Exposure, musculoskeletal disorders and organisational aspects of hospital cleaning work.

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ABSTRACT

The ambition of this report was to enhance the implementation of ergonomic interventions by presenting two articles deriving from the same project. This project had the aim to survey and analyse the physical as well as psychosocial workload in cleaning and office work.

The first study describes the development and validation of a method for self-registered work tasks, their occurrences, frequency and duration by using a task diary. The aim was to validate the feasibility of a diary in order to calculate work exposure during over a longer period. After participating in a semi-structured interview and a consensus forum to define the work tasks, the subjects (22 female office workers and 20 female hospital cleaners) used the diary for ten days. During one of these days an observer followed the subject for a whole work day, continuously noting all performed tasks, their duration and shift of tasks. After coding all tasks in the diary and observation protocol, the comparison was made.

The hospital cleaners in this study were part of a larger study of how to organize hospital cleaning and the larger study was an epidemiological survey of all hospital cleaners on two major hospitals in the south of Sweden. The aim was to determine the influence of work organisation on work environment exposure and musculoskeletal health.

Data on individual factors, psychosocial factors, symptoms from muscles and joints as well as self-rated physical load, was collected by postal questionnaire and an interview. Furthermore a physical examination of the neck and upper limb was performed.

Direct technical measurements were performed on a subgroup of 46 subjects during a whole workday; muscular load (EMG) of neck and shoulder muscles, positions and movements of the head, back and upper arms (inclinometry) and for the wrist (electrogoniometry). In addition general activity as heart rate, walking/sitting (posimeter) and number of steps (pedometer) was registered.

The results from the diary study showed that a task diary could be used to obtain a valid assessment of "job exposure", which might be used when performing interventions.

The results from the study of how to organize cleaning work, showed that working in an extended organization in contrast to a traditional organization gave a lower frequency of musculoskeletal disorders and a lower physical as well as psychosocial exposure.

Both studies have practical implications, firstly it was shown that using a diary could improve the calculating of work exposure, secondly it is now possible to make recommendations on how to design a sustainable work organization for hospital cleaning.

LIST OF PAPERS

Unge J, Hansson G-Å, Ohlsson K, Nordander C, Axmon A, Winkel J, Skerfving S. Validity of self-assessed reports of occurrence and duration of occupational tasks. Ergonomics 2005;48:12-24.

Unge J, Ohlsson K, Nordander C, Hansson G-Å, Skerfving S, Balogh I. Differences in physical workload, psychosocial factors and musculoskeletal disorders between two groups of female hospital cleaners with two diverse organizational models. Int Arch Occup Environ Health 2007;81:209-220.

CONTENT

INTRODUCTION

BACKGROUND

Suffering from muscles, soft tissue and joints complaints s a reality for many individuals in the general population. The problems and consequences of musculoskeletal disorders (MSDS) are by now well-known and described.

It is now evident that a significant part of the MSDS are linked to exposure in work (Buckle & Devereux, 2002; Bongers et al., 2006; Carroll et al., 2009; Farioli et al., 2014).

On an individual level, the work related muscular skeletal disorders (WMSDS) are often a cause of long-term sick leave and early pensioning. This implies economic consequences at many levels, both for the individual and society (Pålsson et al., 1997; Norlund et al., 2000). Thus, it is of great importance to implement preventive actions.

In such work it is of great importance to be able to identify the risk factors. Several work conditions have been suspected to play an important role in the development of disorders. In 1997 it was stated in the publications by the National Institute of Occupational Safety and Health in the USA, NIOSH, (NIOSH, 1997) and the National Research Council (NRC) and the Institute of Medicine (NRC, 2001), that awkward postures, force and repetition showed high evidence as to relationships between physical exposure and disorders, especially so for disorders in neck/shoulders; individually as well as in combination. For low back pain, heavy physical work, awkward postures as well as vibration were shown to be of significance.

The Swedish Work Environment Authority (Arbetsmiljöverket), also demonstrated an ambition to identify risk factors in order to create different guidelines used in preventive measures in real work settings (AFS 1998:1; AFS 2012:2).

Moreover forceful exertions and highly repetitive work tasks have proved to be risk factors for the neck /shoulders as well as elbow/hands (Roquelaure et al., 2009; van Rijn et al., 2010; Mayer et al., 2012; Gallagher et al., 2013).

There is a well-documented large difference in work exposure data between occupations which has to be considered (Hansson et al., 2009; Hansson et al., 2010) as well as a different prevalence of disorders (Palmer, 2003; Nordander et al., 2009; Nordander et al., 2013).

Muscular activity has since long been, and still is, of interest to describe the physical workload (Jonsson, 1982; Åkesson et al., 1997; Hansson et al., 2000; Balogh et al., 2016). There are several measures concerning the muscle activity.

When regarding muscular load as a risk factor three dimensions have to be considered – frequency, amplitude and duration (Winkel & Matthiassen, 1994).

An important theory is the concept of "gaps" (Veiersted et al., 1990, 1993), which might indicate the possibility to alter motor unit activation. Another aspect of the muscular activity is the pattern of the load (Mathiassen & Winkel, 1991; Nordander et al., 2000).

Measures to detect variation in work postures between minutes as well as within minutes, has lately been proved to be valuable to describe load in different work tasks (Arvidsson et al., 2012; Balogh et al., 2016).

To the body of knowledge, also individual traits and an individual susceptibility such as subjective stress/tendency to worry and Type A behaviour were added as contributors to a sophisticated pattern (Hägg, 1990; Nordander et al., 2004). One rather early theory was that a type A-behaviour facilitates muscle tension, which in turn might lead to disorders due to accumulated metabolites (Hägg et al., 1990; Theorell et al., 1991; Sjøgaard, 1993). It can be argued that muscle tension and Type A behaviour can be reflected by a higher muscular activity.

The psychosocial factors have since a long time been focused when investigating WMSDS (Bongers et al., 1993; Walker-Bone & Cooper, 2005; Östergren et al., 2005; Burton et al., 2009; Burgel et al., 2010; Arvidsson et al., 2016). These studies show that psychosocial factors may be an important part of the development of disorders.

In connection to these organisational factors at the workplace also important since these may influence both the physical load as well as the psychosocial climate (Arvidsson et al., 2012; Gerr et al., 2014; Balogh et al., 2016).

PREVENTION

To be able to perform effective preventive interventions, it is essential to have thorough knowledge of the present work situation. To make a survey of the work setting, including physical as well as psychosocial conditions, is therefore necessary. Moreover the prevalence of musculoskeletal disorders should also be registered, as well as the characteristics of the work organization.

The interventions could have different focus. It could be focus on an individual level; occupational factors related to risk as well as design of equipment and the workstations (Kumar & Kumar, 2008). Besides, intervention can be targeting the employees by individual training e.g. cognitive behavioural training and physical coordination (Jørgensen et al., 2011; Jørgensen et al., 2012). Another approach can be to make interventions on an organisational level - the size of working groups, work schedule and the distribution of work tasks (Westgaard & Winkel, 2011; Öhrling et al., 2012). On the organisational level factors as the structure and different models of leadership are of importance. To limit the intervention to the individual level is not enough to ensure successful interventions, the organisational level must not be overlooked (Westgaard & Winkel, 2011). Changes in legislations for instance e.g. weekly working hours and duration of vacations might also have interventional effect.

It is also known that the psychosocial work conditions are of importance. Thus such conditions must be included in the intervention.

PHYSICAL EXPOSURE ASSESSMENT

To develop effective preventive interventions in order to prevent WMSDS, it is crucial to assess parameters of significance (the risk factors) in quantitative terms. This data is also needed when establishing dose-response relationships. To a certain extent such efforts have turned out to be successful (Nordander et al., 2013; Heilskov-Hansen et al., 2016; Nordander et al., 2016). Moreover, to establish limits for physical exposure, data in quantitative terms is necessary (Nordander et al., 2013). This work would create a scenario where primary as well as secondary prevention would be realistic.

To divide work into white or blue collar work has been used to characterise the core of different occupations for a long time. Another way to define the work exposure has been to use job title. This, however, is to simplify the work exposure and has proven to be too blunt a tool because individuals with similar job content can be exposed to quite different workloads (Nordander et al., 1999).

There are many ways to obtain data on the physical exposure; e.g. by electrical or optical devices. Moreover, different types of self-reports can obtain information.

All methods to assess physical exposure are based on different technical entities. Before choosing the methods to evaluate work exposure, some matters have to be considered. The methods represent different levels of exactness, versatility, time perspectives and costs (Figure 1). Besides, the methods require a different amount of participation.

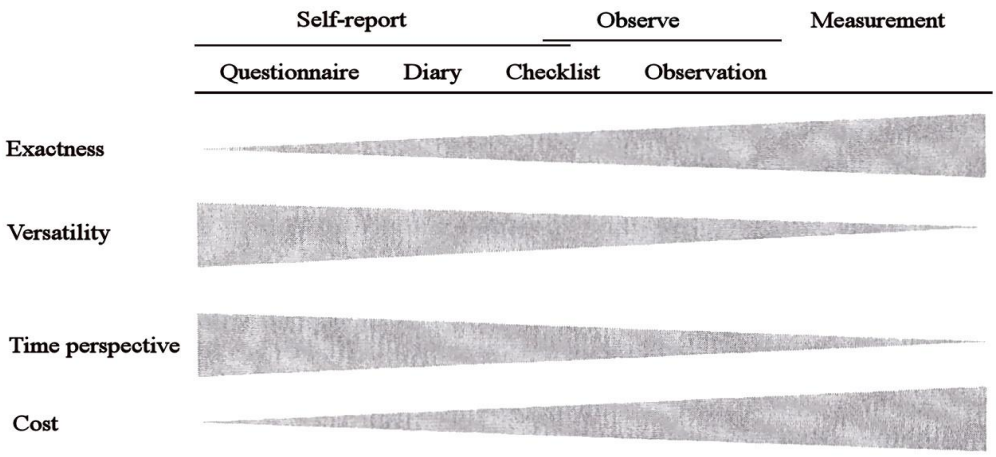


Figure 1. Some strategy aspects of usability in assessing physical exposure. Modified after Balogh 2001.

