand: progression models in resistance training for healthy adults. *Med Sci Sports Exerc.* 2002;34:364–80.

Kristensen TS, Hannerz H, Høgh A, Borg V. The Copenhagen Psychosocial Questionnaire (COPSOQ) – a tool for the assessment and improvement of the psychosocial work environment. *Scand J Work Env Health.* 2005;31:438–49.

Kristensen TS. A questionnaire is more than a questionnaire. *Scand J Public Health.* 2010;38:149–55.

Kriviskas L. Training flexibility. In: Frontera WR, Dawson D, Slovik D. (Eds.) Exercise in rehabilitation medicine. *Human Kinetics,* 1999.

Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sorensen F, Andersson G et al. Standardized Nordic questionnaire for the analysis of musculoskeletal symptoms. *Appl Ergon.* 1987;18:233–7.

Kuukkanen T, Mälkia E, Kautiainen H, Pohjolainen T. Effectiveness of a home exercise programme in low back pain: a randomized five-year follow–up study. *Physiother Res Int.* 2007;12:213–24.

Leka S, Hassard J, Jain A, Makrinov N, Cox T. Towards the development of a European Framework for PS risk management at the workplace. Institute of work, health and organisations. *I-WHO Publications*, 2008.

Leka S, Jain A. Health impact of psychosocial hazards at work: an overview. World Health Organization, 2010.

Li J, Fu H, Hu Y, Shang L, Wu Y, Kristensen TS, Mueller BH, Martin H. Psychosocial work environment and intention to leave the nursing profession: Result from the Longitudinal Chinese NEXT study. *Scand J Public Health.* 2010;-38:69–80.

Linton SJ. A review of psychological risk factors in back and neck pain. *Spine.* 2000;25:1148–56.

Linton SJ, van Tulder MW. Preventive interventions for back and neck pain problems: what is the evidence? *Spine.* 2001;26:778–87.

Lim J, Bogossian F & Ahern K. Stress and coping in Australian nurses: a systematic review. *Int Nurs Rev.* 2010a;57:22–31.

Lim J, Bogossian F & Ahern K. Stress and coping in Singaporean nurses: a literature review. *Nurs Health Sci.* 2010b;12:251–8.
Lipscomb J, Trinkoff AM, Geiger-Brown J, Brady B. Work-schedule characteristics and reported musculoskeletal disorders of registered nurses. *Scand J Work Env Health.* 2002;28:394–401.
Lipscomb J, Trinkoff A, Brady B, Geiger-Brown J. Health care system changes and reported musculoskeletal disorders among registered nurses. *Am J Public Health.* 2004;94:1431–5.
Long MH, Johnston V, Bogossian F. Work-related upper quadrant musculoskeletal disorders in midwives, nurses and physicians: A systematic review of risk factors and functional consequences. *App Ergon.* 2012;43:455–67.
Lorusso A, Bruno S, L´Abbate N. A review of low back pain and musculoskeletal disorders amongst Italian nursing Personnel. *Ind Health.* 2007;45:637–44.
Lu JH. Correlation between regular exercises and mental health with the quality of life. *National Sports Quarterly.* 2002;31:60–73.
Luime JJ, Kuiper JI, Koes BW, Verhaar JA, Miedema HS, Burdorf A. Work-related risk factors for the incidence and recurrence of shoulder and neck complaints among nursing-home and elderly-care workers. *Scand J Work Env Health.* 2004; 30:279–86.
Madan I, Reading I, Palmer KT, Coggon D. Cultural differences in musculoskeletal symptoms and disability. *Int J Epid.* 2008;37:1181:89.
Magnago T, Lisboa M, Griep R, Kirchhof A, Guido L. Psychosocial aspects of work and musculoskeletal disorders in nursing workers. *Rev Lat Am Enfermagem.* 2010;18:429–35.
Malloy T, Penprase B. Nursing leadership style and psychosocial work environment. *J Nurs Manag.* 2010;18:715–25.
Maslach C, Jackson SE, Leiter MP: Maslach Burnout Inventory Manual. 3rd edition. Palo Alto, CA: Consulting Psychologists. Press, Inc, 1996.
Matsudaira K, Palmer KT, Reading I, Hirai M, Yoshimura N, Coggon D. Prevalence and determinants of regional pain and associated disability in Japanese workers. *Occup and Environ Med.* 2011;68:191–196.
McVicar A. Workplace stress in nursing: a literature review. *J Adv Nurs.* 2003; 44:633–642.
Mehrdad R, Dennerlein J, Haghighat M, Aminian O. Association between psycho-social factors and musculoskeletal symptoms among Iranian nurses. *Am J Ind Med.* 2010;53:1032–9.
Moustaka E, Constantinidis TC. Sources and effects of work-related stress in nursing. *J Health Sci.* 2010;4:210–6.
Munabi IG, Buwembo W, Kitara DL, Ochieng J, Mwaka ES. Musculoskeletal disorder risk factors among nursing professionals in low resource settings: a cross-sectional study in Uganda. *BMC Nursing.* 2014;13:7.
Nilsson A, Lindberg P, Denison E. Predicting of pain, disability, and sick leave regarding a non-clinical sample amongst Swedish nurses. *Scand J Pain.* 2010;1:160–6.
Nübling M, Vomstein M, Schmidt SG, Gregersen S, Dulon M, Nienhaus A. Psychosocial work load and stress in the geriatric care. *BMC Public Health.* 2010;10:428.
Page P. Current concepts in muscle stretching for exercise and rehabilitation. *Int J Sports Phys Ther.* 2012;7:109–19.

Palmer KT, Harris EC, Linaker C, Barker M, Lawrence W, Cooper C, Coggon D. Effectiveness of community- and workplace-based experimental to manage musculoskeletal-related sickness absence and job loss: a systematic review. *Rheumatology.* 2012;51:230–42.

Palmer KT, Reading I, Linaker C, Calnan M, Coggon D. Population-based cohort study of incident and persistent arm pain: role of mental health, self–rated health and health beliefs. *Pain.* 2008;136:30–7.

Pedersen BK, Saltin B, Exercise as medicine – evidence for prescribing exercise as therapy in 26 different chronic diseases. *Scand J Med Sci Sports.* 2015;25:1–72.

