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Prevention of workload effects among welders

A preventive guide for welders

DEGREE PROGRAMME IN PHYSIOTHERAPY
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Abstract The aim of this thesis was to gather and provide evidence- based information about work ability and workload as a concept and the focus was on prevention of workload effects among welders. An electronic guide was created based on the current research available about the workload effects among welders. The prevention guide was created to be used welders study program in Länsirannikon Koulutus Oy Winnova. The literature gathered and used in this thesis was mainly from the previous 10 years, but still some literature and research about this topic was published over 10 years ago, but still were concerned reliable and applicable in relation to this thesis topic		
Keywords Work ability, workload, welder's work, ergonomics, strength training, endurance training		

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1 INTRODUCTION

In future, the prevention of workload effects becomes more important as the work careers get longer. This is caused by the increase in age when you can retire and get old-age pension (Työeläke 2022.) To be able to reach these long work careers, without early retirement caused by work related issues, it is important to focus on the prevention of excessive physical and mental load among workers. All work-related loading factors affect to the person in different levels, some might experience the load in physical or mental level, some might experience it in social level or as a combination of all three (Ahola, et al., 2015, 8.)

In this thesis the aim is to give general information about work ability and workload as a concept and the focus is on the prevention of workload effects among welders. Welder's work contains many variables, which can contribute to the workload, however quite little evidence-based research is done about the prevention of workload effects.

2 AIM AND OBJECTIVES

The aim of this thesis is to increase evidence-based knowledge about workload variables and work ability in welders work. The objective is to make a guide for prevention of excessive workload and for better work ability for the welder's study program in Länsirannikon Koulutus Oy Winnova. The guide will include information about work ability and different forms of workload in general, but the main focus is on the welders work and provides general information how it is possible to prevent the consequences of excessive workload for better work ability in the future welders' work.

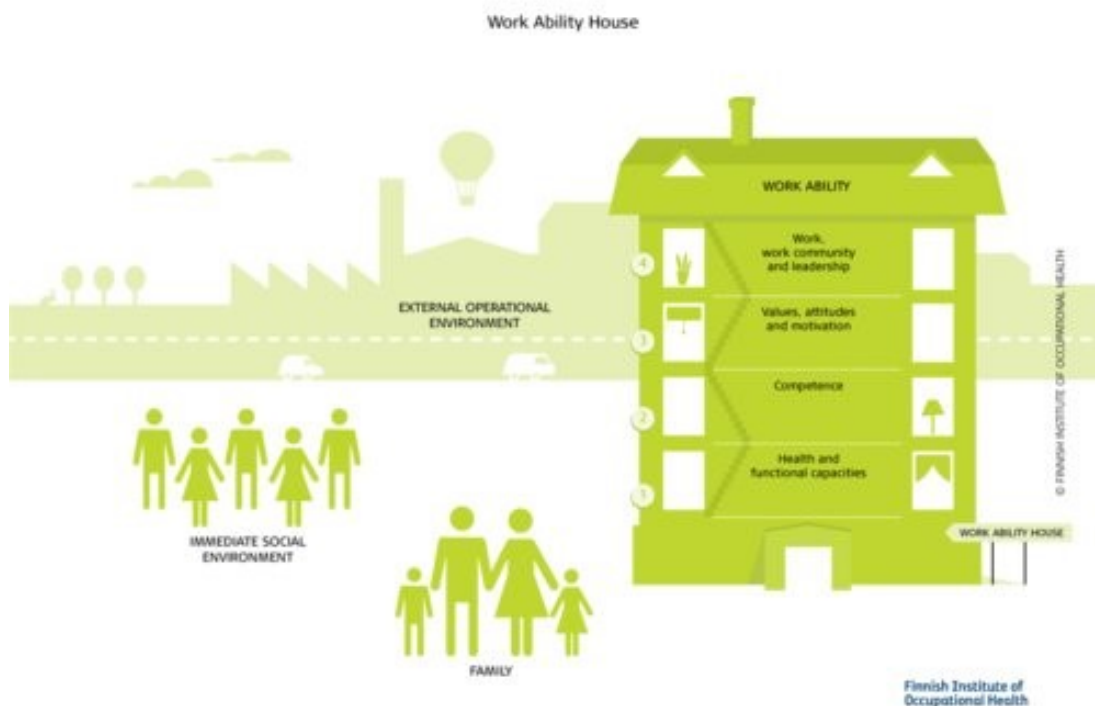
3 WORK ABILITY

3.1 Work ability as a concept

Work ability of a person can be described as a balance between individual, societal and company interest. (Ilmarinen 2021). However, due to the changes in social development, the definition of work ability has changed. (Ilmarinen, Gould, Järvisalo & Järvisalo 2006, 17- 34). Work ability is not only connected to an individual factors like, health, functional ability, or personality, but also to work related factors and other external factors which can either increase or decrease person's ability to work. (Kankainen, et al., 2008, 108- 119). Balance between these factors will ensure healthy working environment, in addition, longer careers, good work ability and employment. (Ilmarinen 2022).

In the future the importance of good work ability will stand out in challenges getting employees and in financing the social security, because of the demographic development. (Gould, Ilmarinen, Järvisalo & Koskinen, 2006, 13 - 34). International Classification of Functioning, Disability and Health (ICF) can be used when examining person's ability to work. ICF describes overall functional ability of a person from biopsychosocial point of view and does not only focus on persons health (Terveyden ja hyvinvoinnin laitos 2022.) The ICF includes three components: body functions and structures, activities and participation at societal and individual level and personal and environmental factors at contextual level. These components interplay and influence on persons health status internally and externally (Physiopedia 2022.)

Work ability can be divided into four different stages to describe different factors affecting to good work ability. These stages support each other and enable work ability. Juhani Ilmarinen has developed the concept of work ability house based on the research in factors influencing work ability. In picture 1, illustrating the work ability house, the different stages can be seen. (Työterveyslaitos 2021).