If a study will comprise a large population and exposure data is required, a questionnaire may be suitable. The cost would be rather low, the data would not be highly exact, but the exposure could be evaluated over a longer time period. Moreover, the registered exposure variables will have a high versatility. On the other hand, using

technical measurement will give data with exactness but to higher costs. To evaluate the exposure data can be combined with e.g. a diary.

Self-reported exposure assessment

Questionnaires are often used but they are usually rather comprehensive and have several disadvantages concerning the complete understanding of the questions, combined with the uncertainty of memory. Also the respondent is alone and unable to obtain any clarification of the purpose or a rephrasing of the questions, moreover the questions may not even be applicable.

There exists a multitude of different questionnaires, one example is the physical mechanical exposure index (MEI) (Balogh et al., 2001; Östergren et al., 2005), generating a lot of information from many persons at a low cost, but not as precise as technical measurements (see Figure 1).

A way of trying to get information from many individuals could be to use *diaries/log books* of different kinds where the employees note the prevalence of tasks and their duration. This might give a picture of the distribution of the tasks. The diaries could be used for a day´s exposure, several whole workdays, weeks or even months. In combination with direct technical measurements it would give possibilities to calculate time weighted job exposure (Heilskov-Hansen et al., 2014).

An *interview* is yet another approach which also gives information about exposure. These have the advantage of complementary communication, but may be complicated by the unsuredness of recollection. A semistructured interview can be used as the medical history when investigating musculoskeletal disorders. Such interviews are performed by different professionals e.g. within the occupational health. This method has the advantage of complementary communication.

Observation methods

To observe is most likely the first choice when to scoring the physical workload. There are a number of different observation methods based on checklists, describing for instance frequency and duration of positions and tasks. It could be a direct observation or an analysis made from filming. Some methods are restricted to assess the upper extremity, whole body exposure movement, manual handling, and defined positions as sitting but there are also more general methods.

A substantial number of observational methods (30) are evaluated by Takala et al. (2010). Some of the most familiar are (in abbreviation) ERGAN (earlier ARBAN), OWAS, VIDAR, RULA, HAL and EWA.

There is no possibility to use a "golden standard" to establish validity for some of the aspects sought for when using an observation method. Also it is concluded by Takala et al. (2010), that the methods generally are more reliable when macro-postures and work

actions are in focus. It is advantageous that several of the methods should be used, supported by more qualitative methods to give an overall impression of potential risks.

Technical measurements

Over time there has been a significant development for the technical possibilities to register physical exposure. Earlier the limitations of the technical methods only made it possible to register information for a shorter duration. The development has now made it possible to register data during much longer time, e.g. a whole working day.

One base for registration has been and still is, optical devices like the MacReflex system (Josefsson et al., 1996). Another way for registration is different portable devices like the Abduflex (Ericson et al., 1994), a trunk flexion analyzer (Ericson, 1994) or the "nickometer" (Johansson, 1996). However, this type of equipment was rather awkward to use. The technical development as to electronics and sensor technology offers now other possibilities to register physical exposure.

As to registration of postures and movements, *inclinometers* and *electrogoniometers* can be used. Muscular activity can be evaluated by *electromyography* (EMG). To obtain knowledge of the general activity e.g. walking (number of steps), sitting/squatting (% time) *pedometers* and *posimeters,* respectively, can be used. As a measure of circulatory load during work, heart rate can be registered.

All these methods generate a large amount of data on a very detailed level. These methods are used in real work setting and have proven to have high precision (Nordander et al., 2004; Hansson et al., 2006; Balogh et al., 2009).

The level of the information from different methods varies in a fundamental way. Some gives a summary of exposure over time; part of a day or several days while others give exact information of the status at a given millisecond. The latter gives the chance of seeing a pattern of exposure, which seems to be crucial from a physiological point of view.

The demand and criteria for methods feasible at work sites are that they have to be easy to apply, not to heavy or spectacular thus allowing the same work technique as usual.

There is at present a wealth of ongoing development as to applicability, for instance small compact sensor systems and other solutions to meet the demands to make equipment smaller, lighter and able to store more information.

ASSESSMENT OF MUSCULOSKELETAL DISORDERS

Self reported complaints

A widely used questionnaire to assess musculoskeletal complaint is the Standardised Nordic Questionnaire (SNQ; Kourinka et al., 1987). This is focused on self-reported complaints (pain, ace and discomfort), during the last twelve months, the last seven days

and inability to perform daily work any time during the last twelve months. SNQ has proved to be repeatable, sensitive and useful for screening purposes but to determine clinical diagnosis an examination is needed (Palmer et al., 1999).

This questionnaire has also been modified with respect to frequency of complaints (Östergren et al., 2005).

Physical examination

A more objective way to register disorders is to perform a physical examination. A protocol for physical examination for neck and upper extremity was suggested by Waris et al. (1979) and Viikari-Juntura (1987). According to this protocol diagnoses could be decided according to specific criteria.

Ohlsson et al. (1994) developed this concept further into a set of criteria, later slightly modified (Sluiter et al., 2001; Juul-Kristensen et al., 2006). Hence, two diagnoses, Cervicalgia and de Quervain´s disease, were added. Further some of the elbow/hand diagnoses were revised according to Sluiter et al. (2001). The kappa values for the inter-examiner agreement have been shown to be good (Nordander, 2004).

Several studies include clinical examinations sometimes with modification as to the criteria (e.g. Palmer & Smedley, 2007).

A shorter form of a clinical examination has been constructed, Health Surveillance in Adverse Ergonomic Conditions (HECO), useful in clinical survey of occurrence of musculoskeletal disorders within the field of occupational health (Jonker et al., 2015).

Register studies

From the Social Insurance (Försäkringskassan), data concerning frequency and duration of sick leave periods can be obtained. This enables to calculate the costs and to make comparisons between different occupational groups (Pålsson et al., 1997; Norlund et al., 2000).

Data derived from this type of study can be linked to occupational conditions and thereby elucidate the relation between disorders and exposure (Dalbøge et al., 2014).

PSYCHOSOCIAL RISK FACTORS AND EXPOSURE ASSESSMENTS

To consider psychosocial aspects in the working environment has only been the case for some decades. The interplay between bio-psycho-socio factors has been shown to be important for the development and coping strategies for many MSDS. The studies at the Boeing factory in Seattle during the 1980´s demonstrated the importance of psychosocial factors for developing disorders in the back (Bigos et al., 1991). Thus a connection between psychosocial factors at work and back pain was suggested.

Several aspects in working life may be associated with musculoskeletal pain, as earlier mentioned physical workload, but in combination with psychosocial work factors, for

instance perceived stress and high work demands (Kraatz et al., 2013). Thus the psychosocial work situation has to be taken into consideration and has been elucidated by several researchers (Ariëns et al., 2001; Bongers et al., 2006; van Rijn et al., 2010, Arvidsson et al., 2016).

The complexity of the matter is further emphasised by Mayer et al. (2012), who declared that the four cause-effect factors (physical, psychosocial, environmental and ergonomic) must be considered when neck and shoulder disorders are the focus. The fact that these two areas – physical as well as psychosocial work environment are interlinked was showed in one-year follow up study of neck-shoulder complaints (Östergren et al., 2005). The authors stated that physical factors and psychosocial singularly showed an increased risk but when combined induced a multiplicatory and synergetic risk. This pattern was most evident in women.

Theories

One might argue that psychosocial factors either functions as stress or coping strategies. Several questionnaires derive from the theories and hypothesis on how different agents for stress reactions and coping strategies might give different responses interpreted by the individual's perception. Thus individuals are posed questions on how they perceive different variables in order to assess the impact of psychosocial risk factors. This makes the theories interlinked with the assessment and therefore the questions are constructed in accordance with the theoretical concept.

There are several models of interest in this field, for instance the *demand-control model* by Karasek (Karasek & Theorell, 1990). Several types of psychological demands, such as cognitive demands, high time pressure, high working pace, difficult and mentally demanding work and so on are identified as are different types of control. The control dimension holds decision authority and skill discretion, which can be combined into the term decision latitude. To this model it was added a theory of social support (Johnson, 1986). The aspects of emotional support, social integration and interpersonal social relations have been focused on in the field of coronary heart disease, particularly for women (Wang et al., 2005).

In connection with the demand-control model by Karasek several approaches are available; the first is "job-strain" with high demands and low decision latitude, the second is "active learning" which states that learning and development is enhanced when the demands are high as well as the decision latitude. Further there is the "dynamic hypothesis" which states that development over time as a learning process and stimulates feelings of control, thus reducing stress and load. When the model was expanded with the aspect of social support the idea of "iso-strain", with low control, high demands and low social support was addressed and considered more severe for developing disorders (Persson & Ørbæck, 2014; Karasek & Theorell, 1990).

The model effort and reward (*effort-reward imbalance model*, ERI), by Siegrist (1996), is often referred to when psychosocial aspects are discussed. Also this model has been developed and resources added and formed a job demands-resources model (Demerouti et al., 2001). Another angle, which might be linked to resources, is the concept of organisational justice and it has proved to be a predictor of psychosocial health (Elovainio et al., 2002).

A strategy for developing the psychosocial work environment in a favourable way has been suggested by Rubenowitz (1991). This strategy holds five dimensions; control, stimulation, climate, work strain and fellowship. A questionnaire was constructed with these dimensions as a base (Ohlsson et al., 1995).

