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Ageing@Work

Smart, Personalized and Adaptive ICT Solutions for Active, Healthy and Productive Ageing with enhanced Workability

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Human factors and metrics analysis

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Executive Summary

The aim of this deliverable is to present the results of the analysis of the data collected on work ability, as well as occupational health and safety issues to be included in the Ageing@Work system. In order to select the most relevant factors for the group of ageing blue-collar workers in terms of their work ability, productivity and quality of life, a literature review was conducted, which resulted in a set of factors from various areas of employee functioning. The next step was to conduct a questionnaire survey and individual interviews in workers from pilot companies (ANEFA and Siemens).

One hundred and five ageing workers participated in the study – 72 from ANEFA and 33 from Siemens. The results of the surveys and interviews revealed that some of the factors identified as mostly correlated with work ability, performance and quality of life seem to systematically appear in both groups of workers and these are mainly: general health and lack of chronic diseases, ability to concentrate, self-efficacy, satisfaction with personal relationships, sleep satisfaction. Some others are more specific to the company. For ANEFA ageing workers it would be important to concentrate on their sleep quality as well as hearing and seeing aids quality. Since a relatively high percentage of them declared obesity, some physical fitness in their leisure time would be beneficial for them. It also seems that these workers need more diversity at work than Siemens workers and more often mentioned their need for having support from friends and colleagues.

For the Siemens ageing workers, avoiding muscular pain being a result of tiring positions, e.g. mainly sedentary positions as well as preventing an overall fatigue, seems to be essential to maintaining their high work ability, performance and quality of life.

Factors related to psychosocial working conditions such as motivation, work involvement and job satisfaction have been found to have a direct impact on work ability, performance and quality but also an indirect impact on them by increasing general health, ability to concentrate and sleep satisfaction, as well as by decreasing physical fatigue, negative feelings or stress.

Therefore, it can be concluded that mutual correlations observed among all the factors mentioned above suggest the need to integrate them into the system directed to improve work ability, performance and quality of life of ageing workers. The study performed in the two different companies showed clearly, that most of these factors have a generic character, independent of the type of company. Only a few of them may vary in this system depending on the character of work performed in the company. Based on the identified factors, an analysis towards relevant recommendations was also made in the scope of the present deliverable.

Where possible, the factors were paired with metrics and preliminary ideas for ICT technologies measurement. For other factors, a periodic survey tool was proposed.

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Abbreviation	Definition
WP	Work Package

Table 1 Definitions

1. Introduction

1.1 Aim of the deliverable

The aim this deliverable is to present the results of the analysis of the data collected on work ability, as well as occupational health and safety issues to be included in the Ageing@Work system. Apart from basic demographics, our methodology will capture also the experience of the workers on using modern ICT tools, their subjective health condition their daily work and/or free time routines and more. It is expected that the results of this deliverable will be used as the recommendations and design guidelines for creating the overall technological system.

1.2 Relationship with other activities and deliverables

Human factors and metrics identified in this deliverable should be further developed in the project tasks T3.2. and T3.3. The Requirements and Use Cases deliverable (D2.1) has been used as a source of user-centred design approach and thus the questionnaires used in this deliverable have been developed by taking into account the user needs and expectations. Both the D3.1 and D2.1 will be used as a reference for finalizing the Ageing@Work System Architecture (D2.3) on M12.

1.3 Structure of the deliverable

This deliverable presents the results of a literature review on factors related to employees' work ability, quality of life, health and safety at work and productivity. Next, the questionnaire tool is described, followed by the results of the questionnaire survey conducted in pilot companies (ANEFA and Siemens). Based on the results of literature review, questionnaire study and individual interviews, the final set of factors recommended to be included in the project is listed.

2. Human factors analysis

2.1 Work ability concept and literature review results

Following the initial idea of the project, work ability was analysed in terms of the Work Ability concept, as proposed by Ilmarinen (2006). This concept of work ability is very broad and comprises the aspects of the "physical, psychological and social capabilities of a worker to perform and interact within their work, and the individual's specific work demands, health conditions, and mental resources" (Ahlstrom et al., 2010). The core of this approach to work ability is the balance between personal resources and work characteristics (Gould et al., 2008).

This holistic model of work ability consists of individual's resources and work-related factors, as well as factors outside the working environment (Ilmarinen and Tuomi, 2004; Ilmarinen, 2006). According to the Work Ability House model (Ilmarinen, 2006), there are several areas of factors related to work ability: Work, work community and leadership (e.g. respectful treatment in the workplace); Values, attitudes and motivation (e.g. job security); Competence (e.g. knowledge, skills and abilities); Health and functional capabilities (e.g. physical health, psychological wellbeing, leisure activities). There are also influences outside the work environment: family, community, social infrastructure.

It means that work ability could be associated with most factors of working life. Our aim was to identify most important factors for ageing, blue-collar employees that could be implemented in the Ageing@Work solution.

Age is one of the most important factors impairing work ability. The variation of work ability by age is significant: younger people perceive their work ability to be much better than older persons do (e.g., Ilmarinen et al., 1997; Ilmarinen and Tuomi, 2004; Goedhard and Goedhard, 2005; in: Gould, Polvinen, Seitsamo, 2008). In the study by Gould, Polvinen and Seitsamo (2008), the difference between the work ability of the employed population and the entire population was great, especially among those after the age of 55. Those with better work ability continued to work. These results show why the importance of maintaining and promoting work ability in ageing employees cannot be underestimated. The aim of the literature review conducted in this task was to identify specific factors apart from age, which could be relevant to the work ability level.

In order to identify factors related to work ability (and also the quality of life and performance, interrelated; Tuomi et al., 1992; Sorensen et al., 2008), a literature review was conducted. Over 100 research papers presenting longitudinal, cross-sectional and literature review studies were reviewed, identifying several areas of factors related to dependent variables. Although our aim was to focus on older blue-collar employees, we decided to include papers examining general population of workers (including older and blue-collar workers) as only few papers met the initial criteria.

Factors identified in the literature review were grouped into the following areas:

- Socio-demographics factors (e.g. age, gender, education level, economic position)
- Lifestyle (e.g. physical activity in leisure time, nutrition, hydration)
- Health: physical (e.g. chronic diseases, sickness absence), mental (e.g. depression symptoms, stress symptoms)
- Personal resources (e.g. self-efficacy, social support)
- Job demands (physical job demands, psychological job demands)
- Job resources (e.g. social support from colleagues and supervisors, influence, possibility for development)
- Organizational factors (e.g. type of employment, working hours)

Table 2 presents an overview of these areas and factors. Additionally, it is indicated which study design was used (longitudinal, cross-sectional, literature review), if a given study was focused on ageing or blue-collar employees or more general group of workers was included. There were several cases where a general group of workers was included, but the analyses were stratified into age-, gender-, or occupational-groups. In such cases, these studies were also marked as focused on ageing- or blue-collar workers, respectively to the results obtained.

Most studies identified various working conditions (both job demands and job resources) that hinder or support work ability, quality of life or productivity. The role of individual-level variables in maintaining work ability was also prevalent in research papers (e.g. wellbeing, lifestyle factors). Fewer studies considered organisational factors as predictors of work ability.

Table 2 Overview of literature review results on factors related to work ability and productivity

Factors related to work ability and productivity	Source (literature)	Ageing workers	Blue-collar work	Study design (C-cross-sectional; L-longitudinal; R – literature review)
Current/present work ability (+)	Airilaa, Hakanena, Schaufeli, Luukkonenc, Punakalliod, Lusad, 2014; Alavinia, de Boer, van Duivenbooden, Frings-Dresen, Burdorf, 2009	x	x	L
SOCIO-DEMOGRAPHICS				
Age (-)	Thorsen, Burr, Diderichsen, Bjorner, 2013; Solem, 2008; Miranda et al., 2009; Gould et al., 2008; Bethge, Radoschewski, Gutenbrunner, 2012; xVaronen, Husman, Viikari-Juntura, 2007; Pohjonen, 2001; Amorim, Salla, Trelha, 2014; Yong et al., 2012	x	x	C, L, R
Education level (+)	Sanders et al., 2011; Jędryka-Góral et al., 2006 Martelin et al., 2008; in: Gould et al., 2008;	x		C, L, R
Job tenure (-)	Bugajska, Makowiec-Dąbrowska, Konarska, 2008; Bellusci & Fischer, 1999; Amorim , Salla, Trelha, 2014; Sormunen, Remes, Hassi, Pienimäki, Rintamäki, 2008	x	x	C, R
Gender (females -/+)	Gould and Polvinen, 2006; in: Gould et al., 2008; Pensola et al., 2016; Sanders et al., 2011 Gupta et al., 2014	x		C, L
Marital status (+)	Rineer, 2015 Labbafinejad et al., 2014		x	C, R
Occupational group/socio-economic group (+)	Wilke, Ashton, Elis, Biallas, Froböse, 2015;	x	x	C, L, R

Factors related to work ability and productivity	Source (literature)	Ageing workers	Blue-collar work	Study design (C-cross-sectional; L-longitudinal; R – literature review)
	Thorsen, Burr, Diderichsen, Bjorner, 2013; Jędryka-Góral et al., 2006; Aittomäki et al., 2003; Martimo, Varonen, Husman, Viikari-Juntura, 2007			
Income (+)	Ilmarinen et al., 2008 Amorim , Salla, Trelha, 2014	x		R, C
Dependent persons living in a household (-)	van den Berg, Elders, de Zwart, Burdorf, 2008			R
LIFESTYLE				
Physical activity in leisure time (+)	Arvidson et al., 2013; Airila et al., 2012 Kettunen, 2015 Rongen, Robroek, Schaufeli, Burdorf, 2014 Sormunen, Remes, Hassi, Pienimäki, Rintamäki, 2008		x	C, L, R
Smoking (-)	Amorim , Salla, Trelha, 2014 Mohammadi et al., 2015 Airila et al., 2012 Sell, Faber, Sogard, 2009	x	x	C, L, R
BMI, obesity (-)	Mohammadi et al., 2015 Labbafinejad et al., 2014 Sell, Faber, Sogard, 2009 Abbasi, Zakerian, Kolahdouzi, Mehri, Akbarzadeh, & Ebrahimi, 2016; Nevanpera et al., 2015 van den Berg, Elders, de Zwart, Burdorf, 2008		x	C, L, R
Properly composed diet (+)	van den Berg, Elders, de Zwart, Burdorf, 2008; Merecz et al., 2004 Bugajska, Makowiec-Dąbrowska, Konarska, 2008		x	C, R
Alcohol consumption (-)	Pensola et al., 2016 Bugajska, Makowiec-Dąbrowska, Konarska, 2008	x		C
Water intake (+)	Kenefick and Sawka, 2007;			R

Factors related to work ability and productivity	Source (literature)	Ageing workers	Blue-collar work	Study design (C-cross-sectional; L-longitudinal; R – literature review)
	Shearer, Graham, Skinner, 2016			
HEALTH				
General health/self-rated health (+)	Thorsen, Burr, Diderichsen, Bjorner, 2013 Agnew et al., 2015 Solem, 2008 McGonagle, Fisher, Barnes-Farrell, Grosch, 2015 Yong et al., 2012 Jędryka-Góral et al., 2006 Koskinen et al., 2008		x	C, R
Physical health (+), Physical ability (+)	Thorsen, Burr, Diderichsen, Bjorner, 2013; Gamperiene et al., 2008; van de Vijfeijke et al., 2013' Padula et al., 2013	x		C, L, R
Sensory ability: vision (+)	Sainio et al., 2008			C
Sensory ability: hearing (+)	Sainio et al., 2008			C
Sickness absence (-)	Sormunen, Remes, Hassi, Pienimäki, Rintamäki, 2008; Gustafsson & Marklund, 2011		x	L
Sickness presence (-)	Gustafsson & Marklund, 2011			L
Functional balance (+), body balance (+)	van den Berg, Elders, de Zwart, Burdorf, 2008; Punakallio, 2003			R
Cardiorespiratory fitness, physical fitness (+)	Sainio et al., 2008; van den Berg, Elders, de Zwart, Burdorf, 2008; Kaleta, Makowiec-Dąbrowska, Jegier, 2004; Sorensen, 2008; Gupta et al., 2014	x	x	C, R
Musculoskeletal disorders (MSDs) (-)	Koskinen et al., 2008; van den Berg, Elders, de Zwart, Burdorf, 2008; Martimo, Varonen, Husman, Viikari-Juntura, 2007; Neupane et al., 2011; Pensola et al., 2016; Hengel et al., 2012;	x	x	C, L, R

Factors related to work ability and productivity	Source (literature)	Ageing workers	Blue-collar work	Study design (C-cross-sectional; L-longitudinal; R – literature review)
	Lunde et al., 2014; Lindegård et al., 2012; Tuomi et al., 1991; Bugajska and Sagan, 2014; Miranda et al., 2009			
Other chronic diseases (-)	Koskinen et al., 2008; Gould and Polvinen, 2008; Nazarov et al., 2019; Lejten et al., 2014	x		C, L
Fatigue (-)	Vasconcelos et al., 2011; da Silva et al., 2016 Seitsamo et al., 2008			C
Chronic fatigue (-), daytime tiredness (-)	Bugajska, Makowiec-Dąbrowska, Konarska, 2008;			C
Mental health (+)	Thorsen, Burr, Diderichsen, Bjorner, 2013 Gamperiene et al., 2008 Tuomi et al., 1991; Leiten et al., 2014			C, L
Depression (-)	Koskinen et al., 2008; Rineer, 2015; Slebus et al., 2008; Lee et al., 2016			C, R
Stress (-)	Agnew et al., 2015; van den Berg, Elders, de Zwart, Burdorf, 2008; Yong et al., 2012; Merecz et al., 2004 Bugajska, Makowiec-Dąbrowska, Konarska, 2008; Bugajska i Makowiec-Dąbrowska, 2006; Bethge, Radoschewski, 2012; Lindegård et al., 2012			L, C, R
Cognitive resources (+)	Sainio et al., 2008; Ihle et al., 2012; Abbasi, Zakerian, Kolahdouzi, Mehri, Akbarzadeh, & Ebrahimi, (2016)			C
Quality of sleep (+)	Labbafinejad et al., 2014; Airila et al., 2012		x	L, C

Factors related to work ability and productivity	Source (literature)	Ageing workers	Blue-collar work	Study design (C-cross-sectional; L-longitudinal; R – literature review)
	Lian et al., 2015 Yong et al., 2016			
PERSONAL PSYCHOSOCIAL RESOURCES				
Self-esteem (+), self-confidence (+), self-efficacy (+)	Airilaa, Hakanena, Schaufeli, Luukkonenc, Punakalliod, Lusad, 2014; Gould et al., 2008; Agnew et al., 2015; van den Berg, Elders, de Zwart, Burdorf, 2008; Rineer, 2015		x	L, C, R
Coping skills (+)	van de Vijfeijke et al., 2013	x		L
Social support in private life (+)/social network	Sainio et al., 2008; Pensola and Järvikoski, 2008; Ilmarinen, Tuomi, Seitsamo, 2005; Sainio et al., 2008; Calderon-Larranaga et al., 2019			L, C
Continuing training motivation (+)	Thieme, Brusch, Busch, 2015			C
Other wellbeing indicators				
Work engagement (+)	Rongen, Robroek, Schaufeli, Burdorf, 2014; Airilaa, Hakanena, Schaufeli, Luukkonenc, Punakalliod, Lusad, 2014; Airila et al., 2012; Hakanen et al., 2005; Gould and Polvinen, 2008		x	L, C
Job satisfaction (+)	Gould and Polvinen, 2008; Silva et al., 2012; Palermo et al., 2013			C, R
Quality of Life (general, work-related, health-related) (+)	Sörensen et al., 2008; Ilmarinen et al., 2008; Agnew et al., 2015;			L, C
Work-life balance (+)	Yong et al., 2012;; Demerouti, Taris, Bakker, 2007; Weale et al., 2019			C
Job insecurity (-)	Gould et al., 2008; Staufenbiel and Konig, 2010; Wang, Lu, Siu, 2015			C

Factors related to work ability and productivity	Source (literature)	Ageing workers	Blue-collar work	Study design (C-cross-sectional; L-longitudinal; R – literature review)
WORK DEMANDS (-)	Rongen, Robroek, Schaufeli, Burdorf, 2014 McGonagle, Fisher, Barnes-Farrell, Grosch, 2015		x	L
Physical job demands / ergonomic exposures (-)	Sell, Faber, Sogard, 2009 Thorsen, Burr, Diderichsen, Bjorner, 2013; van den Berg, Elders, de Zwart, Burdorf, 2008; Gould et al., 2008; Sell, Faber, Sogard, 2009; Amorim , Salla, Trelha, 2014; Bugajska i Makowiec-Dąbrowska, 2006; Tuomi et al., 1991	x		C, L, R
Physical strain (-)	Airila et al., 2012; van den Berg, Elders, de Zwart, Burdorf, 2008; Pensola et al., 2016; Sanders et al., 2011; von Bonsdorff et sl., 2011; Aittomäki et al., 2003 Bugajska, Makowiec-Dąbrowska, Konarska, 2008; Hengel et al., 2012; Tuomi et al., 1991	x	x	C, L, R
Physical activity at work (-)	Thorsen, Burr, Diderichsen, Bjorner, 2013			L
Heavy loads (-)	Thorsen, Burr, Diderichsen, Bjorner, 2013; Sell, Faber, Sogard, 2009; van den Berg, Elders, de Zwart, Burdorf, 2008			L, R
Pushing (-)	Thorsen, Burr, Diderichsen, Bjorner, 2013			L
Awkward, uncomfortable postures (-)	van den Berg, Elders, de Zwart, Burdorf, 2008; Sanders et al., 2011; Hengel et al., 2012; Rineer, 2015;		x	L, C, R

Factors related to work ability and productivity	Source (literature)	Ageing workers	Blue-collar work	Study design (C-cross-sectional; L-longitudinal; R – literature review)
	Tuomi et al., 1991			
Working with the hands lifted (-)	Sell, Faber, Sogard, 2009			L
Working standing (-)	Sell, Faber, Sogard, 2009; Tuomi et al., 1997			L, C
Sedentary work (-)	van den Berg, Elders, de Zwart, Burdorf, 2008			R
Being exposed to high noise (-)	Sell, Faber, Sogard, 2009; Bugajska i Makowiec-Dąbrowska, 2006; van den Berg, Elders, de Zwart, Burdorf, 2008			L, C, R
Squatting (-), kneeling (-)	Sell, Faber, Sogard, 2009			L
Repetitive movements (-)	van den Berg, Elders, de Zwart, Burdorf, 2008; Alavinia, de Boer, van Duivenbooden, Frings-Dresen, Burdorf, 2009; Tuomi et al., 1997	x	x	L, C, R
Exposure to whole-body vibration (-),Exposure to hand–arm vibration (-)	Alavinia, de Boer, van Duivenbooden, Frings-Dresen, Burdorf, 2009; Bugajska and Makowiec-Dąbrowska, 2006	x	x	L, C
Microclimate (Poor thermal conditions, humidity) (-)	Tuomi et al., 1991; van den Berg, Elders, de Zwart, Burdorf, 2008; Bugajska and Makowiec-Dąbrowska, 2006; Kjellstrom et al., 2009; Fischer et al., 2006; Sormunen, Remes, Hassi, Pienimäki, Rintamäki, 2008		x	C, R
Other				
Exposition to mineral dust (-)	Bugajska and Makowiec-Dąbrowska, 2006			C
Chemical factors (-), Dangerous substances (-)	Bugajska and Makowiec-Dąbrowska, 2006; Tuomi et al., 1991; Peters et al., 2018	x		L, C
Psychological job demands	(-) Bethge, Radoschewski, Gutenbrunner, 2012;		x	L

Factors related to work ability and productivity	Source (literature)	Ageing workers	Blue-collar work	Study design (C-cross-sectional; L-longitudinal; R – literature review)
	Rongen, Robroek, Schaufeli, Burdorf, 2014			
Quantitative job demands (+)	Thorsen, Burr, Diderichsen, Bjorner, 2013			L
Time pressure, imposed, high or uneven tempo (-)	Pohjonen, 2001; Bugajska, Makowiec-Dąbrowska, Konarska, 2008; Bugajska and Makowiec-Dąbrowska, 2006			C, R
Task variety (+)	Sanders et al., 2011			L
Mental workload, high mental work demands, mental strain (-)	van den Berg, Elders, de Zwart, Burdorf, 2008; von Bonsdorff et al., 2011			R, L
IT skills/demands	Aittomäki et al., 2003 (not precisely IT demands, but white-collar work is more favorable for work ability than blue-collar)			C
JOB RESOURCES (+)				
Supervisory relations, social support from supervisors (+)	Airilaa, Hakanena, Schaufeli, Luukkonenc, Punakalliod, Lusad, 2014; Pensola et al., 2016; Sanders et al., 2011; Hengel et al., 2012; Peters et al., 2018	x	x	L, C
Interpersonal relations, social support from colleagues (+)	Sanders et al., 2011; Pensola et al., 2016; Peters et al., 2018	x		L, C
Conflicts at work (-)	Sell, Faber, Sogard, 2009			L
Influence, autonomy (+)	van den Berg, Elders, de Zwart, Burdorf, 2008; Sanders et al., 2011; Hengel et al., 2012; Alavinia, de Boer, van Duivenbooden, Frings-Dresen, Burdorf, 2009; Aittomäki et al., 2003; Bethge, Radoschewski, Gutenbrunner, 2012; McGonagle, Fisher, Barnes-Farrell, Grosch, 2015;	x	x	C, L, R

Factors related to work ability and productivity	Source (literature)	Ageing workers	Blue-collar work	Study design (C-cross-sectional; L-longitudinal; R – literature review)
	Pohjonen, 2001			
Opportunities for learning (+) Possibilities for development (+)	Aittomäki et al., 2003; van den Berg, Elders, de Zwart, Burdorf, 2008; Rineer, 2015; Solem, 2008			C, R
Age diversity climate (+)	Rineer, 2015			R
Recognition(+)	van den Berg, Elders, de Zwart, Burdorf, 2008; Bethge, Radoschewski, Gutenbrunner, 2012			L, R
ORGANISATIONAL FACTORS				
Type of employment	Rotenberg et al., 2008			C
Working hours (+/-)	Bugajska, Makowiec-Dąbrowska, Konarska, 2008; Hengel et al., 2012 Note: long working hours are found positively related to work ability in some studies, whereas long working hours are related to low work ability in quantitative studies (Pak et al., 2019), to ill health (Caruso et al., 2006) and disability pension risk in other studies (e.g. Krause et al., 1997).		x	C
Working in more than one location (-)	Bugajska, Makowiec-Dąbrowska, Konarska, 2008; Bugajska i Makowiec-Dąbrowska, 2006	x		R, C
Shift work (including night shifts) (-)	Bugajska, Makowiec-Dąbrowska, Konarska, 2008; Labbafinejad et al., 2014; van den Berg, Elders, de Zwart, Burdorf, 2008;	x	x	R, C
Poor work schedule (-)	van den Berg, Elders, de Zwart, Burdorf, 2008			R
Additional OSH factors:				
Using PPE (+)	No direct link to work ability or productivity but not using PPE			C

Factors related to work ability and productivity	Source (literature)	Ageing workers	Blue-collar work	Study design (C-cross-sectional; L-longitudinal; R – literature review)
	increases risk of accidents and injuries (Arcury et al., 2015)			
Access to public healthcare (+)	deBelvis et al., 2008			C

Note: + and – symbols indicate if the relationship is positive or negative

All of the factors included in the table above, were found to be correlated with work ability or productivity of employees, although there were some contradictory results. In most studies age was the significant factor for work ability, meaning that the older age is a risk factor for decreasing work ability (e.g. Thorsen, Burr, Diderichsen, Bjorner, 2013; Solem, 2008). However, in some studies this relationship was not observed. For instance, McGonagle, Fisher, Barnes-Farrell, Grosch (2015) found that a significant relationship between age and work ability was observed in one of their samples, i.e. among older workers (51+), and not in other two groups of employees (with the average age of 36.58 and 47.69). This relationship was also found not to be significant in the study carried out by Wilke, Ashton, Elis, Biallas, Froböse (2015) and Padula et al. (2013). These relationships (or lack of them) were explained by some studies. In their longitudinal study, Sell, Faber, Sogard (2009) showed that age was a significant predictor of work ability only in unskilled and blue-collar workers. Rineer (2015) found that for men between the ages of 51-58, there is a faster decline in work ability for those in physical and mixed jobs as compared to those that are more demanding mentally. Moreover, the relationship between physical work demands and limited work ability was stronger for people aged 50 and 60 than for younger workers (Rineer, 2015). Similarly, Bugajska, Makowiec-Dąbrowska and Konarska (2008) found that heavy physical work, working in more than one location and shift work were related to lower work ability in men aged 45+ (in a study comprising 1205 employees, both genders, working in both mental and physical jobs).

Employees with high physical job demands and ergonomic exposures have often poorer work ability (e.g. Sell, Faber, Sogard, 2009; Thorsen, Burr, Diderichsen, Bjorner, 2013; van den Berg, Elders, de Zwart, Burdorf, 2008; Gould et al., 2008). Work strain may have far-reaching negative effects on individuals' work ability from midlife to old age (von Bonsdorf et al., 2011). These factors also partly explain the relationship between socio-economic groups or blue-collar work with work ability. An interesting analysis was performed by Aittomäki et al. (2003): authors found that in the general group of employees aged 40+, lower socioeconomic groups were characterized by poorer work ability, but adjusting for physical stress was a substantial part of the socioeconomic inequalities. Subsequently, adjusting for possibilities for influence and development at work accounted for some of the difference between white collar and blue-collar employees. These results suggest that group of ageing, blue-collar employees could be the most vulnerable group in terms of the increased risk of poor work ability.

When analysing the results presented in the Table 2, it is also worth noticing the study setting and group. In order to determine most reliable factors determining work ability, it could be important to highlight the results of longitudinal and systematic review studies.

In their systematic review, van den Berg, Elders, de Zwart, Burdorf (2008) found that poor work ability was associated with individual characteristics (older age, degradation of economic position, hard life situation

outside work, raising underage children, low self-confidence, cardiorespiratory fitness, poor musculoskeletal capacity, poor functional balance), lifestyle (overweight, lack of leisure-time physical activity, diet with low fiber intake), demands at work (high mental work demands, lack of autonomy, blue-collar work, shift work, high-strain job, poor management, mental stress, skill discretion & possibilities for development, poor work schedule, role ambiguity, poor recognition, poor promotion of wellbeing), and physical conditions (physical demands**, i**ncreased muscular work, sedentary work, poor work postures, repetitive movements, lifting and poor ergonomic conditions e.g. poor thermal conditions, noise).

In the systematic review of studies conducted only in the group of ageing employees, Amorim, Salla, Trelha (2014) showed that age, smoking, service time and physical demands in occupational activities were related to low work ability, while life satisfaction, sufficient income, physical activity, volunteering and mental workload were considered positive associations with work ability that protect the elderly from functional loss.

It is interesting that in these two systematic reviews a different role of mental workload was observed: in the first review, the high mental work demands were negatively correlated with work ability, while in the second one the relationship was positive. Both directions could be explained. On the one hand, mental workload is usually observed in white-collar work, more favorable for work ability. Mental workload often means low physical workload, proven to be a risk factor for work ability. On the other hand a high work-strain is also related with poorer work ability: mental strain, related with high mental workload, could also drain employees from their resources, causing stress, exhaustion and lower work ability. High mental strain was also found to be a risk factor for work ability in a longitudinal study by von Bonsdorff et al. (2011) and cross-sectional study by Seitsamo, Tuomi, Ilmarinen, & Gould (2008).

Another group of studies to be distinguished are longitudinal studies:

In a study of Thorsen, Burr, Diderichsen, Bjorner (2013), high age, poor health (physical and mental) and ergonomic exposures (physical activity at work, lifting and pushing) were associated with low workability for men and women (in a representative group of blue- and white-collar employees) which were identified as risk factors for poor work ability. Also in this study, low social class and low quantitative demands were associated with low workability among men. Contrary to other research, none of the lifestyle variables (smoking, BMI, leisure time activity) were significantly related to the workability.

Gustafsson & Marklund (2011) showed that sickness presence and sickness absence were strong predictors of future poor health, physical complaints, low mental well-being and low work ability.

In the longitudinal study conducted among construction workers aged 40+ Alavinia, de Boer, van Duivenbooden, Frings-Dresen&Burdorf (2009) demonstrated that work-related factors (awkward postures, kneeling and squatting, manual materials handling, exposure to whole-body vibration, exposure to hand–arm vibration, work demands, job control, skill discretion) were associated with a lower work ability at baseline, but had little prognostic value for disability during follow-up.

However, in a longitudinal study of a general group of employees, Bethge, Radoschewski & Gutenbrunner (2012) showed that effort-reward imbalance, higher age, higher psychological job demands, lower job control were related with poorer work ability, while health-related behaviours significantly reduced the odds of poor or moderate work ability at follow-up.

In the aforementioned research of McGonagle, Fisher, Barnes-Farrell & Grosch (2015), health and sense of control were consistently and most strongly related to work ability perceptions relative to other job demands and job resources when perceived work ability was measured concurrently or two weeks later in samples with varying occupations. Job demands (along with health and sense of control) were most strongly related to work ability perceptions when the perceived work ability was measured in a manufacturing worker sample 1.6 years later. These results confirms especially significant role of job demands in blue-collar employees.

One of a lifestyle and health-related factor, i.e. obesity was found to be a significant predictor of work ability, including developing obesity between the ages of 31 and 46 in both genders and in employees working in both low and high physically strenuous work (Nevanpera et al., 2015).

Another longitudinal study identified multi-site musculoskeletal pain to be a stronger predictor of poor work ability after 4 years among industrial workers (Neupane et al., 2011). Surprisingly, these associations were stronger for younger and white-collar workers (but still significant in older and blue-collar employees).

In a longitudinal study conducted in a group of ageing, lower-educated workers, Sanders et al. (2011) found that the predictors of poor work ability were: physical strain, uncomfortable position. High autonomy, task variety, social support from colleagues and supervisors were predictors of higher work ability. Emotional workload was found harmful in this respect, while contact with customers predicted higher work ability. In this group, time pressure was not related to work ability, contrary to other studies (e.g. Pohjonen, 2001; Bugajska, Makowiec-Dąbrowska, Konarska, 2008; Bugajska i Makowiec-Dąbrowska, 2006).