Picture 1. Work Ability House (Työterveyslaitos 2021)

In literature review done in 26.01.2022 as a part of implementation the Government Plan for Analysis, Assessment and Research, investigated how early supportive actions taken towards better work ability effects to the costs caused by decreased work ability. To take the supportive work ability into action, it depends if there is economic benefit from it. (Turunen 2022). Strong evidence from this literature review was that, promoting healthy living habits at workplaces has beneficial factors against somatic illnesses and mental health and the costs or disabilities related to them. (Ervasti, et al., 2022, 99). Individual stress management has shown positive influence in mental health, and managing stress influences on the sick leaves, to the costs and working ill. Adjustments in work or replacement of work while ill, enables early return to work from musculoskeletal illnesses (Ervasti, et al., 2022, 99.) Partial sickness allowance has positive influences on the time spend on work related disability and participation in work, in both, mental disorders and somatic illnesses. Individual psychotherapies, such as, short-therapies and web-therapies had positive outcome also in economical level, due to the decrease of sick leaves and working while ill (Ervasti, et al., 2022, 99.)

3.2 Health and functional capacities

Health can be explained as a complete physical, mental, and social well-being state of a person. (World Health Organisation 2021). Functional capacity can be defined as an ability for a person to have psychological, physical, and social skills to cope in meaningful and necessary everyday life functions, such as, working, studying, and taking care of themselves or others in the environment they live in. (Terveiden ja hyvinvoinninlaitos 2021). Health is important factor when we are talking about working, however good health does not always mean that the person has a good work ability and a person with decreased health status might not have limitations in his or her ability to work. This can be seen in work life barometer results mentioned in publication *Työkyvyn ulottuvuudet – Terveys 2000 tutkimuksen tuloksia* (2006), which shows that over half of the people suffering from chronic diseases, stated that illnesses do not influence their work ability. (Koskinen, Martelin, Sainio & Gould, 2006, 114-134).

Adequate functional capacities such as physical-, social- and mental- capacities are the cornerstone for successful functioning in working life and the expectation of functioning varies on the nature of the work. (Sainio, Koskinen, Martelin & Gould, 2006, 135-150).

Musculoskeletal and mental problems are the biggest challenge when we talk about factors decreasing work ability, especially among middle-aged workers. In article by Juho Korpi in *Fysioterapia* magazine, he writes about the effects of long sick leaves among aging people caused by musculoskeletal problems. The cost of lost working hours alone is over 400 million euros. He also states that early physiotherapy and rehabilitation could save millions of euros (Korpi, 2022, 44- 49.)

Living habits have huge impact to workability and health. Health promoting habits enable to keep adequate workability and health, studies have shown that physical activity improves workability. However, health issues and restrictions in workability may lead the person to change one's manners of living. (Koskinen, Martelin, Sainio & Gould 2006, 151- 161). Unhealthy living habits support the development of common

public diseases, such as, cardiovascular diseases, and this can have impact on persons health and workability. These unhealthy habits like smoking, excessive alcohol use or inactive lifestyle combined with unhealthy eating will increase the risk of common public diseases and obesity. Obesity can impact on person's ability to implement physically challenging tasks at work or excessive alcohol use can decrease person's ability for social, physical, or mental functioning (Koskinen, Martelin, Sainio & Gould 2006, 151- 161.)

3.3 Competencies

Competence is described in Merriam- Webster dictionary webpage as an individual's state or quality to have sufficient resources and skills to perform duties or particular responsibilities. (Merriam-Webster 2022). Basic education and professional skills, and knowledge create the base for work ability competencies. (Työterveyslaitos 2021). Improving and updating professional skills continuously is important because of the new requirements for work ability and skills, which evolve all the time in every field of industry. One greatly influencing factor for the need to increase and update professional skills, is the increase in work years. This kind of lifetime learning creates a solid ground for the competencies of work ability. (Työterveyslaitos 2021).

3.4 Values, attitudes, and motivation

Work ability is greatly influenced by persons own attitudes, motivation, and values towards one's work. There is a clear connection between these three factors, and all these will improve the persons interest to continue working. (Gould & Polvinen 2006, 169- 175). If the work is enjoyable and challenging enough, it will strengthen the work ability and well- being of a person. (Työterveyslaitos 2022). Work ability decreases if the person sees the work as an obligatory part of life and the work does not respond to the expectations person has toward the work. (Työterveyslaitos 2022). When we are looking at motivation as an influencing factor to persons work ability, we can divide motivation as internal and external factors. The internal motivation factors include working and tasks included in the work. When we look at the external factors, the

economic aspects are highlighted (Gould & Polvinen 2006, 169- 175.) The professional confidence and energy towards one's work improves the work well-being, as cynical and tiredness driven approach has been connected to increased work ability. (Gould & Polvinen 2006, 169, 175).

3.5 Leadership, work community and working conditions

When work is planned and managed effectively and the working conditions are designed well, the quality of the work and results will increase, and this will also have beneficial outcome on work ability. (Ahola 2011, 37). The support from foremens and co- workers and good working conditions enable high impact towards better work ability. (Tuomi, Seitsamo, Ilmarinen & Gould 2006, 176- 189). Men without the support of co- workers, restricted work ability was related to age group over 55 years and with women in all age groups. (Tuomi, Seitsamo, Ilmarinen & Gould 2006, 176- 189).

In work that mainly contains bad postures and demand excessive strength, restricted and decreased work ability is often experienced. These physically demanding tasks among workers have doubled decrease in work ability as among workers with lighter tasks (Tuomi, Seitsamo, Ilmarinen & Gould 2006, 176- 189.)

3.6 Assessment of work ability

Work ability assessment is usually done in collaboration with workplace and professionals in occupational health care. This enables good communication between workplaces, managers, and occupational healthcare professionals. When assessing work ability, not only the physical health should be taken in consideration but also the psychosocial variables. The work ability can be assessed with different questioners and meters at workplace and physical assessment is done by occupational professionals. (Ilmarinen 2021). One of these evaluation methods for work ability is the Work Ability Index (WAI), developed in Finnish Institute of Occupational Health

in 1980's for use in health examinations. Its functionality has been tested at both national and international levels. (BAuA 2022).