In organisational sciences there is a focus possibilities of individual growth (Meurs & Perrewé, 2011). By the use of feedback, development of different skills and planning, negative response can be prevented. The balance models are not considered to be sufficiently elaborated when taking into consideration the individual´s adaption and learning from experienced stress, the importance of time and past experiences when dealing with stressful situations or how the expected outcome of a stressful situation influences response to stressors (Meurs & Perrewé, 2011).

Assessment

There are several ways to obtain data. Typically it is represented by different questionnaires but also by heart rate or hormone markers in saliva.

As to questionnaires, among the most commonly used are by Karasek & Theorell (1990), the QPS-Nordic (Lindström et al., 1997; Lindström et al., 2000), SF-36 (Sullivan et al., 1995) and the Copenhagen Psychosocial Questionnaire (COPSOQ; Kristensen et al., 2005). The latter gives extensive information on both psychosocial aspects and work organisation, based on 30 dimensions. A great amount of psychosocial questionnaires have been reviewed by Kopp et al. (2010).

WORK ORGANISATION

The organisation has a large impact on the physical as well as the psychosocial work environment. There is a large amount of different models on how to organise the work and there is and has been developments over time.

Historical review

The most genuine way to organize a work was probably the work situation for the craftsman. He owned and controlled the whole process. He was also the owner of all equipment and tools. Moreover, he made all the decisions concerning the work. He was the master of the total procedure. However, due to the guild system there were regulations and restrictions, which limited the work for the craftsmen.

During the latter part of the 18th century, the first phase of the industrialization took place. One of the most obvious differences was that the work now was performed in special buildings – factories. The new way to organise working life had wide consequences on the working conditions and the individuals were exposed to hazardous work factors e.g. dust, noise and heavy materials handling in awkward positions. Since then, the industrial work has been, and is still the target of on-going changes.

Thus, to a large extent industrialisation was characterized by splitting up the work. This was introduced by Adam Smith in 1776 and further developed by Charles Babbage in 1832. However, it was not until the work of Frederick Taylor (1911) became known, as their approach was addressed in a large scale. One aim with the "Taylorism" was to increase the efficiency and thereby the production. This could be achieved by fragmentizing the work process. Dividing the work into small items induced easy teaching and easy learning. The workers performed their shares with high skill and high speed – time consumption could be reduced. Taylor presented two theses – there is a best way and the right man in the right place to perform a work task (Johansson & Abrahamsson, 2008). Moreover, in some aspects this model induced evident costs as the work had to be scrutinized and controlled on several levels.

These ideas, presented as "Scientific management", also led to the separation of "manual work" and "intellectual work" (Eriksson-Zetterquist et al., 2015).

As time was an important and easily identified variable (for instance by methods-time measurement), the piece rate system was in this context a logical consequence.

Henry Ford was another important profile and his ideas concerning mass production and the introduction of the assembly line was for its time – the beginning of the 20th century – pioneering.

Fragmentizing the work process, the piece rate system and the focus of manual work resulted in repetitive and constrained work. This resulted in static muscle loads and certain pattern of movements. The consequences were an epidemic spread of WMSDS above all in neck and upper extremities (Buckle & Devereux, 2002; Nordander et al., 2009) – thus, there became a growing interest in other models on how to organise work.

The self-directed group

The Human-relations school was derived from a series of experiment at the Hawthorne factories during the latter part of the 1920's and early 1930's. The legacy from this

school, is to acknowledge the importance of social relations and that work is – to a large extent – a group activity (Johansson & Abrahamsson, 2008).

Another dimension of the organisation theory, was the sociotechnical one, where the social culture was integrated with the technical (Eriksson-Zetterquist et al., 2015). This theory was developed at the Tavistock Institute of Human Relations during the 1950's and derived from a combination of the Scientific management and the Human-Relation school (Johansson & Abrahamsson, 2008). This approach was linked to, among other influences, the psychodynamic perspective and had a far more complex view on how new techniques in society could influence individuals. Several professional groups studied together with a broad approach, mostly concerning the importance of the self regulated work group (Eriksson-Zetterquist et al., 2015).

So, within the sociotechnical movement, the whole amount of the performed tasks as well as the working group was central. The group was controlled from within, often with a rotation of leadership and the individuals had the possibilities to influence the technical devices rather than be defined by them. To sum it up by increasing abilities; increased skills, variety-increasing, redundancy of functions and discretionary distribution of job roles, this showed to be an effective organisation (Trist, 1981). One might argue that this organisation was characterized by a more organic and smooth adjustment of situation based requirements. This was linked to the possibilities and options at hand for the individuals in the group. The following was considered to be individual basic demands as to work content; variation, learning, making decisions, reputation, a connection between the work and the surrounding world and future aspirations, all in a modest and reasonable way (Thorsrud & Emery, 1969). Thus the self directed group gave the opportunities to perform a variety of tasks and for the members to help each other out. (Johansson & Abrahamsson, 2008)

In Norway experiments with partly self-directed groups were conducted during the 1960´s to enhance efficiency through the employees' creativity, inventiveness and ability. During the late 1960's this way of organising work came to Sweden and the first more known branch using self-directed groups was the car industry (Johansson & Abrahamsson, 2008; Eriksson-Zetterquist et al., 2015).

Lean production

During the 1980's the production technology and working organisation in Japan was in focus and this restored the way to organise production used in the 1950's (Johansson & Abrahamsson, 2008). That is that the "Scientific management", the control of the workers and the idea of rationalising, never was abandoned even if the methods-time measurement was left out (Johansson & Abrahamsson, 2008).

Several companies from USA and Europe looked closer at the Japanese factories and in particular at the Toyota factories. Thus the concept "Lean Production" was introduced, based on the book by Womack et al. (1990). This was the way of working at the Japanese

Toyota factories with a tighter flow and more control throughout the process to enhance quality and efficiency with a minimum of waste. This was a reflection of Fredrick Taylor's ideas of the "density" of the work as well as the optimisation of the work setting – the right component at the right time with the right quality – and all the employees on a mission to trim all that could be trimmed (Johansson & Abrahamsson, 2008; Sederblad et al., 2013).

Around the year 2000 the original Lean Production model was further developed, modified and reintroduced (Johansson & Abrahamsson, 2008; Sederblad et al., 2013). In Sweden it was adapted to the cultural context of the Swedish business life regarding aspects of participation, influence, the possibilities to take own initiatives and independence (Brännmark & Eklund, 2013; Oudhuis, 2013). Also the strong union, a tradition of communication between employers and employees as well an extensive legislation in work environmental issues influenced the adaptation (Brännmark & Eklund, 2013). This version appears to be more of a cultural transformation and closely related to a learning organisation were the creativity of the employees is emphasized as is other concepts to enhance innovation and flexibility (Johansson & Abrahamsson, 2008). So during the late 2010's the concept had spread to almost every sector of society, for instance day care and health care, but in a modified version (Johansson & Abrahamsson, 2008; Sederblad et al., 2013).

It might be argued that a lot of Taylorism is recognisable in these "new" production strategies (Johansson & Abrahamsson, 2008; Sederblad et al., 2013). At least the first version of Lean Production could lead to a more "anorectic" working life thus implying a risk of developing more musculoskeletal disorders (Johansson & Abrahamsson, 2008; Sederblad et al., 2013; Öhrling, 2014[a]). On the other hand in some cases it might lead to a better working situation, if the more developed model is used, so the picture is very complex and depends on the situation at hand and how the different parts are emphasised and implemented (Johansson & Abrahamsson, 2008; Oudhuis, 2013). To return to the core of the concept for the self-regulated groups appears to be a way to enhance the work situation.

CLEANING WORK

Cleaning work itself is a prerequisite for high quality both for the activity at hand as well as for the employees themselves, to reduce the risk for development of allergies or other diseases. Cleaning and moreover a clean environment has proved to improve productivity, reduce the wear and tear on inventories and buildings, thus giving less financial loses (Kumar & Kumar, 2008; Öhrling, 2014[a]). In pharmaceutical industries cleaning is of vital importance for the production itself.

Work conditions

Cleaning is exposed to unsuitable working conditions i. a. high frequency of awkward postures and highly physically demanding work in a environment which contribute to a

risky work setting (Kumar et al., 2005[b]). Even though the risks vary in different environments.

Cleaning implies a difficult exposure situation where several unsuitable conditions are present and both the physical and psychosocial situation is suboptimal (Chang et al., 2012). Several physical risk factors are present as well as potential chemical risk factors. Typically cleaning induces static muscle loads and repetitive movements, which are regarded as risk factors (Kumar & Kumar, 2008). Calvet et al. (2012) states that cleaning is "associated with a number of physical, chemical, biological and emotional hazards" (p. 161). Lynde et al. (2009) demonstrates in their study a strong link between cleaners and work-related symptoms of dermatitis and asthma, and Gamperiene et al. (2006), shows that risk factors for mental health problems also are present.

During the last decades the number of cleaners employed by cleaning companies has increased, thus an outsourcing of cleaning has taken place.

Several cleaners work during the daytime, as quite a few organisations aim at day time cleaning, for instance schools, offices and so forth. But there are several working places where this is unwanted for instance at large shops and therefore cleaners often work unsocial hours as well as split shifts and at different employers, which reduces the chances of recovery both physically and mentally. All these conditions are unbeneficial for a healthy life (Åkerstedt et al., 2012). Also they risk to be excluded from the working community at the workplace since they work early and/or late and tends to be invisible. These working hours are getting more common and recommendations from the EU discouraged against it already in the early 1990´s (93/104/EC).

Cleaning is in many ways not a very rewarding work. Studies have shown that it is the reverse – rude treatment, lack of respect and low appreciation (Chen & Skillen, 2006; Woods & Buckle, 2006). The fact that when the job is done is the base line and when not, causes reactions, is per definition not a situation to prosper in. Also the cleaners themselves tend to rank their work as less meaningful than other professions (Swedish Work Environment Authority, Arbetsmiljöverket, 2012).