In a longitudinal cohort of employees aged 40-54, Peters et al. (2018) demonstrated that low social support, low work-related quality of life, solvent-exposure, followed by solvent-exposure related memory and concentration-attention symptoms, were predictors of lower level of work ability.

Active coping and good mental, and especially physical health, predicted a high work ability in employees aged from 45 to 64 (van de Vijfeijke et al., 2013), while workers with chronic health problems had a lower work ability at one-year follow-up than workers without such health problems (Leijten et al., 2014).

Contradictory results

Although the aim of the review was to find significant factors related to work ability or productivity and not to examine whether particular factors are or are not related to work ability, some contradictory results were identified. Age was one of the factors, mentioned above. Moreover, although lifestyle factors were often found to be significantly related with work ability, in one study (Thorsen, Burr, Diderichsen, Bjorner, 2013) none of the lifestyle variables (smoke, body mass index, leisure time activity) were significantly associated with workability. However, in this study physical health – factor related with lifestyle - was found to be most significant predictor of work ability.

Also time pressure was another factor that was related with work ability in different ways, depending on the study: in one study it was found not to be significantly related with work ability (Sanders et al., 2011), while in other the relation was negative (Pohjonen, 2001; Bugajska, Makowiec-Dąbrowska, Konarska, 2008; Bugajska i Makowiec-Dąbrowska, 2006). Perhaps these differences could be explained by individual factors (e.g. coping, level of strain perceived) or level of job resources available.

Working hours were found to be positively correlated with work ability, but these results were derived from cross-sectional studies. This could mean that employees with a higher work ability tend to work longer hours because they feel they are able to do so. These results do not prove that longer working hours lead to a higher work ability. It is also stated that in other studies long working hours are related to low work ability (Pak et al., 2019), to ill health (Caruso et al., 2006) and disability pension risk in other studies (e.g. Krause et al., 1997), so is poor work schedule and shift work.

On the basis of the literature review, a quite broad range of factors were identified, based on the results obtained in various study designs and study groups. However, several conclusions about most significant factors could be stated. In their longitudinal study, Thorsen et al. (2013) estimated the hierarchy of predictors' relationships with work ability and sickness absence in a representative sample of Danish employees (N = 6,743), doing both blue- and white-collar work. It was found that health had the highest value of explained variance of workability and sickness absence, and physical work environment explained more than the psychosocial work environment. The odds ratio of physical health was higher than the odds ratio for mental health for both outcomes (work ability and sickness absence) and for both genders (Thorsen et al., 2013).

Physical job demands are also found to be one of most significant factors predicting work ability in Costa and Sartori (2007), Rineer (2015), Lahelma et al. (2012), Leinonen et al. (2011). Another factor found to be of a great importance was job control (Lahelma et al., 2012; Costa and Sartori, 2007) which was also less often observed in manual jobs (Aittomäki et al. 2003)

Following the literature review, a set of factors was identified and a questionnaire was developed for the questionnaire survey in pilot site companies of the Ageing@Work project. The aim of the study was to determine the factors related to work ability, productivity and quality of life in ageing blue-collar employees that could be included into the Ageing@Work system.

3. "Health and working conditions" questionnaire

The questionnaire was developed according to the areas identified in the literature review. A set of measurement tools was selected to measure most of the identified factors. The aim of the questionnaire was to measure the widest possible range of factors with as few questions as possible, in order to facilitate the data collection process. Therefore, single item questions were used, where possible. Tools already available in the pilot site languages, i.e. Spanish and German, were also explored.

- Relevant questions from the European Working Condition Survey (2017) were selected to measure sociodemographic factors, general health, physical health/illnesses, physical working conditions and organizational factors
- Relevant scales from the COPSOQ III (Burr et al., 2018) were selected to measure psychological job demands, job resources, job satisfaction, work – life conflict, job insecurity
- Saltin-Grimby Physical Activity Level Scale (Grimby et al., 2015) was used to measure physical activity in leisure time
- Questions from Sainio et al. (2008; in: Gould et al., 2008) work ability study was used to measure physical ability
- Single question from the Three-Dimensional Work Fatigue Inventory (3D-WFI) was used to measure physical fatigue
- Selected questions from WHOQOL – BREF (WHO, 2004) were used to measure depressive symptoms, concentration, quality of sleep, social support in private life, general quality of life, satisfaction with access to healthcare
- Single question from Work Ability Index (Tuomi et al., 1998) was used to measure work ability: "Assume that your work ability at its best have a value of 10 points. How many points would you give your current work ability?". Respondents answer the question without any given definition of work ability, which is in line with the original Work Ability Index instrument. Every respondent has to decide what does it mean if they are able or not able to work. This single item had been used in other research proving its validity and similar results as the full Work Ability Index questionnaire (e.g. Berthelsen, Hakanen, Westerlund, 2018; Thorsen et al., 2013). However, in further tasks a full version of Work Ability Index could be implemented, where there is no definition, but other questions on different aspects of work ability are included
- Single question was used to measure job performance. It was built on the basis of the work ability question: "Assume that your job performance at its best has a value of 10 points. How many points would you give your current job performance?" In this case also the respondent had to decide what is their job performance. This item was similar to the item from the Health and Work Performance Questionnaire (HPQ) by the WHO (2003), where respondent is asked to assess their own job performance on a 10-point scale, without any additional definition provided
- Stress was measured using single question from Elo et al., 2003
- Single item by Williams & Smith (2015) was used to measure self-efficacy

- Single item from Glei et al., 2005 was used to measure frequency of socializing with friends and family
- Single item by Andersen et al., 2012 was used to measure physical exertion at work
- Single item from OECD (2019) was used to measure sickness absence
- Single item from the INCLUSIVE "Worker satisfaction" questionnaire was used to measure sensory abilities
- Own items were used to measure lifestyle indicators, such as the amount of alcohol, smoking, water intake, nutrition, BMI

Additionally, few questions on learning method preferences were added in order to gain insight into users' needs regarding Ageing@Work tools.

The questionnaire can be found in the Annex.

4. Questionnaire survey

4.1 Questionnaire survey conducted at ANEFA

4.1.1 Procedure

The survey was conducted during the annual safety training courses for various groups of ANEFA employees. Prior to the survey, all participants were instructed about the study aims and procedure, as well as the Ageing@Work project in general. Next, informed consent forms were handed out to employees willing to participate in the study.

4.1.2 Study group

The study group consisted exclusively of 57 male employees. The average age was 52.63 years (*SD* = 4.90). The youngest participant was 45 years old and the oldest one was 62 years old. Approximately, two thirds of the group were employees aged 45-55 and one third constituted employees aged 56+ (fig. 1).

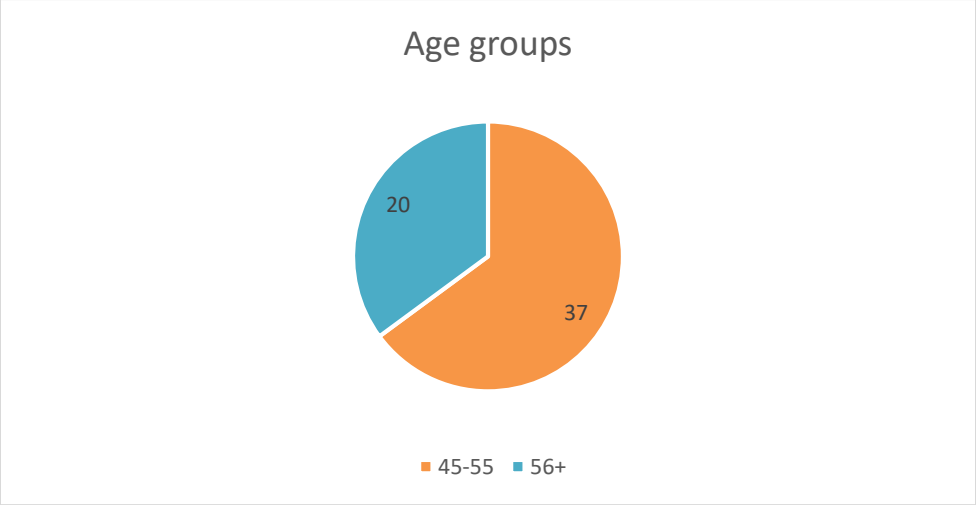

Figure 1 Age groups representatives (quantity)

The mean job tenure at the company was 16.34 years (SD = 10.56; Min = 1, Max = 45).

Most study participants were married or in a relationship (fig. 2).

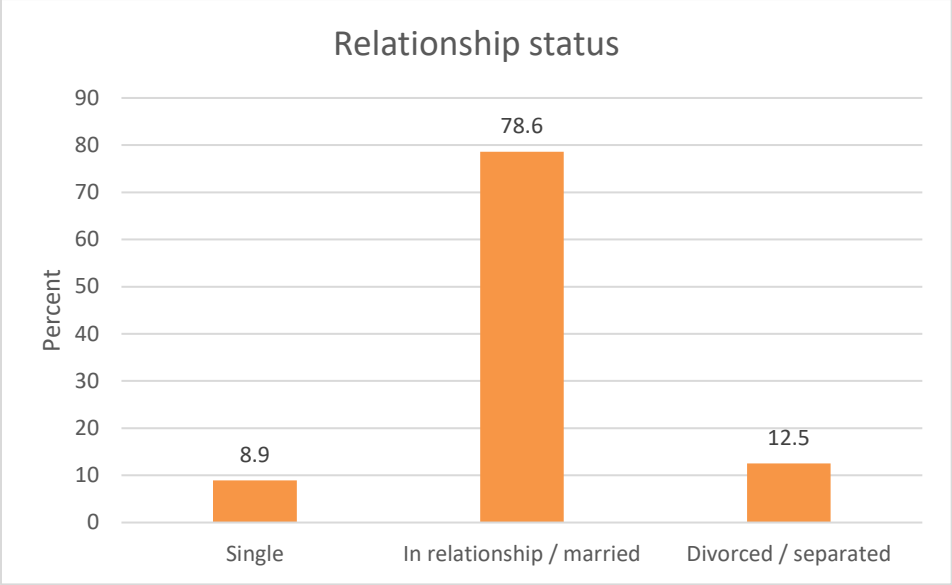

Figure 2 Relationship status in the study group.

The majority of the group (58.5%) was characterised by primary education level. 34 % of the group received lower secondary education and 7.5 % received upper secondary education (fig. 3).

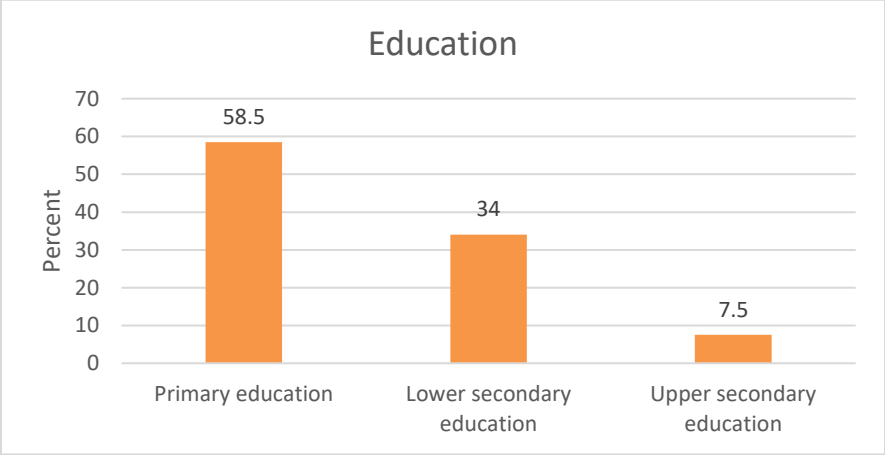

Figure 3 Education level in the study group.

Position in the company

Thirty-two respondents (56.1%) were employees without supervisory responsibilities, while 5 respondents had supervisory responsibilities. Twenty respondents did not answer the question about their job position.

Out of those who did respond, 86.1% respondents performed mostly manual work, 8.3% performed mental work, while 5.6% of the group had both manual and mental work.

The most frequently identified job positions were: loader machinist/loader operator, dumper driver/truck driver/dumper operator, followed by drilling operator and quarry operator. Other identified positions were: electrical maintenance operator/electrical technician/electrical operator, machinery operator/paddler loader machinist/loader operator, foreman, plant manager, production manager, quarry manager, welder and boiler operator.

Income

35.7 % of the study group found it easy for their household to make ends meet, while 32.1% of the group encountered some difficulties in this aspect.

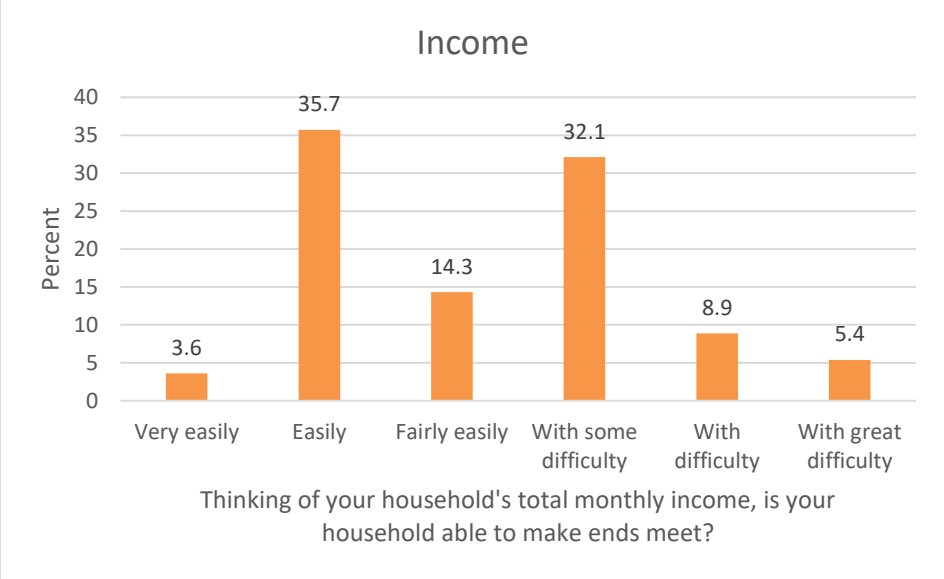

Figure 4 Income assessment in the study group

Most of the study group (80%) felt they were the biggest contributors to their household income.

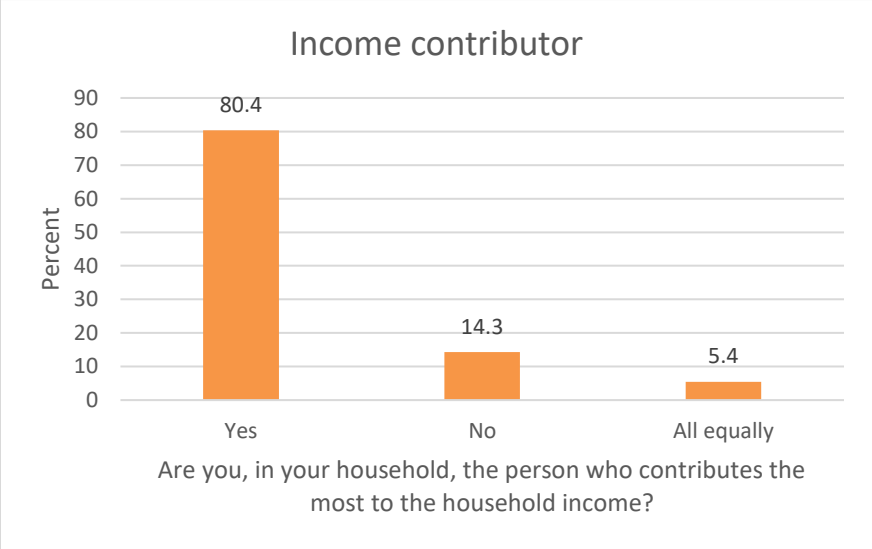

Figure 5 Household income contribution

People aged 50+ are often referred to as the 'sandwich generation' (Gillet & Crisp, 2017) which means they are responsible for both their children as well as their elderly parents. It may exert significant pressure, both mental and physical, affecting their wellbeing, health and work ability. Hence, the study participants were asked about their involvement in taking care of children and grandchildren, as well as elderly or disabled relatives.

67.4% of the study group admitted they were involved in caring for and/or educating their children and grandchildren on a daily basis or several times a week, while 24.5% had to take care of elderly or disabled relatives with similar frequency.

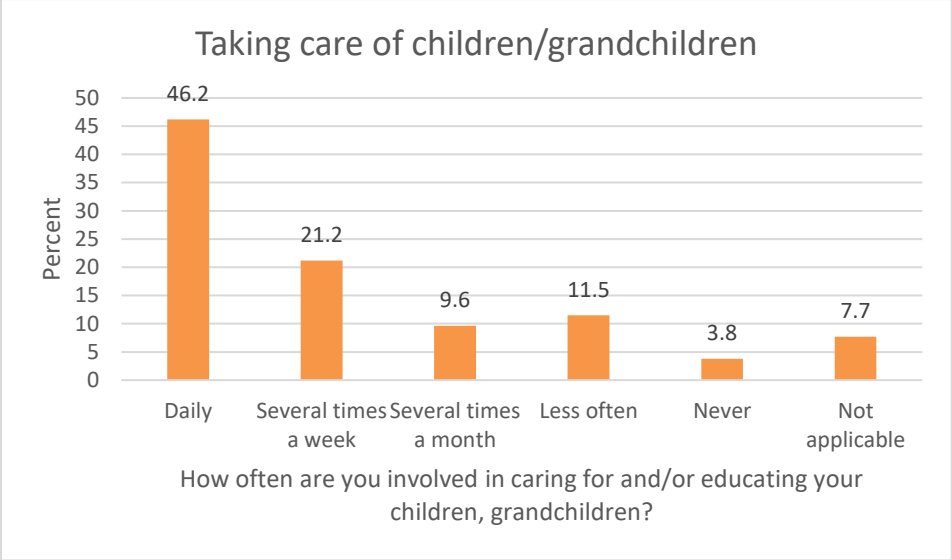

Figure 6 Involvement in caring for children/grandchildren

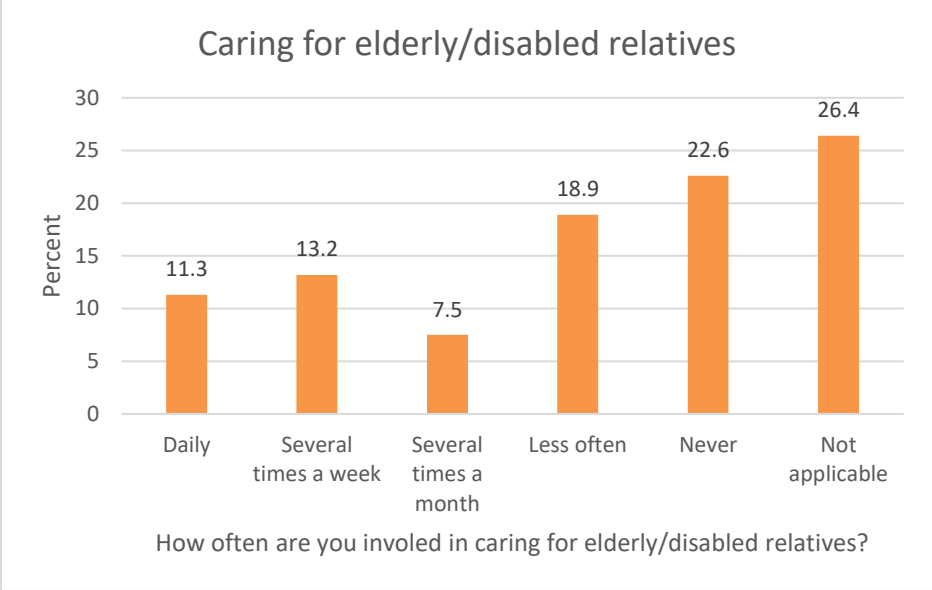

Figure 7 Involvement in caring for elderly/disabled relatives

Work ability and productivity level in the study group

The study participants assessed their work ability rather highly. The average work ability was 8.09 (SD = 2.00; Min = 0; Max = 10). However, 13% of the study group rated their work ability as lower than 7 points (fig. 8).

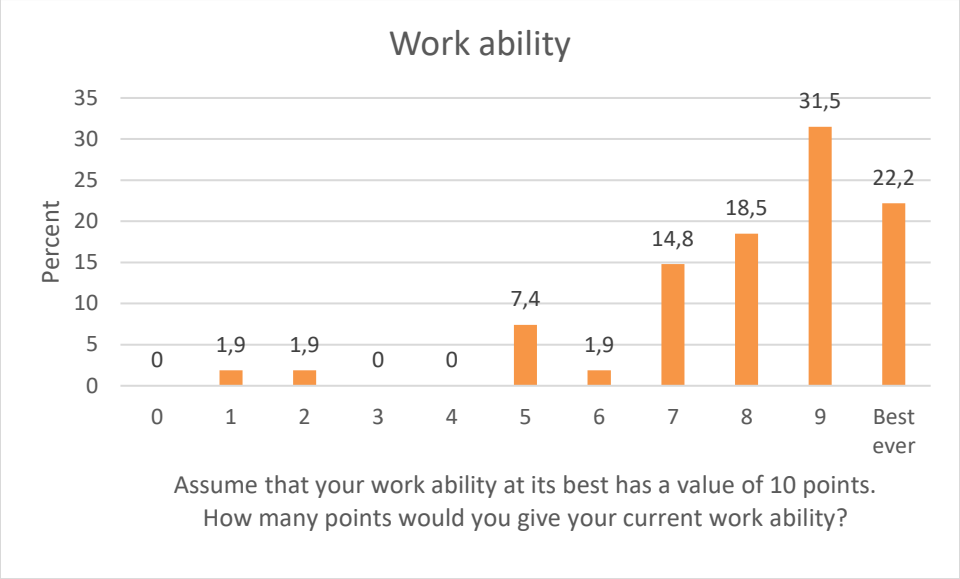

Figure 8 Work ability in the study group

Similarly, the study group assessed their job performance highly. The average job performance was 8.63 (SD = 1.26; Min = 5, Max = 10). Again, 13% of the group assessed their job performance lower than 8 points.

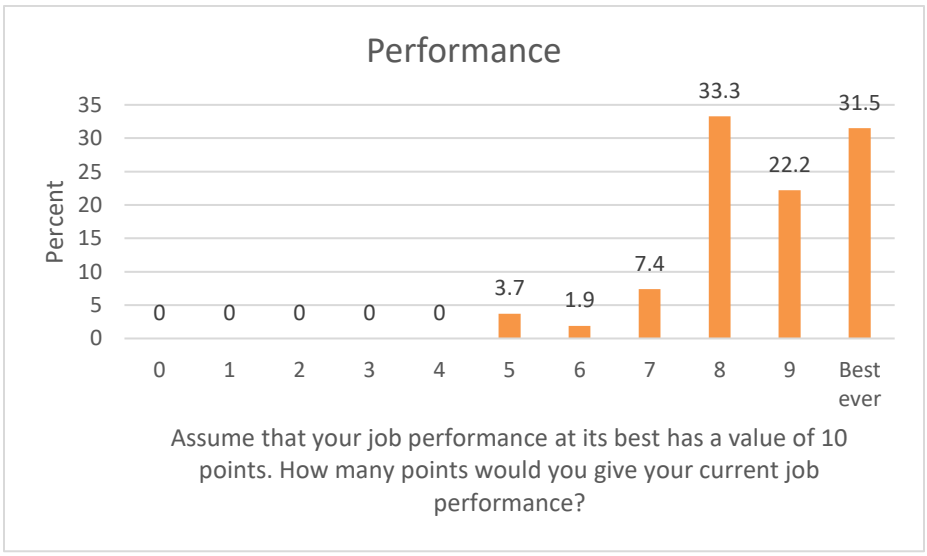

Figure 9 Job performance in the study group

Health, capabilities, lifestyle

Self-assessed health

When it comes to self-assessed health, most of the study group (64.3%) described their health as 'good'. Nearly 9% of the study group assessed their health as poor or fair, while 26.8% of the group assessed their

health as very good or excellent. When two age groups are considered, the general trend is similar, although more employees aged 56+ indicated their health was 'fair' and 'good', while more employees aged 45-55 indicated their health was 'very good' (fig. 10).

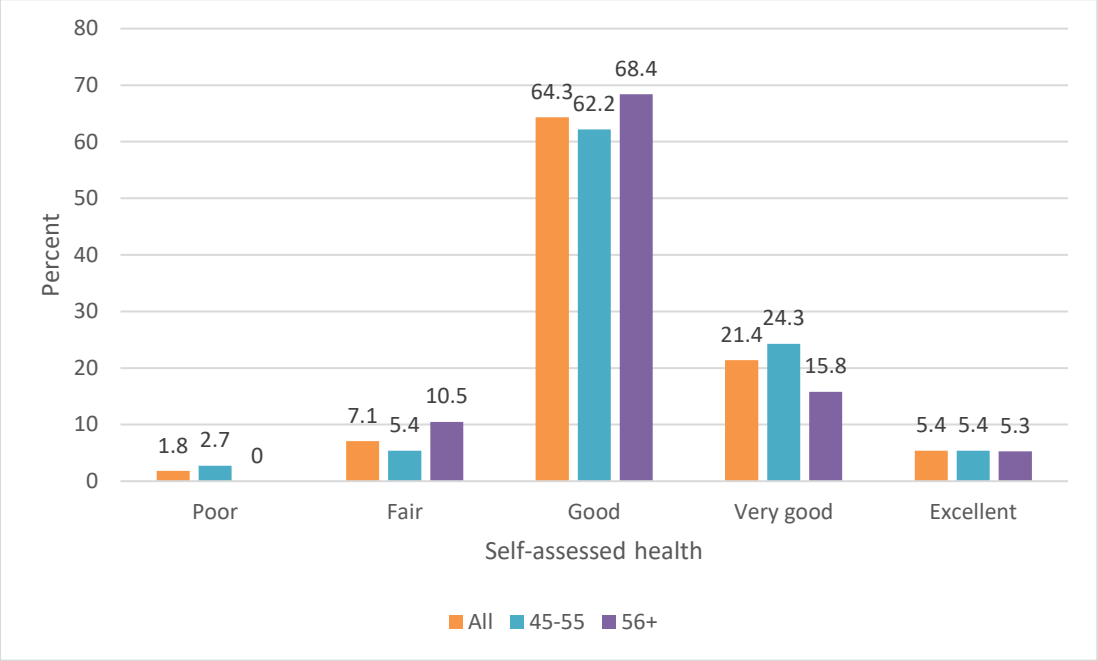

Figure 10 Self-assessed health in age groups

Sickness absence

Average sickness absence was 10.86 days (*SD* = 54.44; *Min* = 0; *Max* = 365) but most respondents did not use the sickness absence (Mode = 0). Employees with zero days of sickness absence constituted 82% of the group, while those with one day of sickness absence constituted 6% of the group. 8% of the group consisted of employees with 2 or more days of sickness absence.

Health problems

There was a high rate of musculoskeletal disorders in the study group. Over 71% of respondents felt muscular pain in shoulders, neck and/or upper limbs, 67.3% felt backache and 56.9% - muscular pain in lower limbs. Half of the respondents felt overall fatigue. When asked about long-term diseases (lasting more than 6 months), 10.5% admitted having such a problem.

Table 3 Prevalence of physical health problems in the study group

	Yes (%)	No (%)
Long-term disease	10.5	89.5
Backache	67.3	32.7
Muscular pain in shoulders, neck and/or upper limbs	71.7	28.3
Muscular pain in lower limbs	56.9	43.1
Overall fatigue	52.0	48.0

Among other health problems, respondents mentioned sleep disturbances and dental problems.

Respondents felt rather able to concentrate and their self-efficacy level was rather high, with a low level of depression symptoms reported. Stress level was not high, satisfaction with sleep level was above the average. Physical fatigue intensity was close to the arithmetic average of 5 points.

Table 4 Prevalence of physical and mental health problems and resources

	Mean	*SD*	*Min*	*Max*
Physical fatigue	4.37	2.58	1	10
Satisfaction with sleep	6.53	2.89	1	10
Stress	3.50	2.56	1	10
Depression symptoms	2.98	2.27	1	9
Ability to concentrate	7.10	1.95	2	10
Self-efficacy	7.91	2.14	2	10

Physical activity

Most of the study group described their physical activity in leisure time as 'Some light physical activity'. 20% of the group considered themselves as 'physically inactive'. Only 11.4% of the group declared regular physical activity. The general trend is similar in age groups, with employees aged 45-55 more often engaged in the regular physical activity and training and employees aged 56+ more often engaged in some light physical activity.

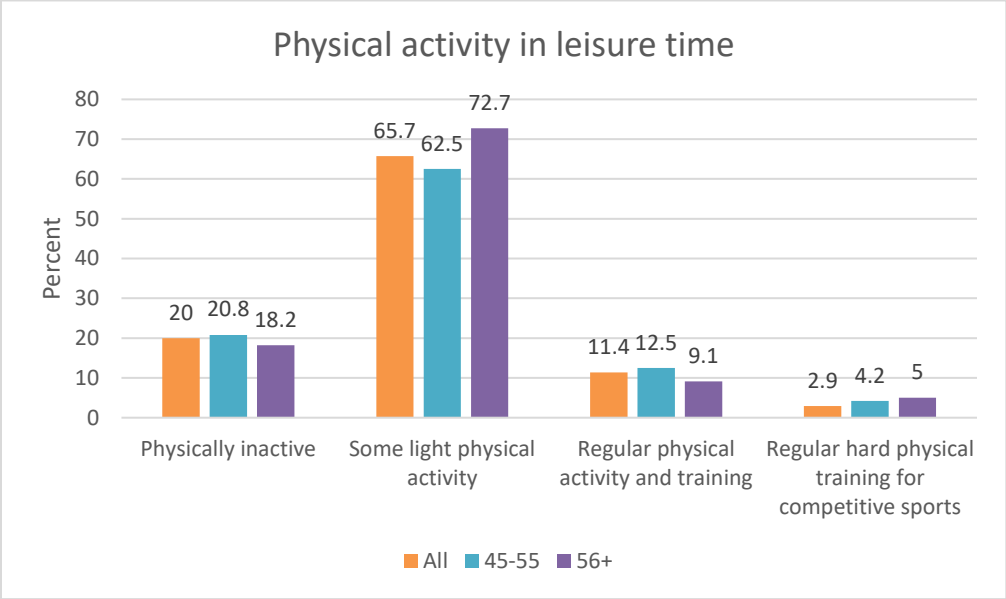

Figure 11 Physical activity in leisure time in different age groups

Smoking and consuming alcohol

21.4% of the group smoked/used tobacco. Most of the study group refused to answer the question concerning the amount of alcohol consumed weekly. Among those who responded (43% of the group), the average amount of consumed alcohol was 1.60 unit per week (SD = 2.41; Min = 0, Max = 8).

