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ASSOCIATION OF PHYSICAL FITNESS ON SELF-PERCEIVED WORK ABILITY ON WORKING AGED PEOPLE

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ABSTRACT

Ageing population combined with plans of lengthen careers compel both organizations and occupational healthcare system to renew. Sufficient physical fitness is one of the key factors to pursuit this goal which enables workers to continue in the working life. Aim of the study was to clarify association of physical fitness on self- perceived work ability on working aged people by utilizing Laturi Energy Index and short version of Work Ability Index (WAP) questionnaire in a working age population. Study was a sub-study of a larger ALIWO research project.

Altogether 197 participants, 39 executives and 158 employees from 39 local companies in different sectors took part to the study. Energy Index result was calculated based on the preliminary information and results in eight subtests including a wellness questionnaire, fitness assessment, and biometric data. Energy Index results are presented in hours and minutes and results can vary from 4-16 hours. The score in the WAP varies from 0-100 points. WAP is created by the Finnish Institute of Occupational Health (Seitsamo 2013) and it is based on international Work Ability Index (Ilmarinen et al. 1997).

The average result in Energy Index among all the 197 participants was 10:39 h:min, varying from 4:43 h:min to 15:21h:min. The results did not differ between executives and employers, however female had better Energy Index than male. ($p=0.001$). The mean in WAP was 83.86 points. Results varied from 39 points to 100 points. Results in WAP did not statistically differ between executives and employees, between genders or between different age groups. However, individuals who reported high physical activity had higher WAP compared to moderate physical activity ($p<0,007$). In total, there was a positive correlation between Energy Index and WAP ($r=0.26$, $p<0.001$). In addition, a significant positive correlation was found between Energy Index and WAP in all of the subgroups: executives, employees, female and male. Energy Index and WAP showed also a positive correlation among those whose work type was sedentary and those who reported their nature of work to be mentally demanding.

As a conclusion, this study succeeded in strengthening the association of physical fitness and work ability on cross-sector worker population. All in all, results indicates that both tools Energy Index and WAP are applicable specially workers in different positions for both genders and for mentally demanding and sedentary work types. The statistically significant correlation between Energy Index and WAP indicates that health and functional capacity are significantly related to work ability in occurring now.

Key words: Work ability, physical activity, physical fitness, Energy Index, WAP

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A man asked:
What surprises you most about humankind?

God answered:
"That they lose their health to make money and then lose their money to restore their health"

- James J. Lachard "interview with God"

1 INTRODUCTION

Labor markets in Finland are going through a lot of changes. Ageing population and rapid changes in the structures of the working life set challenges to meet the goals of lengthen work careers in Finland. Work ability plays key role in this situation and importance of work ability will increase even further in the future. (Gould et al. 2008.) Changing circumstances compels decision makers, organizations and occupational healthcare providers to revise policies and practices and to seek for new approaches to promote and maintain sufficient work-ability. It is hardly possible to lengthen workers' careers if workers are unable to work (Ilmarinen et al. 2008).

The actuality of maintaining work ability has steadily grown due to the demographic changes (Ilmarinen et al. 2005). The population in Finland ages rapidly and the mean age of the Finnish employees, 41 years, is one of the highest among OECD countries (Myrskylä 2009; Heikkinen & Ilmarinen 2001). Employees aged 40-50 years form the core of the workforce in many companies and organizations and the same cohort will constitute the core working group also in ten years which underlines the importance of sufficient work ability in the future (Hasselhorn 2008).

Due to the ageing population. the number of working aged Finns (18-64 years) decreases 13 000-14 000 annually, causing imbalance in dependency ratio. In 2010, per 100 working aged there was about 61 children and pensioners in Finland. By 2030 the ratio is estimated to increase to over 80. (Kauppinen et al. 2013.)