Moreover, cleaning is a very strenuous work resulting in long sick leave periods (AFA, 2015).

Interventions

Öhrling (2014[a]) states in her thesis that there are many important recommendations from several studies, decades back, on how to improve the work situation for cleaners, but instead of improvement of health and cleaner´s working environment, the development seems to aggravate the situation with for instance even more monotonous work. She promotes the importance of a more holistic approach with a context that includes social and societal aspects.

Calvet et al. (2012) illuminates in their article the importance of the follow-up on ergonomic interventions otherwise the recommendations might be forgotten in a low-status work as cleaning. The authors report that the majority of the recommendations had been left out or even been reversed.

Cleaners were the professionals in Sweden that least experienced a systematic work with environmental issues to improve the working environment (Swedish Work Environment Authority, Arbetsmiljöverket, 2012). The fact that cleaners often work on someone else's worksite might complicate the ambitions to improve the situation (Öhrling, 2014[a]).

Organisational changes

Lean management is also present in cleaning and the cleaning companies tend to specialise in fewer tasks (Holley & Rainnie, 2012). This promotes quite the reverse to what is recommended with alteration to accomplish a varied exposure pattern. Even the number of employees is flexible and lean in relation to the need for the moment (Öhrling, 2014[a]).

It might be argued that the cleaners are better off in a public administration, since rules and regulations are more transparent in such an organisation. Examples from societal workplaces where the cleaning was outsourced and reduced, shows worse working conditions and a decline of quality (Öhrling, 2014 [a]).

Increasing time pressure increases the impact of the risk factors as well as lowers the quality of the work and decreases the possibilities to obtain pride and work satisfaction. Studies show that many cleaners takes own initiatives to compensate in time or/and tasks to obtain a sufficient result (Hägg et al., 2008).

Hospital cleaners

Not only are the hospital cleaners exposed to all risk factors that cleaners in general encounter, but they are at higher risk injury categories defined by Alamgir and Yu (2008), compared to healthcare workers in general. This includes ergonomically aspects but also for instance contusion, cuts, allergies. Salwe et al. (2011) showed that the highest injury rates and morbidity of all employees at the hospital, was for the cleaners.

Also there are special circumstances in hospitals addressing cleaning and to prohibit the spread of infections. Dancer (2009), shows that better cleaning, has a positive impact on the decline of nosocomial infections. The authors point out that cleaning should become an "evidence-based science", which among other methods could use techniques from the food industry.

Another study on hospital cleaners by Calvet et al. (2012) showed the high cognitive demands due to the complex situation with staff and patients. Also quick changes of scenario make it impossible to perform the cleaning of the rooms in a geographical order and to remember what task to continue with, or find the equipment someone

moved away. Further the cleaners had to move many objects, an example –"polish the floor of a corridor", where 27 items had to be moved, twice.

OFFICE WORK

Office work has been subjected to great changes during the three last decades, mainly, due to the transition to computerized work tasks. Earlier work tasks in a office setting was typically machine typing, handling papers (sorting, stamping, signing, stapling, copying, using punch, filing, put in a binder, archiving), using calculator, taking shorthand, make telephone calls, send mail, faxing information, attending meetings, deliver messages and so on. This work could mean work tasks implying movement, while others were very stationary as for example typing using a "dictaphone", but the lowest common denominator being "paper". The majority of work tasks were usually performed by women.

To work in an office scenario nowadays indicates in general a sitting-down computer driven situation. This implies among other things, an immobile individual in a stressful environment with continuous input. As to the risks of sedentary time they are clearly demonstrated by Biswas et al. (2015).

Computerization has a large impact on many levels simultaneously, for example biomechanically, psychologically (work demands and conditions) and how the work is organised. Stressors might be triggered and the diversity of tasks reduced thus influencing the variability of muscle activity. Some tasks may be simplified and others become more complex. In addition to one´s profession it is also expected to master the software, implying greater demands on cognitive processes and decision making thus introducing new psychosocial stressors. Also on an individual level the person is expected to generate more output and this might result in more work during leisure time to compensate for not mastering the techniques and soft ware. Deadlines exacerbate these conditions (Lindgren Griffiths et al., 2007). Mainenti et al. (2014) shows the importance of taking breaks and using an adequate working technique.

So the computerization is not simply an improvement or a worsening. It could imply "deskilling" or "upgrading" (Eriksson-Zetterquist, 2015), making the tasks more abstract and the social situation more isolated, the tasks may become more fragmented but it could also make the work /tasks more flexible, more competent, varied and interesting.

The computerization also generates different and more demands on the office environment as to lightning, ventilation, furniture, space and so on. The design of the equipment is also essential, inducing unsuitable or awkward positions resulting in higher demands on muscles and joints. But the handling of the equipment equally important, i.e. the possibilities to adjust the ergonomic factors. Thus the physiological response might be a result from a psychological demand, as well as a physiological demand or a combination between the two, but the structures concerned partly the same (Lindgren Griffiths et al., 2007; Cho et al., 2012).

Also computerization seems to generate longer working hours and in addition many people use the same type of devices in their spare time maintaining at least the same physical exposure. The long exposure times has been proved a large risk factor for disorders (Hakala et al., 2010; Lindegård et al., 2012).

AIMS

The main aim of this work is to enhance the work of ergonomic interventions in order to prevent musculoskeletal disorders.

Specific aims:

- To validate a task diary as to occurrences of tasks, their frequency and duration.

- To describe the influence of two different professions (cleaners and office workers) on the agreement between a task diary and direct observations.

- To determine if a work task diary would be a feasible method for calculating job exposure.

- To evaluate if the physical and psychosocial workload for female hospital cleaners, is related to organisational factors.

- To decide if the prevalence of neck and upper limb disorders is influenced by organisational factors.

DESIGN

The two studies in this Licentiate thesis derived from a large population based study, the "Malmö Shoulder Neck Study" (MSNS; Östergren et al., 2005). This was a prospective study, based on a comprehensive questionnaire with the aim to decide the influence of the physical, as well as the psychosocial exposure on the 1-year incidence of neck/shoulder complaints. This study was is in turn a part of the "Malmö Diet and Cancer Study" (Östergren et al., 2005). The aim for our research group in the context of MSNS, was to validate the questions concerning the physical exposure, using technical measurements (Hansson et al., 2001; Balogh et al., 2004). In order to evaluate the question of validity, two different occupations with a large contrast in physical exposure, where chosen– office work and hospital cleaning. For the study of office workers three units were chosen, one was a printing company and the two others were municipal offices. The hospital cleaners were employed in two different hospitals.

All participants answered a postal questionnaire (the same as used in the MSNS). Moreover an interview was carried out as well as a physical examination.

Finally, direct technical measurements were used to register physical workload in two subgroups of female office workers and hospital cleaners. The data from the group of office workers is not included in this report. In addition in Study I, the hospital cleaners and office employees registered their work tasks in a task diary and was simultaneously observed during work.

PARTICIPANTS AND METHODS

Participants

Study I comprised 20 female hospital cleaners as well as 22 female office employees (Table 1). Study II comprehended 246 hospital cleaners, 135 subjects belonged to a group with a traditional organisation (TO) and 111 participants to a group with an extended organisation (EO), (Table 1).

Table 1. The number of participants in the two studies – their mean age and employment time.

	Study I		Study II	
	cleaners	office workers	cleaners, TO	cleaners, EO
Number	20	22	135	111
Age (years) (m; range)	43 (23 - 59)	54 (47 - 63)	45 (24 - 62)	44 (21 - 64)
Employment time (years) (m; range)	14 (2 - 25)	16 (2.2 - 35)	15 (0.5 - 29)	14 (0.3 - 40)

Methods

Study I

In Study I, the two occupations (office work and hospital cleaning) with different types of exposure were selected in order to test if the subjects were able to write a task diary to show occurrences and duration of tasks during ten days. One of these days the subject was observed and a observation protocol was established to be compared to the diary of that specific day. This was also the same day an extensive battery of direct technical measurements was carried out.

Task diary

In the study of the validity of a task diary, it all started with a survey to accumulate a picture of the tasks at hand as well as the terminology used by the subjects. In combination with visits at the work place, a semi-structured interview with each subject was performed. The ambition with this procedure was to establish which tasks where at hand and the correct term for them, as well as to achieve a consensus about the content of each task. At the same time the purpose of the study was elaborated and motivation sought for.

Both for the cleaners and for the office workers some major tasks were identified and used when predefining the tasks used in the diary. The tasks breaks/pauses and meetings were used by both groups. A physical task diary for each subject was used for writing down the tasks agreed on in a practical form – as a figure or an abbreviation continuously during the whole workday.

There was a large discrepancy between the different ways of keeping the diary as shown (in Swedish) in the Figures 2 and 3 below.