Pejtersen JH, Kristensen TS, Borg V, Bjorner JB. The second version of the Copenhagen Psychosocial Questionnaire. *Scand J Public Health.* 2010;38:8–24.

Penedo FJ, Dahn, JR. Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Curr Opin Psychiatry.* 2005; 18:189–93.

Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP. Common method biases in behavioural research: A critical review of the literature and recommended remedies. *J Appl Psychol.* 2003;88:879–903.

Proper KI, Koning M, van der Beek AJ, Hildebrandt VH, Bosscher RJ, van Mechelen W. The effectiveness of worksite physical activity programmes on physical activity, physical fitness, and health. *Clin J Sport Med.* 2003;13:106–17.

Rial-González E, Copsey S, Paoli P, Schneider E. Report on the priorities for occupational safety and health research in EU-25. European Agency for Safety and Health at Work. *Luxembourg: Office for Official Publications of the European Communities*, 2005.

Rivilis I, Van Eerd D, Cullen K, Cole DC, Irvin E, Tyson J, Mahood Q. Effectiveness of participatory ergonomic interventions on health outcomes: a systematic review. *Appl Ergon.* 2008;39:342–58.

Sarquis LMM, Coggon D, Ntani G, Walker-Bone K, Palmer KT, et al. Classification of neck and shoulder pain in epidemiological research: a comparison of risk factors, disability and prognosis among 12,195 workers from 18 countries. *Pain.* 2016.

Saur PMM, Ensink FBM, Frese K, Seeger D, Hildebrandt J. Lumbar range of motion: reliability and validity of the inclinometer technique in the clinical measurement of trunk flexibility. *Spine.* 1996;21:1331–8.

Scott J, Huskisson EC. Vertical or horizontal visual analogue scales. *Ann Rheum Dis.* 1979;38:560.

Seppo I, Järve J, Kallaste E, Kraut L, Voitka M. Psühhosotsiaalsete riskide levik Eestis. Center for Applied Research. CENTAR 2010. Available: http://www.centar.ee/uus/wp–content/uploads/2010/03/CENTAR_ l6pparuanne.pdf. Accessed 18 January 2017.

Sherehiy B, Karwowski W, Marek T. Relationship between risk factors and musculoskeletal disorders in the nursing profession: a systematic review. *Occup Ergon.* 2004a;4:241–79.

Sherehiy B, Karwowski W, Marek T. Risk factors for Work-related musculoskeletal disorders in the nursing profession: a review. *Ergonomia IJE&HF.* 2004b;26:19–47.

Skargren E, Oberg B. Effects of an exercise programme on musculoskeletal symptoms and physical capacity among nursing staff. *Scand J Med Sci Sports.* 1996;6:122–30.

Smedley J, Egger P, Cooper C, Coggon D. Manual handling activities and risk of low back pain in nurses. *Occup Environ Med.* 1995;52:160–3.
Smedley J, Egger P, Cooper C, Coggon D. Prospective cohort study of predictors of incident low back pain in nurses. *BMJ.* 1997;314:1225–8.
Smedley J, Inskip H, Trevelyan F, Cooper C, Coggon D. Risk factors for incident neck and shoulder pain in hospital nurses. *Occup Environ Med.* 2003;60:864–9.
Smith DR, Kondo N, Tanaka E, Tanaka H, Hirasawa K, Yamagata Z. Musculoskeletal disorders among hospital nurses in rural Japan. *J Rural and Remote Health.* 2003a;3:241.
Smith DR, Ohmura K, Yamagata Z, Minai J. Musculoskeletal disorders among female nurses in a rural Japanese hospital. *Nurs Health Sci.* 2003b;5:185–8.
Smith DR, Wei N, Kang L, Wang RS. Musculoskeletal disorders among professional nurses in Mainland China. *J Prof Nurs.* 2004a;20:390–5.
Smith DR, Wei N, Zhao L, Wang RS. Musculoskeletal complaints and psychosocial risk factors amongst Chinese hospital nurses. *Occup Med.* 2004b;54:579–82.
Smith DR, Choe MA, Jeon MY, Chae YR, An GJ, Jeong JS. Epidemiology of musculoskeletal symptoms amongst Korean hospital nurses. *Int J Occup Saf Ergon.* 2005;4:431–40.
Smith DR, Mihashi M, Adachi Y, Koga H, Ishitake T. A detailed analysis of musculoskeletal disorder risk factors among Japanese nurses. *J Safe Research.* 2006;37:195–200.
Solidaki E, Chatzi L, Bitsios P, Markatzi I, Plana E, Castro F, Palmer K, Coggon D, Kogevinas M. Work related and psychological determinants of multi-site musculoskeletal pain. *Scand J Work Environ Health.* 2010;36:54–61.
Stone PW, Du Y, Gershon R. Organizational climate and occupational health outcomes in hospital nurses. *J. Occup Environ Med.* 2007;45:50–58.
Swinkels RAHM, Swinkels-Meewisse IEJCM. Normal values for cervical range of motion. *Spine.* 2014;5:362–7.
Tabanelli MC, Depolo M, Cooke RMT, Sarchielli G, Bonfiglioli R, Mattioli S, Violante FS. Available instruments for measurement of psychosocial factors in the work environment. *Int Arch Occ Env Health.* 2008;82:1–12.
Tezel A. Musculoskeletal complaints amongst a group of Turkish nurses. *Int J Neuroscience.* 2005;115:871–80.
Terviseamet. Kutsehaigestumine ja tööst põhjustatud haigestumine 2015. aastal. 2015. Available: http://www.terviseamet.ee/tervishoid/toeoetervishoid/aruanded.html. Accessed 18 January 2017.
Tinubu BMS, Mbada CE, Oyeyemi AL, Fabunmi AA. Work-related musculoskeletal disorders amongst nurses in Ibadan, South–West Nigeria: a cross-sectional survey. *BMC Musculoskelet Disord.* 2010;11–2.
Trinkoff AM, Lipscomb JA, Geiger–Brown J, Brady B. Musculoskeletal problems of the neck, shoulder and back and functional consequences in nurses. *Am J Ind Med.* 2002;41:170–8.
Trinkoff AM, Lipscomb J, Geiger-Brown JS, Carla L, Brady B. Perceived physical demands and reported musculoskeletal problems in registered nurses. *Am J Prev Med.* 2003;24:270–5.
Trinkoff AM, Rong L, Geiger–Brown J, Lipscomb JA, Lang G. Longitudinal relationship of work hours, mandatory overtime, and on-call to musculoskeletal problems in nurses. *Am J Ind Med.* 2006;49:964–71.