Nutrition

The average quantity of fruit and vegetable portions consumed daily was 2.13 (SD = 1.47; Min = 0, Max = 8). The average amount of water intake per day was 1.89 litres (SD = 0.77; Min = 0; Max = 4). Most participants declared drinking 2 litres (57.4%) or 1 litre (22.2 %) of water per day (fig. 12).

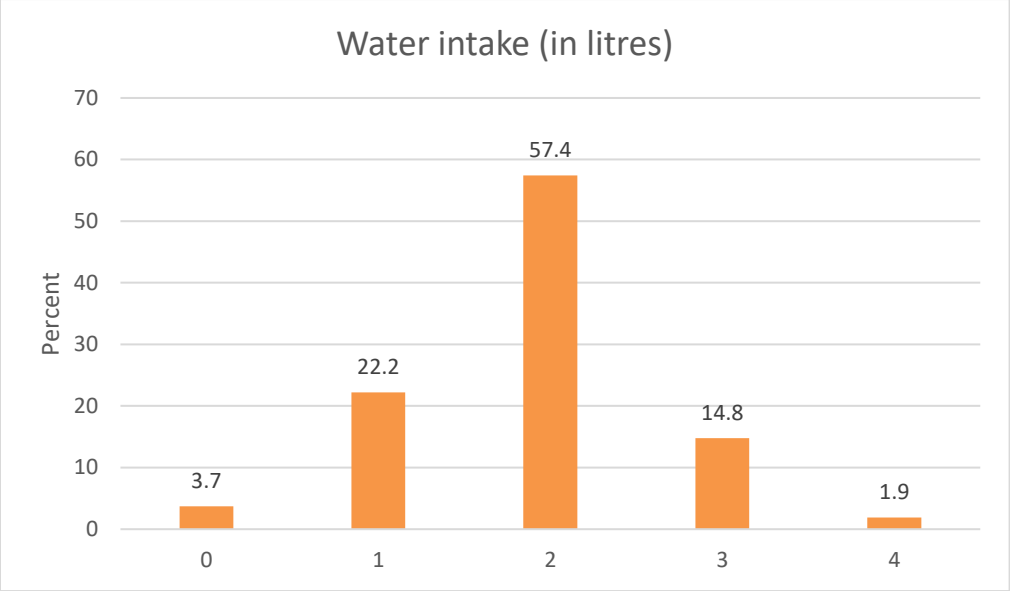

Figure 12 Water intake in the study group.

BMI

The mean BMI (Body Mass Index) was 27.77 (*SD* = 3.39; *Min* – 22.22; *Max* = 34.69).

Most of participants' BMIs indicated overweight both in the general population as well as in two age groups (45-55 and 56+). The obesity rate was 30.4% in the general study population. The obesity rate was even higher in the group of older workers (56+). Only 5.3% of workers aged 56+ had normal BMIs.

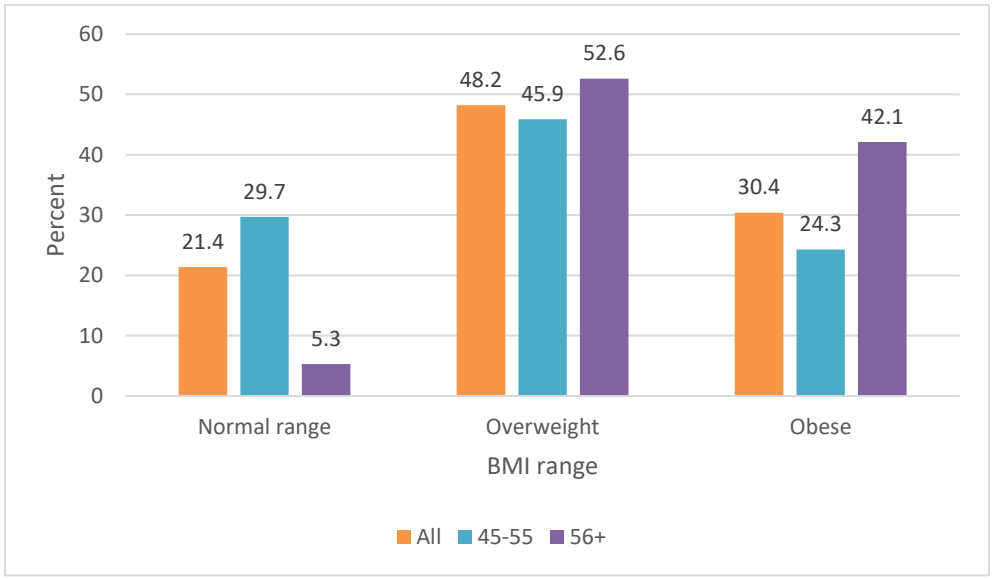

Figure 13 BMI range in age groups.

Vision and hearing

Most of the study group had problems with vision, while 24.6% of the group reported hearing problems.

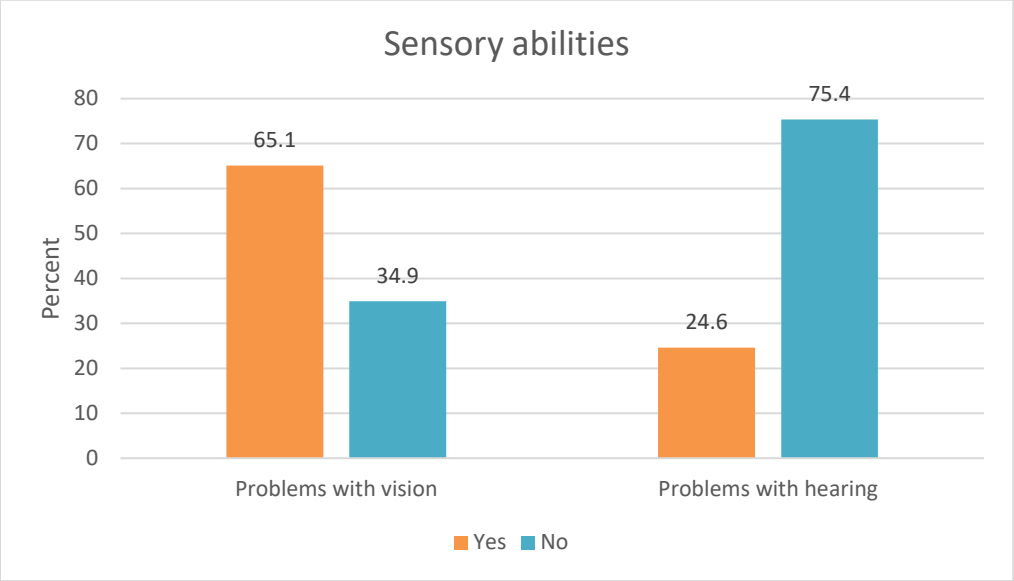

Figure 14 Problems with vision and hearing in the study group. Percentage of answers 'yes' and 'no' to the statements 'I have problems with vision' and 'I have problems with hearing'.

Most of those who reported problems with vision (66.7% of the group) were affected by myopia, followed by hyperopia (25.6%). Three respondents reported other problems, i.a. colour-blindness and astigmatism.

Most employees with vision problems reported that their vision with corrective glasses/lenses was good and 17.8% indicated that their vision was excellent. However, some employees with vision problems estimated their vision with corrective glasses/lenses to be moderate.

Similarly, most employees who reported hearing problems felt that their hearing with hearing aid was good, 15.8% said it was excellent, another 15.8% said it was moderate, and 5.3% rated it as poor (fig. 15).

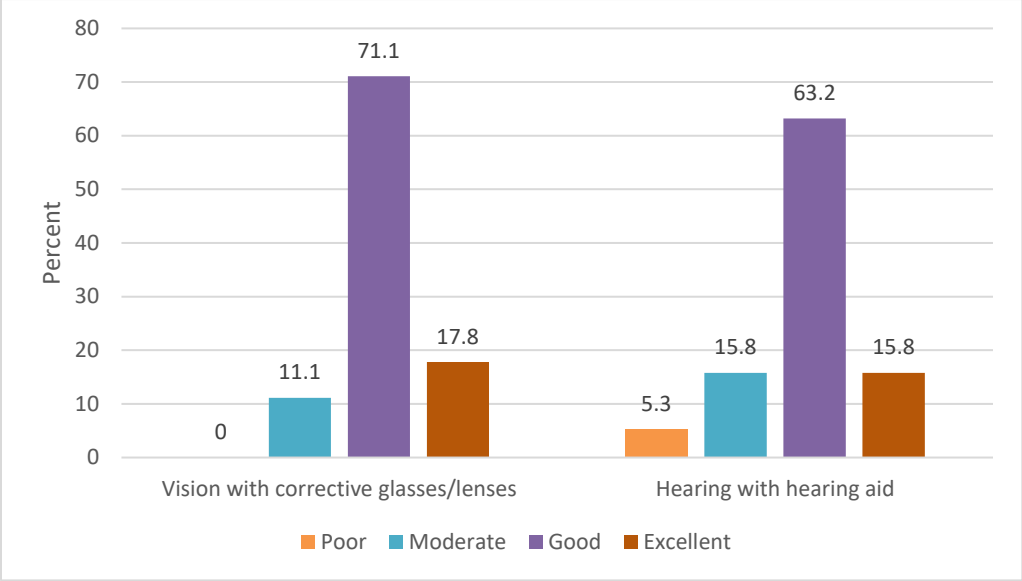

Figure 15 Vision and hearing with vision and hearing aids

Physical fitness / cardiovascular fitness

Most respondents rated their physical ability/cardiovascular fitness as high: they felt they could climb several flights of stairs, or walk two kilometres without difficulty. However, almost 1/5 of employees felt they could only run half a kilometre distance with difficulty or would be unable to complete such a challenge.

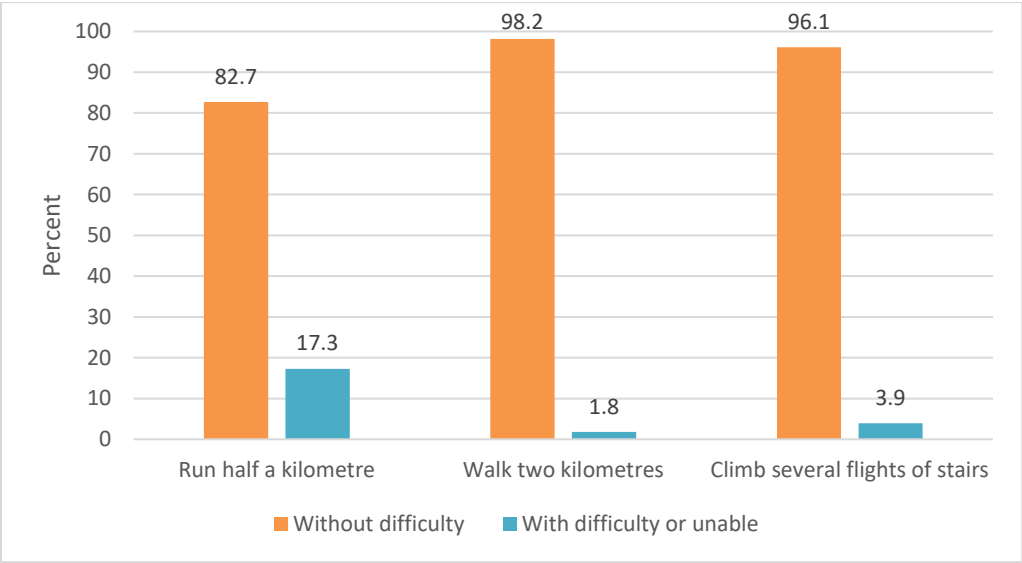

Figure 16 Physical ability/cardiovascular fitness in the study group. Percentage of answers 'without difficulty' or 'with difficulty or unable' to the questions: In your opinion, are you able to: run half a kilometre, walk two kilometres, climb several flights of stairs.

Social support in private life and general quality of life

The results indicate that respondents generally felt satisfied with their personal relationships, social support from friends and general quality of life. The results also show high frequency rate of socializing with friends and relatives.

Table 5 Social support in private life and general quality of life in the study group

	Mean	*SD*	*Min*	*Max*
Satisfaction with personal relationships	8.15	2.45	1	10
Satisfaction with the support from friends	7.85	2.22	2	10
Socializing frequency	7.88	2.28	2	10
General quality of life	7.28	2.02	2	10

Work-related wellbeing

Work-related wellbeing was measured by job involvement, job satisfaction, work-life conflict and job insecurity. The results show that participants' job involvement was below the arithmetic average of 5 points but job satisfaction was above. Levels of work-life conflict and job insecurity were below the average, meaning that employees felt rather secure in terms of losing their jobs. They also felt they could rather maintain work-life balance.

Table 6 Work-related wellbeing in the study group

	Mean	*SD*	*Min*	*Max*
Job involvement	4.18	3.24	1	10
Job satisfaction	7.42	2.52	1	10
Work-life conflict	43.41	24.40	0	87.5
Job insecurity	44.44	28.07	0	100

Working conditions

Physical job demands

Respondents felt rather high physical exertion at work (*M* = 6.61; *SD* = 2.54; *Min* = 1; *Max* = 10). The highest frequency of physical demands in the study group was observed in case of sitting, repetitive hand or arm movements, vibrations from hand tools, machinery etc., and breathing in smoke, fumes, etc. The lowest frequency of physical demands was observed in case of exposure to high or low temperature, tiring or painful positions and handling or being in skin contact with chemical products or substances (tab. 7).

Psychosocial working conditions

Quantitative job demands were estimated to be rather low. This means that employees felt they had an adequate amount of responsibilities and tasks. The average work tempo (time pressure) level was close to the arithmetic average. Similarly, variation of work, cognitive demands and recognition were also assessed as average. Above the average, social support from supervisors and colleagues was assessed, as well as development opportunities. This means that employees felt they were supported by colleagues and supervisors and that they could use their skills and learn new things at work. There were also low levels of workplace conflicts and social isolation from colleagues while working. Quite a low level of age inclusiveness was observed, meaning that employees did not think there was a space for elderly employees in their workplace. Employees assessed their influence (autonomy) below the arithmetic average of 50.

Table 7 Psychological job demands and job resources in study group

	Mean	*SD*	*Min*	*Max*
Quantitative demands	15.18	16.47	0.00	75.00
Tempo	52.23	19.53	12.50	100.00
Variation of work	50.23	18.86	12.50	100.00
Cognitive demands	50.80	21.42	6.25	100.00
Social support from supervisors	61.11	31.35	0.00	100.00
Social support from colleagues	73.18	23.99	25.00	100.00
Conflicts and quarrels	7.41	19.20	0.00	100.00
Influence	40.74	30.05	0.00	100.00
Development opportunities	62.27	22.37	12.50	100.00
Age Inclusiveness	30.39	30.13	0.00	100.00
Recognition	59.26	26.29	0.00	100.00

Moreover, low level of social isolation at work was observed: 77,4% of the group answered “Never” or “Seldom” to the question “Do you feel isolated from your colleagues while working?”, while 19% sometimes felt isolated.

IT skills demands

Most of the group reported that they did not need to use ICT tools such as computers, laptops, smartphones etc. while working (fig. 17). This result is related to two factors: the nature of work of most of the employees was mainly manual, where there was no need to use ICT devices, and the second reason is that the organization’s policy with the focus on employee safety did not include using additional devices, such as smartphones or smartwatches.

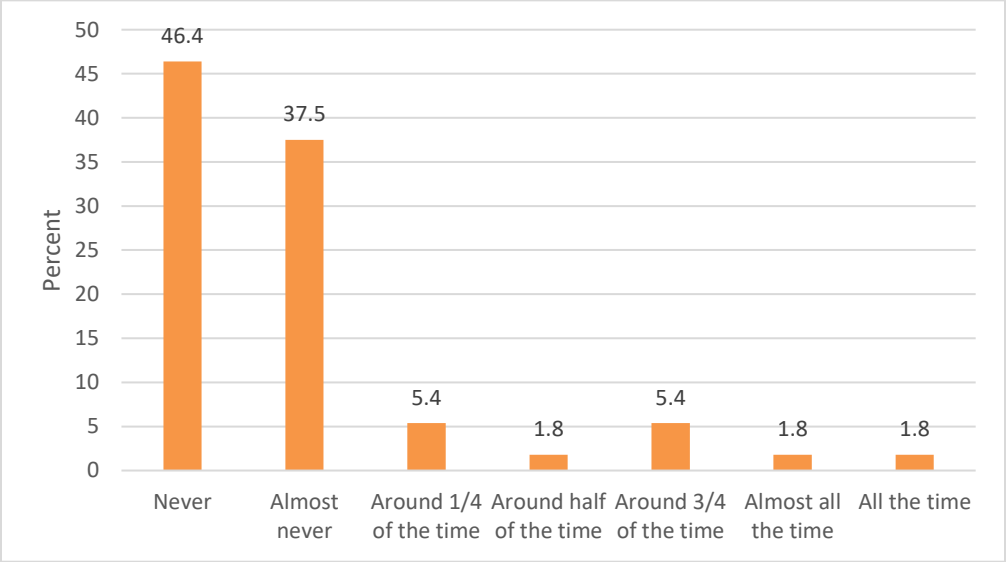

Figure 17 Use of ICT tools in the study group. Percentage of the workers per answer to the question: Does your main paid job involve working with computers, laptops, smartphones, etc.?

Organisational factors

Although mean working time in the study group was close to 40 hours per week (M = 41.49; SD = 10.32; Min = 8; Max = 60), 26.5% of the group worked longer than 40 hours per week, with 10 employees (17.6%) working longer than 50 hours per week.

Most employees (70.4% of the group) felt well informed regarding health and safety risks related to performance of the job, while 22,2% felt very well informed (fig. 18).

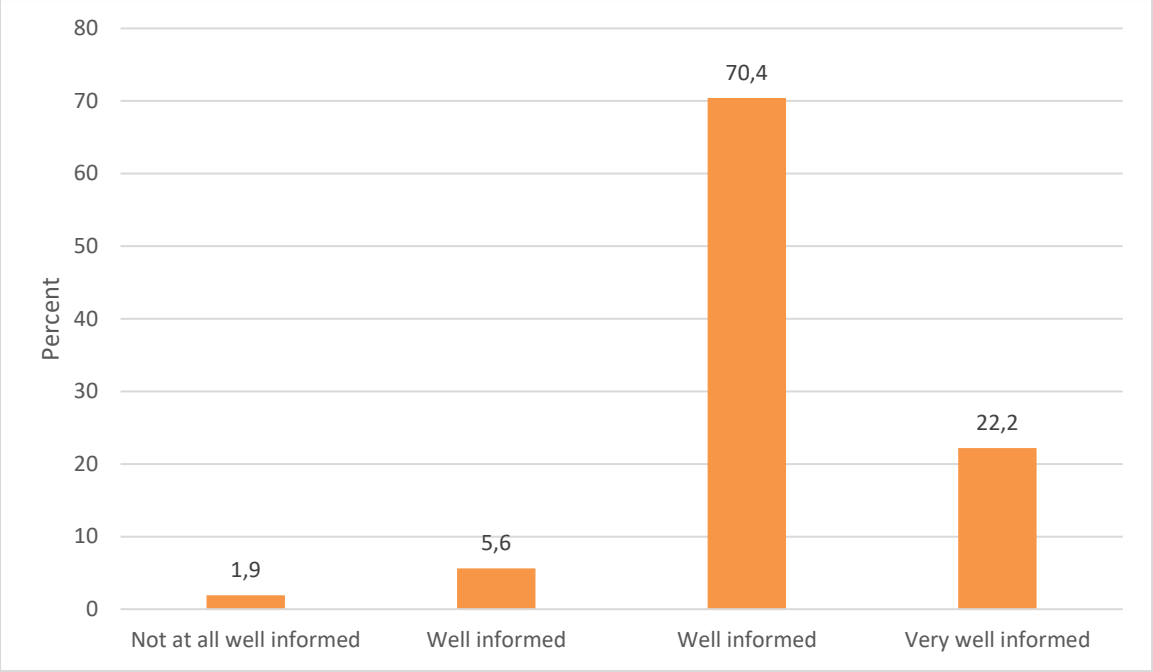

Figure 18 OSH related risk awareness.

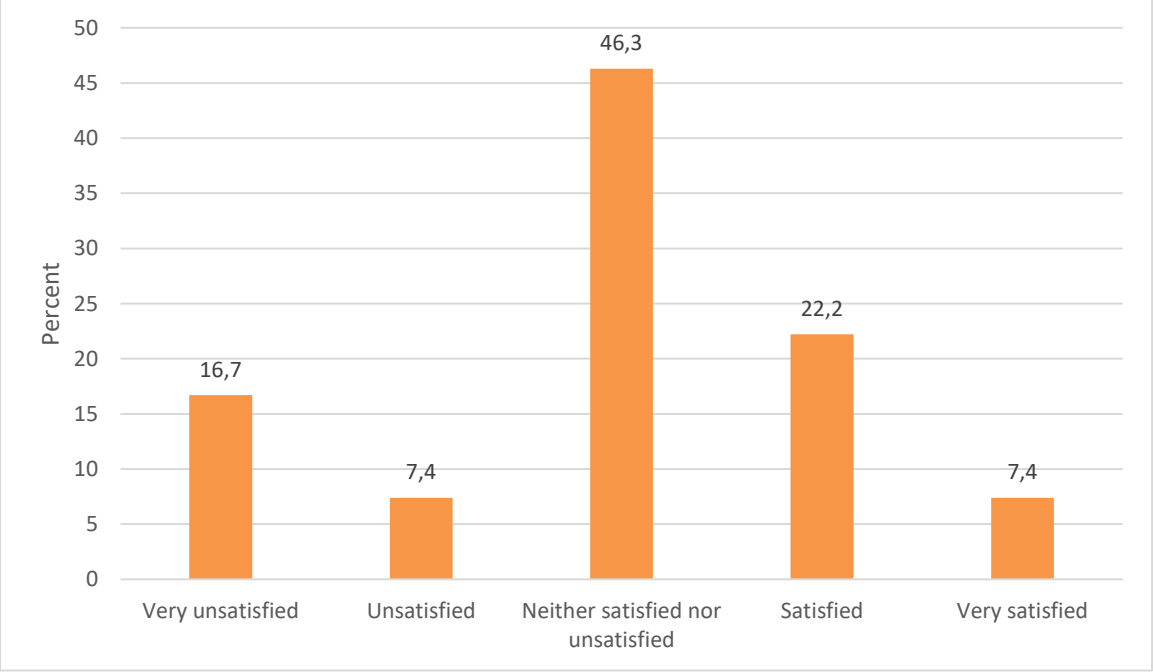

Figure 19 Satisfaction with access to health services

Satisfaction with access to health services in the study group was neither high nor low: almost 50% of the group was neither satisfied not unsatisfied, 22.2% of the group was satisfied and nearly 17% felt very unsatisfied (fig. 19). Moreover, 33.3% of the respondents reported that the employer provided an additional health insurance, while 66.7% of the group did not receive such an insurance.

Type of contract

Most of the group (94.2%) worked as an employee, while 5.8% were self-employed. 83.3% of the group had contracts of unlimited duration, while 9.3% of the group had contracts of limited duration.

Working in more than one location

In the 12 months prior to the survey, 30.2% of the employees worked in more than one location.

OSH risk awareness

OSH risk awareness was quite high – employees felt informed about the risks related to their work. 98.2% of the employees used personal protective equipment when required and 92.2% of the group had trust in the emergency/rescue procedures and staff in the company.

Learning method preferences

Additionally, we asked our respondents about their preferred learning methods as well as difficulties in previous experiences in learning how to use ICT devices or programs.

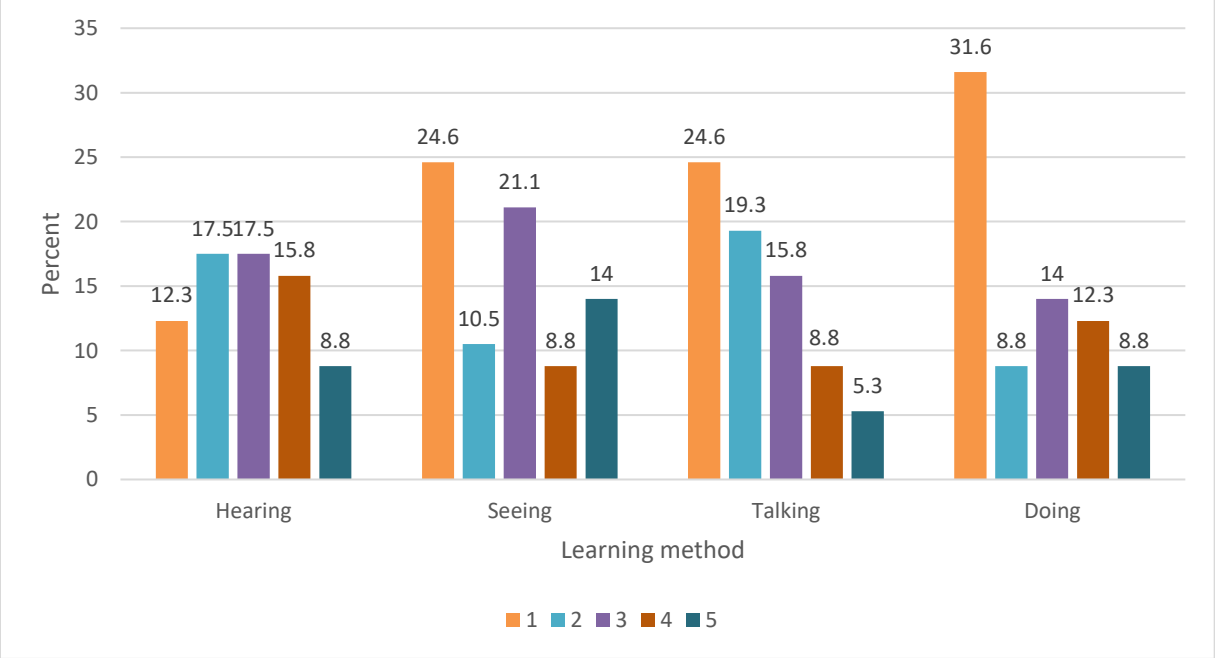

Figure 20 Learning method preferences in the study group. 1 – most important method, 5 – least important method.

The most preferred learning method was 'doing' (e.g. real-life problem-solving, tasks, exercises), followed by seeing (e.g. reading an instruction, watching a demonstration, video) and talking (e.g. taking part in a discussion). 'Hearing' was the learning method that was least frequently chosen as method no. 1.

47.2% of the group reported encountering difficulties while learning to use new technologies (computer, smartphone, Internet, or app). Respondents who admitted they had some difficulties, were asked about specific reasons for such difficulties.
The most common difficulty was lack of repetition and practice (10 respondents), followed by lack of learning support (9 respondents), difficult or complex instructions (7 respondents), lack of cues, reminders, navigational aids (7 respondents), memory and mental agility issues (6 respondents), fear of using or breaking the device/program (5 respondents) and, finally, user-unfriendly technology (1 respondent). One respondent was not attracted to learning new technologies because of lack of time and practical use outside of work.

4.1.3 Results of the analysis of relationships between variables included in the survey

Categorical variables – U-Mann-Whitney and Kruskal-Wallis tests

U-Mann-Whitney and Kruskal-Wallis tests were conducted in order to test the relationships between various categorical variables (e.g. *job position, type of job demands, vision and hearing problems, general health, BMI, physical fitness*) and three main dependent variables: **work ability, job performance, and general quality of life**. As not many significant relationships were identified, only significant results are provided below. An overview of all categorical variables analysed is provided in table 10.

Long-term disease

The Mann-Whitney U test showed that there was a significant difference (U = 58.50; p < 0.01; Z = -2.417) in **work ability** between employees who did (*Mdn* = 6.50) and did not suffer from a **long-term disease** (*Mdn* = 9.00). Moreover, significant differences (*U* = 224.00; *p* < 0.05; *Z* = 2.25) were observed in **general quality of life** between employees who did (Mdn = 5.50) and who did not suffer from a long-term disease (Mdn = 8.00).

Problems with vision

The Mann-Whitney U test showed that there was a significant difference (U = 62.50; p < 0.001; Z = -3.88) in **performance** between employees who reported **problems with vision** (*Mdn* = 8) and those who did not have problems with vision (*Mdn* = 10).

Quality of vision using corrective glasses/lenses

The Kruskal-Wallis H test showed that there was a statistically significant difference in **general quality of life** score between employees with different levels of **vision quality using corrective glasses/lenses**, $\chi^2(2) = 6.35$; $p < 0.05$, with a mean rank work ability score of 31.00 for those with excellent, 21.05 for those with good and 12.90 for those with moderate vision quality using corrective glasses/lenses.

Dunn's pairwise tests were carried out for the three pairs of groups. There was evidence (p < 0.05) of a difference between the group reporting moderate vision quality and the group reporting excellent vision quality using corrective glasses/lenses. The median performance score in the group characterized by moderate vision quality was 6 compared to 8.50 median score in the group characterized by excellent vision quality.

Quality of hearing using hearing aids

The Kruskal-Wallis H test showed that there was a statistically significant difference in **work ability** score between employees with different levels of **hearing quality using hearing aids**, $\chi^2(2) = 7.17$; $p < 0.05$, with a mean rank work ability score of 13.75 for those with excellent, 9.79 for those with good and 2.67 for those with moderate hearing quality.

Dunn's pairwise tests were carried out for the three pairs of groups. After using the Bonferroni correction, no significant differences were found between the groups.

The Kruskal-Wallis H test showed that there was a statistically significant difference in **performance** score between employees with different levels of **hearing quality using hearing aids**, $\chi^2(2) = 8.73$; $p < 0.05$, with a mean rank performance score of 15.00 for those with excellent, 9.67 for those with good and 2.33 for those with moderate hearing quality.