One of the attempts to balance this phenomenon is to postpone retirement. In recent years the statutory retirement age has been 63 years. Yet, in 2014 mean retirement age was 59,6 years for all the new pensioners and 60,5 years for those who retire for employee pension. (Eläketurvakeskus & Kansaneläkelaitos 2015, 109.) Renewed labor market policies (Eläkeuudistus 2017) aim to extent careers and progressively postpone statutory retirement age up to 65 years by 2027 in order to keep national economy better in balance for the future (KEVA 2016). Due to these changes in the demographic structures, the means to maintain work ability of the ageing workforce needs to be developed and the importance of work ability highlighted (Heikkinen & Ilmarinen 2001).

Also the nature of work has changed considerably during the past decades, leading to new kind of health challenges. As a result of progression in mechanics and technology, the physical load in the working life has generally dropped. (Husu et al. 2011, 31.) About two thirds of employees in Finland are regularly involved with computers in their jobs. (Tuomivaara 2013.) Information technology work has generated a growing group of sedentary workers who spend most of the workday sitting. In the recent years, increased sedentary time and prolonged sitting have been identified as an independent health risk (Vasankari 2014). Static, monotonic and unilateral movements have also created a whole new branch of work-related musculoskeletal disorders (MSDs). Even though the physical load in the working life has generally decreased, yet about 25 percent of the employees in Finland are still involved with physically demanding work. (Husu et al. 2011, 31).

Physical activity is positively associated with number of different factors in physical, mental and cognitive health which are eventually strongly linked with individuals' work ability. Sufficient level of physical activity is associated with lower rates of non-communicable diseases such as diabetes, cancer and cardiovascular disease and their risk factors such as raised blood sugar raised blood pressure and overweight. (World Health Organization 2010, 10.) Physical activity is positively associated with functional capacity, prevalence of musculoskeletal problems, body composition and weight control. In addition it has been proven to have beneficial effects on depression, stress, anxiety, cognitive decline and may improve the quality of life and sleep. (Liikunta 2016; Mattila 2010; ODPHP 2016).

In general, Finns asses their work-ability quite high, 8,25 on a scale 0-10 However work ability tends to decreases by age and at the age group of 55-64 almost one out of 10 consider themselves incapable to work. In the older age groups decrease in work ability is often associated with the physical demands of the work. (Gould et al. 2012.) Consequently, sufficient physical condition can be seen one of the key factors in enabling employees to maintain their work ability in the older age groups.

Health and functional capacity (physical, psychological, social) can be seen as a foundation of personal resources and thus one of the cornerstones of work ability (Heikkinen 2005). Functional capacity needs to exceed the demands of the working life in order to ensure workers health, safety and recovery. (Ilmarinen 2005). As ageing limits activities and decreases functional capacity, new balance can be found either by supporting health and functional capacity or altering the demands and requirements of the work, or both (Ilmarinen 2005).

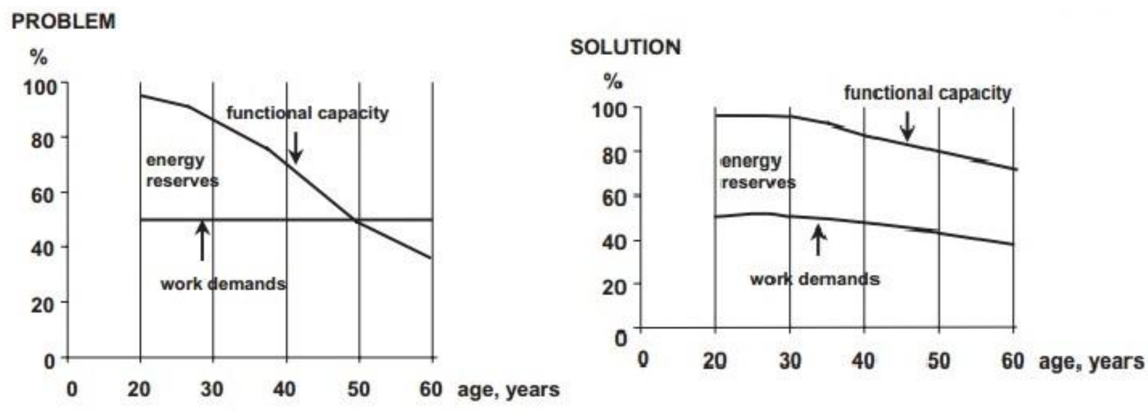

Figure 1. Functional capacity and coping at work - problem and solution. Adapted from Ilmarinen 2001a.