Tseng CN, Chen CCH, WU SC, Lin LC. Effects of range-of-motion exercise programme. *J Adv Nurs.* 2006;57:181–91.

Vargas-Prada S, Serra C, Martínez JM, Ntani G, Delclos GL, Palmer KT, et al. Psychological and culturally influenced risk factors for the incidence and persistence of low back pain and associated disability in Spanish workers: findings from the CUPID study. *Occup Environ Med.* 2013;70:57–62.

Ware IE. SF–36 Health Status Questionnaire. Boston, MA: Institute for the Improvement of Medical Care and Health, New England Medical Centre Hospital, Quality Quest Inc. Boston, 1989.

Warming S, Precht DH, Suadicani P, Ebbehøj N. E. Musculoskeletal complaints among nurses related to patient handling tasks and psychosocial factors – Based on logbook registrations. *Appl Ergon.* 2009;40:569–76.

Windt E, Thomas E, Pope DP, Winter AF, Macfarlane GF, Bouter LM, Silman AJ. Occupational risk factors for shoulder pain: a systematic review. *Occup Environ Med.* 2000;57:433–42.

Ylinen J, Kautiainen H, Wiren K, Hakkinen A. Stretching exercises vs manual therapy in treatment of chronic neck pain: a randomized, controlled crossover trial. *J Rehabil Med.* 2007;39:126–32.

Yuan SC, Chou MC, Hwu LJ, Chang YO, Hsu WH, Kuo HW. An intervention programme to promote health-related physical fitness in nurses. *J Clin Nurs.* 2009;18:1404–11.

Youdas JW, Carey JR, Garrett TR. Reliability of measurements of cervical spine range of motion – comparison of three methods. *Phys Ther.* 1991;71:98–104.

SUMMARY IN ESTONIAN

Skeleti-lihasvalud õdedel: levimus, ohutegurid ja sekkumine

Sissejuhatus

Skeleti-lihasvalu (SLV) on kõige sagedasem tööga seotud terviseprobleem Euroopa töötajaskonna hulgas, hõlmates Euroopa Komisjoni Statistikaameti andmetel 60% töötajatest (*Eurostat 2010*). Kuigi SLV on kaua uuritud, on see jätkuvalt lahendamata probleem nii Eestis kui ka kogu Euroopas. Toetudes Eesti Terviseameti 2015. aasta statistikale, moodustavad luu- ja lihaskonna häired 80% kõikidest kutsehaigustest Eestis.

Skeleti-lihasvalude esinemissagedus on kõrge kogu maailma õdede hulgas, põhjustades õdedele füüsilisi, psühholoogilisi ja sotsiaalseid probleeme. SLV võib halvendada õdede toimetulekut ja elukvaliteeti ning põhjustada olulist töövõime langust (Alexopoulos et al. 2003, Cameron et al. 2008, Costa & Vieira 2009, Gillen et al. 2007). Õdede töölt puudumine kroonilise SLV tõttu tekitab märkimisväärseid töövõimetuse kompenseerimisega seotud kulusid ning on oluliseks finantskoormuseks vananeva elanikkonnaga Eesti majandusele.

Eelmise sajandi 1970ndatel alustati SLV riskide uuringuid epidemioloogiliste uurimismeetoditega. Sellest ajast on publitseeritud märkimisväärne hulk teadustulemusi, mis kirjeldavad tööga seotud ohutegurite seoseid SLVga. Kui esialgu keskenduti füüsiliste ohutegurite uurimisele, siis viimastel aastakümnetel on pööratud suuremat tähelepanu psühhosotsiaalsetele teguritele. Euroopa Tööohutuse ja Töötervishoiu Agentuur soovitas 2005. aastal keskenduda töötervishoiu ja terviseuuringutes tööga seotud psühhosotsiaalsete tegurite ja SLV vaheliste seoste uurimisele.

Kuigi SLV riske hõlmav teadustöö maht on suur, esineb tänaseni vastuolulisi andmeid SLV ohutegurite kohta. Vastukäivat teavet põhjendatakse sageli SLV mitmepõhjusliku iseloomuga ning mitme ohuteguri koosmõjuga (Leka & Jain 2010). Viimastel aastakümnetel on SLV ohutegurite uurimisel pööratud rohkem tähelepanu füüsiliste, psühholoogiliste ja sotsiaalsete (sealhulgas kultuuriliste) ohutegurite koosmõjule. Teaduskirjandusest võib leida erinevaid teooriaid, mis käsitlevad SLV seoseid individuaalsete ning tööga seotud füüsiliste ja psühhosotsiaalsete riskidega (Bongers et al. 1993, 2002, Cox et al. 2000), kuid uuringutes on seni vähe käsitletud seoseid lülisamba piiratud liikuvusulatuse ja SLV vahel. Samuti on vähe tõenduspõhist teavet erinevate sekkumismeetmete kohta SLVde vähendamiseks õdede hulgas. Veel vähem on teavet tõhusate treeningteraapia programmide kohta õdede lülisamba kaela ja nimmeosa liikuvusulatuse parandamiseks.

Uurimistöö eesmärgid

Käesoleva uurimistöö eesmärk oli välja selgitada SLV esinemissagedus, lokalisatsioon ja ohutegurid õdedel, analüüsida SLV seoseid ohutegurite ja vaimse tervisega ning hinnata koduvõimlemisel põhineva treeningteraapia mõju õdede lülisamba kaela- ja nimmepiirkonna liikumisulatusele, et ennetada või vähendada SLVsid.

Uurimistöö alaeesmärgid:

1. Selgitada SLV esinemist, lokalisatsiooni ja ohutegureid kliinikumi õdedel (artikkel I).
2. Uurida psühhosotsiaalseid riske õdede töös ning analüüsida nende seoseid õdede vaimse tervise probleemidega (artikkel II).
3. Analüüsida psühhosotsiaalsete tegurite ja vaimse tervise probleemide seoseid SLV esinemisega õdedel (artikkel III).
4. Hinnata kaela- ja alaseljavaludega õdedele koostatud koduharjutustel põhineva sekkumisprogrammi mõju lülisamba kaela- ja nimmepiirkonna liikuvusulatusele (artikkel IV).