Dunn's pairwise tests were carried out for the three pairs of groups. There was evidence ($p < 0.05$) of a difference between the group reporting moderate hearing quality and the group reporting excellent hearing quality. The median performance score in the group characterized by moderate hearing quality was 7 compared to 10 median score in the group characterized by excellent hearing quality.

Physical activity in leisure time

The Kruskal-Wallis H test showed that there was a statistically significant difference in **work ability** score between the different levels of **physical activity in leisure time**, $\chi^2(2) = 6.39$; $p < 0.05$, with a mean rank work ability score of 9.93 for physically inactive employees, 20.22 for employees doing some light physical activity and 15.13 for employees reporting regular physical activity and training.

Dunn's pairwise tests were carried out for the three pairs of groups. There was evidence ($p < 0.01$) of a difference between the group physically inactive and the group reporting some light physical activity. The median work ability in the group characterized by being physically inactive was 7 compared to 9 median score in the group characterized by some light physical activity.

Physical fitness/ cardiovascular fitness

The Man-Whitney U test showed that there was a significant difference ($U = 87.50$; $p < 0.05$; $Z = -2.45$) in **general quality of life** between employees who were able to run 0.5 km without difficulty ($Mdn = 8.00$) and employees who could run 0.5 km with difficulty or were unable to run such a distance at all ($Mdn = 6.00$).

Table 8 Overview of results (Yes = significant vs No = non-significant difference between groups) of Kruskal-Wallis / Mann-Whitney tests conducted for categorical variables with work ability, job performance and quality of life as independent variables

	Work ability	*Job performance*	*Quality of Life*	*Number of answers Yes/No*
Relationship status	No	No	No	
Education level	No	No	No	
Household income	No	No	No	
Financial responsibility	No	No	No	
Character of job demands (manual vs mental)	No	No	No	
Job position	No	No	No	
Problems with vision	No	**Yes**	No	
Quality of vision with glasses/lenses	No	No	**Yes**	
Hearing problems	No	No	No	
Quality of hearing using hearing aids	**Yes**	**Yes**	No	
Ability to run 0.5 km	No	No	**Yes**	
Ability to walk 2 km	No	No	No	
Ability to climb several flights of stairs	No	No	No	
BMI	No	No	No	
General health	No	No	No	
Long-term disease	**Yes**	No	**Yes**	
Backache	No	No	No	
Muscular pain in shoulders	No	No	No	
Muscular pain in lower limbs	No	No	No	
Overall fatigue	No	No	No	
Employee vs self-employed	No	No	No	
Type of employment contract	No	No	No	
Working in more than 1 location	No	No	No	
Using PPE	No	No	No	
Trust in emergency procedures	No	No	No	
Additional health insurance	No	No	No	

Results of correlation analysis

Correlation analysis was performed in order to establish significant relationships between work ability, job performance and general quality of life and all groups of factors identified in the literature review. The results are presented in table 11.

Table 9 Pearson's r correlation coefficients for the significant correlates of work ability, job performance, general quality of life

	Work ability	*Job performance*	*Quality of Life*
Work ability	1	0.52***	0.33*
Job performance	0.52***	1	0.31*
General quality of life	0.33*	0.31*	1
Stress	-0.29*	-0.18	-0.35**
Negative feelings (blue mood, despair, anxiety, depression)	-0.28*	-0.10	-0.23
Satisfaction with sleep	0.39**	0.49***	0.50***
Concentration	0.60***	0.68***	0.44**
Self-efficacy	0.42**	0.43**	0.52***
Satisfaction with personal relationships	0.35*	0.39**	0.50***
Satisfaction with the support from friends	0.31*	0.31*	0.53***
Socialization in private life	0.24	0.25	0.72***
Motivation and involvement in work	-0.17	-0.31*	-0.003
Job satisfaction	0.14	0.26	0.33*
Physical exertion at work	0.21	0.32*	0.17
Satisfaction with access to health services	0.14	0.19	0.31*
Work-life conflict	-0.04	-0.21	-0.33*
Variation of work	-0.04	-0.01	0.28*
Cognitive demands	0.25	0.48***	0.21
Social support from colleagues	0.22	0.32*	0.16
Conflicts and quarrels	-0.25	-0.37**	-0.13
Repetitive hands or arm movements	0.12	0.08	-0.28*
OSH risk awareness	0.24	0.13	0.34*
Vibrations from hand tools, machinery, etc	0.06	-0.02	-0.37**

**p<0.05; **p<0.01; ***p<0.001*

Nine factors correlated significantly with **work ability**:

1. Cognitive resource, i.a. concentration: the better ability to concentrate, the higher work ability.
2. Job performance: the higher job performance, the higher work ability in the study group.
3. Self-efficacy: the higher self-efficacy, the higher work ability.
4. Satisfaction with sleep: the better sleep satisfaction, the higher work ability.
5. Quality of life: the higher quality of life the higher work ability, in the study group.
6. Psychosocial resources in private life, i.a. satisfaction with personal relationships, satisfaction with the support from friends, and self-efficacy: the higher level of satisfaction with personal relationships and support from friends, the higher work ability.
7. Mental health factors, i.a., negative feelings, such as depression or anxiety: the more negative feelings, the lower work ability.
8. Stress symptoms: the more stress symptoms, the lower work ability.

Twelve factors significantly correlated with **job performance**. Apart from two other dependent variables (work ability and quality of life) the correlates of job performance were:

1. Concentration was positively related to job performance: the higher ability to concentrate, the better job performance.
2. Satisfaction with sleep was positively correlated with job performance: the higher sleep satisfaction, the better job performance.
3. Cognitive demands: the higher cognitive demands, the higher job performance.
4. Self-efficacy: the higher level of self-efficacy, the higher job performance.
5. Satisfaction with personal relationships and support from friends: the higher level of satisfaction with personal relationships and support from friends, the higher job performance.
6. Conflicts at work was negatively related to job performance: he higher level of conflicts at work, the lower job performance.
7. Social support from colleagues was positively related with job performance: the higher social support, the higher job performance.
8. Motivation and involvement in work: this factor, contrary to expectation, was related negatively with job performance: the more employees felt motivated and involved in their work, the lower their estimation of their job performance.
9. Job demands factor, i.e. physical exertion at work: also contrary to expectations, the higher physical exertion at work, the higher job performance.

Sixteen factors were related with general quality of life. Apart from two other dependent variables (work ability and job performance), factors correlated with quality of life were:

1. Frequency of socialization activities: the higher frequency of socialization activities, the better quality of life.
2. Satisfaction with support from friends: the higher satisfaction with support from friends, the better quality of life.
3. Self-efficacy: the higher level of self-efficacy, the better quality of life.

4. Satisfaction with personal relationships: the higher satisfaction with personal relationships, the better quality of life.
5. Concentration: the higher ability to concentrate, the better quality of life.
6. Satisfaction form sleep and satisfaction with sleep: the lower level of sleep satisfaction, the lower level of quality of life.
7. Vibrations from hand tools, machinery: the higher level of vibrations from hand tools, machinery, the lower quality of life.
8. Stress: the higher level of stress symptoms, the lower quality of life.
9. OSH risks awareness: the higher OSH risks awareness, the better quality of life.
10. Job satisfaction: the higher job satisfaction, the better quality of life.
11. Work-life conflict: the bigger conflict between work and private life, the lower quality of life.
12. Satisfaction with access to health services: the higher level of satisfaction with access to health services, the better quality of life.
13. Repetitive hands or arm movement: the more repetitive hands or arm movements, the lower quality of life.
14. Variations of work: the higher level of variation at work, the higher level of quality of life.

Apart from the relationships with three main variables (work ability, productivity and quality of life), other significant correlations were also identified (see Annex for the complete correlation table). As physical working conditions were related with work ability, productivity and quality of life only to the limited extent, it seems to be worth mentioning other correlates of physical working conditions, because of their importance and prevalence in physical work.

Correlation analysis shows that two already mentioned physical demands factors, i.e. **vibrations from tools and machinery** and **repetitive hands or arms movements** are related not only with lower quality of life, but also with:

- Higher level of stress
- Higher level of negative feelings
- Higher level of physical fatigue
- Higher work tempo
- Lower variation of work

Higher frequency of vibrations is also related with higher feeling of social isolation at work, while higher frequency of repetitive movements is also related with higher level of job insecurity and lower satisfaction with access to health service.

Physical exertion at work was also correlated with higher amount of water intake, lower frequency of conflicts and quarrels, lower frequency of variation of work and better satisfaction with sleep.

More frequent **contact with chemical substances** and **breathing in vapours** was associated with lower concentration ability (both factors), lower satisfaction with sleep (contact with chemical substances) and higher levels of stress (breathing in vapours). Contact with chemical substances was also related with lower social support from colleagues and lower OSH risk awareness.

It also turned out that **tiring and painful body postures** were related with lower job satisfaction, lower recognition, lower OSH risk awareness and lower variation of work.

Exposure to **sitting,** with a high prevalence in the study group, was related to low variation of work and low cognitive demands, as well as tiring or painful positions.

On the other hand, more frequent **work with computer, laptops, smartphones**, was correlated with lower physical exertion and higher degree of influence at work, which probably indicates differences in job positions.

Greater **OSH risk awareness** was related with several additional factors: caring for children/grandchildren, nutrition (greater amount of fruits and vegetables portions consumed per day), concentration, higher level of satisfaction with personal relationships and social support from friends, as well as frequency of socialization in private life. This factor is also connected with higher level of social support from colleagues, lower level of conflicts at work, better work-life balance, as well as possibilities for development. Again, it may indicate better job position, but also shows that with better risk awareness comes more responsible behaviors and appreciation of social support.

Another group of factors that should be examined more closely are mental health indicators. Apart from work ability and general quality of life, **stress** was related also with:

- Physical fatigue
- Negative feelings (depression, anxiety)
- Lower concentration ability
- Lower satisfaction with sleep
- Lower self-efficacy
- Higher level of work-life conflict
- Lower satisfaction with access to health services
- Lower variation of work
- Physical job demands mentioned above (**vibrations from tools and machinery** and **repetitive hands or arms movements, breathing in vapours**

Correlates of **psychosocial working conditions**:

Interestingly, **quantitative job demands** were related only with the support from supervisor: the higher support from supervisor perceived, the lower quantitative job demands.

Work tempo was related to physical fatigue: the higher tempo, the higher level of fatigue. High tempo was also related to lower frequency of socialization in private life, which can be understood given the higher fatigue level. On the other hand, this factor is also related with higher level of cognitive demands, higher level of influence and possibilities for development. High tempo was correlated to several physical job demands: exposure to vibrations, repetitive movements and high temperatures.

Cognitive demands were positively correlated with satisfaction with sleep and concentration ability, but also with self-efficacy, satisfaction with personal relationships and support from friends, social support from colleagues, recognition, influence, age inclusiveness, and possibilities for development.

Social support from supervisors was unrelated to main independent variables but was related to higher job satisfaction level, social support from colleagues and lower level of conflicts and quarrels at work, as well as lower level of social isolation at work. It was also related to better possibilities for development and recognition.

Social support from colleagues was related with better concentration ability, self-efficacy, satisfaction with support from friends, job satisfaction, better possibilities for development and recognition.

Influence at work was related with job satisfaction, higher tempo and cognitive demands, possibilities for development and recognition, but also with working with computers/laptops/smartphones. It seems that valuable psychosocial working conditions are related to better job positions.

There were also some significant correlates of the lifestyle and socio-demographic factors:

BMI was negatively related with age inclusiveness: the higher BMI, the lower feeling of age inclusiveness in the workplace. On the other hand, BMI was related to higher level of recognition.

Age was related with more frequent socialization with friends and neighbours as well as with lower work-life conflict.

Sickness absence was related with feeling of social isolation at work. **Physical fatigue** was related with negative feelings, stress, work-life conflict, work tempo, physical working conditions and feeling of social isolation at work.

Conclusions:

Almost all identified areas of factors were found to be significantly related with outcome variables, although to a limited degree. The lowest amount of significant relationships was found in the group of organizational factors and socio-demographic and lifestyle factors, as well as physical health factors. Although work ability, job performance and quality of life were correlated to a limited number of variables, other relationships suggest more direct relations. E.g. physical job demands where related to work ability and quality of life to a limited degree, but they were also related to job satisfaction, fatigue, stress or negative feelings (depression and anxiety symptoms), proving their significance in the context of employees wellbeing, as well as some psychosocial working conditions or individual factors. In turn, these mental health indicators were significantly related to work ability, quality of life or productivity of ageing workers. Among physical job demands, exposure to vibration and repetitive movements were most significantly related to work ability and quality of life as well as other wellbeing indicators. These two physical demand factors, together with exposure to sitting, were also most prevalent in the study group, comparing to other physical demands.

Long-term diseases and sensory abilities, as well as physical abilities were also found related to the outcome variables.

The results also show the significant role of personal resources in maintaining work ability and quality of life: from concentration ability and self-efficacy, to social relationships in private life and at work.

Not many significant relationships may be a result of quite low number of the study group and low variability of working conditions, age or lifestyles. Also, because of low number of answers explaining respondents' job position it was not possible to analyse the differences between various job positions (e.g. manual and mental or with and without supervisory responsibility).

However, similar results were derived from the research by Gould and Polvinen (2008): the quality of social community at work, as well as mental strain, were mentioned by older employees among factors hindering the survival in working life. Also, in this Finnish study, it was concluded that compared to men, the work ability in older women was more likely to worsen. Such comparisons were not possible in our study as only men were examined.

Nevertheless, a series of factors related to work ability, job performance and quality of life were identified and other relationships were also examined. Despite low number of relationships between specific physical job demands and work ability, we suggest to keep these factors in the final set of factors to be included in the Ageing@Work system. This is because the literature review suggested that for ageing men there is a faster decline in work ability for employees working in physical and mixed jobs (Rineer, 2015). Also Costa and Sartori (2007) showed that although work ability decreases over the years, it also depends on working conditions and employee health with significant decrease in employees with high physical workload and low job control, while in employees with mental work and high level of autonomy, it is more stable. Similar results were demonstrated in Lahelma et al. (2012); after controlling for all working conditions, the most significant risk factors for disability retirement (also for disability retirement due to musculoskeletal disorders) were heavy physical workload and low job control.

Physical workload and hazardous exposures also play a role as a mediator in the relationship between risk of disability retirement for all causes and for musculoskeletal diseases in particular and lower social classes (blue-collar work), while the role of health behaviours was significant but weaker (Leinonen et al., 2011). That is why physical workload, physical job demands and job control should be taken into account when promoting work ability in ageing employees in manual and mixed jobs, as well as personal and job resources that could moderate the negative impact of job demands (Demerouti et al., 2001).

4.2 Individual interviews @ANEFA

Individual interviews were conducted during workshops organized by UPM (WP2) with ANEFA employees, which consisted of presentations of Use Cases, followed by focus group interviews on users' needs and requirements concerning the Ageing@Work solution. After the focus group interviews, participants were invited to take part in the individual interviews, aimed to obtain more information about drivers and obstacles with regard to the acceptance of the Ageing@Work solution, as well as factors related to work ability, quality of life and productivity of workers as part of WP3, Task 3.1. Semi-structured interviews were conducted individually with six ANEFA employees. Each interview was scheduled to last about 40 minutes. All participants were quarry workers. The objective of the project was explained at the beginning of the workshop.

Drivers and obstacles concerning acceptance of Ageing@Work

Users noticed that Ageing@Work tools could be helpful in highlighting the problems of ageing workers, improving the employees' attitudes and generating empathy towards ageing workers. They could also be used as a good learning support. Moreover, in employees' opinion, the Ageing@Work solution could positively affect safety and productivity in the quarry. Participants admitted that the main aspects of the project that could have an impact on their lives were: increasing the safety in the quarry and helping to keep healthy habits in their personal lives. The implementation of the solution was perceived as necessary. However, there were doubts whether the tool would be used as often as needed, e.g. managers might give instructions to continue working despite a breakdown (ignoring the recommendations of the tools).

When asked about the barriers to the implementation of the Ageing@Work solutions at work and in private life, most participants did not see any difficulties. It was stressed that these tools would be comfortable to wear. However, it was pointed out that it might be more difficult to take advantage of these solutions in private life unless they were easy to use. One respondent explained:

"*I do not believe that there would be a great problem with using the applications at work, as long as managers did not see a decrease in productivity. The biggest problem I see using them in my private life is that I do not have much free time. I get up at five in the morning every day and I get home at 7.30 at night. I do not feel like doing anything. I would need the app to be very easy and fun to use to take the time to enjoy it*".

The managers' attitude was seen as crucial. Employees would depend on managers' decisions if they followed the recommendations of the solution.

"*A barrier to implementing these solutions at work depends on the organisational structure. In family businesses, even if a machine breakdown is reported, the boss can assess whether the worker's life is in danger or not and ignore the breakdown. In multinational companies, where there are more middle managers, it is more difficult to overlook failures, especially if the technology is used to report information to the machine responsible*".

"*The main barriers for the project are the directives and the attitude of the businessmen in charge of the quarry, the norm that may limit the reach and application of certain IT solutions in the working environment…*".

As far as the ICT experience and skills are concerned, the respondents felt good about using new technologies and they were motivated to learn. They had some experience in using new technologies.

"*I'm not at all an expert, but I have a smartphone, e-book, smart tv and PC. I think that compared to the rest of my generation I would be average".*

However, there were concerns that using these tools in private time would be uncomfortable and privacy issues would arise. It was pointed out that it was important not to use physiological data for purposes other than giving workers advice on how to improve their health. At the same time, when asked about their impressions related to the monitoring of their physiological parameters (e.g. heart rate) using a smartphone or a chest band for the purpose of adjusting working conditions to employees' capabilities, respondents thought that it was a good idea, as it would be useful for early detection of health problems.

"*It seems good to me that they measure my vital signals if the information is used to give me advice to improve [my health], rather than for other purposes*".

Respondents identified the best ways to learn new technologies, which would combine theory and practice, e.g. through courses, explanations from others, tutorial videos, but also learning through an app with clear instructions.

"*I think the best way I can learn is to see how it is done, to take a short initiation course, and from that point on, to use it for myself*".

Using real machines and not virtual reality was also very important.

"*To learn how to use new machinery, it would be necessary to do it on the same real machine. Virtual reality can help but it is not the same. There are many sensations that cannot be transmitted in virtual reality, for example, it is not the same to load stone, to load mud, etc. First, it would be necessary to equip each machine with the instruction manual and to compel the operators to read it*".

It was important to have access to clear instructions, as very complex instructions would be difficult to follow:

"*The biggest difficulty is that sometimes you end up with very complex instructions that you do not understand, or that you need to take action but you do not know what to do and in the end you have to see a tutorial on the internet*".

Summary: Respondents were motivated to learn new technologies and thought that they would not have much difficulty doing so. Employees were also willing to have their physiological parameters monitored in order to improve their health provided their personal data were secured. An increase in safety and productivity in the quarry was also important for them and they hoped that these solutions could be of help here.

Factors related to employees' work ability, quality of life and productivity

The next part of the interviews concerned factors related to employees' work ability, quality of life and productivity. They were asked about the most tedious physical environment factors at work and desired changes. Forced, uncomfortable postures and noise were mentioned as the most disturbing factors in the working environment. Complaints also concerned physical effort and boredom related to monotonous tasks (doing the same thing for a long time).

"*What I find troublesome, is the noise. During my last medical review I was told that I was losing my hearing. Earplugs are very uncomfortable and really impair your senses: you do not know, for example, if a wheel has been punctured*".

"*Forced postures are the worst. Sometimes you spend six hours in the same position and as you are concentrated on your work you do not even notice it, and when you leave the cabin your whole body hurts. I think a few short exercises or stretches could make it better*".

It was proposed to introduce short breaks combined with exercise and to equip cabins with more ergonomic chairs that would help deal with musculoskeletal disorders caused by uncomfortable positions.

Among the other difficult job demands, frequently repeated stressful periods related to the amount of work or work pressure, e.g. the beginning of the month, were mentioned.

"*I have gone through almost all the positions in the company and I have adapted to all of them. In my current administrative position, there is a peak of work between the 1st and the 5th day of each month, but I have adapted to it and ultimately the work is ok*".

When asked about the desired changes aimed at improving working conditions, changes in the schedule, more breaks, exercise or stretching were mentioned. What helps workers deal with job demands? Some workers tried to change their own attitude, e.g. by treating their work as a necessity: "I think about it as a way to cover my needs". Others mentioned social atmosphere (relationships with colleagues, support of the supervisors, nice working environment) as being helpful. The role of private life was also highlighted:

"*On Monday and Wednesday afternoons I go to the gym and play games with my friends. It's my way of disconnecting. Saturday afternoons when you finally finish [work], and you can be with the family is the happiest time of the week*".

Respondents did not feel their work ability deteriorated as they aged. For example, they observed worsening eyesight but it was corrected with glasses. They also noticed that they did not work as fast as in the past, but on the other hand – they worked more safely.

"*I have been in the company for five years and I notice that I have lost elasticity and agility. I think twice about doing things […] even though I have not had any accidents. Now I'm doing things more slowly but more safely*".

Other positive age-related changes were also observed, e.g. easier adaptation to the environment. Employees tried to prevent the negative changes by taking care of their health, e.g. by going to the gym

or taking medications. Most respondents admitted that they would be able to perform their current tasks in two years' time. Some thought they would stay in the same job but would not be able to perform the same task because of deteriorating health or to keep up with the job at the same tempo. The role of stress was also mentioned:

"*The main problem is emotional stress not physical. I see myself working on the site in two years because the salary allows me to pay off my debts, and with the schedule that we have, my wife can also work. If I didn't work out of necessity, I would be looking for something else*".

Summary: The main concerns regarding work ability were forced postures, physical effort and doing the same task for a long time. Employees would like to introduce short breaks, physical exercise and have more comfortable chairs. Social resources at work and in private life help them cope with job demands.

General questions

The next part of the interview concerned desired changes in the job in general. Although not many specific answers were given, the financial aspect was most often mentioned. The amount of free time after work to rest and spend time with the family was also mentioned. For some employees, the quantitative job demands and lack of time for family were the main difficulties of the job, including waking up early, working long hours and working weekends. The challenge was to overcome age limitations in order to keep up with the work tempo. When asked about motivating factors that keep them at work, respondents mentioned stability, safety and good knowledge about work tasks. Good salary was also a motivating factor, especially in the context of age and upcoming retirement. Recognition in the form of job promotion was also a significant factor for one of the workers. Finally, respondents simply liked their jobs, that is why they were keen to stay.

"*What motivates me to stay in my position is that it is a job I know, and I feel safe doing it*".

"*I like my job, I have not changed in 29 years of work, although I have been promoted to positions of greater responsibility in the company*".

Summary: In this part of the interview respondents did not give comprehensive answers. They sometimes said that they would not change anything in their job or that they did not encounter difficulties in their work. It was noticeable they felt tired and they would like to work fewer hours, have more days off and more free time to spend with their families.

Stress

When asked about stressful work-related situations, few aspects were mentioned. One respondent said that work organisation could be improved:

"*The most stressful thing about my work is that sometimes lack of organisation and resources leads to the accumulation of my tasks, so I end up being rough with my colleagues*".

Another significant factor was the lack of control over the working process: respondents described a situation in which they did not have control and were dependent on their colleagues and their colleagues'

work results. "(…) Those [ed. situations] that do not depend on me but on the performance of my colleagues or work force. The ones I cannot control but eventually become a problem for me". They referred to frequently repeated periods of increased stress, e.g. the beginning of the month, when billing is being processed. Respondents' approach to dealing with stress was the avoiding a coping style, i.e. they tried not to think about the problem. They also mentioned using physical exercise as stress relief.

"*Sometimes I'm rough with my teammates, or sometimes I keep it to myself and then release tensions while exercising*".

Summary: Employees most often cope with stress by using avoidance techniques. They try not to think about the problem but they point out that the work of other people influencing their own tasks is a source of stress for them.

Lifestyle

Respondents mainly did not see the need to change anything about their lifestyle. One person would like to give up smoking and exercise more often. All respondents said that they had enough time for rest during their work even though they mentioned beforehand that they would like to have greater number of short breaks to neutralize physical effort.

Social support

Social support from colleagues and supervisors was a great resource for the respondents and a factor in improving working conditions with respect to their job satisfaction as well as other psychological aspects.

"*Yes, colleagues support each other. Sometimes there are tensions but nothing serious. We try to solve everyone's problems as a team*".

There was a common feeling of being part of the team. The respondents maintained a very good relationship and helped each other out, especially the senior receiving help from younger co-workers:

"*Although I have been much less time in the company compared to others, I am part of the group. There are many things that you do when you're 40 that you cannot do when you're 60. Colleagues help us fill these gaps*".

Their answers indicate that they did not have any trouble with relationships at work. They mainly focused on support from their colleagues rather than supervisors.

Health

Most frequently mentioned health problems were those relating to hearing, respiratory and musculoskeletal deficiency.

"(…) *Hearing problems and above all sciatica and lumbago that I attribute to the forced posture. Sometimes the leg goes numb and it's very difficult for me to get out of the cabin*".

Respondents believed that more exercise, greater number of short breaks or changing the diet could help improve health.

General summary

The outcomes of the interviews suggest that there is a demand for implementing the Ageing@Work solutions. Respondents observed several difficulties and areas for improvement within their working environment. All respondents mentioned musculoskeletal problems as an issue. Working for a long time in the same posture can be difficult, causing pain and health problems. They also complained about physical effort and monotonous tasks, as well as noise causing hearing problems.

In order to improve their health and working conditions, workers would like to introduce short breaks and have more ergonomic/comfortable chairs in the cabin to neutralize physical pain. Also, more free time to spend with their family was mentioned as an important issue. As it turned out, respondents did not see the need to improve their lifestyle. Gamification system foreseen in the Ageing@Work project should help to increase employees motivation in this aspect.

Most participants believed they could do the same job after two years and could find the factors that would motivate them to continue working: from salary and recognition to simply liking what they do. They felt their age still allows them to work - maybe not as fast as before, but more safely.

Most of them have some experience in using modern technology and are not afraid of using apps or learning new solutions. They noticed that some of the solutions could help them increase the safety and productivity in the quarry. They also confirmed that Ageing@Work solutions could be helpful for them. Monitoring physiological parameters could detect health problems and allow them to start treatment early, but only if data privacy is ensured.

The work atmosphere and relationships between co-workers seemed to be a great source of much needed help and support, although coping with stress could be improved.

5. Questionnaire survey

5.1 Questionnaire survey conducted at Siemens

5.1.1 Study group

The study group consisted exclusively of 15 male and 18 female employees. The average age was 54.93 years (*SD* = 4.12). The youngest participant was 50 years old and the oldest one was 63 years old. Approximately, 55% of the group were employees aged 45-55 and 45% constituted employees aged 56+ (fig. 21).

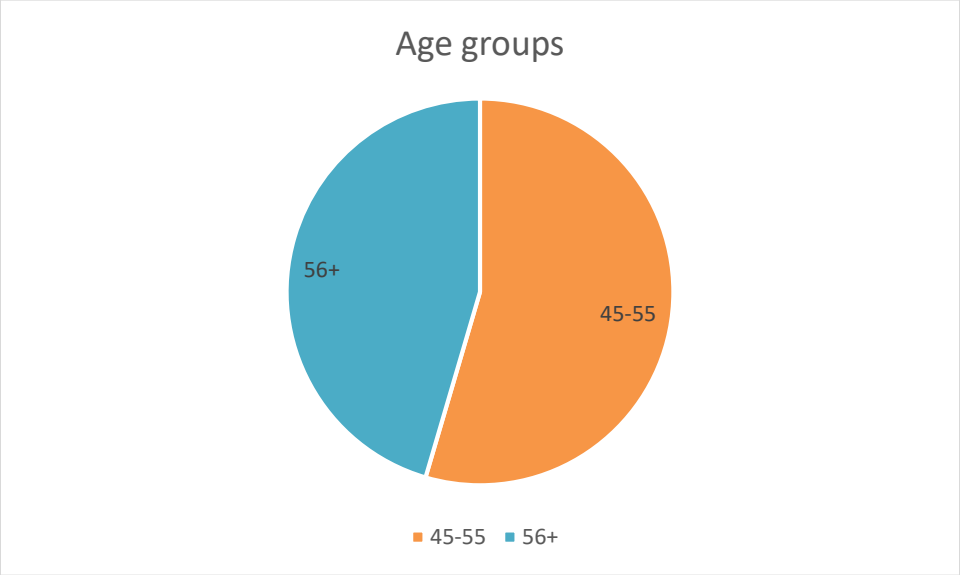

Figure 21 Age groups representatives (quantity)

The mean job tenure at the company was 29.13 years (SD = 10.39; Min = 1, Max = 43).

Most study participants were married or in a relationship - 75.8% (fig. 22).

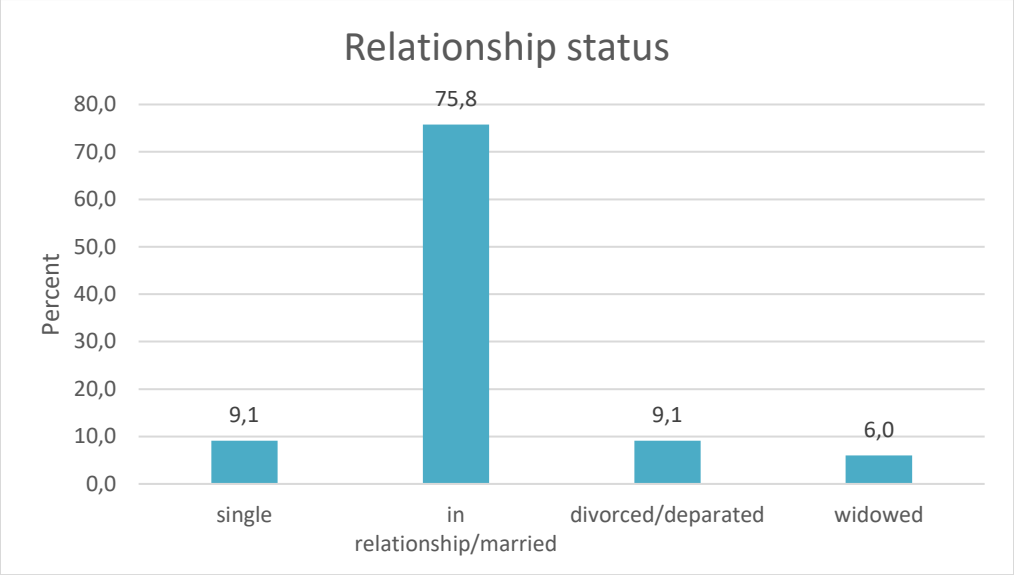

Figure 22 Relationship status in the study group.