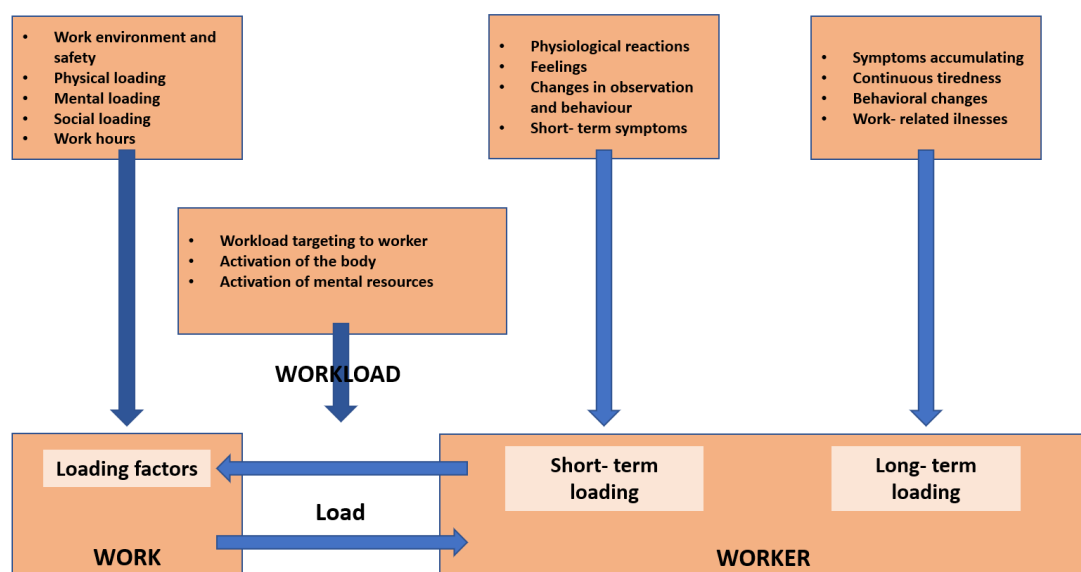
The physical assessment can be done by occupational health doctor or by occupational health physiotherapist for example, with muscle fitness test or with cycle ergometer, where cardiopulmonary functions are monitored during the test. These tests give results about persons physical fitness but does not take in consideration of the psychosocial aspects, for example, how the person feels pain or sees the present work ability. (Työterveyslaitos 2022).

4 WORKLOAD

4.1 Workload as a concept

Workload can be defined as a physical and mental load related to the work and the work process. (Teollisuusliitto 2022). Controllable and challenging workload can even increase well-being. When estimating the workload, we should not focus on one individual loading factor, the whole working process should be taken in consideration. (Ahola, et al., 2015,8.) Workload can be assessed with special assessment tools, such as TIKKA workload assessment tool, and is usually assessed by the occupational health care, occupational safety personnel or by other persons specialized in workload. (Ahola, et al., 2015, 3). Loading factors such as, work environment, methods used in the work process or how the work is organized, also the working hours, interaction and the functioning of the work community or organization can have an impact to the workload of a person. (Ahola, et al., 2015, 7). Physical workload can include repetitive movements, heavy lifting done with hands, poor working positions, or VDU (visual display unit) work. (Teollisuusliitto 2022). Other factors increasing physical workload can be, for example, high working temperatures, chemical substance exposure or excessive noise. (Teollisuusliitto 2022).

Mental workload can be increased by the nature of the work and how the work is arranged and how well the social aspects in the working community are carried out, all these can have impact on the workers' health. (Työsuojelu 2022). Mental or psychosocial workload can be assessed with guideline books or with surveys such as the psychosocial workload factors survey made by Regional State Administrative Agency for Occupational Safety and Health Administration in Finland. This survey can be used to examine psychosocial workload in companies, and it is done anonymously. Companies are obligated by the Occupational Safety and Health Act to identify and investigate loading factors in workplaces and in different work processes and to evaluate how it will influence to the health of workers (Työsuojelu 2022.) Exposure to excessive and long-term workload can lead to occupational diseases. These diseases are mainly caused by biological, chemical, or physical factors related to the work (Työterveyslaitos 2022.) In picture 2, modified workload model shows different factors influencing the workload. (Ahola, et al., 2015,8.)



Picture 2. Modified workload model. (Ahola, et al., 2015,8.)

4.2 Work environment

A well designed, healthy, and safe work environment increases effectivity, prevents accidents and illnesses. Work environment needs to be planned and built to meet the

requirements of the work and to offer safe working conditions and the premises together with equipment used in the work should be serviced regularly (Työsuojelu 2022.) In Finnish Occupational Safety and Health Act (Työturvallisuuslaki) are regulations and demands for good work environment and the responsibility to follow these regulations includes both parties, the employer, and the employee. If lack of any deficiency, or malfunction in equipment used in working environment is noticed, these needs to be corrected as soon as possible by either maintenance or renewal of the equipment. The employer is responsible of mapping hazardous risks in the work environment regularly and is responsible of correcting and minimizing the identified risks (Työsuojelu 2022.)

Workspaces should have enough room for working and moving around safely. Lighting, temperature, and well-functioning ventilation should meet the needs to perform the work. There are guidelines set for the temperatures for different works. The amount of free air in the workspace should be at least ten cubic meters per worker. The workspace should have sufficient first-aid equipment and firefighting equipment related to the risks and the nature of the work. Workspace floors and corridors should be clean and not packed with un-necessary items to prevent falls and stumbling's. Emergency exits needs to be marked clearly and should be accessible all times. Machinery and other equipment need to be positioned so that the work can be done easily and effectively and most of all, safely (Työsuojelu 2022.) At the workspace there should be chairs available if the work can be performed in sitting position. Chairs are needed also during the breaks so that the worker can unload the weight from his/her legs for a moment. If the work needs to be carried out in a high-risk location, easy access and safe working level with suitable safety equipment should be available. (Työsuojelu 2022).