Metoodika

Käesolev uurimistöö põhineb kolmel empiirilisel uuringul, mis viidi läbi Tartu Ülikooli Kliinikumi (kliinikumi) õdede hulgas ajavahemikul 2008–2011. Esimene uuring toimus Southamptoni Ülikooli (Inglismaa) poolt koordineeritud rahvusvahelise uuringu „Töövõimetuse kultuurilised ja psühhosotsiaalsed aspektid“ (*Cultural and Psychosocial Influences on Disability*, *CUPID*) raames, millest võttis osa 18 riiki (Coggon et al. 2012). Kahes küsitlusvoorus hinnati SLV levimust peamiselt kontoritöötajate, õdede ja tööstustööliste hulgas. Antud uurimistöös analüüsiti esimese ankeetküsitlusega kliinikumi õdedelt kogutud andmeid. Anonüümne ankeetküsitlus viidi läbi 416 täiskohaga töötava õe hulgas juhusliku valiku alusel. Täidetud küsimustikke laekus uurijale 227 (57%), millest analüüsiks sobis 221 naissoost õe küsimustikku. Küsimustikuga koguti andmeid SLV esinemise kohta kuues kehapiirkonnas ning nende valude võimalike füüsiliste, psühhosotsiaalsete ja individuaalsete ohutegurite kohta. SLV esinemissageduse, lokalisatsiooni ja ohutegurite analüüsimiseks kasutati kirjeldavat statistikat. Logistilist regressiooni kasutati tunnustevaheliste seoste analüüsimiseks.

Teise uuringu raames viidi läbi anonüümne elektrooniline ankeetküsitlus kõikide täiskohaga töötavate õdede (n=906) hulgas, kes olid kliinikumis töötanud vähemalt 12 kuud. Täidetud küsimustikke laekus 409 (45%), millest analüüsiks sobis 397 naissoost ja 7 meessoost õe küsimustikku, kokku 404. Küsitlemiseks kasutati rahvusvaheliselt valideeritud küsimustikku *Copenhagen Psychosocial Questionnaire II, COPSOQ II* (Kristensen et al. 2005) ja küsimusi ankeedist *Nordic Musculoskeletal Questionnaire, NMQ* (Kuorinka

et al. 1987). Skeleti-lihasvalude esinemissageduse ja psühhosotsiaalsete ohutegurite kirjeldamiseks kasutati kirjeldavat statistikat. Skeleti-lihasvalude esinemissageduse sõltuvust psühhosotsiaalsetest ohuteguritest ja vaimse tervise probleemidest analüüsiti logistilise regressiooniga. Vaimse tervise probleemide ja psühhosotsiaalsete ohutegurite vaheliste seoste analüüsimiseks kasutati Pearsoni korrelatsiooni koos Bonferroni korrektsiooniga (Holm 1979), mis võimaldab paljude tunnuste üheaegset võrdlemist.

Uurimistöö kolmandas etapis teostati kvaasi-eksperimentaalne juhtkontrolluuring täiskohaga töötavate intensiivravi õdede hulgas. Kolmteist naissoost õde, kellel oli viimase kuue kuu jooksul esinenud SLVsid kaela ja alaselja piirkonnas, osalesid eksperimentaalrühmas ja läbisid kaheksa nädalat kestnud koduharjutustel põhineva treeningteraapia programmi. Programm sisaldas lülisamba liikuvust parandavaid ja stabiliseerivaid harjutusi ning jõu- ja venitusharjutusi kaela-, selja- ja kõhulihastele. Üksteist naissoost õde, kellel valusid ei esinenud, osalesid kontrollrühmas ja jätkasid uuringu ajal oma tavapärast eluviisi. Vaatlusaluste valu esinemise ja valu tugevuse hindamiseks kasutati rahvusvaheliselt tuntud küsimustikke NMQ (Kuorinka et al. 1987) ja *Visual Analogue Scale, VAS* (Scott & Huskisson 1979).

Lülisamba liikuvusulatust kaela- ja nimmeosa fleksioonil, ekstensioonil ja lateraalfleksioonil ning kaelaosa rotatsioonil paremale ja vasakule mõõdeti eksperimentaalrühma vaatlusalustel enne ja pärast treeningteraapia programmi. Kontrollrühma vaatlusaluste lülisamba liikuvusulatuse mõõtmised toimusid samaaegselt eksperimentaalrühma teistkordsete mõõtmistega. Mõõtmisteks kasutati digitaalset goniomeetrit *AcumarTM Digital Inclinometer (Laffayette Instrument Company, USA, version 5.0).* Sekkumiseelsete ja -järgsete mõõtmistulemuste võrdlemiseks kasutati paaris t-testi ning kahe rühma mõõtmistulemuste võrdlemiseks *Student* t-testi.

Tulemused

Skeleti-lihasvalude esinemissagedus kliinikumi õdede hulgas oli uuringule eelnenud 12 kuu jooksul kõrge. Esimese uuringu põhjal kannatas vähemalt ühe kehapiirkonna SLVsid 84% uuritavatest. Teises uuringus oli vastav näitaja 70%. Umbes 60% õdedest koges SLVsid kahes ja enamas kehapiirkonnas. Kõige rohkem esines alaselja- ja kaelapiirkonna valusid.

Esimese uuringu tulemusena leiti seoseid raskuste tõstmise (>25 kg) ja alaseljavalude vahel ning ülestõstetud kätega töötamise ja õlavalude vahel (artikkel I). Füüsiline koormus (rohkem kui kolm koormavat tegevust tööpäeva jooksul) oli seotud mitme kehapiirkonna valude esinemisega. Individuaalsetest ohuteguritest olid SLVdega seotud vanus, madal tervisehinnang ja tööga seotud psühholoogilised tegurid, sealhulgas psühhosomaatilised sümptomid, emotsionaalne kurnatus ja depersonalisatsioon (küünilisus). Psühhosomaatilised sümptomid suurendasid alaselja-, kaela- ja õlavalude esinemissagedust, emotsionaalne kurnatus alaselja, randme ja käelaba ning

mitme kehapiirkonna valude esinemist. Depersonalisatsiooni kõrgemad skoorid olid seotud kaelavalude esinemisega.