Keeping that in mind, the future of Finnish employees appears alarming. Research indicates that especially the younger age-groups in the working life are in relatively poor physical condition and based on calculations, general work ability is predicted to worsen notably in the future. (Heiskanen et al. 2011, 44.)

As employees spend significant part of their time awake in their working environment, can work ability therefore be seen as essential part of one's overall health. Supporting the work ability is primarily on responsibility of the organization supported by occupational healthcare (Husman et. 2010). A total of 1,9 million employees, more one third of the Finnish population, are covered by occupational healthcare services (Kauppinen et al. 2013.). Worksites practices, investments on work wellbeing and occupational healthcare solutions can then have significant impact on public health on a long run.

Finnish Occupational Safety and Health Act 1§ defines the aim of occupational healthcare to ensure and maintain the working capacity of employees. Also the policies of quality occupational healthcare (*Työterveyshuollonnhyvä sairaanhoitokäytäntö)* highlights the importance of primary prevention in order to maintain employees work ability (Husman et al. 2010). Nevertheless, occupational healthcare system in Finland is often criticized for focusing too much on ill-being and taking care of sickness rather than focusing on its primary tasks of preventive healthcare and maintaining working capacity.

In order to succeed in lengthen work careers, wellbeing at work sites and actions aiming at maintaining and enhancing work-ability is needed to take into closer consideration in the future both in worksites and in occupational healthcare. Co-operation of these two units will help to indentify the individuals with deteriorated work ability (Husman et al. 2010). Rather than implementing same homogeneous promotion actions to all of the employees, it would be important to early identify individuals with risks of decreased work ability and perform enhancing or maintaining actions according to the reason behind the elevated risk of decreased work ability.

This naturally raises the question how can work ability be assessed and promoted? Work ability is associated wide range of factors that describe individual resources and working life. Effects of the different factors on work ability needs further research as better understanding of work ability offers better possibilities to promote it. (Ilmarinen et al. 2008.)

Aim of this study is to clarify the association of physical fitness and self-reported work ability. The model of Work Ability House (Ilmarinen et al. 2006,) works as the theoretical framework in this study (Figure 3). Here, the first floor of the house, *Health and functional* *capacity*, is emphasized focusing to clarify the connection and importance of health and functional capacity as a core part of individuals work-ability. Therefore, other dimensions of the house, competence, values, attitudes & motivations, and work itself are excluded from this study. In this study, participants' health and physical condition was evaluated by using Energy Index - fitness test . Work-ability was assessed by using the short version of Work Ability Index - questionnaire by Finnish Institute of Occupational Health.

2 WORK-ABILITY

The concept of work ability has changed and evolved with time and research. The definition of work ability has altered, as changes in society have taken place. Over time, the spectrum has shifted from a solely medical way of thinking to a model of balance between the demands of work and the resources of the individual and, further, to a multidimensional way of looking at work ability. Consequently, modern multidimensional and diverse concept of work ability has make defining it challenging and its promotion demanding (Ilmarinen et al. 2008).

Work ability is often thought just as an individual character but in fact it actually impacts on all the layers of the society and is associated with nearly all factors of the working life (Ilmarinen et al. 2008). Work ability is a core resource for every worker, for enterprises and even for national economies and good work ability of the population is a crucial objective of health and social policy, which increases wellbeing and supports employment (Hasselhorn 2008; Gould et al. 2008a). Good work ability is not only important for the sake of coping and continuing at work, it also supports well-being in other areas of life. Consequently, promoting work ability can increase happiness and well-being, as well as the employment rate (Gould et al. 2008b).