Lighting in the working environment should be planned so that the work can be executed safely and there are no lighting variations which can cause momentary blinding and this way cause hazard risk. Insufficient lighting stresses the workers eyes and can cause mistakes when performing work tasks and this way create another hazard risk at the work environment. (Työsuojelu 2022).

The employer is obligated to arrange facilities to the workers for recovery and hygiene purposes. There should be enough facilities to accommodate the whole number of workers, and these are obligatory for the employer to provide. These facilities include eating-, dressing-, hygiene-, recovery- and waiting-rooms for the workers (Työsuojelu 2022.) Clean indoor climate at the work environment is important because poor indoor air quality can affect to the productivity and the work environment as well as to the atmosphere and the whole working community. Poor indoor climate can cause, for example, respiratory tract infections, headache, fatigue, and hoarseness of the throat. (Työsuojelu 2022). The employer has the primary responsibility to provide safe and healthy indoor climate, but everybody in the working community is obligated to report about issues in the indoor air quality. (Työsuojelu 2022).

In work environment biological agents can cause poisonings, infections, and allergies if a worker gets exposed to them. Exposure to these micro-organisms can lead to occupational illnesses or to other health related problems (Rantanen & Oksa 2006, 164.) Many different work environments can contain biologically originated impurities, such as, parasites, mold and yeast, bacteria or viruses and can be defined as biological risk factors. These impurities are often difficult to identify because those are normally not visible to the human eye. (Työsuojelu 2022). Exposure to a biological agent can occur via skin contact, ingestion or inhalation in a work where biological agents are handled or used, and this can lead to health issues. Exposure can also occur in a work where biological agents are not handled intentionally, but worker can still become exposed to them (Työsuojelu 2022.)

Biological agents are divided to four groups based on the hazard risk and working environment should follow precautions based on the risk level, for example, prevention of exposure or regular health examinations. (Rantanen & Oksa 2006, 165; Työsuojelu 2022). Employer is obligated to provide education and guidance about the prevention of possible health risks and provide action plan in dangerous situations. Employer needs to arrange sufficient protective devices and clothes for the workers, for example, respirator masks (Työsuojelu 2022.) Working with chemical agents is regulated by the law and the employer is obligated make sure that workers are protected from the hazardous risks of chemical exposure. (Työsuojelu 2022). Chemical agents include, for example, working with washing solutions, chemical

substances, lubricants, paints, or oils. Exposure agents, such as, fumes, vapors and exhaust gases produced during work process are included in definition of chemical agents. (Työsuojelu 2022). Workplaces use approximately 30 000 different chemical products and there can be dozens, or hundreds of products used in one workplace. Over 1 million workers get exposed to these chemical substances or to the combination of the substances in a year (Rantanen 2006, 116-117.) Exposure to these substances can cause skin diseases, occupational diseases, and other work- related illnesses on the workers. (Rantanen 2006, 116). In the degree of the Finnish government (715/2001) is stated that workplaces are obligated to provide adequate information about chemicals used in the work, exposure to them, and about the hazard risks and properties of the chemicals. This helps to identify and prevent safety risks at the workplace and ensure the safety of workers (Rantanen 2006, 117.) Employee is obligated to follow the work and safety instructions set by the employer. Employee is also obligated to report any deficiencies in safety and work-related issues, when working with chemicals (Työsuojelu 2022.)

Machinery and tools used at workplace provided by the employer, should be suitable for safe working, enable ergonomic working positions during the work, which is accomplished with the proper placement and use of the machinery, and should follow the regulations stated by the governments decree on the safety of machinery. The employer is obligated to provide adequate guidance and information about the use and safe operation of the tools or machines. When operating machinery or tools, safety and protective features should always be used and also instructions provided by the manufacturer should be followed. (Työsuojelu 2022.) Machinery and tools need to be maintained in good working condition throughout their lifespan and the use of them should be discontinued in case of any malfunctions or breakdown. The maintenance and regular checks can be done by a person, who is familiar with the structure and use of the machine, but in some cases expert checkup is needed. This is stated in Governments Decree on the Safe Use and Inspection of Work Equipment (403/2008). Machinery provided by the employer must have CE- markings, with the exception tools made before 1995 (Työsuojelu 2022.)

In work, if it is impossible to remove hazardous risks with work arrangements or with technical solutions, personal protective equipment must be used. The employer is

obligated to map these risks and offer necessary protective equipment for the employee. These will protect the worker from getting ill from the work and protects from possible injuries during the work. Personal protective equipment can contain safety helmets, hearing protection, fireproof clothing and safety masks or goggles (Työsuojelu 2022.) Protective equipment used in work needs to have CE- markings and the manufacturer needs to ensure that the demands of regulations are filled. Personal protective equipment should always be serviced, used, or stored to the manufacturers and to the workplace's norms (Työsuojelu 2022.) Employer is obligated to offer guidance for the use of protective equipment. (Työsuojelu 2022).

4.3 Psychosocial workload

Psychosocial workload can be defined as factors included in the work itself, organization of the work and as the social aspect in the work community. These factors can have major increase in psychosocial workload and can therefore affect to the health of the personnel (Työsuojelu 2022.) Companies should educate their supervisors to notice possible signs of excessive psychosocial workload, for example increased sick leaves, behavioral changes, or increased conflicts in the work community, as soon as possible. (Työsuojelu 2022). Work well-being such as finding the work satisfying and meaningful will decrease the psychosocial workload, resulting for example, as less work-related stress. (Ahola, et al., 2015, 7). Psychosocial workloads are not individual employee's problems, those involve the whole working community. The employer needs to actively investigate possible harms and dangers of psychosocial workload at the workplace and to be initiative for decreasing or avoiding them. Monotonous work can be one factor increasing the psychosocial workload, because it is always the work or working conditions which influence to the load, not the individual who does the work (Työsuojelu 2022.)