Teise uuringu põhjal olid olulisemad tööga seotud psühhosotsiaalsed riskid töökoormus ja kiire töötempo, emotsionaalsed nõudmised, vähene sõnaõigus tööga seotud küsimustes ning vähene austus ja õiglus töökohal. Rahulolematus tööga ja töö-pereelu konflikt tõstsid samuti SLV esinemissagedust. SLV esinemissagedust suurendasid kõik vaimse tervise probleemid, sealhulgas kõige rohkem psühhosomaatilised sümptomid (artikkel III). Uuring näitas, et vaimse tervise probleemid olid õdede hulgas samuti levinud ning enamik tööga seotud psühhosotsiaalseid tegureid olid seotud vaimse tervise probleemidega (artikkel II). Töökoormus oli positiivses seoses stressi, depressiooniilmingute ja läbipõlemisega. Läbipõlemise esinemissagedust suurendasid veel kiire töötempo ja kõrged emotsionaalsed nõudmised. Stressi ja läbipõlemise esinemissagedust vähendasid kõige rohkem informeeritus, tunnustus, head sotsiaalsed suhted ning austus ja õiglus töökohas.

Sekkumisuuringust selgus, et kaheksanädalase treeningteraapia mõjul suurenes eksperimentaalrühma vaatlusalustel lülisamba kaelaosa liikuvusulatus oluliselt kõikides liikumissuundades ($p<0,05$) (artikkel IV). Kõige rohkem suurenes liikuvusulatus kaelaosa fleksioonil ja kõige vähem kaelarotatsioonil. Pärast treeningteraapiat oli eksperimentaalrühma vaatlusaluste lülisamba kaelaosa liikuvus fleksioonil oluliselt suurem kui kontrollgrupil ($p<0,01$). Harjutuste mõju lülisamba nimmeosale oli väiksem kui kaelaosale. Kõige rohkem suurenes nimmeosa liikuvusulatus lateraalfleksioonil ($p<0,01$).

Käesoleva teadustöö raames tehtud uuringud aitavad täiendada süsteemset teavet SLV esinemise ja ohutegurite kohta õdedel. Uuringutel on oluline praktiline väärtus, kuna SLVdega seotud riske on võimalik leevendada ennetavate tegevustega. On palju võimalusi, kuidas muuta töökorraldust, -tingimusi ja -õhkkonda nii, et töökeskkond ohustaks vähem õdede füüsilist ja vaimset tervist. Antud uurimistööle tuginedes tuleks jälgida ja reguleerida õdede töökoormust ja tempot, emotsionaalset koormust, analüüsida töökohustusi ning parandada juhtimise kvaliteeti. Kuna kliinikumi õed hindasid austust ja õiglust oma töökohal madalamaks kui teised Eesti palgatöötajad (Seppo jt 2010), tuleks õdedele luua turvaline, austav ja õiglane töökeskkond, kus tööülesandeid jagatakse õdede vahel võrdselt ning töötajate vahelisi konflikte lahendatakse õiglaselt. Juhid peaksid õdede ettepanekutesse suhtuma tõsiselt, usaldama töötajaid tööülesannete täitmisel ning varustama neid tööks vajaliku usaldusväärse teabega. Tööõhkkond peaks olema avatud, soodustama seisukohtade ja tunnete väljendamist ning head tööd peaks alati tunnustama.

Kuna SLVd on seotud vaimse tervise probleemidega, on turvalise töökeskkonna arendamisel oluline arvestada ka vaimse tervise riske. Vaimse tervise seisukohalt on oluline lisaks töö- ja emotsionaalse koormuse reguleerimisele parandada inimestevahelisi suhteid töökohal, suurendada informeeritust ja usaldust juhtimise suhtes ning jagada piisavalt tunnustust. Kuna kõiki tööga seotud riske ei ole võimalik kõrvaldada, soovitavad uurijad õde-

del treenida oma toimetuleku, ajaplaneerimise ja probleemi lahendamise oskusi ning arendada toetavaid sotsiaalseid suhteid töökohal (Lim et al. 2010a). Tööstressi vähendamiseks soovitatakse erinevaid lõõgastumise võtteid, mõõdukat füüsilist aktiivsust, tervist toetavaid lemmiktegevusi ning sotsiaalset tuge perekonnalt (Lim et al. 2010b).

Sekkumisuuringu positiivsed tulemused julgustavad kasutama koduvõimlemist SLV ennetamiseks ja vähendamiseks, kuid edaspidi tuleks teha täiendavaid uuringuid suurema valimiga. Võimalusel tuleks valida nii eksperimentaal- kui ka kontrollrühma sarnaste SLV sümptomitega õed.

Järeldused

1. Skeleti-lihasvalude esinemissagedus kliinikumi õdede hulgas on kõrge, hõlmates kõige sagedamini alaselja- ja kaelapiirkonda. Individuaalsed ohutegurid, nagu vanus ja madal tervisehinnang ning füüsiliselt koormavad tegevused on seotud SLV esinemisega õdedel ühes või enamas kehapiirkonnas. Olulist mõju SLV esinemisele avaldavad ka psühholoogilised tegurid, nagu halb enesetunne, psühhosomaatilised sümptomid, emotsionaalne kurnatus ja depersonalisatsioon.
2. Töökoormus ja -tempo ning emotsionaalsed nõudmised on positiivses seoses vaimse tervise probleemidega ning võivad olla õdede stressi ja läbipõlemise põhjuseks.
3. Tööga seotud psühhosotsiaalsed tegurid ja vaimse tervise probleemid suurendavad SLV esinemise tõenäosust õdedel.
4. Koduharjutustel põhinev kaheksanädalane treeningteraapia parandab lülisamba kaela- ja nimmeosa liikuvusulatust kaela- ja alaseljavaludega õdedel.