The majority of the group (54.6%) was characterized by lower secondary education level. 39.4% of the group received primary education and 3% received post- secondary education (fig. 23). There is no information about education of one of employees.

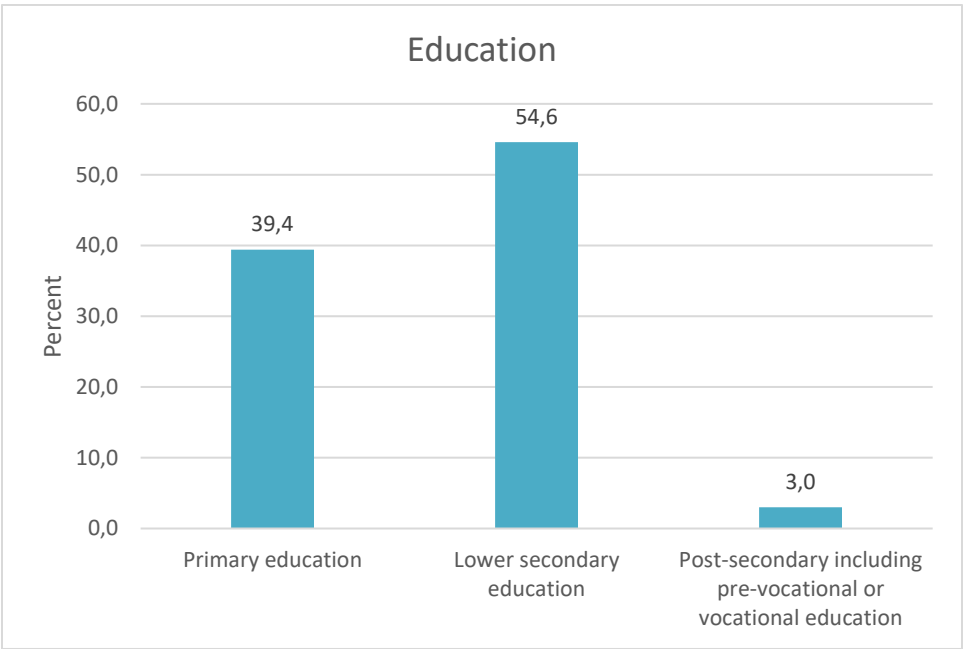

Figure 23 Education level in the study group.

Position in the company

Fourteen respondents (42.4%) were employees without supervisory responsibilities, while 8 respondents had supervisory responsibilities. Eleven respondents did not answer the question about their job position.

Out of those who did respond, 54.5% respondents performed mostly mental work, 9.1% performed manual work, while 36.4% of the group had both manual and mental work.

The most frequently identified job positions were: electrician, inspector, installation assistant, manufacturing worker and group/team leader. Other identified positions were: energy installation electronics engineer, severely disabled representative, track head, precision mechanic, prototype builder, adjuster.

Income

48.5 % of the study group found it easy or very easy for their household to make ends meet, while 15.1% of the group encountered some difficulties in this aspect.

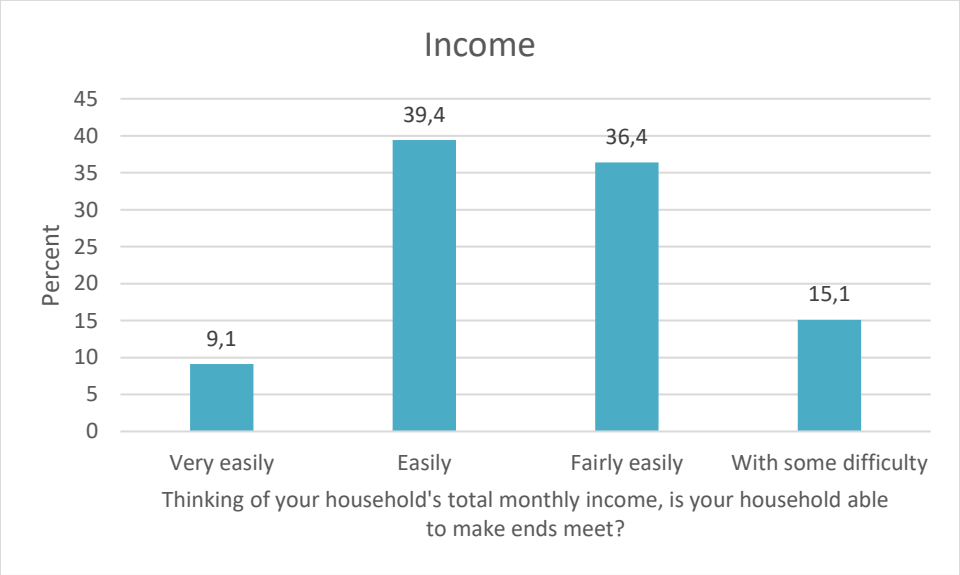

Figure 24 Income assessment in the study group

57,6% of the study group felt they were the biggest contributors to their household income.

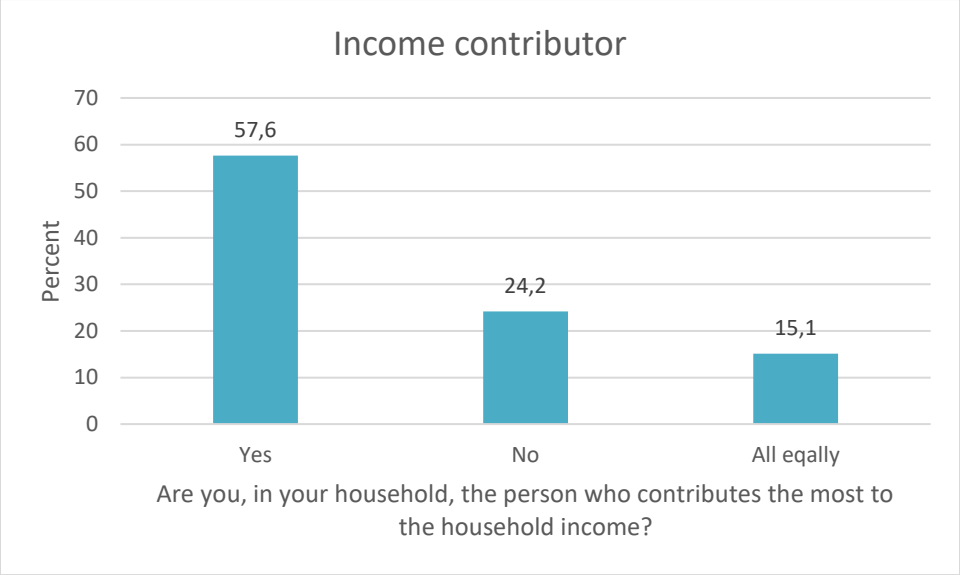

Figure 25 Household income contribution

30.3% of the study group admitted they were involved in caring for and/or educating their children and grandchildren on a daily basis or several times a week, while 9.1% had to take care of elderly or disabled relatives with similar frequency.

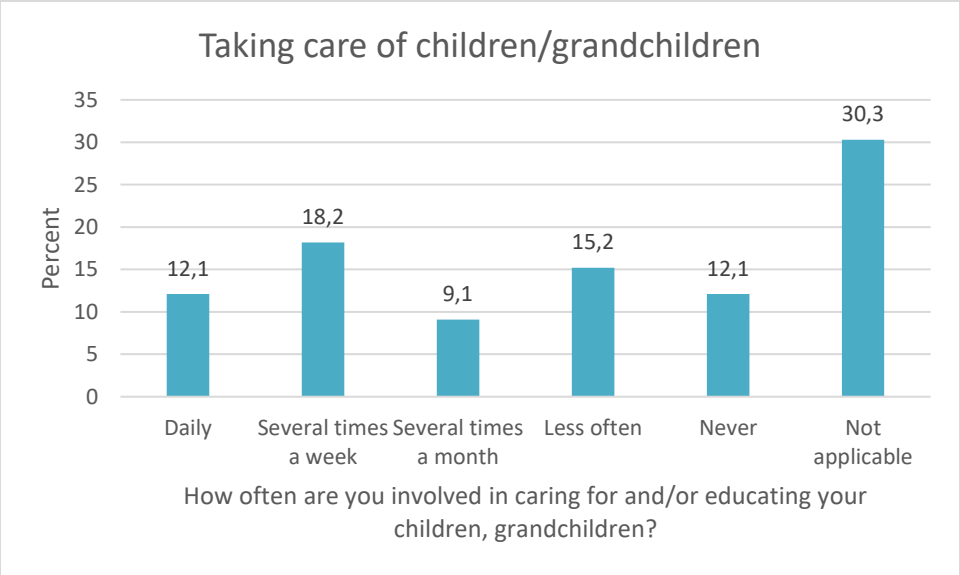

Figure 26 Involvement in caring for children/grandchildren

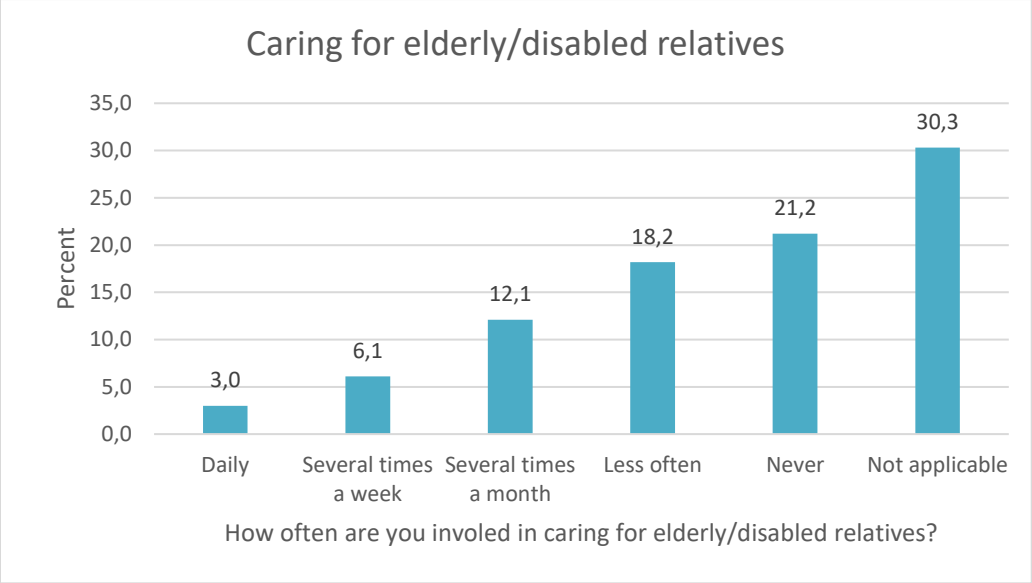

Figure 27 Involvement in caring for elderly/disabled relatives

Work ability and productivity level in the study group

The study participants assessed their work ability rather highly. The average work ability was 7.48 (SD = 1.86; Min = 3; Max = 10). However, 24.2% of the study group rated their work ability as lower than 7 points (fig. 28).

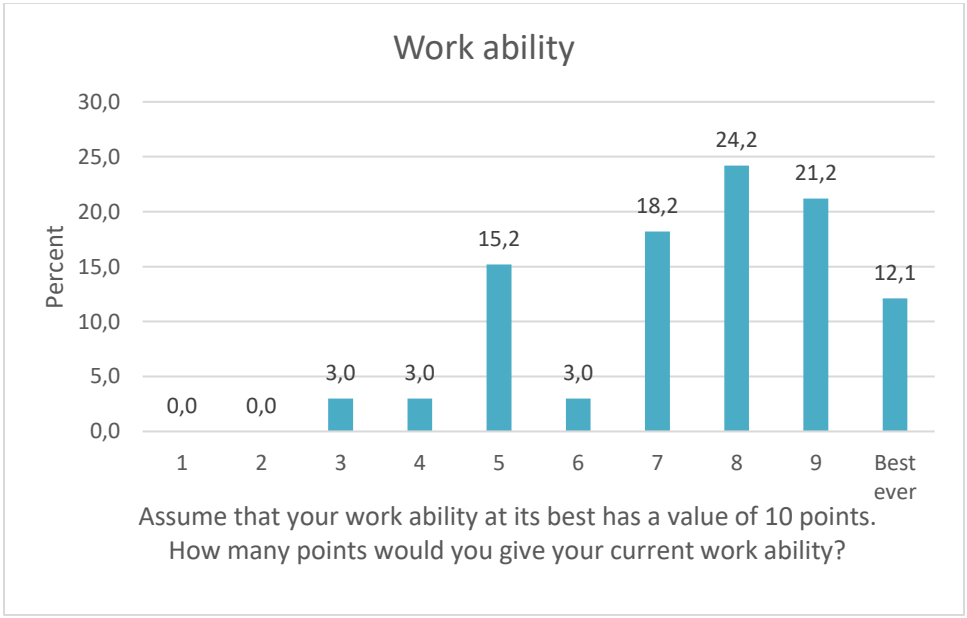

Figure 28 Work ability in the study group

Similarly, the study group assessed their job performance highly. The average job performance was 8.24 (SD = 1.39; Min = 3, Max = 10). 3% of the group (one person) assessed their job performance lower than 7 points.

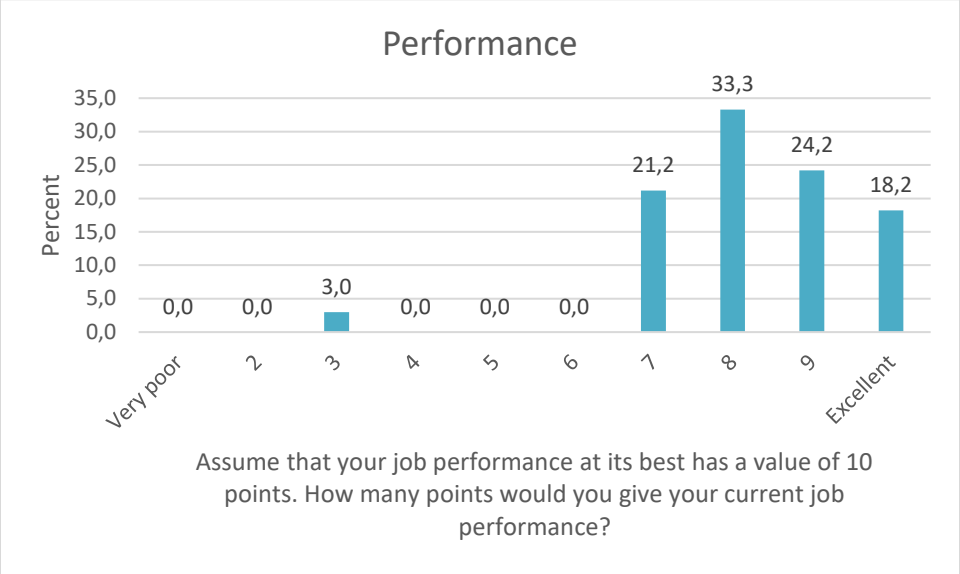

Figure 29 Job performance in the study group

Health, capabilities, lifestyle

Self-assessed health

When it comes to self-assessed health, most of the study group (51.5%) described their health as 'good'. Nearly 27.3% of the study group assessed their health as fair, while 21.2% of the group assessed their health as very good or excellent. When two age groups are considered, the general trend is similar, although more employees aged 56+ indicated their health was 'fair', while more employees aged 45-55 indicated their health was 'good' (fig. 30).

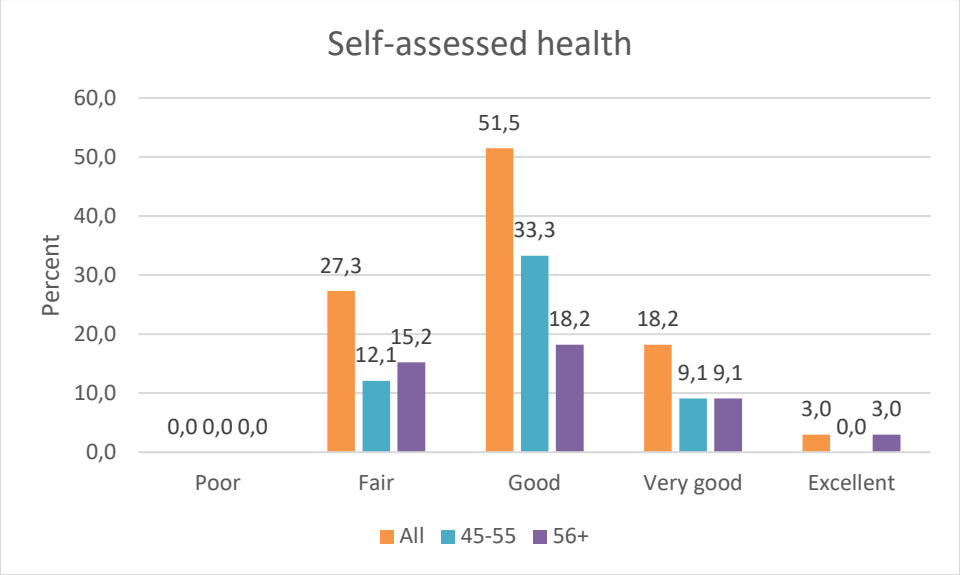

Figure 30 Self-assessed health in age groups

Sickness absence

Average sickness absence was 6.35 days (*SD* = 7.41; *Min* = 0; *Max* = 25) but only 7 respondents had more than 5 days of sickness absence (21.2%).

Health problems

There was a high rate of musculoskeletal disorders in the study group. Over 57% of respondents felt muscular pain in shoulders, neck and/or upper limbs, 66.7% felt backache and 30.3% - muscular pain in lower limbs. Over 36% of the respondents felt overall fatigue. When asked about long-term diseases (lasting more than 6 months), 48.5% admitted having such a problem.

Table 10 Prevalence of physical health problems in the study group

	Yes (%)	No (%)
Long-term disease	48.5	45.5
Backache	66.7	24.2
Muscular pain in shoulders, neck and/or upper limbs	57.6	24.2
Muscular pain in lower limbs	30.3	36.4
Overall fatigue	36.4	30.3

Among other health problems, respondents mentioned sleep disturbances and dental problems.

Respondents felt rather able to concentrate and their self-efficacy level was rather high, with a low level of depression symptoms reported. Stress level was not high, satisfaction with sleep level was above the average. Physical fatigue intensity was close to the arithmetic average of 5 points.

Table 11 Prevalence of physical and mental health problems and resources

	Mean	*SD*	*Min*	*Max*
Physical fatigue	5.44	2.40	1	10
Satisfaction with sleep	5.91	2.89	2	10
Stress	5.53	2.64	1	10
Depression symptoms	3.45	2.65	1	8
Ability to concentrate	6.88	1.98	1	10
Self-efficacy	7.24	1.87	2	10

Physical activity

51.5% of the study group described their physical activity in leisure time as 'Some light physical activity'. Only 6.1% of the group considered themselves as 'physically inactive'. 33.3% of the group declared regular physical activity. The general trend is similar in age groups, but employees aged 45-55 are more often engaged in the regular physical activity and training and in some light physical activity.

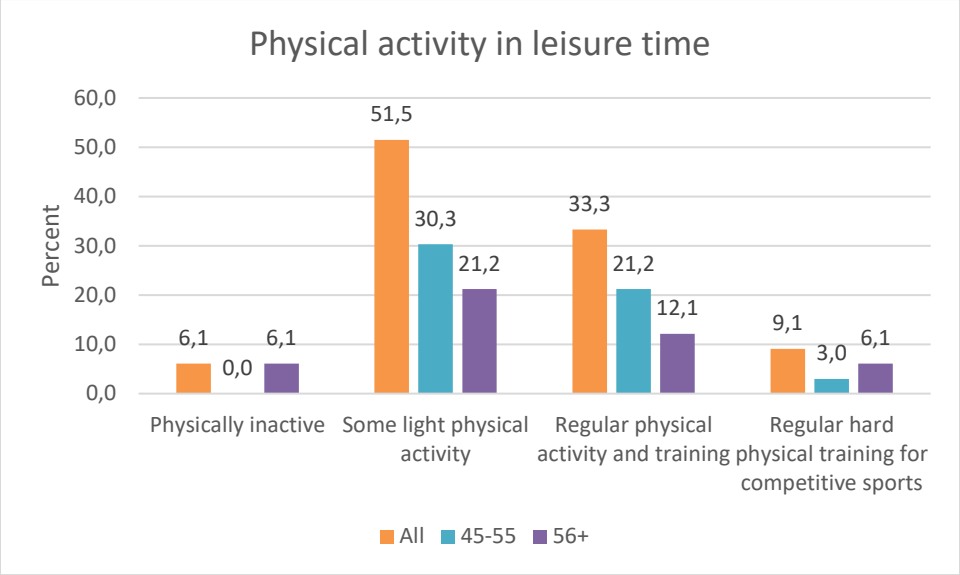

Figure 31 Physical activity in leisure time in different age groups

Smoking and consuming alcohol

27.3% of the group smoked/used tobacco. 11 respondents refused to answer the question concerning the amount of alcohol consumed weekly. Among those who responded, the average amount of consumed alcohol was 3.95 unit per week (SD = 5.35; Min = 0, Max = 26).

Nutrition

The average quantity of fruit and vegetable portions consumed daily was 1.74 (SD = 1.714; Min = 0.5, Max = 10). The average amount of water intake per day was 1.66 litres (SD = 0.65; Min = 0.5; Max = 3). Most participants declared drinking 2 litres (57.4%) or 1 litre (22.2 %) of water per day (fig. 12).

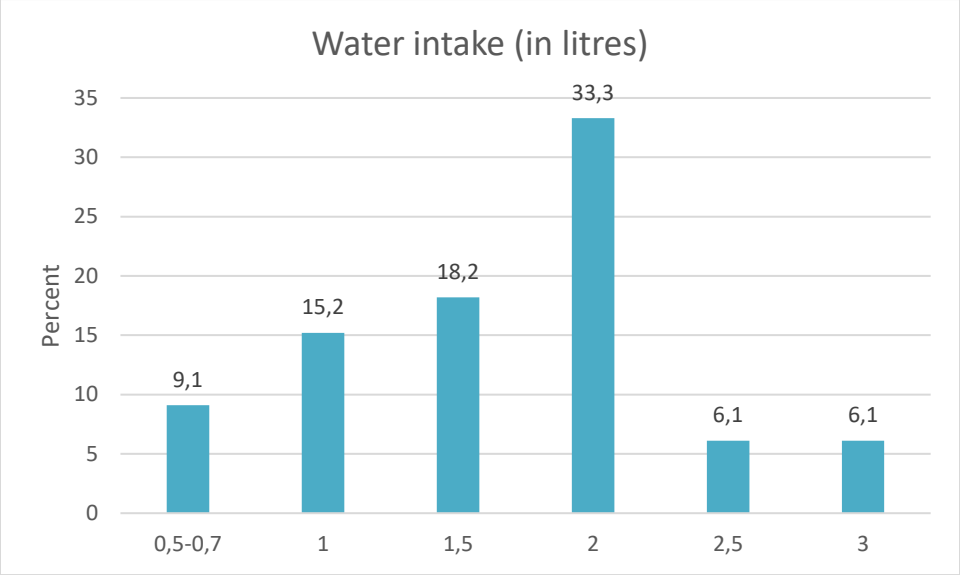

Figure 32 Water intake in the study group.

BMI

The mean BMI (Body Mass Index) was 25.58 (*SD* = 3.43; *Min* = 19.88; *Max* = 32.69).

Most of participants' BMIs indicated normal BMI or overweight both in the general population as well as in two age groups (45-55 and 56+). The obesity rate was 9.1% in the general study population. The obesity rate was even higher in the group of older workers (56+).

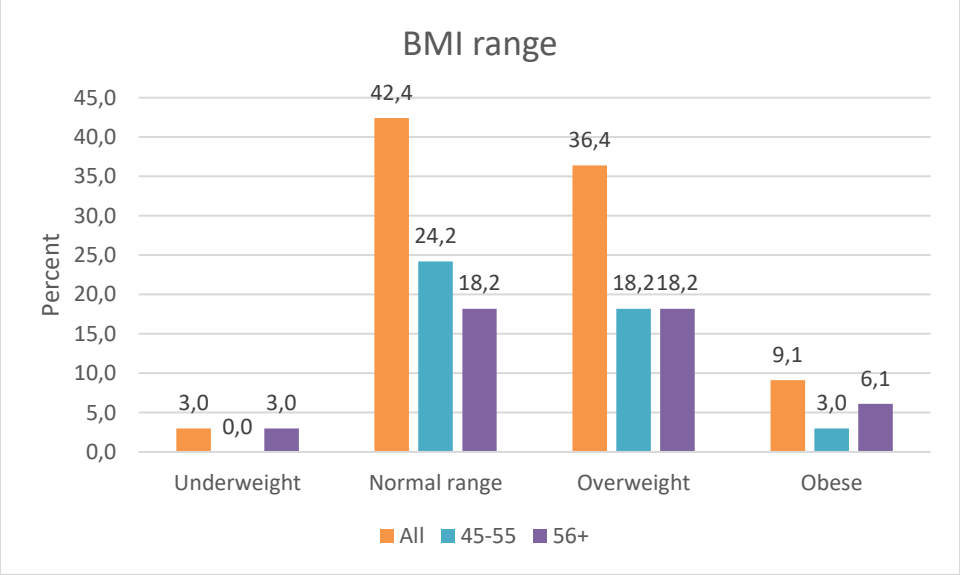

Figure 33 BMI range in age groups.

Vision and hearing

Most of the study group had problems with vision, while 6.1% of the group reported hearing problems.

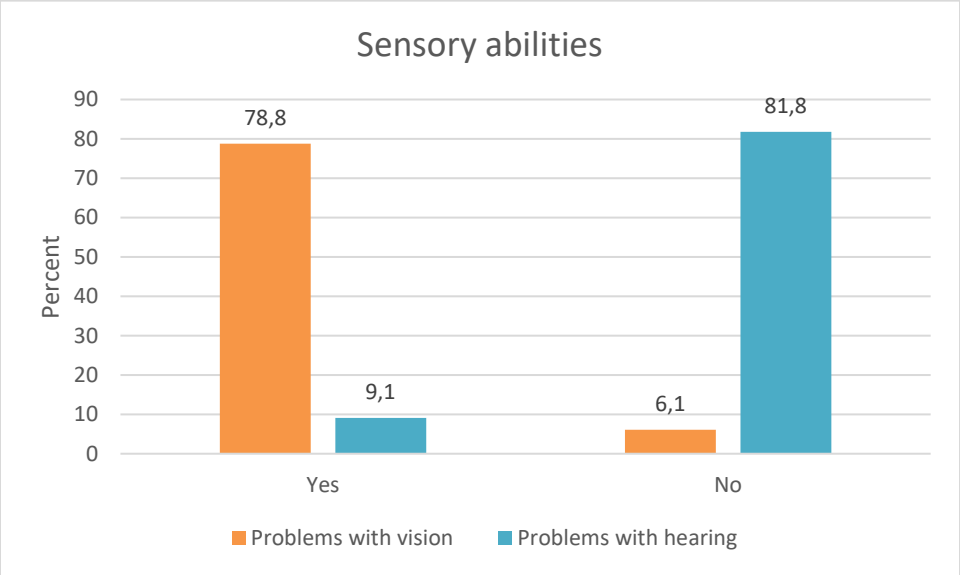

Figure 34 Problems with vision and hearing in the study group. Percentage of answers 'yes' and 'no' to the statements 'I have problems with vision' and 'I have problems with hearing'.

Most of those who reported problems with vision (78.8% of the group) were affected by myopia (45.5%), followed by hyperopia (42.4%).

Most employees with vision problems reported that their vision with corrective glasses/lenses was good and 26.9% indicated that their vision was excellent.

Similarly, most employees who reported hearing problems felt that their hearing with hearing aid was good or moderate, one person did not answer for that question. (fig. 35).

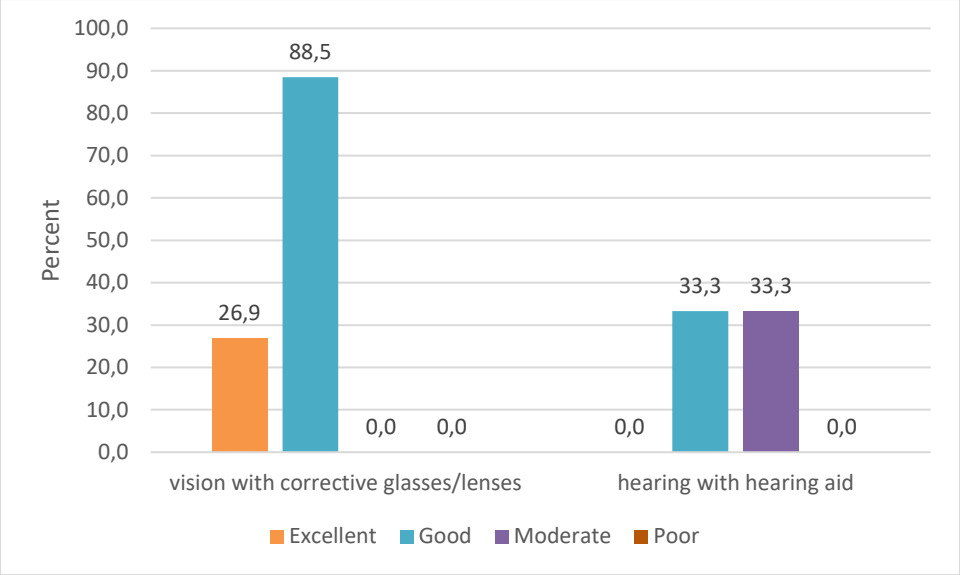

Figure 35 Vision and hearing with vision and hearing aids

Physical fitness / cardiovascular fitness

Most respondents rated their physical ability/cardiovascular fitness as high: they felt they could climb several flights of stairs, or walk two kilometres without difficulty. However, 30.3% of employees felt they could only run half a kilometre distance with difficulty or would be unable to complete such a challenge.