Employee's health, both psychological and physical, can be disturbed if harassment or other kind of unfair treatment is present in work environment, these can be for example constant threatening, unnecessary judging of the work outcome, outcasting from the work community or sexual harassment. (Työsuojelu 2022). If unfair treatment is seen at the workplace, the employer is obligated to take actions to resolve them. Employer

should actively follow the social well-being among the workers, this enables early prevention and better well-being at the work. The earlier the problems are noticed, the easier finding a solution to the problem will be. Workplace rules are a good way of preventing unfair treatment and harassment issues, everybody needs to follow same rules at the workplace and the consequences of delinquency are equal to everybody (Työsuojaelu 2022.)

Psychosocial workload can be affected also if there is threat of violence present in working community. The violence at the workplace can be described as a threat of violence, such as intimidating or harassment or actual physical violence, such as hitting, kicking, or attacking with the weapon (Työsuojaelu 2022.) Violence can be caused by for example, robbery or other purpose for violent action or it can be violence between a customer or co- worker. These situations can affect the workers well-being and increases the workload and stress level, it can also affect to the productivity of one's work results. Violent behavior is usually seen as intentional behavior but can also be a side-effect of some medical disease (Työsuojaelu 2022.) Employers are obligated to take actions to prevent workplace violence by the legislation of Finnish Occupational Safety and Health Act, employees are obligated to inform the employer immediately about any violent incidences at work. (Työsuojaelu 2022). Functional planning of the procedures and actions during the work and good workspace design can be a reducing factor for the risk of violence. However, these need to be assessed on regular basis by the company to identify possible new risk factors in work environment, arrangements in work, safety, and operating instructions and in education of the whole personnel, including new workers or substitutes, workers from another company that work at the same work environment and rental workers from different agencies (Työsuojaelu 2022.)

Working hours and especially shift work can have big effects on the workload both physically and in psychosocial level. Worker's work well-being, work ability, productivity and health can be affected by insufficiently arranged working hours. With good planning, managing and possibility of the worker to influence to the work hours, decreases the workload and improves the recovery of work. Better work ability and longer careers can be achieved with proper scheduling of the work (Työterveyslaitos 2022.)

Working in shifts might be economically beneficial and it can offer more leisure time but if the recovery time from work is inadequate, shift work can cause health problems. The brain and bodily functions can have either momentary or in worst cases, permanent changes affecting to the different parts of mental and physical health. The changes in sleeping pattern can also disturb social life. (Työterveyslaitos 2022).

4.4 Physical workload and physical factors

Physical workload can influence workers health. Uncomfortable feelings, symptoms, or illnesses and in the worst cases, occupational illnesses or loss of work ability can be results of excessive physical workload. (Ketola & Lusa 2001, 105). Musculoskeletal and cardiorespiratory problems are the most common causes of excessive physical workload. (Ahola, et al., 2015, 28). Usually work- related musculoskeletal and cardiorespiratory problems progress slowly and there is not just one factor causing it. (Työsuojelu 2022). However, even temporary short-time excessive physical loading can cause damage to the musculoskeletal system. The lifestyle and heritage of a person, combined with physical, biomechanical, and psychosocial risk factors in the work, can contribute to these work-related physical problems (Työsuojelu 2022.)

Physical workload can be assessed by interviewing the employees and supervisors and by observing the work process, this is usually done by the occupational health care. (Ahola, et al., 2015, 28). The assessed working space and work should be defined precisely, to gain reliable results from the assessment. The working space can be individual work- station or work- station for a group of workers and the assessment should include, for example, machinery used in the work, passageways, worktops, and flooring in that particular work- space (Ahola, et al., 2015, 28.) When evaluating how hard and loading the work is physically, it is important to assess if the work contains highly physically loading peaks. These peaks can cause muscle tiredness, out of breathiness or sweating. The assessment should also investigate if it's possible to do heavy loading work process in pairs or if it's possible to use machinery or assistive aids to decrease the load (Ahola, et al., 2015, 28.) Suitable clothing and safety equipment for specific work decreases excessive physical workload, but sometimes factors such as heat or cold can still increase the physical load during the work and it

is important to think about should the work pace or timing of the breaks be adjusted. (Ahola, et al., 2015, 28).

Physical factors at work can be defined as outside forces effecting on the working individual during the work. These outside forces can be detected with sensory inputs or there is information provided about the possible forces caused by machinery, for example, noise, optic radiation, or electromagnetic fields. The magnitude of the physical factors can be either evaluated or in other cases measured with specific devices (Työsuojelu 2022.) Vibration, noise, temperature, and lighting are detected by sensory inputs; therefore, the effects are easily recognized. (Kähkönen 2001, 192). Human body touching a vibrating surface and being exposed to vibration, can cause effects to the persons health, and increase safety risks. For example, excessive and long-lasting vibration to the hands can cause Reynaud's Syndrome, a vibration disease which makes fingers turn white, blue, or red when exposed to cold. This is caused by damages to the peripheral nervous system and to the walls of blood vessels in hands and fingers (Työterveyslaitos 2022.)

Sound which is hazardous to the health and is disturbing can be described as noise, is one of the most common factors causing occupational illnesses. Human ear detects pressure changes created by longitudinal waveform of a sound travelling through air. Decibel (dB) is the measurement unit for noise, and it measures the pressure level changes of the sound. Exposure to over 85 dB of sound pressure or noise causes permanent hearing loss (Olkinuora 2001, 197- 198.) Sounds between 0- 120 dB and frequencies between 20- 20 000 hertz (Hz) are what can be detected by human ear. Most important frequencies are between 200- 4000 Hz, this enables human ear to detect speech. (Olkinuora 2001, 197). The hearing loss caused by excessive exposure to noise depends on the volume and time, which person has been exposed to it. (Olkinuora 2001, 198). Impulse noise, which creates high singular decibel (dB) peaks or series of high decibel (dB) peaks are more hazardous than constant noise. Sources for impulse noise can be for example, forging (high singular decibel peak) or MIG-welding (series of high decibel peak) (Olkinuora 2001, 197- 198.) If employee is exposed daily to noise over 85 dB, employer is obligated to investigate the causes and make a noise reduction plan by the Council of State Decision (1404/ 1993). (Olkinuora 2001, 197- 199).