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APPENDIX I

Table 1. Associations between risk factors and low back, neck and shoulder pain in the past year in Study I

Risk factors	Low back pain			Neck pain			Shoulder pain		
	N	[a]OR (95% CI)	[b]OR (95%CI)	N	[a]OR (95% CI)	[b]OR (95%CI)	N	[a]OR (95% CI)	[b]OR (95%CI)
Age (years)									
23–29	24	1	1	24	1	1	5	1	1
30–39	41	1.2 (0.6-2.5)	1.3 (0.6-2.9)	41	1.2 (0.6-2.5)	1.6 (0.7-3.7)	15	2.2 (0.7–6.5)	3.2 (0.9-11.9)
40–49	29	1.4 (0.7-3.1)	1.8 (0.8-4.6)	26	1.1 (0.5-2.4)	0.8 (0.3-2.0)	14	3.4 (1.1–10.3)	5.1 (1.3-19.6)
50–59	30	3.4 (1.4-8.3)	5.5 (1.8-17.1)	24	1.7 (0.7-3.9)	2.6 (0.9-7.3)	13	4.4 (1.4–13.8)	6.2 (1.4-26.9)
Self-rated health									
Good	62	1	1	59	1	1	13	1	1
Poor	62	2.1 (1.2-3.7)	1.1 (0.5-2.3)	56	1.9 (1.1-3.2)	1.2 (0.6-2.4)	34	4.8 (2.3-9.9)	4.4 (1.7-11.4)
Number of distressing somatic symptoms									
0	60	1	1	55	1	1	15	1	1
1	31	1.7 (0.9-3.5)	1.5 (0.7-3.4)	27	1.5 (0.8-2.9)	1.4 (0.6-3.0)	15	3.2 (1.4-7.3)	2.0 (0.7-5.2)
≥2	33	3.5 (1.6-7.5)	2.4 (0.9-6.0)	33	3.9 (1.8-8.5)	5.0 (1.8-13.9)	17	4.9 (2.1–11.2)	2.1 (0.7-6.0)
Mood									
Good	14	1	1	18	1	1	7	1	1
Intermediate	88	1.6 (0.7-3.4)	1.8 (0.7-4.3)	77	0.8 (0.4-1.7)	0.7 (0.3-1.6)	27	0.6 (0.2-1.7)	0.3 (0.1-0.9)
Poor	22	4.5 (1.5-13.7)	3.4 (0.9-12.5)	20	1.9 (0.7-5.3)	0.8 (0.2-2.8)	13	3.3 (1.0-10.6)	0.7 (0.2-3.2)
Emotional exhaustion									
Low	13	1	1	14	1	1	4	1	1
Medium	85	2.1 (0.9-4.7)	2.1 (0.8-5.4)	73	1.2 (0.5-2.6)	0.9 (0.4-2.2)	31	1.9 (0.6-6.1)	2.6 (0.7-10.8)
High	19	2.0 (0.7-5.7)	1.5 (0.4-6.1)	23	3.2 (1.1-9.1)	2.2 (0.5-9.3)	10	3.0 (0.8-11.2)	2.0 (0.3-11.9)

Risk factors	Low back pain			Neck pain			Shoulder pain		
	N	[a]OR (95% CI)	[b]OR (95%CI)	N	[a]OR (95% CI)	[b]OR (95%CI)	N	[a]OR (95% CI)	[b]OR (95%CI)
Depersonalisation									
Low	13	1	1	6	1	1	3	1	1
Medium	82	0.6 (0.2-1.7)	0.4 (0.1-1.2)	83	2.9 (1.0-8.0)	3.5 (1.1-10.9)	32	1.4 (0.4-5.3)	1.6 (0.3-8-1)
High	21	0.7 (0.2-2.1)	0.4 (0.1-1.6)	23	3.8 (1.2-12.4)	2.6 (0.6-11.3)	11	2.1 (0.5-9.2)	1.7 (0.3-10.9)
Stressful occupational physical activity									
No	69	1	1	87	1	1	31	1	1
Yes	54	2.1 (1.2-3.7)	2.2 (1.1-4.3)	27	1.3 (0.7-2.6)	1.1 (0.5-2.4)	15	2.1 (1.0-4.5)	3.0 (1.2-7.3)
Time pressures at work									
Low	33	1	1	26	1	1	12	1	1
High	88	1.2 (0.7-2.2)	0.9 (0.5-1.9)	87	1.9 (1.1-3.5)	1.4 (0.7-2.8)	33	1.2 (0.6–2.5)	0.7 (0.3-1.7)

[a] Adjusted for age (age is presented without any adjustment).
[b] Adjusted for all the risk factors in the table.

APPENDIX II

Table 2. Associations between risk factors and elbow, wrist/hand and knee pain in the past year in Study I

Risk factors	Elbow pain			Wrist/hand pain			Knee pain		
	N	[a]OR (95% CI)	[b]OR (95%CI)	N	[a]OR (95% CI)	[b]OR (95%CI)	N	[a]OR (95% CI)	[b]OR (95%CI)
Age (years)									
23–29	3	1	1	18	1	1	13	1	1
30–39	6	1.3 (0.3-5.6)	1.4 (0.3-6.5)	19	0.6 (0.3-1.3)	0.6 (0.2-1.4)	19	0.9 (0.4-2.1)	1.1 (0.4-2.7)
40–49	7	2.5 (0.6-10.2)	2.4 (0.5-10.6)	9	0.4 (0.2-1.0)	0.3 (0.1-0.9)	22	2.1 (0.9-4.9)	2.1 (0.8-5.3)
50–59	9	4.6(1.2-18.5)	5.0 (1.1-22.1)	14	1.0 (0.4-2.3)	1.4 (0.5-3.9)	18	2.4 (1.0-5.8)	2.0 (0.7-5.7)
Self-rated health									
Good	10	1	1	29	1	1	34	1	1
Poor	15	1.9 (0.8-4.7)	2.1 (0.7-6.2)	31	1.9 (1.0-3.6)	1.5 (0.7-3.2)	38	1.8 (1.0-3.3)	2.0 (1.0-4.4)
Number of distressing somatic symptoms									
0	12	1	1	30	1	1	35	1	1
1	7	1.4 (0.5-3.9)	1.3 (0.4-4.2)	15	1.3 (0.6-2.8)	1.2 (0.5-2.7)	20	1.7 (0.8-3.5)	2.0 (0.9-4.4)
≥2	6	1.5 (0.5-4.4)	0.8 (0.2-3.0)	15	1.8 (0.8-3.8)	1.7 (0.6-4.4)	17	1.7 (0.8-3.5)	1.8 (0.7-4.4)
Mood									
Good	2	1	1	12	1	1	13	1	1
Intermediate	19	1.8 (0.4-8.5)	1.2 (0.2-6.5)	38	0.5 (0.2-1.2)	0.4 (0.1-1.0)	52	0.7 (0.3-1.6)	0.5 (0.2-1.2)
Poor	4	2.7 (0.4-16.4)	1.3 (0.2-9.9)	10	0.9 (0.3-2.7)	0.6 (0.2-2.2)	7	0.5 (0.2-1.7)	0.3 (0.1-1.0)
Emotional exhaustion									
Low	2	1	1	4	1	1	9	1	1
Medium	18	2.3 (0.5-10.7)	1.5 (0.3-7.9)	42	2.9 (0.9-9.0)	3.7 (1.1-12.3)	48	1.3 (0.5-3.1)	1.3 (0.5-3.3)
High	5	2.6 (0.4-14.8)	1.8 (0.2-15.6)	13	5.1 (1.4-18.6)	8.2 (1.6-41.6)	11	1.2 (0.4-3.6)	1.5 (0.4-6.0)