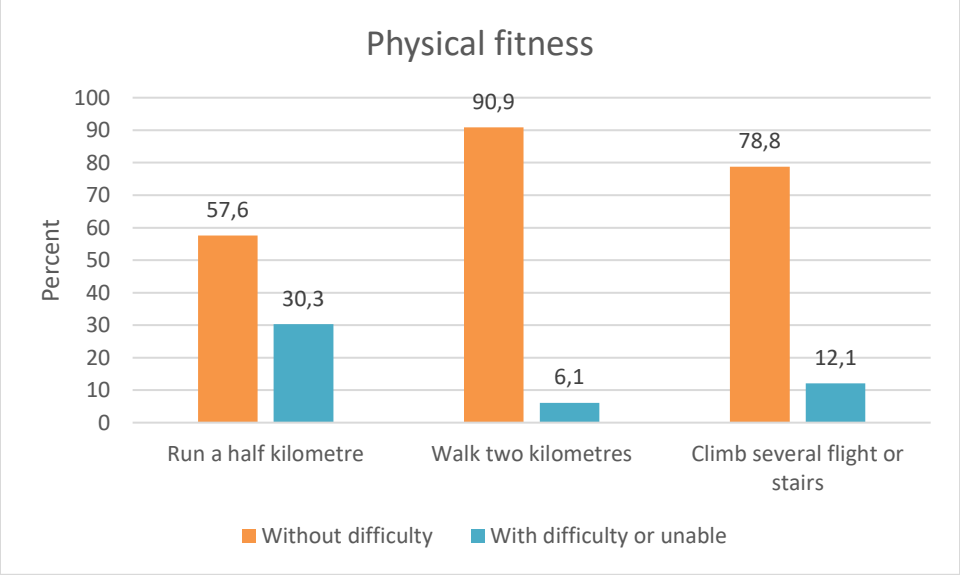

Figure 36 Physical ability/cardiovascular fitness in the study group. Percentage of answers 'without difficulty' or 'with difficulty or unable' to the questions: In your opinion, are you able to: run half a kilometre, walk two kilometres, climb several flights of stairs.

Social support in private life and general quality of life

The results indicate that respondents generally felt satisfied with their personal relationships, social support from friends and general quality of life. The results also show high frequency rate of socializing with friends and relatives.

Table 12 Social support in private life and general quality of life in the study group

	Mean	*SD*	*Min*	*Max*
Satisfaction with personal relationships	8.24	1.99	2	10
Satisfaction with the support from friends	8.06	1.72	3	10
Socializing frequency	6.09	1.84	2	9
General quality of life	7.91	1.51	5	10

Work-related wellbeing

Work-related wellbeing was measured by job involvement, job satisfaction, work-life conflict and job insecurity. The results show that participants' job involvement was below the arithmetic average of 5 points but job satisfaction was above. Levels of work-life conflict and job insecurity were below the average, meaning that employees felt rather secure in terms of losing their jobs. They also felt they could rather maintain work-life balance.

Table 13 Work-related wellbeing in the study group

	Mean	*SD*	*Min*	*Max*
Job involvement	7.21	1.88	3	10
Job satisfaction	7.36	2.03	1	10
Work-life conflict	35.61	25.02	0	100
Job insecurity	25.76	17.38	0	50

Working conditions

Physical job demands

Respondents felt rather low physical exertion at work (*M* = 3.30; *SD* = 1.61; *Min* = 1; *Max* = 7). The highest frequency of physical demands in the study group was observed in case of sitting, repetitive hand or arm movements, standing tiring and painful positions, and also vibrations from hand tools, machinery etc. The lowest frequency of physical demands was observed in case of skin contact with chemical products or substances, breathing in vapours and low temperature.

Psychosocial working conditions

Quantitative job demands were estimated to be rather high. This means that employees felt they had an adequate amount of responsibilities and tasks. The average quantitative job demands level was below the arithmetic average of 50. Above the average, work tempo (time pressure), variation of work and cognitive demands were assessed. Employees assessed their influence (autonomy) above the arithmetic average of 50, as well as development opportunities - they could use their skills and learn new things at work. Quite a low level of conflicts and quarrels was observed. Above the average, social support from colleagues and also supervisors was assessed. This means that employees felt they were supported by colleagues and supervisors and that they did not observe much conflicts. There were also low levels of recognition. Age inclusiveness was assessed close to the arithmetic average.

Table 14 Psychological job demands and job resources in study group

	Mean	*SD*	*Min*	*Max*
Quantitative demands	44.53	15.53	12.50	75.00
Tempo	67.80	21.20	0.00	100.00
Variation of work	54.17	15.52	12.50	75.00
Cognitive demands	60.29	17.68	25.00	93.75
Social support from supervisors	55.47	25.19	0.00	100.00
Social support from colleagues	71.88	25.99	0.00	100.00
Conflicts and quarrels	24.22	22.44	0.00	75.00
Influence	62.50	24.59	0.00	100.00
Development opportunities	60.61	16.27	37.50	100.00
Age Inclusiveness	53.13	17.68	25.00	75.00
Recognition	46.21	25.86	0.00	100.00

Moreover, low level of social isolation at work was observed: 84.9% of the group answered "Never" or "Seldom" to the question "Do you feel isolated from your colleagues while working?", while 15.2% sometimes or often felt isolated.

IT skills demands

The majority of the group (87,9%) answered that they need to use ICT tools such as computers, laptops, smartphones etc. while working. 30.3% of the group reported that they need to use ICT tools all of the time (fig. 37), while 15.2% of the group use ICT tools almost all of the time. Only 9.1% almost never use such tools.

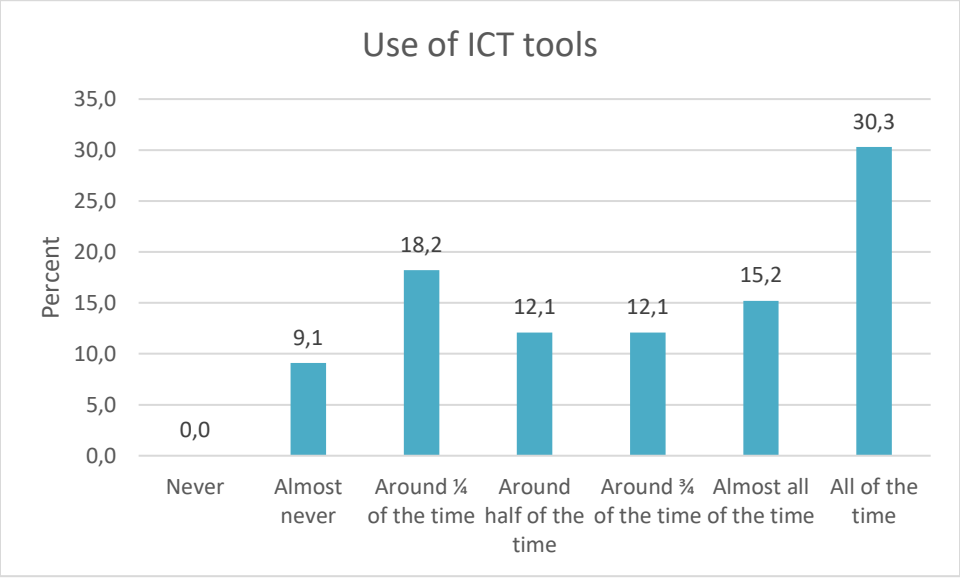

Figure 37 Use of ICT tools in the study group. Percentage of the workers per answer to the question: Does your main paid job involve working with computers, laptops, smartphones, etc.?

Organisational factors

The average working time in the study group was 36 hours per week (M = 36.00; SD = 4.57; Min = 20; Max = 44), however, three respondents work more than 40 hours per week.

All respondents felt well informed regarding health and safety risks related to performance of the job, while 51,5% felt very well informed (fig. 38).

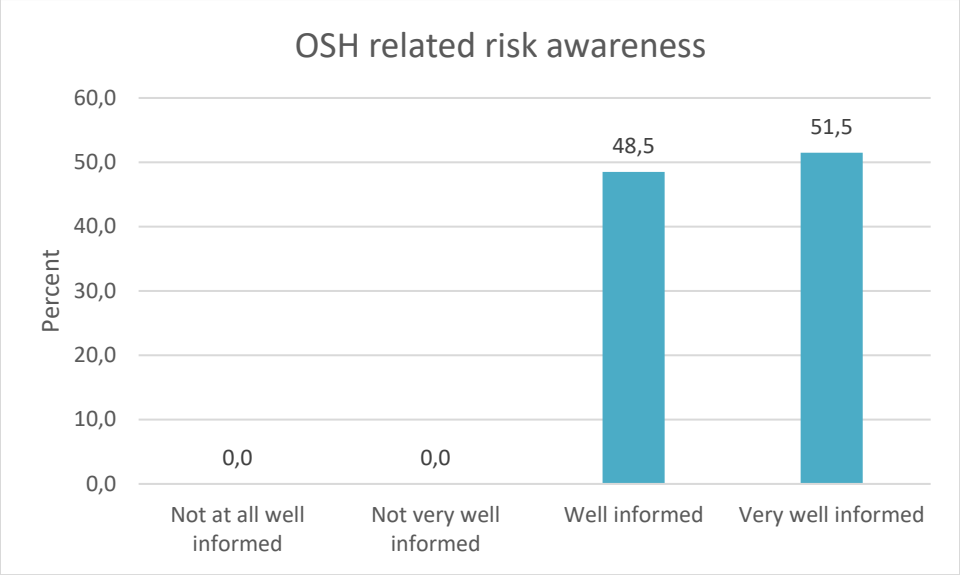

Figure 38 OSH related risk awareness.

Most of the group (63.6%) was satisfied with an access to health services. 18.2% of the group was neither satisfied not unsatisfied, 9.1% of the group was very satisfied and also 9.1% felt very unsatisfied (fig. 39). Moreover, 15.2% of the respondents reported that the employer provided an additional health insurance, while 30.3% of the group did not receive such an insurance.

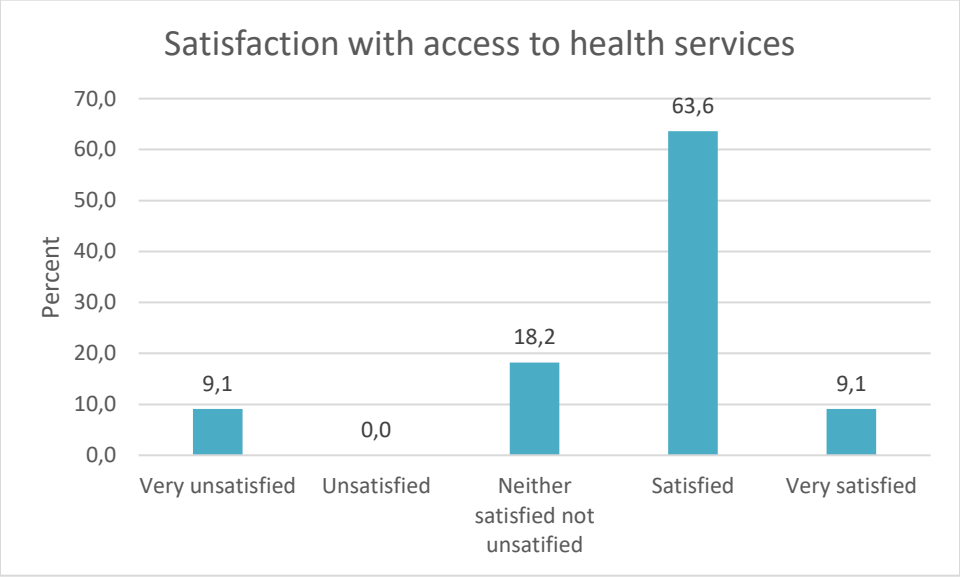

Figure 39 Satisfaction with access to health services

Type of contract

All respondents worked as an employee (one person did not answer) and all of them had contracts of unlimited duration.

Working in more than one location

In the 12 months prior to the survey, only 9.1% of the employees worked in more than one location.

OSH risk awareness

OSH risk awareness was quite high – employees felt informed about the risks related to their work. 90.9% of the employees used personal protective equipment when required and 97.0 % of the group had trust in the emergency/rescue procedures and staff in the company.

Learning method preferences

Additionally, we asked our respondents about their preferred learning methods as well as difficulties in previous experiences in learning how to use ICT devices or programs.

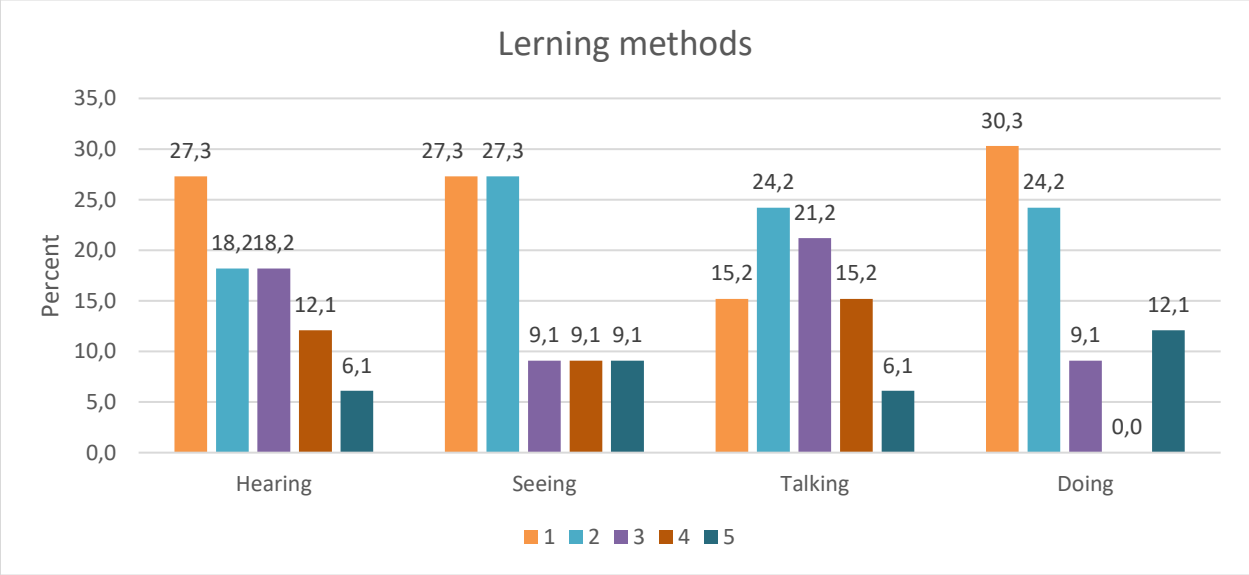

Figure 40 Learning method preferences in the study group. 1 – most important method, 5 – least important method.

The most preferred learning method was 'doing' (e.g. real-life problem-solving, tasks, exercises), followed by seeing (e.g. reading an instruction, watching a demonstration, video) and 'hearing' (e.g. lecture, instructions). 'Talking' (e.g. taking part in a discussion) was the learning method that was least frequently chosen as method no. 1.

39.4% of the group reported encountering difficulties while learning to use new technologies (computer, smartphone, Internet, or app). Respondents who admitted they had some difficulties, were asked about specific reasons for such difficulties.

The most common difficulty was lack of learning support (7 respondents), followed by difficult or complex instructions (6 respondents), fear of using or breaking the device/program (5 respondents), lack of repetition and practice (4 respondents), memory and mental agility issues (2 respondents), and finally, user-unfriendly technology (2 respondent).

5.1.2 Results of the analysis of relationships between variables included in the survey

Categorical variables – U-Mann-Whitney and Kruskal-Wallis tests

U-Mann-Whitney and Kruskal-Wallis tests were conducted in order to investigate the relationships between categorical variables (e.g. *job position, type of job demands, vision and hearing problems, general health, BMI thresholds, physical fitness*) and three main dependent variables: **work ability, job performance, and general quality of life**. As not many significant relationships were identified, only significant results are provided below. An overview of all categorical variables analysed is provided in table 15.

Job position

The Mann-Whitney U test showed significant difference (U = 85.00; p = 0.05; Z = 2.11) in **quality of life** between employees with (Mdn = 7) and without (Mdn = 8) supervisory responsibility. Quality of life was higher in supervisors' group, comparing to regular employees.

Physical fitness/ cardiovascular fitness

The Man-Whitney U test showed that there was a significant difference (U = 48.50; $p < 0.05$; Z = -2.49) in **general quality of life** between employees who were **able to run 0.5 km without difficulty** (*Mdn* = 8) and employees who could run 0.5 km with difficulty or were unable to run such a distance at all (*Mdn* = 7).

Long-term disease

The Mann-Whitney U test showed significant difference (U = 199.00; p < 0.01; Z = 2.73) in **work ability** between employees with (Mdn = 7) and without (Mdn = 8,5) chronic diseases.

Moreover, employees suffering from chronic diseases assessed their **job performance** significantly lower (Mdn = 8) from employees not suffering from chronic diseases (Mdn = 9; U = 200.50; p < 0.01; Z = 2.83).

Finally, the Mann-Withney U test showed significant differences (U = 195.50; p = 0.01; Z = 2.61) also in quality of life between employees with and without chronic diseases. Employees suffering from chronic diseases assessed their quality of life lower (Mdn = 7,5) than employees not suffering from chronic diseases (Mdn = 8,5).

Backache

The Mann-Whitney U test showed significant difference (U = 131.00; p < 0.05; Z = 2.05) in **work ability** between employees with (Mdn = 7) and without (Mdn = 8) back pain.

Significant differences were also observed in job performance (U = 132.50; p < 0,05; Z = 2.17) between employees suffering from backache (Mdn = 8) and employees without backache (Mdn = 9).

Muscular pains in shoulders, neck and/or upper limbs

The Mann-Whitney U test also showed that employees suffering from muscular pain in shoulders, neck and/or upper limbs (Mdn = 8) had lower **productivity** comparing to employees not suffering (Mdn = 9) from such problems (U = 128.50; p < 0.01; Z = 2.90).

Muscular pains in lower limbs (hips, legs, knees, feet, etc.)

The Mann-Whitney U test showed significant differences in work ability (U = 92.50; p < 0,05; Z = 2.19) between employees suffering from muscular pains in lower limbs (Mdn = 7) and employees not suffering from these problems (Mdn = 8).

Moreover, employees with muscular pains in lower limbs assessed their job performance significantly lower (Mdn = 7) compared to their colleagues not suffering from such issues (Mdn = 8; U = 97.50; p < 0.05; Z = 2.60).

Overall fatigue

The Mann-Whitney U test showed significant difference in work ability (U = 91.00; p < 0.05; Z = 2.09) between employees suffering from overall fatigue (Mdn = 7) and employees not suffering from overall fatigue (Mdn = 8).

Similarly, significant differences were also found in job performance (U = 102.50; p < 0.01; Z = 2.91) between employees with (Mdn = 8) and without (Mdn = 9) overall fatigue.

It was also found that employees experiencing overall fatigue had significantly lower quality of life (Mdn = 7) comparing to employees not experiencing overall fatigue (Mdn = 8; U = 93.00; p < 0.05; Z = 2.26).

Table 15 Overview of results (Yes = significant vs No = non-significant difference between groups) of Kruskal-Wallis / Mann-Whitney tests conducted for categorical variables with work ability, job performance and quality of life as independent variables

	Work ability	*Job performance*	*Quality of Life*	*Number of answers Yes/No*
Gender	No	No	No	
Relationship status	No	No	No	
Education level	No	No	No	
Household income	No	No	No	

Financial responsibility	No	No	No	
Character of job demands (manual vs mental)	No	No	No	
Job position	No	No	**Yes***	
Problems with vision	No	No	No	
Quality of vision with glasses/lenses	No	No	No	
Hearing problems	No	No	No	
Quality of hearing using hearing aids	No	No	No	
Ability to run 0.5 km	No	No	**Yes**	
Ability to walk 2 km	No	No	No	
Ability to climb several flights of stairs	No	No	No	
Smoking	No	No	No	
BMI	No	No	No	
Long-term disease	**Yes**	**Yes**	**Yes**	
Backache	**Yes**	**Yes**	No	
Muscular pain in shoulders	No	**Yes**	No	
Muscular pain in lower limbs	**Yes**	**Yes**	No	
Overall fatigue	**Yes**	**Yes**	**Yes**	
Employee vs self-employed	No	No	No	
Type of employment contract[1]	-	-	-	
Working in more than one location	No	No	No	
Using PPE	No	No	No	
Trust in emergency procedures	No	No	No	
Additional health insurance	No	No	No	

* p = 0.05

Next, U-Mann-Whitney and Kruskal-Wallis tests were conducted in order to test the relationships between categorical variables (e.g. *job position, type of job demands, vision and hearing problems, general health, BMI thresholds, physical fitness*) and health-related variables: **general health, sickness absence, overall fatigue, negative feelings, ability to concentrate and stress**. As not many significant relationships were identified, only significant results are provided below. An overview of all categorical variables analysed is provided in table 16.

Character of work

The Kruskal-Wallis H test showed that there was a statistically significant difference in **general health** score between employees with different character of work, $\chi^2(2) = 8.45$; $p < 0.05$, with a mean rank general

[1] All of study participants had contract of unlimited duration, hence the test could not be performed

health score of 3.50 for those with manual work, 14.62 for those with mental and 8.81 for those with both manual and mental character of work.

Dunn's pairwise tests were carried out for the three pairs of groups. There was evidence ($p < 0.05$) of a difference between the group with mostly manual and the group with mostly mental character of work. The median general health score in the group characterized by mostly manual character of work was [Mdn = 2] compared to [Mdn = 3,5] median score in the group characterized by mostly mental character of work.

Moreover, the Kruskal-Wallis H test showed that there was a statistically significant difference in **physical fatigue** score between employees with different character of work, $\chi^2(2) = 8.33$; $p < 0.05$, with a mean rank physical fatigue score of 17.00 for those with manual work, 7.72 for those with mental and 15.50 for those with both manual and mental character of work.

Dunn's pairwise tests were carried out for the three pairs of groups. There was evidence ($p < 0.05$) of a difference between the group with mostly mental and the group with both mental and manual character of work. The median physical fatigue score in the group characterized by mostly mental character of work was [Mdn = 4] compared to [Mdn = 7,5] median score in the group characterized by both manual and mental character of work.

Smoking

The Mann-Whitney U test showed significant difference in **negative feelings** ($U = 52.00$; $p < 0.05$; $Z = -2.10$) between smoking (Mdn = 8) and non-smoking employees (Mdn = 2).

BMI

The Kruskal-Wallis H test showed that there was a statistically significant difference in **general health** score between employees with different BMI ranges, $\chi2(2) = 8.33$; $p < 0.05$.

Dunn's pairwise tests were carried out for the four pairs of groups (underweight, normal range, overweight, obese). There was evidence ($p < 0.05$) of a difference between the group with normal range and the group with overweight. The median general health score in the group characterized by normal range was [Mdn = 3,5] compared to [Mdn = 3] median score in the group with BMI indicating overweight.

Moreover, the Kruskal-Wallis H test showed statistically significant difference in **ability to concentrate** between employees with different BMI ranges, $\chi2(2) = 8.99$; $p < 0.05$.

Dunn's pairwise tests were carried out for the four pairs of groups (underweight, normal range, overweight, obese). There was evidence ($p < 0.05$) of a difference between the group with normal range and the group with overweight. The median ability to concentrate score in the group characterized by normal range was [Mdn = 8] compared to [Mdn = 6] median score in the group with BMI indicating overweight.

Backache

The Mann-Whitney U test showed significant difference in **physical fatigue** (U = 31.00; p < 0.01; Z = - 2.62) between employees suffering from backache (Mdn = 6) and employees not suffering from backache (Mdn = 3).

Moreover, the Mann-Whitney U test showed significant difference in **negative feelings** (U = 16.00; p < 0.001; Z = - 3.41) between employees suffering from backache (Mdn = 3) and employees not suffering from backache (Mdn = 1).

Muscular pain in shoulders, neck, and/or upper limbs

The Mann-Whitney U test showed significant difference in **general health** (U = 118.00; p < 0.05; Z = 2.48) between employees suffering from muscular pain in shoulders, neck and/or upper limbs (Mdn = 3) and employees not suffering from such problems (Mdn = 3,5).

The Mann-Whitney U test also showed significant difference in **physical fatigue** (U = 21.00; p < 0.01; Z = - 2.97) between employees suffering from muscular pain in shoulders, neck and/or upper limbs (Mdn = 6) and employees not suffering from such problems (Mdn = 3).

Muscular pain in lower limbs

The Mann-Whitney U test showed significant difference in **general health** (U = 104.00; p < 0.01; Z = 3.20) between employees suffering from muscular pain in lower limbs (Mdn = 2) and employees not suffering from such problems (Mdn = 3).

The Mann-Whitney U test also showed significant difference in **physical fatigue** (U = 21.00; p < 0.01; Z = - 2.62) between employees suffering from muscular pain in lower limbs (Mdn = 6) and employees not suffering from such problems (Mdn = 3,5).

Moreover, significant difference in negative feelings level (U = 27.50; p < 0.05; Z = -2.22) was also observed between employees suffering from muscular pain in shoulders, neck and/or upper limbs (Mdn = 6) and employees not suffering from such problems (Mdn = 1).

Finally, employees who experienced muscular pain in shoulders, neck and/or upper limbs were less able to concentrate (Mdn = 5,5) comparing to employees not experiencing these problems (Mdn = 8; U = 100.00; p < 0.01; Z = 2.69).

Overall fatigue

The Mann-Whitney U test showed significant difference in **general health** (U = 100.00; p < 0.01; Z = 2.82) between employees suffering from overall fatigue (Mdn = 2) and employees not suffering from overall fatigue (Mdn = 3).

Also, the Mann-Whitney U test revealed significant differences in **physical fatigue** level (U = 6.50; p < 0.001; Z = -3.58) between employees experiencing overall fatigue (Mdn = 8) and employees not experiencing this issue (Mdn = 3,5).

Negative feelings level was also different in two groups employees: those who did (Mdn = 6) and those who did not (Mdn = 1,5) suffer from overall fatigue (U = 26.50; p < 0.05; Z = -2.26).

Similarly, employees who suffered from overall fatigue had lower **ability to concentrate** score (Mdn = 6) comparing to employees who did not suffer from overall fatigue (Mdn = 8; U = 98.50; p < 0.01; Z = 2.59).

Also, **stress** level in the group of employees suffering from overall fatigue was higher (Mdn = 7) than in the group of employees not suffering from this issue (Mdn = 3; U = 26.50; p < 0.05; Z = -2.23).

Table 16 Overview of results (Yes = significant vs No = non-significant difference between groups) of Kruskal-Wallis / Mann-Whitney tests conducted for categorical variables

	General health	Sickness absence	Physical fatigue	Negative feelings	Ability to concentrate	Satisfaction with sleep	Stress
Gender	No	No	No	No	No	No	No
Relationship status	No	No	No	No	No	No	No
Education level	No	No	No	No	No	No	No
Financial responsibility	No	No	No	No	No	No	No
Character of job demands	**Yes**	No	**Yes**	No	No	No	No
Job position	No	No	No	No	No	No	No
Problems with vision	No	No	No	No	No	No	No
Quality of vision with glasses/lenses	No	No	No	No	No	No	No
Hearing problems	No	No	No	No	No	No	No
Quality of hearing using hearing aids	No	No	No	No	No	No	No
Physical activity in leisure time	No	No	No	No	No	No	No
Ability to run 0.5 km	No	No	No	No	No	No	No
Ability to walk 2 km	No	No	No	No	No	No	No
Ability to climb several flights of stairs	No	No	No	No	No	No	No
Smoking	No	No	No	**Yes**	No	No	No
BMI	**Yes**	No	No	No	**Yes**	No	No

Long-term disease	No	No	No	No	No	No	No
Backache	No	No	**Yes**	**Yes**	No	No	No
Muscular pain in shoulders	**Yes**	No	**Yes**	No	No	No	No
Muscular pain in lower limbs	**Yes**	No	**Yes**	**Yes**	**Yes**	No	No
Overall fatigue	**Yes**	No	**Yes**	**Yes**	**Yes**	No	Yes
Employee vs self-employed	No	No	No	No	No	No	No
Type of employment contract[2]	-	-	-	-	-	-	-
Working in more than one location	No	No	No	No	No	No	No
Using PPE	No	No	No	No	No	No	No
Trust in emergency procedures	No	No	No	No	No	No	No

Results of correlation analysis

Correlation analysis was performed in order to establish significant relationships between work ability, job performance and general quality of life and all groups of factors identified in the literature review. The results are presented in table 16.

Table 17 Spearman's rho correlation coefficients for the significant correlates of work ability, job performance, general quality of life

	Work ability	*Job performance*	*Quality of Life*
Work ability	1,00	**0,78*** **	**0,66*** *
Job performance	**0,78*** **	1,00	**0,56** **
Quality of life	**0,66*** **	**0,56** **	1,00
Nutrition	**0,38***	0,23	0,37
General health	**0,61*** **	**0,48** **	**0,50** **
Sickness absence	**-0,57** **	-0,38	**-0,47***
Physical fatigue	**-0,37***	**-0,46** **	**-0,46** **
Negative feelings (blue mood, despair, anxiety, depression)	-0,31	-0,27	**-0,44***
Ability to concentrate	**0,55** **	**0,47** **	**0,63*** *

[2] All of study participants had contract of unlimited duration, hence the test could not be performed

Self-efficacy	**0,46****	**0,38***	**0,37***
Satisfaction with personal relationships	0,28	0,31	**0,60*****
Satisfaction with the support from friends	**0,48****	**0,41***	**0,46****
Motivation and involvement in work	**0,51****	**0,51****	**0,55****
Job satisfaction	**0,41***	**0,51****	**0,44***
Working hours	0,31	0,17	**0,39***
Tempo (time pressure)	0,29	0,20	**0,42***
Social support from supervisor	**0,39***	0,25	**0,48****
Tiring or painful positions	**-0,39***	**-0,50****	-0,14
High temperatures	**-0,35***	-0,23	**-0,37***
Breathing in vapours	**-0,48****	-0,33	**-0,36***

**p<0.05; **p<0.01; ***p<0.001*

Fifteen factors correlated significantly with **work ability**:

- Two other dependent variables, i.e. job performance and quality of life. The higher work ability, the higher job performance and quality of life in the study group.
- One lifestyle variable, i.e. nutrition (amount of fruits and vegetables consumed daily): the higher number of portion of fruits and vegetables eaten every day, the higher work ability
- Three general health indicators, i.e. self-assessed health, sickness absence and physical fatigue: the better health assessment, the higher level of work ability. The higher sickness absence and physical fatigue, the lower work ability.
- Cognitive resource, i.e. concentration: the better ability to concentrate, the higher work ability.
- Psychosocial resources in private life, i.e. satisfaction with the support from friends, and self-efficacy: the higher level of satisfaction with support from friends and self-efficacy, the higher work ability.
- Two work-related wellbeing indicators, i.e. motivation and involvement in work and job satisfaction were positively related with work ability. The more motivated and involved employees felt, the higher work ability was indicated. Moreover, the higher job satisfaction was observed, the higher level of work ability was declared.
- One of job resources, i.e. social support from supervisors: the higher level of social support, the higher level of work ability
- Three physical job demands variables, i.e. tiring or painful positions, high temperatures and breathing in vapours: the higher level of these physical job demands, the lower level of work ability was observed.