4.5 Assessment of workload

When estimating the workload, we should not focus on one individual loading factor, but the whole working process should be taken in consideration. Workload can be assessed with special assessment tools, such as TIKKA workload assessment tool, and is usually assessed by the occupational health care, occupational safety personnel or by other persons specialized in workload (Ahola, et al.,2015, 3.)

5 WELDING AND WELDERS WORK

5.1 Welding

Welding can be described according to Kemppi website as uniting or fusing pieces together with the use of heat and/ or compression to form a continuous structure. (Kemppi 2022). Most common welded materials are metals, such as mild steel, aluminum, and stainless steel. Plastic can be welded by using hot air or an electric resistor. The heat source for metal welding is usually an arc flame produced by the electricity of the welding power source. This arc is created by burst of electricity between the welding electrode and welded piece. This arc generates temperature of several thousand degrees centigrade and can be at maximum as much as 10,000 centigrade. Fusing the pieces together can be done by using the heat from the arc to melt the pieces together or by using filler metal which is melted to the seam with the arc. Filler metal can be applied by using wire feeder through welding torch or it can be applied by using manual feed welding electrode. The melting point of the pieces and filler metal should have approximately similar melting points (Kemppi 2022.) Shielding gas has an important role, when the productivity and quality of welding is discussed. It shields the melted weld from oxygenation, impurities in the air and from moisture, which can affect to the quality of the weld. These quality deficiencies can be weak corrosion tolerance of the weld, porous formation in the weld and weakened durability of the weld caused by geometrical changes in it. Shielding gas also cools down the welding torch (Kemppi 2022.)

5.2 Welder's work

Welding is a process used widely among many different types of industries. However, most typical working environment for welder is usually in mechanical-, transportation-, or in metal- industry. These can be, for example, automotive factories or shipyards or other industries where welding is needed as a part of the manufacturing process. (Turun AKK 2022). Welders construct products by following schematics to produce desired structures. The work may contain for example, grinding with angle grinder to achieve desired form, bending, or drilling and joining parts together with welding (Työterveyslaitos 2009.) In welder's work there are many influencing factors which effect to the work ability and workload. For example, accidents, excessive physical and mental loading, due to bad ergonomics or shift work can decrease person's work ability and it can predispose long sick- leaves or even work-related disability. About half of the accidents happened in metal industry in one year, leads to sick leaves. The total amount is approximately 20 000 accidents in a year (Työterveyslaitos 2009.)

6 LOADING FACTORS IN WELDERS WORK

6.1 Physical factors

Welder's work contains many variables in physical loading, for example, difficult working positions when it is impossible to execute the work by following good ergonomics, this type of working puts high demands to the musculoskeletal system. Welder's work is physically challenging and in different working positions require good balance and proper control of the equipment used. (Työterveyslaitos 2009). This is where good ergonomics and good planning how to execute the work without putting too much loading to the musculoskeletal system becomes important. Adjustable workstations and other assistive equipment, such as lifting accessories, decrease the loading and enables ergonomic work. Neck, shoulder girdle and low- back issues are the most common factors for sick leaves among welders according to the research.

These issues are mainly outcome of static working positions and muscle tension in accuracy demanding work (Työterveyslaitos 2022.)

Noise is often present in welders work and in general, in metal industry. Excessive or long-term exposure to noise causes hearing loss, which will affect to the welder's work ability and workload, and therefore adequate protective equipment should be used. (Työterveyslaitos 2022).

Excessive and long-lasting vibration to the hands caused by, for example, angle grinder, can cause Raynaud's Syndrome or disease, which is one of the occupational diseases among welders. This is a disease where small blood vessels in hands and often in toes get hyper contracted and in cold, they will first get white and later blue and red (Terveyskirjasto 2022; Työterveyslaitos 2022.) This phenomenon can be triggered also by stress, wind or touching a cold surface. (Terveyskirjasto 2022).

Irregular working hours or shift work affects to the musculoskeletal system. However, workers who work in shifts, self-estimate their own physical fitness to be same or better compared to workers who work office time. (Työterveyslaitos 2022). The physical effects of shift work have been investigated and results have shown effects in physical health. (Työterveyslaitos 2022). These effects include for example, increased risks for cardiopulmonary diseases, obesity, cancer, and diabetes. (Partonen 2022). More common symptoms from shift work are effects on the digestive system causing gastroesophageal reflux, stomach aches or flatulence. (Partonen 2022).

6.2 Chemical factors

In welders work person gets exposed to the particles from grinding metal and from the fumes created from the welding, which varies on the method of welding and the material to be welded. The fumes commonly include, for example, iron oxide (Fe₂O₃), manganese (Mn) or copper (Cu). Near the welding arc fumes include carbon monoxide (CO), ozone (O₃) and nitrogen oxide (NO). (Työterveyslaitos 2022). All these particles included in welding fumes in long-term exposure, double the possibility for work-related chronic obstructive pulmonary disease (COPD). According to the

estimation of population research, over 15% of COPD cases are related to work (Hengitysliitto 2022.)

6.3 Thermal factors

In welders work, thermal exposure is constantly present. In many industries welders work contains working either in cold or hot circumstances, which decreases the work capacity and puts stress to the whole body, and results as increase in workload. The threshold value for cold work is below + 10 Celsius and for hot work above + 28 Celsius. Cold or hot tolerance, timing of breaks, workers own personal qualities and what kind of work is done, affects how the person feels the workload (Työsuojelu 2022; Työterveyslaitos 2022.)

Fireproof clothing helps welders to be protected against flying hot debris and hot surfaces but puts also challenges to the thermal regulation of the body, especially when working in hot circumstances. In some cases, the objects to be welded, needs to be pre-heated to a certain temperature before sufficient weld can be achieved and this increases the need for sufficient thermal regulation of the body and for good fluid balance. (Työsuojelu 2022). Working in hot and sweating also stresses the skin and enables it for skin changes and diseases. Working in hot can also have effects on person's balance and this way increase the risk of falls (Työterveyslaitos 2009.) Average healthy person does not have big impact when working in hot or cold circumstances, however certain diseases can inhibit for example, working in hot circumstances. These diseases, such as severe kidney disease or cardiac insufficiency can endanger the welder's health (Työsuojelu, 2022.)