Risk factors	Elbow pain			Wrist/hand pain			Knee pain		
	N	[a]OR (95% CI)	[b]OR (95%CI)	N	[a]OR (95% CI)	[b]OR (95%CI)	N	[a]OR (95% CI)	[b]OR (95%CI)
Depersonalization									
Low	2	1	1	5	1	1	7	1	1
Medium	19	1.3 (0.3-6.3)	1.1 (0.2-6.8)	44	1.4 (0.5-4.3)	1.3 (0.4-4.4)	50	0.9 (0.3-2.4)	0.9 (0.3-2.9)
High	4	1.0 (0.2-6.6)	0.7 (0.1-6.5)	8	1.0 (0.3-3.7)	0.5 (0.1-2.3)	12	0.8 (0.2-2.6)	0.6 (0.2-2.7)
Stressful occupational physical activity									
No	5	1	1	11	1	1	61		1
Yes	20	2.1 (0.7-6.0)	1.5 (0.5-4.8)	49	1.5 (0.7-3.2)	1.0 (0.4-2.3)	11	0.7 (0.3-1.5)	0.7 (0.3-1.6)
Time pressures at work									
Low	2	1	1	15	1	1	26	1	1
High	23	5.6 (1.2-24.7)	5.3 (1.1-26.5)	45	1.3 (0.7-2.6)	1.0 (0.5-2.2)	87	1.1 (0.6-2.2)	1.3 (0.6-2.7)

[a] Adjusted for age (age is presented without any adjustment).
[b] Adjusted for all the risk factors in the table.

PUBLICATIONS

CURRICULUM VITAE

Name: Tiina Freimann
Date of birth: February 24, 1955
Citizenship: Estonian
E-mail: tiina.freimann@kliinikum.ee; tiina.freimann@ut.ee

Education:

2010–2017	University of Tartu, Faculty of Medicine, Institute of Family Medicine and Public Health, PhD studies
2002–2004	University of Tartu, Faculty of Medicine, Department of Nursing Science, Master of Science in Health Science (Nursing Science)
1996–2002	University of Tartu, Faculty of Medicine, Department of Nursing Science, Diploma in Nursing Science
1973–1975	Nursing School of Tartu, Diploma in Nursing
1969–1972	Elva Secondary School

Professional experience:

1999–	Tartu University Hospital, Chief Nurse
1994–1999	Tartu University Maarjamõisa Hospital, Chief Nurse
1991–1994	Tartu Central Hospital, Cardiac Surgery Department, Nursing Manager
1990–1991	Helsinki University Hospital, Cardiac Surgery Intensive Care Unit, Nurse
1988–1990	Tartu Central Hospital, Cardiac Surgery Operating Room, Nurse
1982 –1988	Tartu Central Hospital, Cardiac Surgery Department, Nursing Manager
1976–1982	Tartu Central Hospital, Cardiac Surgery Department, Nurse
1973–1976	Tartu Central Hospital, Internal Medicine Department, Nurse

Teaching experience:

2006–2009	University of Tartu, Faculty of Medicine, Department of Nursing Science, Teaching Assistant (part-time employee)
2010–	University of Tartu, Faculty of Medicine, Institute of Family Medicine and Public Health, Lecturer (supernumerary)

Membership:

2003–	Estonian Nurses' Association
2006–	European Nurse Directors' Association

Main field of research: musculoskeletal pain among nurses, risk factors and prevention opportunities.

Publications:
Eight scholarly articles in international peer reviewed journals, and seven international conference presentations have been published in abstract books and special issues of journals. One scholarly article and three conference presentations have been published in the journal Eesti Arst.

Scholarly articles in international peer-reviewed journals:

1. Freimann T, Coggon D, Merisalu E, Animägi L, Pääsuke M. Risk factors for musculoskeletal pain amongst nurses in Estonia: cross-sectional study. BMC Musculoskeletal Disorders. 2013;14:334. Originally published online 1 Dec 2013, doi: 10.1186/1471–2474–14–334.
2. Freimann T, Merisalu E. Work-related PS risk factors and mental health problems amongst nurses at a university hospital in Estonia: A cross-sectional study. Scandinavian Journal of Public Health. 2015; 43:447–452. Originally published online 7 April 2015, doi: 10.1177/1403494815579477.
3. Freimann T, Pääsuke M, Merisalu E. Work-related psychosocial factors and mental health problems associated with musculoskeletal pain in nurses: a cross-sectional study. Pain Res Manag. 2016;3:9361016. Originally published online 12 October 2016, doi: 10.1155/2016/9361016.
4. Freimann T, Merisalu E, Pääsuke M. Effects of a home exercise therapy programme on cervical and lumbar range of motion among nurses with neck and lower back pain: a quasi–experimental study. BMC Sport Science, Medicine and Rehabilitation. 2015;7:31. Originally published online 4 December 2015, doi: 10.1186/s13102–015–0025–6.
5. Sarquis LMM, Coggon D, Ntani G, Walker-Bone K, Palmer KT, Felli VE, Harari R, Barrero LH, Felknor SA, Gimeno D, Cattrell A, Vargas-Prada S, Bonzini M, Solidaki E, Merisalu E, Habib RR, Sadeghian F, Kadir MM, Warnakulasuriya SSP, Matsudaira K, Nyantumbu B, Sim MR, Harcombe H, Cox K, Marziale MH, Harari F, Freire R, Harari N, Monroy MV, Quintana LA, Rojas M, Harris EC, Serra C, Martinez JM, Delclos G, Benavides FG, Carugno M, Ferrario MM, Pesatori AC, Chatzi L, Bitsios P, Kogevinas M, Oha K, Freimann T, Sadeghian A, Peiris-John RJ, Sathiakumr N, Wickremasinghe AR, Yoshimura N, Kelsall HL, Hoe VCW, Urquhart DM, Derrett S, McBride D, Herbison P, Gray A, Vega EJS. Classification of neck/shoulder pain in epidemiological research: a comparison of risk factors, disability and prognosis among 12,195 workers from 18 countries. Pain. 2016;157:1028–1036. Originally published online 7 May 2016, doi: 10.1097/j.pain.0000000000000477.
6. Vargas-Prada S, Coggon D, Ntani G, Walker-Bone K, Palmer KT, Felli VE, Harari R, Barrero LH, Felknor SA, Gimeno D, Cattrell A, Bonzini M, Solidaki E, Merisalu E, Habib RR, Sadeghian F, Kadir MM, Warnakulasuriya SSP, Matsudaira K, Nyantumbu B, Sim MR, Harcombe H, Cox K, Sarquis LMM, Marziale MH, Harari F, Freire R, Harari N, Monroy MV, Quintana LA, Rojas M, Harris EC, Serra C, Martinez JM, Delclos G, Benavides FG, Carugno M, Ferrario MM, Pesatori AC, Chatzi

L, Bitsios P, Kogevinas M, Oha K, Freimann T, Sadeghian A, Peiris-John RJ, Sathiakumr N, Wickremasinghe AR, Yoshimura N, Kelsall HL, Hoe VCW, Urquhart DM, Derrett S, McBride D, Herbison P, Gray A, Vega EJS. Descriptive Epidemiology of Somatising Tendency: Findings from the CUPID Study. Plos One. Originally published online 29 April 2016, doi: 10.1371/journal.pone.0153748.

7. Coggon D, Ntani G, Walker–Bone K, Palmer KT, Felli VE, Harari R, Barrero LH, Felknor SA, Gimeno D, Cattrell A, Vargas–Prada S, Bonzini M, Solidaki E, Merisalu E, Habib RR, Sadeghian F, Kadir MM, Warnakulasuriya SSP, Matsudaira K, Nyantumbu B, Sim MR, Harcombe H, Cox K, Sarquis LMM, Marziale MH, Harari F, Freire R, Harari N, Monroy MV, Quintana LA, Rojas M, Harris EC, Serra C, Martinez JM, Delclos G, Benavides FG, Carugno M, Ferrario MM, Pesatori AC, Chatzi L, Bitsios P, Kogevinas M, Oha K, Freimann T, Sadeghian A, Peiris–John RJ, Sathiakumr N, Wickremasinghe AR, Yoshimura N, Kelsall HL, Hoe VCW, Urquhart DM, Derrett S, McBride D, Herbison P, Gray A, Vega EJS. Epidemiological differences between localised and non-localised low back pain. Spine. Originally published 19 October 2016.
8. Merisalu E, Animägi L, Oha K, Freimann T, Sirk T. Job-Specific Factors and Prevalence of Multiple and Disabling Musculoskeletal Pain Among Office Workers, Nurses, and Caregivers in Estonia. Proceedings of the Latvian Academy of Sciences. Section B: Natural Exact and Applied Sciences. 2016;70:286–293.

ELULOOKIRJELDUS

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Haridus:

2010–2017	Tartu Ülikool, meditsiiniteaduste valdkond, peremeditsiini ja rahvatervishoiu instituut, doktoriõpe
2002–2004	Tartu Ülikool, arstiteaduskond, õendusteaduse osakond, terviseteaduste magistrikraad (õendusteadus)
1996–2002	Tartu Ülikool, arstiteaduskond, õendusteaduse osakond, diplom õendusteaduse erialal
1972–1975	Tartu Meditsiinikool, diplom meditsiiniõe erialal
1969–1972	Elva Keskkool

Töökogemus:

1999–	Tartu Ülikooli Kliinikum, ülemõde
1994–1999	Tartu Ülikooli Kliinikum Maarjamõisa Haigla, ülemõde
1991–1994	Tartu Kliiniline Haigla kardiokirurgia osakond, vanemõde
1990–1991	Helsingi Ülikooli Keskhaigla III kirurgiakliinik, südame-intensiivravi osakond, õde
1988–1990	Tartu Kliiniline Haigla intrakardiaalsete uuringute röntgen-angiograafia laboratoorium, operatsiooniõde
1982–1988	Tartu Kliiniline Haigla kardiokirurgia osakond, vanemõde
1976–1982	Tartu Vabariiklik Kliiniline Haigla, kardiokirurgia osakond, õde
1973–1976	Tartu Vabariiklik Kliiniline Haigla, siseosakond, õde

Õpetamine:

2006–2009	Tartu Ülikool, arstiteaduskond, õendusteaduse osakond, õendusteaduse assistent
2010–	Tartu Ülikool, meditsiiniteaduste valdkond, peremeditsiini ja rahvatervishoiu instituut, mittekoosseisuline lektor

Liikmelisus:

2003–	Eesti Õdede Liit (mentorliige)
2006–	Euroopa Õendusjuhtide Assotsiatsioon

Teadustöö põhisuunad: skeleti-lihasvalud õdedel, riskid ja ennetamise võimalused.

Publikatsioonid:
Kaheksa teadusartiklit eelretsenseeritavates rahvusvahelise levikuga ajakirjades ja seitse rahvusvahelise konverentsi ettekannet (teesid) konverentsi kogumikes ja rahvusvahelise levikuga ajakirjade eriväljaannetes. Üks teadusartikkel ja kolm konverentsi ettekannet on avaldatud ajakirjas Eesti Arst.

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