Ten factors significantly correlated with **job performance**. Apart from two other dependent variables (work ability and quality of life) the correlates of job performance were:

- General health: the higher assessment of general health, the better job performance

- Physical fatigue: the higher physical fatigue at the end of the work day, the lower job performance
- Concentration was also positively related to job performance: the higher ability to concentrate, the better job performance.
- Psychosocial resources in private life, i.e. self-efficacy, satisfaction with the support from friends: the higher level of satisfaction with support from friends, the higher job performance. Similarly, the higher level of self-efficacy, the higher job performance.
- Two work-related wellbeing indicators, i.e. motivation and involvement in work and job satisfaction were positively related with job performance. The more motivated and involved employees felt, the higher job performance was indicated. Moreover, the higher job satisfaction was observed, the higher level of job performance was declared.
- Only one job demand factor was related to job performance in this group, i.e. tiring or painful positions: the higher level of tiring or painful positions, the lower job performance was observed.

Seventeen factors were related with **general quality of life**. Apart from two other dependent variables (work ability and job performance), factors correlated with quality of life were:

- Three general health indicators, i.e. self-assessed health, sickness absence and physical fatigue: the better health assessment, the higher quality of life. The higher sickness absence and physical fatigue, the lower quality of life.
- One mental health factor, i.e. negative feelings (blue mood, despair, anxiety, depression): the higher level of negative feelings, the lower level of quality of life.
- Cognitive resource, i.e. concentration: the better ability to concentrate, the better quality of life.
- Psychosocial resources in private life: the higher satisfaction with personal relationships, satisfaction with support from friends, the better quality of life. And the higher level of self-efficacy, the better quality of life.
- Two work-related wellbeing factors, i.e. job satisfaction and motivation and involvement were related positively with quality of life: the higher job satisfaction and motivation and involvement, the higher quality of life.
- One job resource, i.e. social support from the supervisor: the higher level of support from supervisor, the higher quality of life.
- One psychosocial job demands, i.e. work tempo (time pressure): the higher tempo, the higher quality of life.
- Two of physical job demands factors, i.e. high temperatures and breathing in vapours: the higher temperatures at work and the higher frequency of contact with chemical substances, the lower quality of life.
- Finally, one organizational factor, i.e. working hours: the higher number of working hours, the higher quality of life.

Health status correlates

Apart from satisfaction with sleep, all health indicators analysed in terms of continuous variables shown significant correlations with other variables included in the survey.

Self-assessed general health was significantly related with twelve variables:

- Other general health indicators, i.e. sickness absence and physical fatigue: the better general health, the lower sickness absence and the lower physical fatigue
- Mental health indicators, i.e. negative feelings, ability to concentrate and stress: the better general health, the lower level of negative feelings, the lower stress and the better ability to concentrate.
- One life-style factor, i.e. BMI: the better general health, the lower BMI was observed
- Psychosocial resources in private life, i.e. self-efficacy and satisfaction with the support from friends: the higher level of these resources, the better general health status
- One work-related wellbeing factor, i.e. motivation and involvement in work: the better general health, the higher motivation and involvement
- Psychosocial job resources, i.e. influence and possibilities for development: the higher level of employee's influence at work and possibilities for development, the better general health
- One physical job demands factor, i.e. sedentary work: the longer time spent sitting at work, the worse health status

Sickness absence was significantly correlated with nine factors:

- Other health status variable, i.e. general health (see above)
- One mental health indicator, i.e. prevalence of negative feelings (anxiety, depression): the higher prevalence of such symptoms, the higher sickness absence
- One work-related wellbeing indicator, i.e. motivation and involvement: the more motivated and involved employees, the lower level of sickness absence
- Social isolation at work: the more employees felt isolated from other colleagues while working, the higher sickness absence was observed
- Two psychosocial job resources: possibilities for development and recognition. The higher level of possibilities for development and recognition, the lower sickness absence.
- Three physical demand factors, i.e. sitting position, repetitive hands or arm movements and breathing in vapours: the higher prevalence of these conditions, the higher sickness absence

Physical fatigue was significantly related with eight variables:

- One general health status indicator, i.e. self-rated general health (see above)
- Three mental health indicators, i.e. negative feelings, ability to concentrate and stress: the more negative feelings, the lower ability to concentrate and the higher level of stress, the more physically exhausted at the end of work day employees felt
- One psychosocial resource in private life, i.e. satisfaction with personal relationships: the more employees were satisfied with their personal relations, the less exhausted their felt
- Three work-related wellbeing indicators, i.e. motivation and involvement, job satisfaction and work-life conflict: the lower level of motivation and involvement, the lower job satisfaction and the bigger work-life conflict, the higher level of physical fatigue

Mental health correlates

Another group of factors that should be examined more closely are mental health indicators.

Negative feelings (blue mood, despair, anxiety, depression) were related with thirteen variables:

- All three general health status indicators, i.e. general health, sickness absence and physical fatigue (see above)
- Two other mental health indicators, i.e. ability to concentrate and stress: the higher prevalence of negative feelings (depression symptoms), the lower ability to concentrate and the higher level of stress
- Psychosocial resource in private life, i.e. satisfaction with personal relationships: the higher satisfaction with personal relations, the lower level of negative feelings
- Two work-related wellbeing indicators, i.e. motivation and involvement and work-life conflict: the higher motivation and involvement and the lower work-life conflict, the lower prevalence of negative feelings
- One factor from the job resources, i.e. recognition: the more employees felt recognized and appreciated at work, the less negative feelings they felt
- Two physical job demands factors, i.e. high temperatures and breathing in vapours: the higher prevalence of high temperatures at work and the higher prevalence of breathing in vapours, the higher level of negative feelings
- Two organizational factors, i.e. working hours and working with ICT devices: the longer working hours per week and the higher prevalence of working with ICT devices, the lower level of negative feelings in the study group

Ability to concentrate was significantly related with eight variables:

- Two general health indicators, i.e. general health and physical fatigue
- Two mental health indicators, i.e. negative feelings and stress
- One of psychosocial resource in private life, i.e. self-efficacy: the higher level of self-efficacy, the higher level of ability to concentrate
- One work-related wellbeing indicator, i.e. motivation and involvement: the higher motivation and involvement, the better ability to concentrate
- One of job resources, i.e. social support from supervisor: the higher level of social support an employee gets, the higher is their ability to concentrate
- One of physical job demands, i.e. prolonged sitting: the more sedentary work, the worse ability to concentrate

Satisfaction with sleep turned out to be unrelated with variables taken into account.

Stress was significantly related with nine variables:

- Two general health indicators, i.e. general health and physical fatigue
- Two mental health indicators, i.e. negative feelings and ability to concentrate: the higher level of perceived stress, the higher level of negative feelings and the lower ability to concentrate

- One psychosocial resources in private life indicator, i.e. satisfaction with personal relationships: the more satisfied with personal relationships employees felt, the lower level of stress they perceived
- Three work-related wellbeing indicators, i.e. motivation and involvement, job satisfaction and work-life conflict: the higher level of motivation and involvement and job satisfaction, and the lower level of work-life conflict, the lower level of stress was observed
- Social isolation at work: the more isolated from colleagues employees felt, the higher level of stress they perceived.

Table 18 Spearman's rho correlation coefficients for the significant correlates

	General health	Sickness absence	Physical fatigue	Negative feelings	Ability to concentrate	Satisfaction with sleep	Stress
General health	1,00	**-0,46***	**-0,51****	**-0,65****	**0,64****	0,32	**-0,38***
Sickness absence	**-0,46***	1,00	0,19	**0,50***	-0,36	0,06	0,31
Physical fatigue	**-0,51****	0,19	1,00	**0,48****	**-0,49****	-0,21	**0,61*****
Negative feelings (blue mood, despair, anxiety, depression)	**-0,65*****	**0,50***	**0,48****	1,00	**-0,44***	-0,31	**0,64*****
Ability to concentrate	**0,64*****	-0,36	**-0,49****	**-0,44***	1,00	0,04	**-0,35***
Stress	**-0,38***	0,31	**0,61*****	**0,64*****	**-0,35***	-0,19	1,00
BMI	**-0,41***	-0,02	0,14	0,13	-0,25	-0,004	0,07
Self-efficacy	**0,45****	-0,33	-0,22	-0,02	**0,45****	0,17	-0,08
Satisfaction with personal relationships	0,36	-0,31	**-0,46***	**-0,43***	0,21	0,14	**-0,45***
Satisfaction with the support from friends	**0,40***	-0,47*	-0,28	-0,20	0,12	0,06	-0,21
Motivation and involvement	**0,54****	**-0,51****	**-0,62*****	**-0,42***	**0,49****	0,22	**-0,41***
Job satisfaction	0,20	-0,35	**-0,43***	-0,27	0,32	0,16	**-0,56****
Work-life conflict	-0,27	0,06	**0,45***	**0,60*****	-0,11	0,00	**0,49****
Social isolation at work	-0,23	**0,43***	0,17	0,29	-0,23	0,08	**0,40***
Social support from supervisor	0,29	-0,33	-0,29	-0,19	**0,41***	0,28	-0,19
Influence	**0,47****	-0,28	-0,20	-0,20	0,08	0,08	-0,07
Possibilities for development	**0,41***	**-0,54****	-0,03	-0,30	0,12	0,02	-0,19
Recognition	0,29	**-0,40***	-0,31	**-0,46****	0,16	0,04	-0,23
Sitting	**-0,36***	**0,41***	-0,08	0,27	**-0,35***	-0,08	0,24
Repetitive hands or arm movements	-0,02	**0,48***	-0,15	0,27	0,00	0,14	0,12
High temperatures	-0,34	0,20	0,20	**0,42***	-0,28	-0,23	0,02
Breathing in vapours	-0,28	**0,48***	-0,05	**0,41***	-0,18	0,04	0,05
Working hours	0,33	-0,01	-0,02	**-0,39***	0,33	0,20	-0,18

Working with computers, laptops, smartphones etc.	-0,30	-0,26	-0,27	**-0,42***	0,21	0,12	-0,10

5.1.3 Conclusions regarding ANEFA and Siemens

There were some differences between study group. In Siemens group, the majority of the group (54.6%) was characterized by lower secondary education level, while in the majority of the ANEFA group (58.5%) was characterized by primary education level.

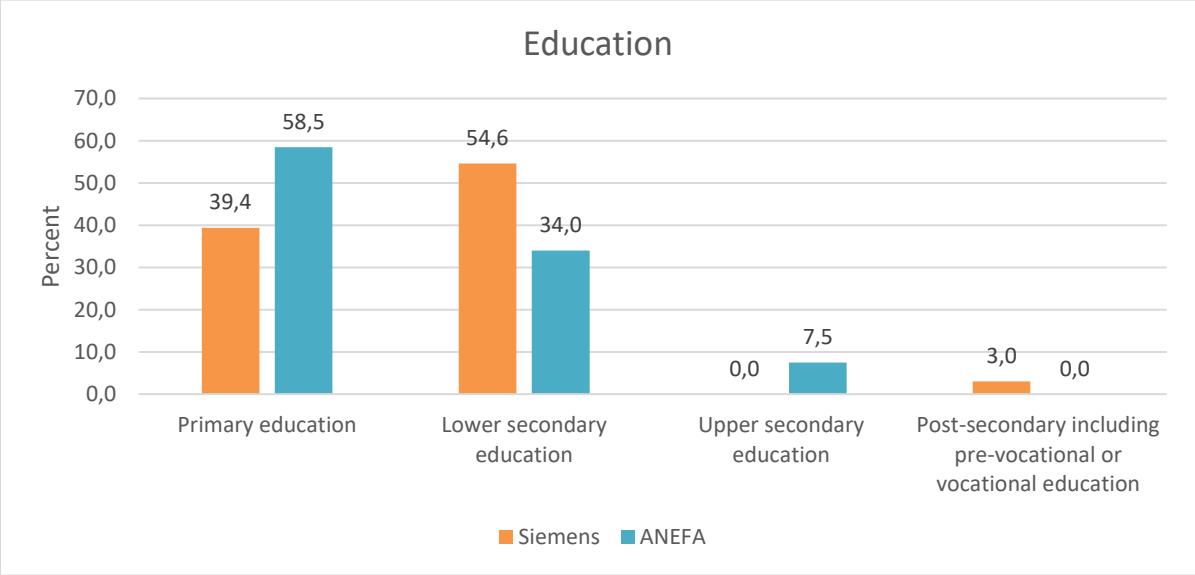

Figure 41 Education level – comparison between both groups

There were also differences between groups in character of work. Out of those who did respond in Siemens group, 36% respondents performed mostly mental work, 6% performed manual work, while 24% of the group had both manual and mental work, while in ANEFA group, 86.1% respondents performed mostly manual work, 8.3% performed mental work, while 5.6% of the group had both manual and mental work.

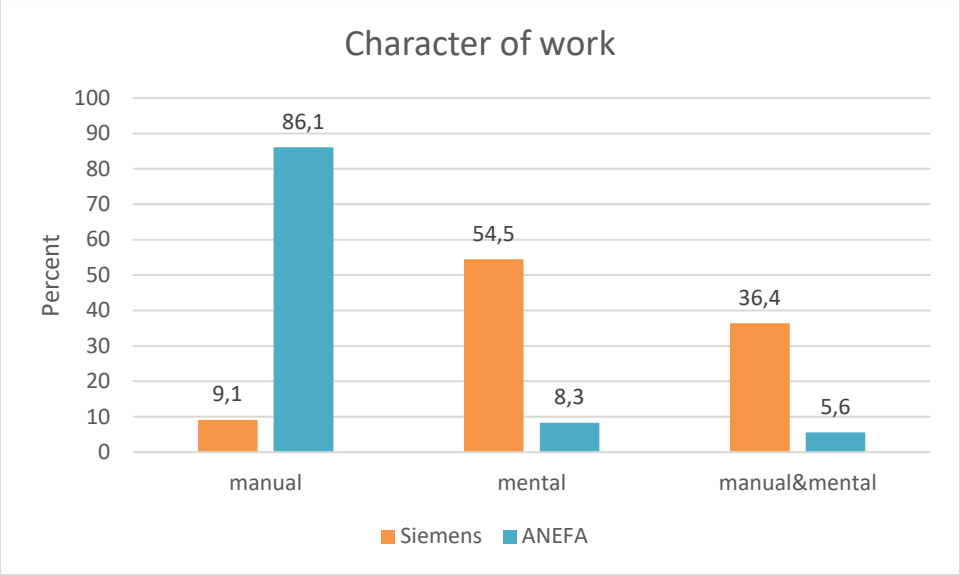

Figure 42 Character of work – comparison between both groups.

The majority of the Siemens group (87,9%) answered they need to use ICT tools such as computers, laptops, smartphones etc., while most of the ANEFA group (83.9%) reported that they did not need to use ICT tools. This result is related to two factors: the nature of work of most employees was mainly manual, where there was no need to use ICT devices, and the second reason is that the organization's policy with the focus on employee safety did not include using additional devices, such as smartphones or smartwatches.

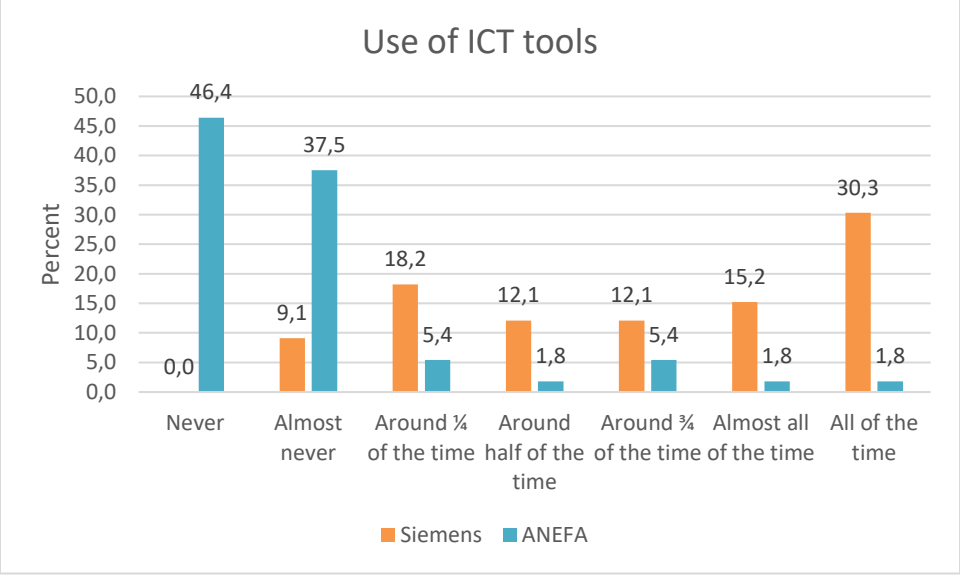

Figure 43 Use of ICT tools – comparison between both groups.

Work ability, job performance, and general quality of life

The study participants at Siemens and ANEFA assessed their work ability rather highly. In Siemens group, the average work ability was 7.48., while in ANEFA, the average work ability was 8.09.

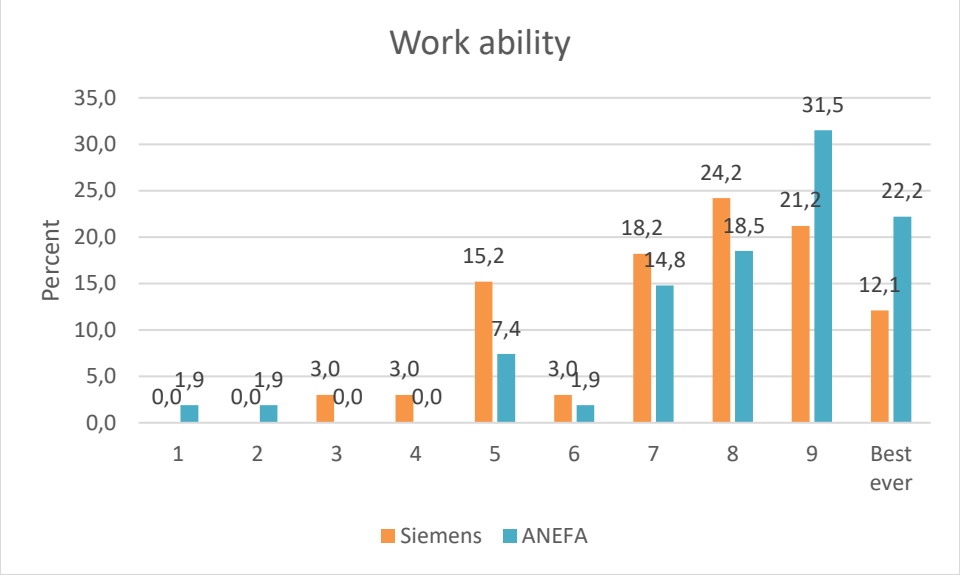

Figure 44 Work ability – comparison between both groups.

Both group assessed their job performance highly. The average job performance was 8.24 in Siemens group and 8.63 in ANEFA group.

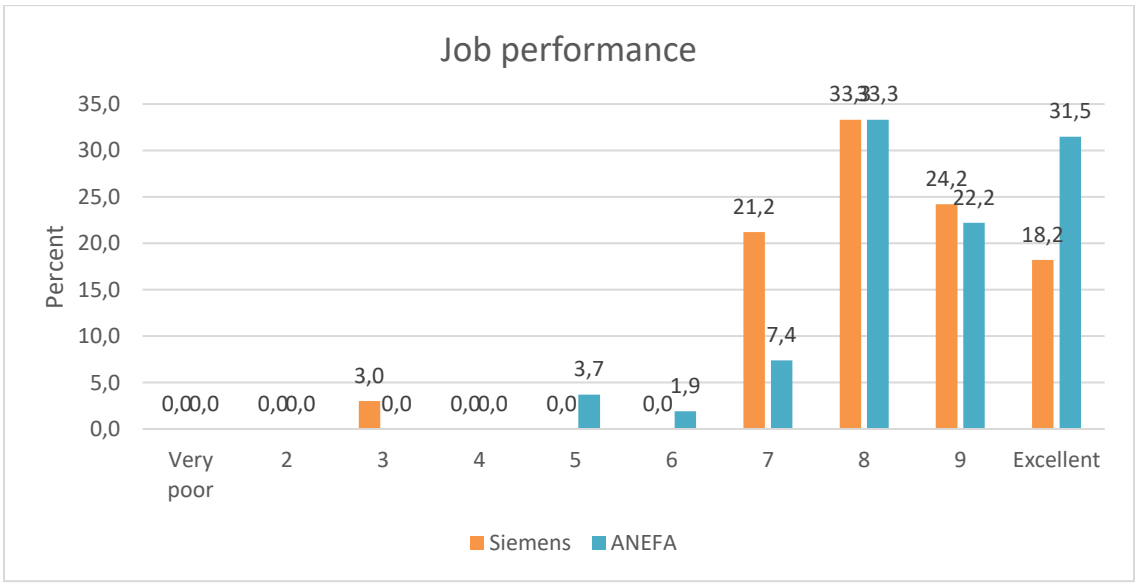

Figure 45 Job performance – comparison between both groups.

Quality of life level was rather high in both group. The average quality of life was 7.28 in Siemens group and 7.91 in ANEFA group.

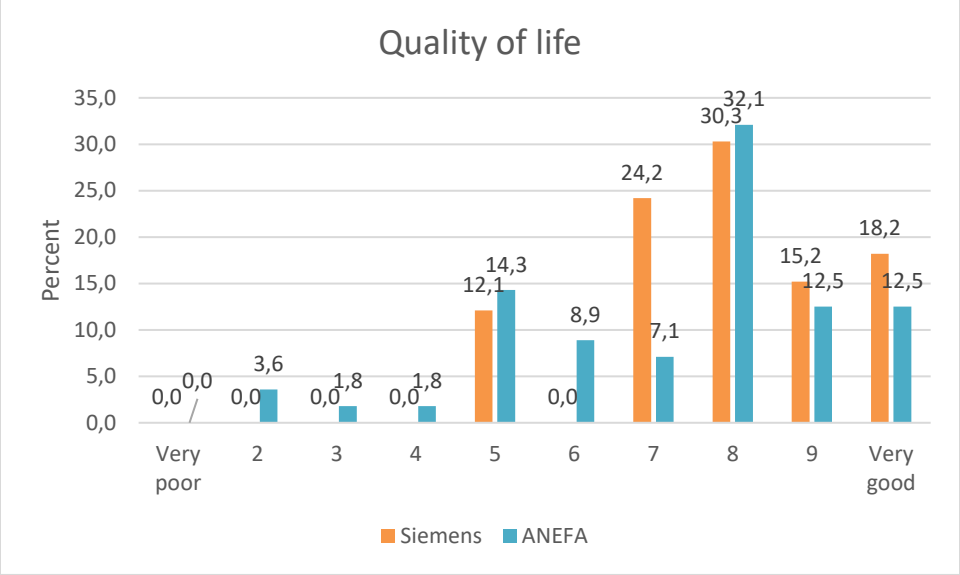

Figure 46 Quality of life – comparison between both groups.

At Siemens, quality of life was higher in supervisors' group, comparing to regular employees. Employees who were able to run 0.5 km without difficulty had higher general quality of life than employees who could run 0.5 km with difficulty or were unable to run such a distance at all. Employees with chronic diseases had lower level of work ability and job performance than those without chronic diseases. Employees suffering from chronic diseases assessed their quality of life to be lower than employees not suffering from chronic diseases. Work ability was assessed to be at lower level in employees with back pain, with muscular pains in lower limbs and in employees suffering from overall fatigue. Job performance was lower in employees suffering from backache, muscular pain in shoulders, neck and/or upper limbs and muscular pains in lower limbs and overall fatigue than employees not suffering from such problems. It was also found that employees experiencing overall fatigue had significantly lower quality of life comparing to employees not experiencing overall fatigue.

At ANEFA, work ability and general quality of life were assessed at lower level in employees who suffer from a long-term disease than employees who did not. Employees who reported problems with vision had lower job performance than those who did not have problems with vision. Those who reported moderate vision quality using corrective glasses/lenses had lower level of general quality of life than those with excellent vision quality. There was a statistically significant difference in work ability score and performance score between employees with different levels of hearing quality using hearing aids. Work ability and job performance were at the highest level in employees with excellent hearing quality. There was a statistically significant difference in work ability score between the various levels of physical activity

in leisure time. Physically inactive employees had the lowest level of work ability. Employees who were able to run 0.5 km without difficulty had higher level of general quality of life than employees who could run 0.5 km with difficulty or were unable to run such a distance at all.

Results of correlation analysis

Correlation analysis revealed significant relationships between work ability, job performance and general quality of life. Significant results for both group are provided below.

Factors correlated significantly with work ability:

- two other dependent variables, i.e. job performance and quality of life. The higher work ability, the higher job performance and quality of life in the study group
- the better ability to concentrate, the higher work ability
- the higher level of satisfaction with support from friends and self-efficacy, the higher work ability

Factors significantly correlated with job performance.

- the higher ability to concentrate, the better job performance.
- the higher level of satisfaction with support from friends, the higher job performance
- the higher level of self-efficacy, the higher job performance
- the more motivated and involved employees felt, the higher job performance was indicated

Factors significantly correlated with general quality of life.

- the better ability to concentrate, the better quality of life
- the higher satisfaction with personal relationships, satisfaction with support from friends, the better quality of life
- the higher level of self-efficacy, the better quality of life
- the higher job satisfaction, the higher quality of life

6. Metrics and tools

Based on literature review, questionnaire survey and individual interviews, a set of factors and metrics has been proposed. Due to the limited size of the study group, this is still a fairly wide range of factors. We would like to stress, however, the importance of psychosocial working conditions (psychological job demands and job resources), physical working conditions and physical strain at work (especially relevant for individual interviews and literature review).

Moreover, although the relationships between musculoskeletal disorders and outcome variables were not significant in the questionnaire survey, these disorders and uncomfortable body postures as well as monotonous movements were identified as most difficult issues to deal with during the individual interviews with employees.

The following set of factors and metrics (table 12) was prepared with the support of Partners not directly involved in task T3.1 of the project (CERTH), as an outcome of the collaboration in task T3.2. It proposes questionnaires and ICT tools to measure factors related to work ability, quality of life and productivity. Some questionnaire tools differ from those used in the questionnaire survey at pilot sites. This stems from the fact that our aim was to create the shortest possible questionnaire comprising as many factors as possible for the pilot site questionnaire surveys. However, longer questionnaires could be included in the Ageing@Work measurement system, as users would not have to answer all questions at once. Measurements, e.g. conducted on smartphones, could be split into several parts so that users would not be overloaded with the questionnaire length.

Preliminary ideas on the use of ICT devices are presented in this report but this aspect of measurement will be further developed in upcoming tasks of this WP.