6.4 Accidents

As stated earlier, in a year over 20 000 accidents happen in metal industry and causes sick leaves with duration in average 21 days. (Työterveyslaitos 2009). Accidents in welder's work are main reason why personal protective gear should always be used. This enables safe working and decreases the risk of accidents. However, most of the

accidents in welding do not happen while at workstation or at variable workspaces. Accidents leading to death are usually caused by high falls, fire, or explosion, grinding work, or crushing between two objects. Therefore, safety is very important factor and safety precautions should be taken in consideration before working and when moving in the work premises (Työterveyslaitos 2009.)

Most common accidents leading to sick leaves in welders work are, slipping or moving work objects, different falls and crushing of extremities between worked objects. Minor accidents like cuts or flying debris into eye, despite safety goggles are very common (Työterveyslaitos 2009.)

6.5 Psychosocial factors

Welder's work contains many factors influencing to psychosocial workload. How these effect to a person's work ability is always individual and depends on how the person tolerates temporary or long- lasting excessive physical and mental loading. In an interview with welder in metal industry, we talked about his experiences about psychosocial workload, which were included in his work. He was a welder for over 35- years. In the beginning of the interview, he mainly talked about the physical issues what he has had during his career, such as accidents, neck- and shoulder girdle problems and problems with low- back and knees. Now he has been diagnosed with severe knee- osteoarthritis in both knees and walking is very difficult. He told that in the beginning of his career in 1980's, safety, and work well-being was not priority in welder's work. Protective gears were underdeveloped and heavy, working positions were not ergonomically effective and working hours were long. During the years more attention was given to ergonomics and work well- being and equipment's used in welders work got better. However, not always it was possible to work in best positions or climates. Lot of accidents and sick leaves were result from excessive physical loading, which also increased the psychosocial load of the work. When we started to talk about the mental loading of the work, he was surprised that there were so many factors influencing, which he had never thought about, such as, how working in shifts, tight deadlines and poor management can increase the psychosocial workload and lead to sick leaves or even work-related disability. He said that main concern for him was

always after when the company finished the order, when will the next order be placed again and how to manage economically during a lay-off (Mäntylä, personal interview, 24.10. 2022.)

The psychosocial workload increases if the work, or how the work is organized affects to the welder's health or well-being. The importance of understanding the goals of the work and balancing those with the work process itself, can decrease the amount of psychosocial workload (Ahola et al., 2015, 37-41.) The amount how much welder can influence to the working hours, work pace and can the work be done without disruptions, can create stressful situations and affect to the mental loading of the worker. Reasonable challenges included in welders work create positive outcomes and keeps the work interesting. If the work is not constantly too challenging or unpredictable and there is enough time and different strategies for coping, the mental well-being of the worker is not disrupted (Ahola et al., 2015, 37-41.)

In welding industry, strict deadlines, shift work or irregular work hours are often present, and this increases both, psychosocial and physical load of a person. It has been shown that workers doing irregular working hours have more stress, anxiety, and chronic tiredness, especially when doing night shifts, than on workers who do day shifts. (Työterveyslaitos 2022). About 10% of all people who does shift work, including welders, suffer from shift work related sleeping disorders. (Partonen 2022). Sleeping disorder can increase tiredness, which can cause, for example, problems with focusing on tasks or increase accident risks. Research shows that shift work that contains working at night increases accident risks 1,36 times compared to regular day work. (Partonen 2022). When sleep is inadequate, attentiveness weakens, we cannot determine our own or other's actions and the threshold for taking risks decreases. (Työterveyslaitos 2022).

7 PREVENTION

Prevention as a concept can be divided into three different phases, primary, secondary, and tertiary prevention. Primary prevention aims to prevent illnesses, injuries, and diseases before they even occur, for example, by deleting the possible causes for certain disease. This can be done, for example, by health promotion, which aims to increase the knowledge about healthy lifestyle and well-being of a person or community. Other way for primary prevention is to offer regular health checks to improve the healthy state of a community (Terveyskirjasto, 2022.) Secondary prevention can be described as a reduction of the impacts of disease or injury that has already occurred. The aim is to detect and treat the injury or disease to a halt or to slow down the progress as soon as possible. This can be achieved by encouraging and developing personal strategies to prevent recurrence or reinjury and by implementing programs that help people to return to their original functioning and health to prevent long- term problems. (Institute for Work & Health 2015). Regular screenings and tests to detect diseases in its early stage, and work tasks modified suitable for injured worker to ensure safe returning back to work, are part of secondary prevention. (Kisling & Das 2022). The aim for tertiary prevention is to soften the impact of an ongoing injury or illness that has lasting effects and therefore cannot be totally cured. Helping people to manage with long- term and often very complex injuries and health problems, such as, permanent impairments is the key point in tertiary prevention. This is achieved by improving functional ability as much as possible, increasing the quality of life and life expectancy of a person. One example is vocational rehabilitation, where workers are retrained for a new job when they have recovered as much as possible (Kisling & Das 2022.)

When we talk about the loading factors in welder's work, we need to pay attention to both, physical and psychosocial factors. Physical factors are more prominent and easier to understand in welders work, however there are many things effecting to the mental or psychosocial load as well. (Teollisuusliitto, 2022).

In research done by Weyh, Pilat and Krüeger, published in Occupational medicine journal in December 2022, they focused how adequate leisure time physical activity

affected to the prevalence of musculoskeletal disorders (MSD) among welders. They used the metabolic equivalent (MET) as a measurement point. Welders who increased the leisure time physical activity to reach at least 600 MET, a significant decrease was seen in the prevalence of MSD. (Weyh, Pilat & Krüeger, 2020). This shows how adequate leisure time physical activity can prevent excessive physical loading to the musculoskeletal system. In Finland, UKK- Institute provides weekly physical activity recommendations for different age groups. It provides information, for example, to 18- to 64-years-old persons about the type and amount of physical activity, which is beneficial for the health of working- aged adults (UKK-Institute 2022.) These recommendations also include everyday life activities, which can increase the total amount of physical activity during a day. These can be seen in picture 2. (UKK-Institute 2022).