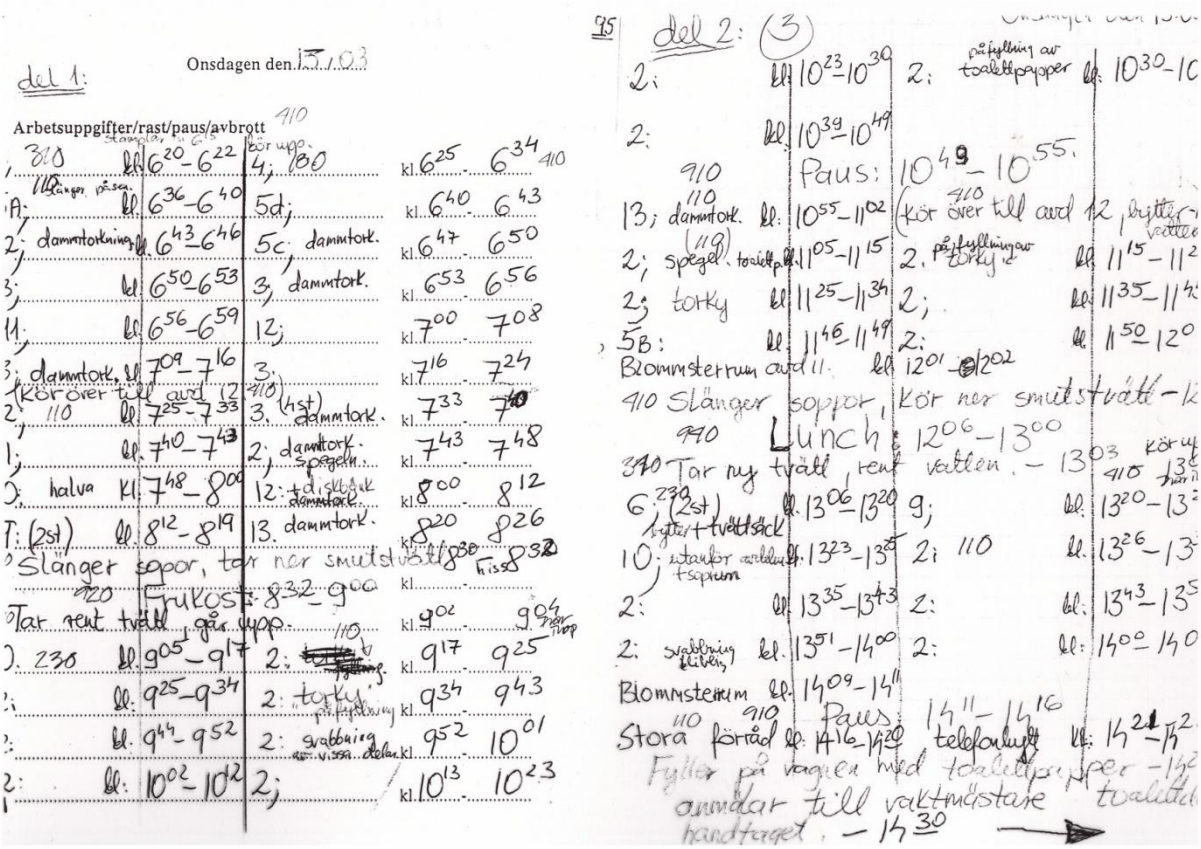


Figure 2. An example of a diary with a high resolution as to information.

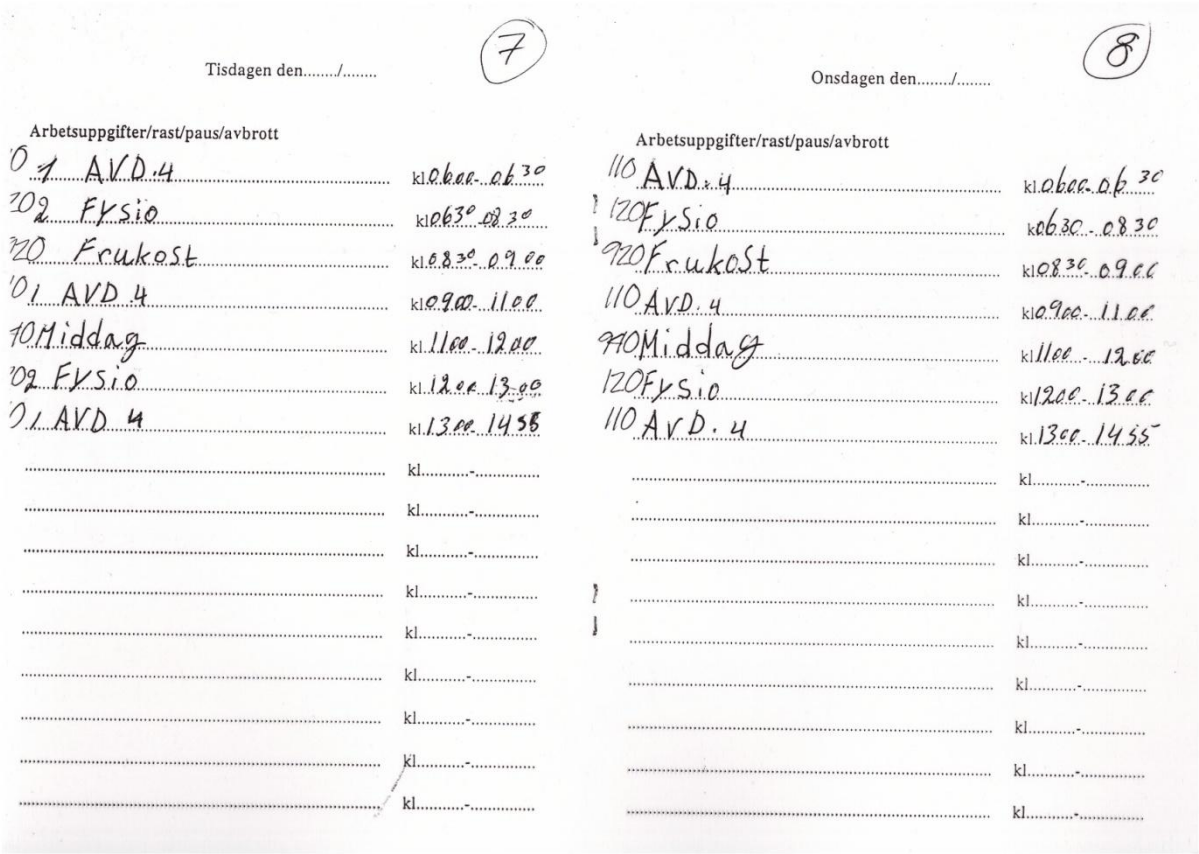
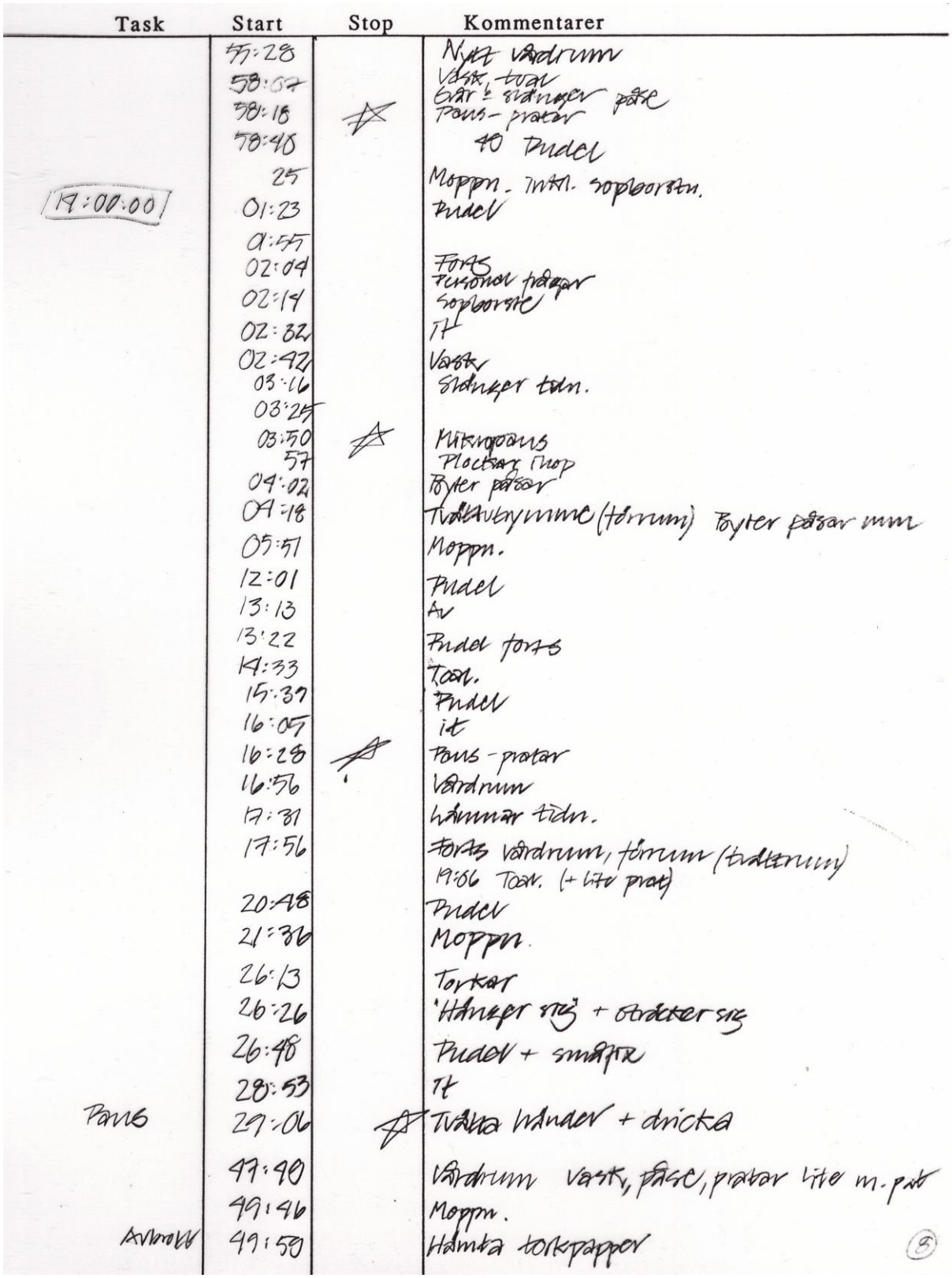


Figure 3. An example of a diary with a low resolution as to information.