Table 19 Factors and metrics for the Ageing@Work system

Factor	Description	Method	Frequency
SOCIO-DEMOGRAPHICS			
Age (-)	Birth date	Q	Once
Education level (+)	According to ISCED 2011	Q	Once
Job tenure in the organization (-)	Year of first recruitment in the company (total job tenure)	Q	Once
Job title (+)	[enter]	Q	12 M
Job position (+)	1 – With supervisory responsibility 2 – Without supervisory responsibility	Q	12M
Character of job demands	1 – Mainly physical 2 – Mainly mental 3 – Both physical and mental	Q	12M
Gender (females -)	What is your gender? Male / Female	Q	Once
Marital status	1: Single never married, 2: Married/Common-law, 3: Unmarried partner present, 4: Divorced/Separated, 5: Widowed, 6: Prefer not to say	Q	12 M
IncomeSub	A household may have different sources of income and more than one household member may contribute to it. Thinking of your household's total monthly income, is your household able to make ends meet…? 1 - Very easily 2 - Easily 3 - Fairly easily 4 - With some difficulty 5 - With difficulty 6 - With great difficulty	Q	12M
IncomeObj	Which of these describes your personal income last year (all sources of income)? 1. Less than 15000 2. 15000 to 30000 3. 30000 to 45000 4. 45000 to 60000 5. More than 60000	Q	12M
Dependent persons living in a household	In general, how often are you involved in any of the following activities outside work? C - Caring for and/or educating your children, grandchildren E - Caring for elderly/disabled relatives	Q - EWCS	6M

LIFESTYLE			
Physical activity in leisure time (+)	Mark only one option! How much do you move and exert yourself physically during your leisure time? If your activity varies greatly between, for example, summer and winter, try to estimate an average. The question refers to the past year. 1. Physically inactive: Almost completely inactive, reading, watching television, watching movies, using computers or doing other sedentary activities, during leisure time. 2. Some light physical activity: Physically active for at least 4 hours/week, such as riding a bicycle or walking to work, walking with the family, gardening, fishing, table tennis, bowling, etc. 3. Regular physical activity and training: Spending time doing heavy gardening, running, swimming, playing tennis, badminton, calisthenics and similar activities, for at least 2-3 hours/week 4. Regular hard physical training for competitive sports: Spending time running, orienteering, skiing, swimming, playing football, handball, etc. several times per week	Q - Saltin-GrimbyPhysical Activity Level Scale	6M
Physical activity Objective	Step counter, fitness tracking app	ICT	Daily/real-time
DailyLifeActivities [+]	A list of tags of known activities (e.g. sport, leisure, hobbies, etc.)	ICT	6 M
Smoking (-)	Do you smoke / use tobacco? YES / NO	Q	6M
Smoking2 [--]	Activity recognition using sensors	ICT	Daily
Height	What is your height in m?	Q	Once
Weight	What is your weight in kg?	Q	6M
BMI (-)	The Body Mass Index (BMI) = Weight(Kg)/Height(m)2 (Underweight=<18.5 Normal weight=18.5–24.9 Overweight=25–29.9 Obesity = BMI of 30 or greater)	Auto	6M
Properly composed diet (+)	How many portions of fruit and vegetables do you eat per day? (A portion of fruit or vegetables is 80g. This is around 1 medium-sized piece of fruit; 1 dessert bowl of salad; 2 or more small fruits; a large handful of berries or grapes; 2 broccoli spears; 3 heaped tablespoons of peas, carrots or sweetcorn) _____ portions / day	Q	6M

NutritionApp	Use of a third party app to estimate nutritional value	ICT	Weekly
Alcohol consumption (-)[3]	How many alcoholic drinks do you usually have each week? _____ (Standard drink: Beer: 1 stubby or can (373ml) Wine: 1 medium glass (125ml) Port or sherry: 1 small glass (60ml) Spirits/liqueur: 1 nip (30ml)	Q	6M
Water intake (+)	How much water do you drink on average per day? ____ glasses	Q	6M
Water intake Objective	E.g. recording water intake through app	ICT	Daily
HEALTH			
General health (+)	In general, I would say my health is Excellent / Very good / Good / Fair / Poor	Q	6M
VisionProblems [-]	Do you have vision problems? [no, near-view, far-view, Colourblind, Cataract, Glaucoma, Scotoma, other vision distortion]	Q	Once
CorrectedVisionProblems	My vision with corrective glasses/lenses is: Excellent / Good / Moderate / Poor	Q	12 M
ColourBlindnessType	Type of colour blindness (colour vision deficiency - CVD): Red-green / blue-yellow / Monochromacy / Achromatopsia	Q	Once
HearingProblem [-]	I have problem with hearing: [list hearing problems possibly categorised by frequency band and/or intensity]	Q	Once
CorrectedHearingProblem	My hearing ability with correction (hearing aids) is: Excellent / Good / Moderate / Poor	Q	12 M
Sickness absence (-)	In the past 6 months, how many days in total were you absent from work for health reasons? [number of days]	Q	6M
Cardiorespiratory fitness Subjective (+)	In your opinion, are you able to: - run half a kilometre? - walk two kilometres? - climb several flights of stairs? [1 - without difficulty; 2- with difficulty or unable]	Q	6M
ObjectiveCardiorespiratoryFitness1 [+]	Km run per day	ICT – smartwatch/wristband/chestband	Daily

[3] There was a low response rate in case of this question in the questionnaire survey at ANEFA. We propose to remove this question from the final set of factors.

ObjectiveCardiorespiratoryFitness2 [+]	Km walk per day	ICT - smartwatch/wristband/chestband	Daily
ObjectiveCardiorespiratoryFitness3	Resting and exercise heart rates providing cardio fitness scores	ICT - smartwatch/wristband/chestband	Daily
ObjectiveCardiorespiratoryFitness4	VO2 max	ICT - smartwatch/wristband/chestband	Daily
Musculoskeletal disorders (MSDs) (-)	Over the last 12 months, have you had any of the following health problems? C – backache D - muscular pains in shoulders, neck and/or upper limbs (arms, elbows, wrists, hands, etc.)	Q - EWCS	6M
Other chronic diseases (-)	Do you have any illness or health problem which has lasted, or is expected to last, for more than 6 months? YES / NO	Q - EWCS	6M
Physical fatigue (-)	Physical fatigue involves extreme physical tiredness and an inability to engage in physical activity. During the PAST 12 MONTHS, how often have you: 1. felt physically exhausted at the end of the workday? 2. hade difficulty engaging in physical activity at the end of the workday? 3. felt physically worn out at the end of the workday? 4. wanted to physically shut down at the end of the workday? 5. felt physically drained at the end of the workday? 6. wanted to avoid anything that took too much physical energy at the end of the workday? 1 – never; 5 – everyday	Q - Three-Dimensional Work Fatigue Inventory (3D-WFI)	6M
Chronic fatigue (-)	Over the last 12 months, have you experienced overall fatigue?	Q - EWCS	6M
Depression (-)	Over the last 2 weeks, how often have you been bothered by any of the following problems? Little interest or pleasure in doing things? Feeling down, depressed, or hopeless? Trouble falling or staying asleep, or sleeping too much? Feeling tired or having little energy? Poor appetite or overeating? Feeling bad about yourself - or that you are a failure or have let yourself or your family down? Trouble concentrating on things, such as reading a newspaper or watching television?	Q – PHQ-9	6M

	Moving or speaking so slowly that other people could have noticed? Or the opposite - being so fidgety or restless that you have been moving around much more than usual? Thoughts that you would be better off dead, or of hurting yourself in some way? [1-4]		
Mental fatigue (-)	Mental fatigue involves extreme mental tiredness and an inability to think or concentrate. During the PAST 12 MONTHS, how often have you… 1. felt mentally exhausted at the end of the workday? 2. had difficulty thinking and concentrating at the end of the workday? 3. felt mentally worn out at the end of the workday? 4. wanted to mentally shut down at the end of the workday? 5. felt mentally drained at the end of the workday? 6. wanted to avoid anything that took too much mental energy at the end of the workday? [1 – Never; 5 – Everyday]	Q - Three-Dimensional Work Fatigue Inventory (3D-WFI)	6M
Stress (-)	1. In the last month, how often have you been upset because of something that happened unexpectedly? 2. In the last month, how often have you felt that you were unable to control the important things in your life? 3. In the last month, how often have you felt nervous and "stressed out"? 4. In the last month, how often have you felt confident about your ability to handle your personal problems? 5. In the last month, how often have you felt that things were going your way? 6. In the last month, how often have you found that you could not cope with all the things that you had to do? 7. In the last month, how often have you been able to control irritations in your life? 8. In the last month, how often have you felt that you were on top of things? 9. In the last month, how often have you been angered because of things out of your control? 10. In the last month, how often have you felt difficulties were piling up to such an extent that you could not overcome them? [1-4]	Q - PSS	4 weeks
Stress – Physiological indicators	Estimated by biosensors, e.g. measuring HRV	ICT – smartwarch/chestband	Real-time
Cognitive abilities (+)	These questions are about how you have been during the last 4 weeks: – How often have you had problems concentrating? – How often have you found it difficult to think clearly? – How often have you had difficulty in taking decisions? – How often have you had difficulty with remembering? [1-5]	Q – COPSOQ III	4 weeks

Quality of sleep (+)	How satisfied are you with your sleep? (1 – very dissatisfied; 9 – very satisfied)	Q – WHOQOL-BREF	6M
Quality of sleep Objective	Estimated by biosensors (e.g. wristband)	ICT - biosensors	Daily
PERSONAL PSYCHOSOCIAL RESOURCES			
Self-efficacy (+)	I am confident in my ability to solve problems that I might face in life (For example: I can usually handle whatever comes my way, If I try hard enough I can overcome difficult problems, I can stick to my aims and accomplish my goals) [1-10]	Q - Williams & Smith, 2015	6M
Social support in private life (+)/social network	How satisfied are you with your personal relationships? How satisfied are you with the support you get from your friends? [1 – very dissatisfied; 9 – very satisfied]	Q - WHOQOL-BREF	6M
Social functioning	How often do you socialize with friends / neighbours / relatives? 1 – never; 7 – everyday	Q	6M
Other wellbeing indicators			
Work involvement (+)	- Do you feel motivated and involved in your work? [1-5]	Q	6M
Job satisfaction (+)	Regarding your work in general. How pleased are you with: -your work prospects? -the physical working conditions? -the way your abilities are used? -your job as a whole, everything taken into consideration? -your salary? [1-5]	Q – COPSOQ III	6M
General Quality of Life (+)	(QOLS total score - 16 items)	Q - QOLS	6M
Work ability	Work Ability Index (Short version, WAI-Netzwerk)	Q - WAI	6M
Productivity	Assume that your job performance at its best has a value of 10 points. How many points would you give your current job performance? [1 = very poor; 10 = excellent]	Q	6M

Work-life balance (+)	- Do you feel that your work drains so much of your energy that it has a negative effect on your private life? - Do you feel that your work takes up so much of your time that it has a negative effect on your private life? [1-5]	Q - COPSOQ	6M
Job insecurity (-)	- Are you worried about becoming unemployed? - Are you worried it would be difficult for you to find another job if you became unemployed? [1-5]	Q - COPSOQ	6M
WORK DEMANDS (-)			
Physical strain (-)	How physically exerting do you usually perceive your current work? [0 = no exertion; 10 = maximal exertion]	Q – Andersen et al., 2018	6M
	Please tell me, using the following scale, are you exposed at work to ...? [1-7]		
Heavy loads (-)	Carrying or moving heavy loads	Q- EWCS	6M
Awkward, uncomfortable postures (-)	Tiring or painful positions (e.g. working with hand lifted, squatting, kneeling)	Q- EWCS	6M
Awkward, uncomfortable postures Objective	Monitored using anthropometric sensors	ICT	Daily
Working standing (-)	Standing	Q- EWCS	6M
Working standing Objective	Monitored using anthropometric sensors	ICT	Daily
Sedentary work (-)	Sitting	Q- EWCS	6M
Sitting Objective	Monitored using anthropometric sensors	ICT	Daily
Repetitive movements (-)	Repetitive hand or arm movements	Q- EWCS	6M
Repetitive movements Objective	Monitored using anthropometric sensors	ICT	Daily
Exposure to vibration (-)	Vibrations from hand tools, machinery, etc.	Q- EWCS	6M
Microclimate (Poor thermal conditions, humidity) (-)	High temperatures which make you perspire even when not working Low temperatures whether indoors or outdoors	Q- EWCS	6M
Temperature Objective	Temperature measurement at the worksite	ICT	Daily
Other			6M

Exposition to mineral dust (-)	Breathing in smoke, fumes (such as welding or exhaust fumes), powder or dust (such as wood dust or mineral dust), etc.	Q- EWCS	6M
Chemical factors (-)	Handling or being in skin contact with chemical products or substances	Q- EWCS	6M
Dangerous substances (-)	Breathing in vapours such as solvents and thinners	Q- EWCS	6M
Psychological job demands	[1-5]		
Quantitative job demands (+)	- How often do you not have time to complete all your work tasks? - Do you get behind with your work?	Q - COPSOQ III	6M
Time pressure, imposed, high or uneven tempo (-)	- Do you have to work very fast? - Do you work at a high pace throughout the day?	Q - COPSOQ III	6M
Task variety (+)	- Is your work varied? - Do you have to do the same thing over and over again?	Q - COPSOQ III	6M
Social isolation	- How often do you feel isolated from your colleagues at work?	Q	6M
Cognitive demands	- Do you have to keep an eye on lots of things while working? - Does your work require you to remember a lot of things? - Does your work require you to be good at coming up with new ideas? - Does your work require you to make difficult decisions?	Q - COPSOQ III	6M
WorkingWithComputers	Does your main paid job involve working with desktop or laptop computers? [1-5]	Q	6M
WorkingWithMobiles	Does your main paid job involve working with smartphones/Tablets or other mobile devices? [1-5]	Q	6M
JOB RESOURCES (+)			
Social support from supervisors (+)	How often do you get help and support from your immediate superior, if needed?	Q - COPSOQ III	6M
Social support from colleagues (+)	How often do you get help and support from your colleagues, if needed?	Q - COPSOQ III	6M
Influence (+)	Do you have a large degree of influence on the decisions concerning your work?	Q - COPSOQ III	6M
Possibilities for development (+)	- Do you have the opportunity to learn new things through your work? - Can you use your skills or expertise in your work?	Q - COPSOQ III	6M
Age diversity climate (+)	Is there space for elderly employees in your company? (To a very large extent / to a very small extent)	Q - COPSOQ III	6M
Recognition(+)	Is your work recognized and appreciated by the management?	Q - COPSOQ III	6M
ORGANIZATIONAL FACTORS			
Type of employment	Do you work as an employee or are you self-employed? (1 – employee; 2 – self-employed)	Q - EWCS	12M

Working hours (+/-)	How many hours do you usually work per week in your main paid job?	Q - EWCS	12M
Working hours Objective	Log in data	ICT	Daily
Working in more than one localization (-)	In the past 12 months, have you worked in more than one location?	Q - EWCS	12M
Using PPE (+)	Do you always use PPE when it is required?	Q - EWCS	12M
OSH awareness (+)	Regarding the health and safety risks related to performance of your job, how well informed would you say you are?	Q- EWCS	12M
Access to public healthcare (+)	How satisfied are you with your access to health services?	Q - EWCS	12M

Note: + and – symbols indicate if the relationship is positive or negative

7. Conclusions

The literature review and questionnaire surveys conducted among ageing blue-collar workers indicate that employees' work ability, quality of life and job performance are interrelated. It has also been concluded that almost all identified areas are related to these factors, to a greater or lesser extent. Individual-level indicators of mental health and wellbeing, but also social resources were found to be the most relevant factors related to work ability, quality of life and performance. Specific working conditions prevalent in this group of workers also played a significant role in employees' work ability and quality of life, as well as in relation to other wellbeing indicators. Organisational factors as well as socio-demographic, lifestyle and physical health factors were found to be of lesser importance for maintaining employees' work ability.

Based on these results and the literature review, a set of factors and metrics was identified and proposed to be included into further tasks as well as user and workplace models.

One hundred and five older workers participated in the study – 72 from ANEFA and 33 from Siemens. The results obtained in ANEFA revealed that almost all identified areas of factors were found to be significantly related with outcome variables, although to a limited level. The lowest amount of significant relationships was found in the group of organizational factors, socio-demographic, lifestyle, as well as physical health factors. Among the physical job demands, exposure to vibration and repetitive movements were most significantly related to work ability and quality of life as well as other wellbeing indicators. These two physical demand factors were also most prevalent in the study group, comparing to other physical demands. Long-term diseases and sensory abilities as well as physical abilities were also found related to the outcome variables. The results also show the significant role of personal resources in maintaining work ability and quality of life: from concentration ability and self-efficacy to social relationships in private life and at work. A number of factors related to work ability, job performance and quality of life were identified and other relationships were also examined. For the ANEFA ageing workers it would be important to concentrate on their sleep quality, as well as hearing and seeing aids quality. Since a relatively high percent of them declared being obese, some physical fitness in leisure time would be beneficial for them. It also seems that these workers need some variations at work more than the workers from Siemens did. They also more often mentioned their need for support from friends and colleagues.

The ageing workers from Siemens are characterised by a relatively high level of work ability and a high level of both performance and quality of life. The latter dimension could be a result of high satisfaction with personal relationships, support from friends and socialising which was indicated in the survey. However, only half of them assessed their health as good, and only a quarter as very good or excellent. Nearly half of them declared having a long-term disease, and almost 70% suffered from backache, muscular pain in shoulders, neck, upper limbs, and almost 80% had vision problems.

The following health-related factors were identified in this analysis as important preconditions to maintain older workers work ability, performance and quality of life: general health, and specifically: lack of long-term diseases, lack of muscular pains in shoulders, neck and/or upper limbs, lack of overall fatigue. Among

the physical conditions avoiding tiring or painful position (prolonged sitting), breathing in vapours and staying in high temperatures turned out to be most strongly correlated with the dependent variables. Some individual characteristics, such as the ability to concentrate, using hearing and seeing aids, being motivated and involved in work and having general job satisfaction were also revealed as extremely important for maintaining high work ability and performance of older workers from Siemens. Two factors related to psychosocial working conditions, namely support from friends and support form supervisors were also shown as relevant with regard to work ability and job performance in this group of workers.

Although workers form both companies were characterised by very similar level of work ability, performance and quality of life, more workers from ANEFA assessed them as excellent than the workers from Siemens did. The workers from these two companies differed significantly in relation to the following aspects: education level (lower in ANEFA), character of work (mainly manual in ANEFA), use of ICT tools (lower in ANEFA).

There were also some significant differences between ANEFA and Siemens workers indicating the higher level of stress, higher number of work demands as well as conflicts and quarrels in Siemens. However, the workers from Siemens declared to be more motivated and involved, to have greater influence on their work and, to have greater age inclusiveness. In ANEFA a higher level of work-life conflicts, a higher level of recognition was observed, and these workers declared a greater ability to concentrate compared to the workers from Siemens.

Some of the factors identified as mostly correlated with work ability, performance and quality of life seem to systematically appear in both groups of workers and these are mainly: general health and lack of chronic diseases, ability to concentrate, self-efficacy, satisfaction with personal relationships, satisfaction with sleep. Some others are more specific to the company. For the ANEFA older workers it would be important to concentrate on their sleep quality as well as hearing and seeing aids quality. As relatively high percent of them declared being obese, some physical fitness in leisure time would be beneficial for them. It also seems that these workers need more variations at work than the workers from Siemens and more often mentioned their need for having support from friends and colleagues.

For the Siemens older workers, avoiding muscular pain being a result of tiring positions, e.g. mainly sedentary positions as well as preventing an overall fatigue seem to be important to maintain their high work ability, performance and quality of life.

All the muscular pain that are experienced by elderly workers in these companies might be prevented by implementing or extending rest breaks and by rotating work tasks in order to make it more varied. Other physical conditions, such as dust, high temperature or chemicals might be easily monitored and modified with the help of ICT. Similarly, health related factors, such as physical fatigue, backache or other musculoskeletal pains, water intake, BMI as well as sleep quality might also be monitored with ICT tools providing workers with recommendations on how to deal with these problems.

Ability to concentrate could be increased by improving the working environment, e.g. by making it more calm and less distractive, and by rotating work tasks in order to engage some other cognitive functions.

For the purpose of preventing pain resulting from long-term sedentary positions some physical activity or different tasks division should be implemented and encouraged.

Factors related to psychosocial working conditions, such as motivation, work involvement and job satisfaction could be probably increased if workers are well rewarded for their job, and if recognition, support from their colleagues and supervisors, opportunities for development, having impact on work and work-life balance would be provided. These factors have been found to have a direct influence on work ability, performance and quality but also to have indirect impact on them by increasing general health, ability to concentrate and sleep satisfaction as well as by decreasing physical fatigue, negative feelings or stress. Therefore it can be concluded that mutual correlations observed among all the factors mentioned above suggest the need to integrate them into the system directed to improve work ability, performance and quality of life of elderly workers. The study performed in the two different companies showed clearly, that most of these factors have a generic character, independent of the type of company. Only a few of them may vary in this system depending on the character of work performed in the company.

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ANNEX

Health and working conditions questionnaire

DEMOGRAPHIC DATA
1. Age _____
2. Gender: 1❑ Male 2❑Female
3. Are you: 1❑Single 2❑In relationship or Married 3❑Divorced / Separated 4❑Widowed
4. Level of education: 1❑No education 2❑Primary education 3❑Lower secondary education 4❑Upper secondary education 5❑Post-secondary including pre-vocational or vocational education 6❑Tertiary education - first level 7❑Tertiary education - advanced level
5. How many years have you been in your company? _____
6. How long have you been involved in the present work tasks? _____
7. What is the title of your main paid job/occupation? _____
8. A household may have different sources of income and more than one household member may contribute to it. Thinking of your household's total monthly income, is your household able to make ends meet…? 1❑Very easily 2❑Easily 3❑Fairly easily 4❑With some difficulty 5❑With difficulty 6❑With great difficulty
9. Are you, in your household, the person who contributes the most to the household income? 1❑ Yes 2❑ No 3❑ All equally
10. In general, how often are you involved in any of the following activities outside work? a. Caring for and/or educating your children, grandchildren 1❑Daily 2❑Several times a week 3❑Several times a month 4❑Less often 5❑ Never 6❑Not applicable b. Caring for elderly/disabled relatives 1❑Daily 2❑Several times a week 3❑Several times a month 4❑Less often 5❑ Never 6❑Not applicable
HEALTH AND CAPABILITIES
1. Assume that your work ability at its best have a value of 10 points. How many points would you give your **current work ability**? (0 means that you currently cannot work at all)

	1 Cannot work	2	3	4	5	6	7	8	9	10 Best ever

2. Assume that your job performance at its best has a value of 10 points. How many points would you give your **current job performance**?

1	2	3	4	5	6	7	8	9	10
Very poor									Excel-lent

3. **How much do you move and exert yourself physically during your leisure time?**

If your activity varies greatly between, for example, summer and winter, try to estimate an average. The question refers to the past year.

Mark only one option!

Physically inactive

Almost completely inactive, reading, watching television, watching movies, using computers or doing othersedentary activities, during leisure time 1❑

Some light physical activity

Physically active for at least 4 hours/week, such as riding a bicycle or walking to work, walking with the family, gardening, fishing, table tennis, bowling etc. 2❑

Regular physical activity and training

Spending time doing heavy gardening, running, swimming, playing tennis, badminton, calisthenics and similar activities, for at least 2-3 hours/week. 3❑

Regular hard physical training for competitive sports

Spending time running, orienteering, skiing, swimming, playing football, handball etc. several times per week 4❑

4. Do you smoke / use tobacco? 1❑ YES 2❑ NO

5. How much do you weigh at present? _____ kg (estimate suffices)

What is your height? _____cm

6. How many portions of fruits and vegetables do you eat per day? (A portion of fruit or vegetables is 80g. eg. 1 medium sized piece of fruit; 1 dessert bowl of salad; a large handful of berries or grapes; 2 broccoli spears; 3 heaped tablespoons of peas, carrots or sweetcorn)

_____ portions / day

7. How many alcoholic drinks do you usually have each week? _____

(Standard drink: Beer: 1 can (373ml); Wine: 1 medium glass (125ml) Port or sherry: 1 small glass (60ml) Spirits/liqueur: 1 nip (30ml)

8. What is an average amount of water you drink per day?

____ liter(s)

9. In general, I would say my health is:
   5❑Excellent 4❑Very good 3❑Good 2❑ Fair 1❑ Poor

10. I have problems with vision: 1❑ YES (check below) 2❑NO

    If YES: 1❑ Near 2❑Far 3❑ I am colorblind 4❑ Other (please describe) ……

11. If an answer to the question 10 is yes, my vision with correction glasses/lenses is:

    1❑ Excellent 2❑ Good 3❑Moderate 4❑ Poor

12. I have problem with hearing: 1❑ YES 2❑ NO

13. If an answer to the question 13 is YES, my hearing with hearing aid is:

    1❑ Excellent 2❑ Good 3❑Moderate 4❑ Poor

14. In your opinion, are you able to:

    a. Run a half kilometre? 1❑ Without difficulty 2❑With difficulty or unable

    b. Walk two kilometres? 1❑ Without difficulty 2❑With difficulty or unable

    c. Climb several flight or stairs? 1❑ Without difficulty 2❑With difficulty or unable

15. In the past 12 months, how many days in total were you absent from work for reasons of health problems?

    _____ days

16. Do you have any illness or health problem which has lasted, or is expected to last, for more than 6 months?

    1❑ YES 2❑ NO

17. Over the last 12 months, did you have any of the following health problems?

    a. backache 1❑ YES 2❑ NO

    b. muscular pains in shoulders, neck and/or upper limbs 1❑ YES 2❑ NO

    c. muscular pains in lower limbs (hips, legs, knees, feet etc.) 1❑ YES 2❑ NO

    d. overall fatigue 1❑ YES 2❑ NO

    e. other (describe)

18. Physical fatigue involves extreme physical tiredness and an inability to engage in physical activity. During the PAST 12 MONTHS, how often did you feel physically exhausted at the end of the workday?

1❑ Never	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Everyday

19. How often do you have negative feelings such as blue mood, despair, anxiety, depression?

1❑ Never	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Everyday

20. How well are you able to concentrate?

1❑ Not at all	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Extremely

21. How satisfied are you with your sleep?

1❑ Very dissatisfied	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Very satisfied

22. **Stress** means the situation when a person feels tense, restless, nervous, or anxious, or is unable to sleep at night because his mind is troubled all the time.
How often have you been stressed during the last 4 weeks?

1❑ Never	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Everyday

23. I am confident in my ability to solve problems that I might face in life
(For example: I can usually handle whatever comes my way, If I try hard enough I can overcome difficult problems, I can stick to my aims and accomplish my goals)

1❑ Strongly disagree	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Strongly agree

24. How satisfied are you with your personal relationships?

1❑ Very dissatisfied	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Very satisfied

25. How satisfied are you with the support you get from your friends?

1❑ Very dissatisfied	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Very satisfied

26. How often do you socialize with friends / neighbours / relatives?

1❑ Never	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Everyday

27. How would you rate your quality of life?

1❑ Very poor	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Very good

WELLBEING AT WORK

1. Do you feel motivated and involved in your work?

1❑ Not at all	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Extremely

2. Regarding your work in general. How pleased are you with your job as a whole, everything taken into consideration?

1❑ Very dissatisfied	2❑	3❑	4❑	5❑	6❑	7❑	8❑	9❑	10❑ Very satisfied

3. Do you feel that your work drains so much of your energy that it has a negative effect on your private life?
   1❑ To a very large extent 2❑To a large extent 3❑ Somewhat
   4❑ To a small extent 5❑ To a very small extent

4. Do you feel that your work takes so much of your time that it has a negative effect on your private life?
   1❑ To a very large extent 2❑To a large extent 3❑ Somewhat
   4❑ To a small extent 5❑ To a very small extent

5. Are you worried about becoming unemployed?
   1❑ To a very large extent 2❑To a large extent 3❑ Somewhat
   4❑ To a small extent 5❑ To a very small extent

6. Are you worried about it being difficult for you to find another job if you became unemployed?
   1❑ To a very large extent 2❑To a large extent 3❑ Somewhat
   4❑ To a small extent 5❑ To a very small extent

JOB DEMANDS

1. How physically exerting do you perceive your current work?

1 No exertion	2	3	4	5	6	7	8	9	10 Maximum exertion

Please indicate, using the following scale, are you exposed at work to ...?

2. Carrying or moving heavy loads
   1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
   4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

3. Tiring or painful positions (e.g. working with hand lifted, squatting, kneeling)
   1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
   4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

4. Standing
   1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
   4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

5. Sitting
   1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
   4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

6. Repetitive hand or arm movements
   1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
   4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

7. Vibrations from hand tools, machinery, etc.
   1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
   4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

8. High temperatures which make you perspire even when not working
   1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
   4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

9. Low temperatures whether indoors or outdoors
   1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
   4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

10. Breathing in smoke, fumes (such as welding or exhaust fumes), powder or dust (such as mineral dust) etc.
    1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
    4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

11. Handling or being in skin contact with chemical products or substances
    1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
    4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

12. Breathing in vapours such as solvents and thinners
    1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
    4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

13. Does your main paid job involve working with computers, laptops, smartphones etc.?
    1❑ All of the time 2❑Almost all of the time 3❑ Around ¾ of the time
    4❑ Around half of the time 5❑ Around ¼ of the time 6❑ Almost never 7❑ Never

14. How often do you not have time to complete all your work tasks?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

15. Do you get behind with your work?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

16. Do you work at a high pace throughout the day?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

17. Do you have to work very fast?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

18. Is your work varied?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

19. Do you have to do the same thing over and over again?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

20. Do you feel isolated from colleagues while working?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

21. Do you have to keep your eyes on lots of things while you work?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

22. Does your work require that you remember at lot of things?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

23. Does your work demand that you are good at coming up with new ideas?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

24. Does your work require you to make difficult decisions?
    1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

1. a. How often do you get help and support from your immediate superior, if needed?
   1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

2. How often do you get help and support from your colleagues, if needed?
   1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

3. Have you been involved in quarrels or conflicts at your workplace during the last 12 months?
   1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

4. Do you have a large degree of influence on the decisions concerning your work?
   1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

5. Do you have the possibility of learning new things through your work?
   1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

6. Can you use your skills or expertise in your work?
   1❑ Always 2❑Often 3❑ Sometimes 4❑ Seldom 5❑ Never / hardly ever

7. Is there space for elderly employees in your company?
   1❑ To a very large extent 2❑To a large extent 3❑ Somewhat
   4❑ To a small extent 5❑ To a very small extent

8. Is your work recognized and appreciated by the management?
   1❑ To a very large extent 2❑To a large extent 3❑ Somewhat
   4❑ To a small extent 5❑ To a very small extent

1. Are you working as an employee or are you self-employed? 1❑ Employee 2❑ Self-employed

2. What kind of employment contract do you have in your main job?
   1❑ Contract of unlimited duration 2❑ Contract of limited duration

3❑ A temporary employment agency contract 4❑ An apprenticeship or other training scheme 5❑ No contract 6❑ Other (describe): _____
3. How many hours do you usually work per week in your main paid job? _____
4. During last 12 months, have you worked in more than one location? 1❑ YES 2❑ NO
5. Do you always use personal protective equipment when it is required? 1❑ YES 2❑ NO
6. Do you trust in emergency/rescue procedures and staff in your company? 1❑ YES 2❑ NO
7. Regarding the health and safety risks related to performance of your job, how well informed would you say you are? 1❑ Very well informed 2❑ Well informed 3❑ Not very well informed 4❑ Not at all well informed
8. How satisfied are you with your access to health services? 1❑ Very unsatisfied 2❑ Unsatisfied 3❑ Neither satisfied not unsatified 4❑ Satisfied 5❑ Very satisfied
9. Does your employer provide you an additional (private) health insurance? 1❑ YES 2❑ NO

LEARNING PREFERENCES

1. What kind of learning method do you prefer? Please, rank the following methods from 1 to 5, where 1 means the highest importance and 5 the lowest importance

___ hearing (e.g. lecture, instructions)

___ seeing (reading an instruction, watching a demonstration, video)

___ talking (e.g. taking part in a discussion)

___ doing (real-life problem-solving, tasks/exercises)

___ other, what? _____

2. Have you encountered any difficulties while learning to use a computer, smartphone, Internet, or app?

1❑ YES 2❑NO

If yes, what kind of difficulties?

___ Memory and mental agility

___ Fear of the device/program or fear of breaking it

___ Lack of learning support or guidance

___ Difficult / complex instructions

___ Lack of repetition and practice

___ Lack of cues, reminders and navigational aids

___ User-unfriendly technology (how?)

___ Other, what? _____

THANK YOU FOR YOUR HELP!