Picture 2. Weekly physical activity recommendation for 18- 64-year-olds. (UKK-Institute 2022)

Suitable machinery and tools and adequate personal protective equipment forms one part of prevention. With proper equipment and safety precautions used during the work, the possibility for accidents and the work related excessive physical loading decreases. (Työsuojelu 2020). Excessive physical loading can be prevented by using assistive aids, such as, lighter equipment, hoists, or ergonomically designed handles,

which help to make the work less loading and more fluent. (Työterveyslaitos 2022). These assistive equipment's, however, make additional cost to the work and should be taken in consideration when estimating the total cost of the work. In welders work different kind of ergonomically designed welding torches and workstations help to prevent excessive loading to the musculoskeletal system. (Työterveyslaitos 2009).

In prevention of excessive psychosocial workload, good management and scheduling of the work plays very important role. With adequate scheduling and possibility for the worker to influence to the work itself and the working hours and breaks, recovery from work becomes more effective and the costs of excessive workload rehabilitation, or days on sick leave, becomes narrower (Ahola et al., 2015, 37-41.)

8 THESIS PROCESS

The idea for my thesis came from my earlier occupation as an electrician, working in maintenance departments in different industrial locations. In most of the locations welding has been a part of the construction process and I have seen the challenges included in welder's work. In November 2021, I started my thesis process and I planned how I would progress in my work. I also presented the topic of my thesis, the aims and objectives and thesis schedule seen in table 1. In the end of November 2021 started to think where I could offer my final product, which I had decided to be a preventive guide for workload effects among welders. First, I contacted local offshore company, where I had worked in a sub-contractor's maintenance unit for 11 years. I contacted them via e-mail, explained the process and that it would not demand any effort from them. I got an answer from them in the end of December 2021. They wanted more information about my thesis and about the content of the guide. I did not get any reply after that from them. In December 2021 I started to gather information from books, websites, and research. First focusing on information in the general level about work ability, workload, and prevention methods of excessive workload and then progressing to the research done about welders. In the end of December 2021, I was still thinking where I could offer my guide to, and I started to think and search for other

options. I noticed that Länsirannikon Koulutus Oy Winnova has a welder's study program and I contacted teacher Jorma Humisto in the beginning of January 2022. I explained the title of my thesis and talked about the future benefits of using my prevention guide in their study program. We signed the thesis contract on 28 of January 2022. In February 2022, I started to focus on finding information and research about the workload effects and common health problems among welders. As I continued, I found out that there was not that much research done focusing on workload effects among welders. However, some research had been done about prevention of musculoskeletal problems among welders. In March 2022, I visited Jorma Humisto at Winnova and got to see the premises and what is included in the study program teaching materials concerning my thesis topic. I gathered more information from different sources to the end of April 2022 and in May 2022 I started to write my thesis, one part at a time, to make sure the consistency of my text. During summer 2022 I worked in two different summer-jobs, which slowed my thesis process down a bit. In September 2022, I started to work on daily basis on my thesis and it progressed quite fast. We agreed with my collaborator Jorma Humisto from Länsirannikon Koulutus Oy Winnova, that my prevention guide would be in digital form, to ensure its easy usage in teaching. I decided to make the guide using Microsoft PowerPoint, which could easily be converted to PDF- form if needed. In October 2022, I did my first draft of the preventive guide. First draft contained too much information in the slides for the target group, in this case most of the students have just finished comprehensive school. Next step was to summarize most of my key elements included in the guide and make it more appealing and interesting for the target group. The preventive guide was finalized in November 2022 and the presentation of finalized thesis was presented on November 22nd, 2022.

Table 1. Schedule of the thesis process.

Time frame	Topic
November 2021- January 2022	Thesis framework, Thesis plan presentation, finding general information and research about workload and work ability, finding possible collaborator
February 2022- April 2022	Finding and reading researches and materials about welders work and work- related health issues.
May 2022- September 2022	Writing thesis
October 2022	Thesis , creating digital preventive guide for welders study program in Winnova
November 2022	Thesis completion and presentation

9 DISCUSSION

Prevention of the effects of excessive workload has become important today's society due to the demands to increase the working years. When I was thinking about the topic for my thesis, I decided to focus on the prevention of workload effects among welders. Welder's work contains factors which can have effects to the physical and psychosocial well-being. Excessive workload can cause decrease in work ability of a welder and the costs of health care are rising; therefore, prevention of workload effects becomes important.

A preventive guide for workload effects among welders was created based on the evidence- based information gathered during the thesis process, the aim was to increase knowledge about the loading factors in welder's work and how those could be prevented. The preventive guide was made for Länsirannikon Koulutus Oy Winnova welders study program, but it could also be used for prevention education in welding industry.

The research about workload effects and the prevention of them among welders is an important topic, however the research done is small and therefore this topic should be investigated more. The validity of this thesis is based on the narrow research done; further research needs to be done to achieve strong reliable results.

When we think about loading factors among welders, the physical aspect comes first into our minds, however we need to also think the psychosocial loading when we talk about welder's work. Welder's work is physically loading, for example, bad working positions, static work, or heavy liftings are factors putting workload to the musculoskeletal system. Neck, low-back and shoulder girdle problems are the most common problems among welders. Studies have shown that these problems can be prevented with adequate leisure time physical activity and healthy lifestyle. The adequate physical activity can be achieved by following, for example, the Finnish weekly physical activity recommendations for adults. These recommendations include, endurance and strength training and studies have shown those to be effective in prevention of musculoskeletal problems among welders. The psychosocial loading can include for example, working in shifts or inadequate recovery times, which can cause sleeping disorders and outcome can be increased accident risk during work. The ability to influence to the work, good managing and adequate recovery from work are part of preventive method.

The prevention of workload effects among welders is important topic because the lifestyles are becoming more sedentary and passive in current society and coping in work is decreasing. Therefore, more research on prevention of workload effects among welders needs to be done, this will enable better work ability and longer careers among welders in the future.

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