Expert observations

In Study I the participants were followed by a expert observer ("the shadow") from a few meters, writing a protocol (see Figures 4 and 5). This was as earlier mentioned during one of the ten days that the diary was used, during the whole working day. The task diary and the observers protocol was then matched on a time resolution present in the diaries as to the commencement and termination for each task in real time. A time resolution of 3 minutes was used for the observation protocol, which in its original form was far more detailed and the diaries in general far more less detailed, which is natural since the mission for the office workers and cleaners was to accomplish a day´s work and observers mission to observe and note a day´s work.



Task	Start	Stop	Kommentarer
	57:28		Nytt vårdrum
	58:07		Vask, tvål
	58:18		Byter + städvagn påse
	58:48		Pausa - pratar
	25		40 Pudel
19:00:00	01:23		Moppn. Inkl. sopborsten.
	01:55		Pudel
	02:04		Forts
	02:14		Personal frågar
	02:32		Sopborste
	02:42		Tt
	03:16		Vask
	03:25		Städvagn tdn.
	03:50		
	57		Mikropause
	04:02		Plockar Chop
	04:18		Byter påsar
	05:51		Tvålautomat (förrum) Byter påsar mm
	12:01		Moppn.
	13:13		Pudel
	13:22		Av
	14:33		Pudel forts
	15:37		Tom.
	16:05		Pudel
	16:28		tt
	16:56		Pausa - pratar
	17:31		Vårdrum
	17:56		Hämtar tdn.
			~~Forts~~ Vårdrum, förrum (tvålautom)
			19:06 Tom. (+ lite prat)
	20:48		Pudel
	21:36		Moppn.
	26:13		Torkar
	26:26		Hänger sig + borstar sig
	26:48		Pudel + smäpta
	28:53		Tt
Pausa	29:06		Tvätta händer + dricka
	47:40		Vårdrum Vask, påse, pratar lite m. pat
	49:46		Moppn.
Avbrott	49:50		Hämta torkpapper

Figure 4. Example of an observation protocol.

"pudelgarnen" mycket slitna → händer ofta att de lossnar från skaften.

Task	Start	Stop	Kommentarer
	9:03:30		förbereder för städning, hämtar nya trasor, viker, packar
transport	9:06:00	9:07:09	sachen med städgrejorna släpande efte sig fyller på mtrl på städvagnen
transport	9:10:32		
korridor	9:11:13	9:17:50	torrmoppar (flyttar undan en del möbler) + sopar upp.
transport			
hygienrum	9:18:15		handfat,
	9:18:50		duschar av mattan, tar bort H_2O med gummiskrapa.
	9:20:10		toalettstol
	9:20:57	9:23:35	pudeln på golvet
hygienrum			p-korgar X 2
	9:24:50		handfat, toalettstol
	9:27:05	9:29:42	pudel
transport			
duschrum	9:30:43		"spritar", spolar av golvet, torkar av
			9:31:54 rensar avloppshålet från hår
	9:32:35	9:34:48	pudel (ont om plats!)
undersökningsrum			spritar handfat, torkar ytor, p-korg,
		9:37:50	tvättar ytor.
korridorr	9:37:51	9:46:45	torrmoppar 4776
undersökningsrum		9:49:01	torrmoppar ~~undersökning~~ + sopar upp.
transport			
kök	9:51:40		hand-fat
	9:52:35		torrmoppar
	9:53:41		p-korg ~ 10 sek
			forts. torrmoppar + sopar upp. +
			våtmoppar (pudel)
			9:57:38 ner på knä, tar bort fläck
		9:58:22	på golvet ~ 7 sek.
AVBROTT			prutskund
patientrum	9:59:23		handfat, p-korg
	10:00:02		torrmoppar

3

Figure 5. Yet another example of an observation protocol.

Coding

To be able to validate the diary, every task in the diary as well as in the observation protocol was coded according to a coding structure in line with the agreement during the semi-structured interview. The whole structure of main tasks and subtasks generated a three digit level, for instance general cleaning 100 was divided into subgroups i. e. cleaning of wards 110 and yet another sublevel i. e. cleaning of toilette/washroom 111. Both the diaries and the observation protocol (see Figure 4 and 5 above), were coded in the same way with as high precision as possible. A time resolution of 3 minutes was chosen for diary and observation protocol to enable a fair comparison.

Study II

In Study II, two groups of hospital cleaners who worked in two different organisational models were compared with the focus on the impact of the organisational models on physical exposure and musculoskeletal disorders, thus a cross sectional design. One being organised in a more traditional work lay out and the other group was organised in a more group oriented model.

Questionnaire

A comprehensive postal questionnaire was used to obtain *individual factors* such as age, employment time, current work tasks, smoking habits, single living (with and without children) and country of birth. In addition *self-assessed physical workload* such as positions and movements expressed as "hardly not/not at all", "somewhat" or "a lot" was asked for.

The self-assessed physical workload was registered through 11 questions concerning work postures and materials handling with a three-point response scale (1-3; hardly nothing, somewhat and a great deal), forming a mechanical exposure index (MEI; Balogh et al. 2001). Physical exertion during work, was assess by a 15-grade scale verbally anchored from "very, very light" (1) to "very, very heavy" (13), i.e. a modified Borg scale (Borg, 1990; Balogh et al., 2004).

Also, according to The Standardised Nordic Questionnaire (Kourinka et al., 1987), *subjective musculoskeletal disorders* were recorded. The questions were confined to complaints during the last 7 days.

The *psychosocial factors* were assessed by three dimensions; job demand, decision latitude and social support (five, six and six items, respectively). Four response categories were used and three indices were calculated (Karasek et al., 1998; Östergren et al., 2005).

Interview

The interview focused on *individual traits*. One of these traits was the tendency toward developing subjective stress/worry, both during and outside work (Ohlsson et al., 1995). Moreover, *habitual muscular tension tendency* was registered by 11 related questions (Theorell et al., 1991; Ohlsson et al., 1995; Nordander, 2004). The personality trait, type A behaviour, was assessed according to Hägg et al. (1990).

Physical examination

The physical examination was performed on all participants in connection with the interview by two physicians and one physiotherapist, all well acquainted with the method. Symptoms and signs were recorded in a standard protocol (Ohlsson et al., 1994). Pain, numbness and limitation of movement in the neck and upper limbs were registered. Besides, detailed additional examinations, as, e.g., pain-provoking tests of the relevant region, were performed. Diagnoses were made by the examiner in conjunctions with the examination. These were based on the earlier mentioned slightly modified standard set of criteria. Each individual could receive more than one diagnosis.

Technical measurements

Participants for registration were chosen according to information of age and subjective complaints (never/sometimes or often/very often) during the last 12 months, registered in the questionnaire. As to the cleaners there were two groups according to age; younger or older than 45 years.

General activity was assessed by registering the number of steps with a pedometer (Fitty-3 electronic, Kasper & Richter, Uttenreuth, Germany; Balogh et al., 2004). The positions sitting/standing were registered with a tilt sensor applied to the thigh (Posimeter 100, Biolin, Mölndal, Sweden; Balogh et al., 2004). Heart rate was recorded by a heart rate meter (Sport Tester TM PE 3000R, Polar Electro OY, Kempele, Finland; Léger & Thivierge, 1988) and heart rate ratio (HRR) calculated based on the heart rate at rest and the estimated maximal heart rate (Balogh et el., 2004).

Positions and movements of the head, back and both upper arms, were registered by inclinometry. Triaxial accelerometers were used to measure the inclination relative to the line of gravity (Åkesson et al., 1997; Hansson et al., 2001; Unge Byström et al., 2002; Hansson et al., 2006). Movements and wrist angles were registered on both wrists by flexible biaxial electrogoniometers (M1110, Biometrics Ltd, Cwmfelinfach, Gwent, UK; Hansson et al., 1996; Unge Byström et al., 2002; Hansson et al., 2004).

Muscular activity was recorded by electromyography (EMG) bilaterally by surface electrodes on the descending part of m. trapezius (Hansson & Mikkelsen, 1997; Åkesson et al., 1997; Nordander et al., 2004).

Portable data loggers were used for sampling at 20 Hz for both inclinometers and electrogoniometers, but for EMG a sampling frequency of 1024 Hz was used (Hansson et al., 2003).

Description of the two organisations

As to the second study it was performed with hospital cleaners in two different county councils in the south of Sweden, at hospitals with similar medical specialities. One hospital in each county was comprised. Both of these organisations had been traditional (see below), however, two years earlier, the organisation of cleaning work in one of the counties changed to become a more extended model with, for instance, enlargement of work tasks (see below).

The traditional organisation (TO) is in line with the way hospital cleaning has been described earlier and the most common type of organisation. A top-bottom hierarchical structure and the cleaners worked alone, often at a far distance from "the base". They worked normally the same area every day and it could be divided into smaller zones without reasonable geographical connection. The cleaners were organised in groups of about 20 subjects with a supervisor handling the administrative work, such as making working schedules, plan the daily work, keep in contact with the wards and replace staff during sick leaves and vacations. An introduction education (2-4 hours) was given. Agreements about the content of the cleaning work were made on yet another, higher level in the organisation.

The departments only decided on agreements that mainly included cleaning of floor and sanitary areas such as lavatories and shower facilities. Hence, due to economical reasons the consequences of this was that the work tasks were monotonous, for instance one individual could clean 48 lavatories during one day.

In *the extended organisation* (EO), all cleaners had earlier worked according to a "traditional" model, but the county was exposed to a comprehensive change of the organisation as to cleaning. A long process throughout the whole cleaning organisation processed this change.

In addition to a 2-4 hours long introduction, all cleaners attended a residential education for altogether a week including among other things; cleaning technique (for instance to clean with less wet methods), equipment, machines, chemicals, purchase of materials. Moreover, there where lectures and discussions on how to deal with conflicts, group dynamics and how to handle feedback from clients/departments. Environmental questions and psychosocial work conditions were also the focus during this week.

The cleaners worked in groups of 6-8 subjects and one person was appointed head of the group with for instance responsibility for economy, to replace staff during sick leaves and vacations. But this person also participated in the daily work.

The group was the first contact for the client/customer/ward and thus received feedback, both good and more difficult. This was intentional to make everyone aware and take part, sharing the responsibility within the group for their specific working area. The procurement was handled by the head of the cleaning organisation but in close cooperation with the head of the group.

Each day the group started with a meeting where the work was discussed and planned. The cleaners had the option to work in pars or individually.

A part of the reorganisation was a scrutinization of the entire organisation to find other suitable work tasks except for cleaning work itself. This resulted in the fact that possible and adjacent tasks and missions were allocated into the business area. For instance conference service, rental of child chair seats, managing the staff shop, running a laundry service and so on, tasks that formed the extended work organisation.

STATISTICAL METHODS

In Study I only descriptive statistics were used as different comparisons were made between the two professional groups as well as between each professional group and the expert observer, illustrated by graphical presentations of line of identity as well as of regression.

Student´s *t*-tests were used in Study II to analyse the impact of organisational differences for the comparison of age, employment time, physical workload and psychosocial factors as well as individual traits. Fisher´s exact test was applied for testing categorical variables as immigrants, single mothers, smokers, musculoskeletal complaints and diagnoses.

RESULTS

STUDY I

Concerning the agreement between the task diaries and observation protocols, as to the total time spent in each task, it was evident for both occupations that there was an overestimation of the main task in the diaries. Breaks/pauses were instead underestimated, more so by the cleaners. Less time consuming tasks were overlooked. For instance, quite a few of the office workers missed reporting the task "meetings".

As to the number of changes between tasks, they were underestimated, more so by the cleaners. Also there was a "coincidence-error" in the time information – the subjects gave the same number of changes during the same time volume, as the observation protocol, but the time set for start and stop of the tasks differed.

STUDY II

When comparing the two cleaning organisations, there were no differences as to background factors and individual traits between the two groups. However, the proportion of immigrants was higher in the TO group.

As to the physical exposure registered by technical devices, the EO group displayed significantly lower loads as to velocities for the head, upper arm and wrist. However, for the postures the only statistical difference was registered for the head as the TO group worked to a greater extent with forward flexion.

As to the measures of general activity, number of steps and time spent in sitting/squatting there were no statistical differences. However, the TO group had a higher circulatory load during work, measured as HRR (heart rate ratio). Also, concerning MEI there was no differences between the two groups.

Regarding muscular load in *m. trapezius*, there were no differences as to the 10th, 50th and 90th percentiles of the amplitude distribution, but the proportion of muscular rest was significantly higher for the EO group.

As for the psychosocial factors the dimensions influence and work demand were more beneficial for the EO group. The social support showed no differences.

There was a higher prevalence of complaints as well as of disorders in neck/shoulder and elbows/hands for the TO group but not statistically significant. Also, the TO group had a seven times higher frequency of overused hand syndrome.

DISCUSSION

METHODOLOGICAL ISSUES

Study I

One purpose to use a diary is to be able to extend task based exposure data to a job exposure profile.

In this study, some of the differences between the diary and the observation protocol elucidate the need of a thorough communication process before using the task diary. It also shows that practical issues in the real work can overthrow a theoretical discussion. For the cleaners this meant that they noted location of the task rather than the content.

To achieve a valuable diary, it is essential that the expert observer is well acquainted with the characteristics and content of the work. This in order to, during the discussions, understand and interpret the information given. As to this study, the four observers had, through earlier experience from occupational health and occupational medicine, a good knowledge of the work conditions in the two professional groups. Therefor we regard the information from the preceding discussions and the notation in the protocols as reliable. Besides, a pilot study with the same approach was carried out and provided useful experience.

An aspect, which complicates the diary method, is that the subject´s conception of the work limits the levels of details that can be included in a useful task definition. Some problems became evident when coding the information in the diaries, one being the difficulties to ensure the limitations of the task. Thus there was a tendency to cluster the tasks, i.e. some supplementary tasks tended to be included in the main tasks as well as tasks with a shorter duration being overlooked. This could lead to an overestimation of the main task as to duration. Moreover, there is a risk for underestimation as well as for overestimation of the workload when calculating job exposure, depending on the character of the tasks included. Thus, it is essential to register the beginning and end of each task.

An overestimation can also be due to over reporting the more strenuous work task, possibly because they are easier to identify and remember (van der Beek et al., 1994; Viikari-Juntura et al., 1996; Åkesson et al., 2001; Meyland et al., 2014).

Another aspect of applying a diary as a method is the large differences in the way to register tasks in the diaries, ranging from the very detailed to the “copy paste”-version (se figures 3 and 4). Both versions have their drawbacks. The detailed one might imply an uncertainty as to the time aspects but can be preferable when planning interventions. The latter one can be regarded as too crude. However, Jonker et al. (2009), have shown that this level of resolution is useful when evaluating job exposure.

An earlier Danish study (Svendsen et al., 2005), stated doubts about the use of self-reported information on task exposure and suggests that strategies disregarding tasks should be prefered in many cases. However, the authors argue that it would be applicable information if the contrast between different occupational groups were large enough.

In spite of this, another Danish study (Heilskov-Hansen et al., 2014) showed how to transform the information from task exposure to job exposure on an individual level, using log books/diaries.

As to differences between the two professional groups in reporting, this can be due to practical reasons. The request of writing continuously during the workday might be more apt for the office workers. For the cleaners using a diary is a more definite and awkward interruption in the work situation. This may be one reason for the discrepancy between diary and observation for the cleaners.

To improve the feasibility of a work diary, it might be a good idea to apply one or two pre-training days with a concluding interview. To use different physical tools to record (for instance a mobile phone) would probably enhance the quality of reporting tasks.

In spite of the aspects mentioned above, the face validity in this study is good regarding the main tasks, but less for other tasks.

Study II

A favourable circumstance was that the total population of cleaners in the two hospitals was comprised in the study; even those on sick leave were included. The response rate was very high in both groups (89% and 95%) highest in the EO group. As to the high response rate, it might to a certain extent be due to the fact that the subjects were offered a physical examination. The somewhat higher response rate for the EO group possibly mirrors a larger motivation to participate due to their experiences of the organisational change.

We recognize that when evaluating an organisational change, a base line data would be preferable. But, as the two groups (TO and EO) did not differ neither with respect to background data, nor to the main tasks. Hence, it was possible to evaluate the consequences of the organisation.

However, the TO group had a larger proportion of immigrants. These individuals might have had a more strenuous work before arriving to Sweden, which in turn might have had an influence on the prevalence on the musculoskeletal disorders. As to subgroups chosen for technical measurements, there were no differences regarding immigrants.

When evaluating the physical workload in the subgroups of the TO and EO groups, it must be based on a sufficient number of subjects. A power calculation was used to certify that the number of subjects for direct technical measurements was sufficient

(Balogh et al., 1999). In the power calculation the inter-individual variation was considered.

As to the subgroup characteristics, the subjects who participated in the direct technical measurements were representative for their group (TO and EO respectively), which is obvious when combining Table 2 and 3 in Unge et al. (2007). We consider this to contribute to ensure the results to be reliable.

For the technical measurements, a voluntary participation was necessary. After the randomly selection, each subject was asked if they wanted to be included in the measurements. As to the compliance there were no differences between the two groups.

When evaluating the physical workload using technical measurements it is crucial that they are valid and reliable. The methods used in this study have proven to have high precision (Nordander et al., 2004; Hansson et al., 2006; Balogh et al., 2009). Thus we regard that the differences displayed between the two groups are true.

As this was a large study, the data collection was performed during several months, thus this period covered the seasonal variation in cleaning for both groups. Furthermore, the same research group was responsible for the whole data collection.

When in this way comparing musculoskeletal disorders in two organisational groups, it would have been an advantage if the examiners were blinded as to which group was examined. This was practically impossible and also since the type of organisation was not the focus from the start of the epidemiological study, this does not constitute a problem.

As to the results of the physical examination it might be argued that the fact that three examiners were involved in the study could be problematic. However, this method for physical examination has proven to have good inter-examiner agreement (Nordander, 2004). Thus this should not diminish the conclusions.

ASPECTS OF PHYSICAL AND PSYCHOSOCIAL WORKLOAD

Cleaning is characterised by high physical workload, in the same level as heavy industrial work (Hansson et al., 2009, 2010). The physical exposure profile for cleaner contains many of the risk factors for WMDSD (Hansson et al., 2009, 2010; Nordander et al., 2013; Nordander et al., 2016). Also, focusing on women, the work is heavier in relation to biological differences in maximal strength (Nordander et al., 2008). The study of risk of WMSDS for men and women in repetitive/constrained work by Nordander et al. (2009) shows that cleaning has the highest, or among the highest, reported prevalence for both complaints and diagnosis in neck/shoulders and elbows/hands. This was the case for cleaning in the traditional organisation as well as in the extended organisation. The present study points out the possibilities to create a more beneficial workload as well as a lower prevalence of disorders, when organisational changes are made.

One important issue for the physical workload is the possibilities for variation, linked to the theory of the ´Cinderella phenomenon´ (Hägg, 1991). Thus job enlargement and job rotation would enhance the possibility to muscular recovery. The EO group demonstrated a tendency to a larger proportion of muscular rest, possibly due to a larger variation in work tasks.

The fact that the EO group worked with a more upright position of the head and showed lower velocities for the upper arm and wrist might partly be due to the training in work technique and/or the enlargement of work tasks. Also the lower workload, presented as HRR and perceived physical exertion, for the EO group might also reflect a more beneficial working technique, enlargement of work tasks and possibly also a higher maintenance of the floor surfaces.

It is important to remember that the EO group accomplished their cleaning work to a full extent. Also the fact that there was no differences between the groups as to wrist and upper arm positions, levels of muscular activity during work, general activity (steps and sitting/squatting) or MEI, indicates that the same work was performed, but with different possibilities to alter the physical workload. Thus we believe that the more beneficial conditions for the EO group are linked to the organisation.

The fact that MEI did not show any differences might indicate that this index is too insensitive when the contrast in exposure is limited.

Since the tendency of stress/worry outside work did not differ between the groups it is another argument for comparability of the two groups. Thus, the differences at work might be linked to the type of organisation and also have an influence on the psychosocial conditions.

It seems as if cleaning in a traditional way generally means working on one´s own. This is also commented by Calvet et al. (2012), who stresses that cleaners, working alone, may feel isolated even on wards with many other professions. Gamperiene et al. (2006) states that contacts with other cleaners seems to have a positive effect on mental health, thus working in small teams or in pairs might be of importance. This might mirror the circumstances in the EO group with a consequence of a higher degree of influence in the work.

In the report on occupational exposure and back disorders (SBU report no 227, 2014) it is concluded that individuals that work in a situation with a high job satisfaction, get social support and reports a high influence over work-related decisions are likely to develop less back trouble than others. Although our study concerned neck/upper limb disorders, these findings might also have some bearing on the situation for the cleaners.

Evaluating the psychosocial factors in the two groups it is evident that the EO group had lower work demand and higher influence at work. In our opinion this is a consequence of the organisational change, which comprised an ambition to increase the professional

status of the cleaners. However, the degree of social support was equal in the two groups.

ASPECTS ON ORGANISATIONAL FACTORS

In the group with a traditional organization (TO) there was since some time been an ongoing rationalization of the cleaning work. This was evident when the content of the work was observed. It consisted to a large extent of cleaning of floor and sanitary areas. Westgaard and Winkel (2011) states in their systematic review that rationalisations in different forms have a dominant negative effect and induce health and risk factors.

On the whole the authors presents in a somewhat another article (Winkel & Westgaard, 1996) that the impact of rationalisations might partly explain the high prevalence of work-related problems in spite of ergonomic interventions. A more successful approach would, according to the same authors, be to also add, interventions on a more organisational level to the individual perspective (Winkel & Westgaard, 2014). This can be said to be the fact in the EO group. In this organisation there had earlier been attempts to achieve ergonomic improvement but without success, thus an organizational change was proposed.

As earlier mentioned, Lean production might be beneficial if modifiers such as: support, group autonomy, information, workers participation, procedural justice and so on are present. In the application of such a change there is an aspect of "participatory ergonomics" which includes many of the modifiers presented in the review by Westgaard and Winkel (2011). This perspective links to the characteristics of the extended organization in our study.

The characteristics of participatory ergonomics is the part taking of the employee in the survey and action plan to enhance the working conditions (Wilson & Haines, 1997). Kumar et al, (2005[a]) applied participatory ergonomics which led to enhance the cleaners´ health as well as to better cleaning results. Another example of participatory ergonomics implied on hospital cleaners is described in the article by Carrivick et al. (2005).

In general an organizational change as in our study, often is performed by a person with a high ambition to achieve successful improvement. In our case it was also important that the organisational change would increase the status of the employees within the business area in the total context of the hospital. This ambition also included to enhance the psychosocial climate i.e. increase the degree of influence. Naturally, in the course of the organisational change, there were strong reactions from the employees, which gradually faded out and to our knowledge nobody resigned due to the circumstances.

The work that promoted the establishing of the extended organisation is very much that of participatory ergonomics and of empowerment. The concept of empowerment can be divided into several parts, one being self-efficacy, which is linked to a person´s view on her capacity to make a change for herself (WHO, 1998, 2006).

The most obvious reason for the differences in WMSDS between the two groups (TO and EO) is physical exposure. However, in the extended organisation, the cleaners where made more visible and active and had more influence in their daily work and the interaction with other personnel had a positive effect (Gamperiene et al., 2006). In a study by Holtermann et al., (2012) concerning factors of importance for sustaining good musculoskeletal health, muscular strength as well as having a higher influence at work, is elucidated.

The cleaning occupation is interlinked with the development of the society as a whole. Öhrling (2014[a]) states that the cleaning departments are being outsourced, as it is not being a core mission for the companies or public administrations. This might imply lower prices and a decline of the working conditions. Parallel to this the improvement of equipment might lead to increased demands on efficiency, for instance less time needed for the job. So it seems that the cleaners loose again, the work becoming more impoverished and it may also imply in less working hours, part unemployment, lower pension and in many cases the cleaners compensating with their own spare time to achieve a, from their point of view, acceptable level of work (Hägg et al., 2008; Öhrling, 2014[b]).

On the other hand the organisational change for the EO has proven that it is possible to achieve better work conditions for cleaners. In fact this organisational form contained several important criteria pointed out by Johansson and Abrahamsson (2009) to create "the good work".

PRACTICAL IMPLICATIONS

In spite of the fact that the task diary is unsuitable for extracting task exposure from continuous direct technical measurements, it may play an important role when quantifying job exposure for jobs with a task distribution, which varies between days, when there is a contrast in task exposure. The diary/log book, as used in the Danish studies, is an effort to create a metrics to enhance the possibilities of guidelines for physical exposure.

The processing of the diaries gave a deeper and more thorough understanding of the work, the tasks included as well as the exposure pattern, thus enabling a tailor made intervention plan.

The impact of the organisation in cleaning work is evident. Such a change is demanding for the employees as well as for management, although rewarding. Also the conclusions support the notion that the effects of organisational changes seem to last over time, if the structure is sustained.

When organisational changes are performed a "participatory ergonomics" approach is essential. A prerequisite is that it is firmly anchored in the entire organisation and moreover sufficient time must be allowed for education and implementation. It is then possible to reach a "win-win-situation".

The importance of empowerment and introducing job enlargement should be considered. For employees who perform cleaning work it is fundamental to make the work more visible and to increase the status of the occupation.

Considering this model for organisational change it should be possible to generalise to other occupations, thus offering possibilities for a sustainable work situation.

GENERAL CONCLUSIONS

The results may offer opportunities to propose practical recommendations in order to improve preventive strategies in the work place.

Generally there was a underreporting of work tasks in the diary. The number of changes between work tasks was underestimated. The occurrences of the main work tasks were overestimated while the durations of breaks/pauses were underestimated.

For the office workers the accordance as to the main work task was very good, less so for the cleaners. The underestimation of breaks/pauses was more evident for the cleaners.

The diary may be useful for calculating job exposure.

The physical and psychosocial workload was more beneficial for the hospital cleaners with an extended work organization.

There was a lower prevalence of neck and upper limb disorders for the cleaners with the extended organization, most so for the neck/shoulder region.

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To tie these two studies together and finding them to have a place in the ambition to enhance working conditions, is after all not a bad feeling, but the price was high.

SVENSK SAMMANFATTNING

Ambitionen med detta arbete är att förbättra arbetet med ergonomiska interventioner genom att presentera två delarbeten, vilka båda härrör från samma projekt. Detta projekts målsättning var att kartlägga och analysera den fysiska och psykosociala belastningen inom lokalvård och kontorsarbete.

Metodstudien beskriver utvecklingen och valideringen av en arbetsdagbok för egenregistrerad av arbetsuppgifter, deras förekomst och duration. Syftet var att utvärdera om dagboken var ett användbart verktyg för att beräkna exponeringsdata under en längre tid.

En semistrukturerad intervju genomfördes och man nådde konsensus av definitionerna av arbetsuppgifter. Efter noggranna instruktioner fyllde deltagarna i en arbetsdagbok under tio dagar. En observatör följde deltagarna (22 kvinnliga kontorsanställda och 20 kvinnliga lokalvårdare på sjukhus) under en hel arbetsdag och gjorde kontinuerligt noteringar. Efter kodning av varje förekommande arbetsuppgift i dagboken och observationsprotokoll jämfördes dessa.

Personerna i detta delarbete utgör en delmängd av den grupp som ingår i delarbete 2.

Studien av organisationens betydelse inom lokalvård, genomfördes som en epidemiologisk undersökning som omfattar lokalvårdare på tre större sjukhus i södra Sverige. Samtliga lokalvårdare inom dessa organisationer ingår i studien. Syftet var att bestämma betydelsen av arbetsorganisationen för exponering och muskuloskeletal hälsa.

Individfaktorer, psykosociala faktorer och symptom från muskler och leder, samt egenskattad fysisk belastning registrerades med hjälp av intervju och enkät. Dessutom genomfördes en fysikalisk undersökning av nacke och övre extremitet.

På en delmängd (46 personer), genomfördes direkta tekniska mätningar under reellt arbete; muskelaktivitet (EMG) av nack-skuldermuskulaturen, ställningar och rörelser i nacke, armar och handleder (goniometri). Dessutom registrerades allmän aktivitet såsom hjärtfrekvens, gående/sittande (posimeter) och antal steg (pedometer).

Resultaten visar att en utvidgad arbetsorganisation gav en lägre frekvens av sjuklighet och lägre fysisk och psykosocial exponering.

Dessa två arbeten har en direkt praktisk användning inom det förebyggande arbetsmiljöarbetet.

Slutsatsen av metodstudien är att dagbok kan användas för att få en valid bedömning av “job exposure”, vilket kan användas vid interventionsarbete. Resultaten från studien av organisationens betydelse innebär att man kan ge direkta rekommendationer om hur ett lokalvårdsarbete bör organiseras och slutsatserna här kan generaliseras till andra områden än sjukhusstädning.

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