On an *individual* level, work ability is the most important capital of each worker and it has significant impact on individual's and his/her family's economy, health and wellbeing (Ilmarinen 2005, 79). Deteriorated work ability in midlife is shown to predict higher mortality and comparably good work ability at the end of career has shown to be associated with better health and functionality after retirement from the working life (Von Bonsdorff et al. 2011; Heikkinen & Ilmarinen 2001). Sufficient work ability is therefore also a matter of public health. For the *organization*, (its) employees' sufficient work ability plays an important financial role, since reduced work wellbeing is associated with higher sick leaves, presenteeism, occupational injuries and reduced productivity and early retirement. (Työterveyslaitos & Ahonen 2015.) As the workers spent significant part of their awake time in their working environments, employers and organizations have a key role in maintaining and enhancing work ability both on individual, organizational and population level. For the *society* and national economy, work ability also plays a major role when considering public healthcare costs, disability pensions and dependency ratio. (Rissanen & Kaseva 2014; Kauppinen et al. 2012.) Adequate work ability should be therefore everyone's common interest and each of the shareholders; employees, employers and society are responsible to support and maintain work-ability and work wellbeing in Finland.

2.1 Statistics about Work ability in Finland

In general self reported work ability is rather high in Finland and results in different research are rather consistent. According to two large Finnish surveys *Health 2011* and *Work and Health 2012*, an average self reported work ability score is between 8,2- 8,3 on a scale 0-10. Overall, general work ability has noticeably increased for the past 10-20 years, especially in the older age groups, but in the recent years the increase has been less rapid. (Gould et al. 2012; Perkiö-Mäkelä 2013.)

There was no statistical difference (Male 8,2, Female 8,3, p=0,099) in work ability between genders in Health 2011 survey as genders in all age-groups scored roughly the same. Age, educational background and field of work appears to be better predictors of work ability in general as young, well educated persons and white-collar workers are most satisfied with their work ability and older workers and worker in blue-collar occupations least satisfied. (Gould et al. 2006, 5). In Health and work 2012 study, work ability in the age group of 25-34 was on average 8,9 compared to 7,9 in the age group of 55-64 and employees with basic education evaluated their work ability lower (7,9) compared to ones with higher education (8,6) (Husman & Kauppinen 2013). Similar, age related decline was seen also in Work Ability Index in Health 2000 study (Figure 2).

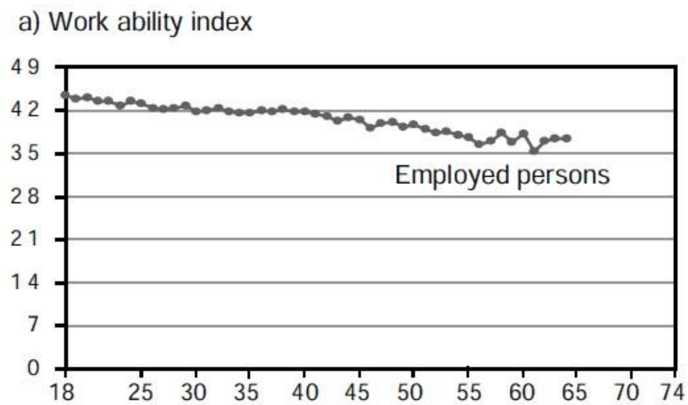

Figure 2. Work ability index according to age in Health 2000 study (Gould et al. 2006)

Additionally, there appears to be notable variation in work ability between different occupational groups. Whereas in 2012, over half of upper white collar workers (53 %) reported their work ability to be very good for the physical demands of the work, only a quarter (24 %) of blue-collar workers felt this way. In contrast, no significant differences between the mental demands of work were observed. (Kauppinen et al 2012.)

Overall, work ability appears to be rather same between genders. Thus, socioeconomic status and age appear to be better predicators for work ability (Gould et al. 2012; Gould et al. 2006, 5). By identifying the groups at higher risks of deteriorating work ability, we can better target the promotion actions both on population and organization level. Individual evaluation and assessment is however essential in order to reliably identify those individuals at risks of deteriorating work ability or work disability. In general, due to apparent negative correlation with work ability and age, importance of preventive actions on work disability will increase in the future, as the mean age of Finnish workers increase.

In other words, an increasing amount of data show that the effects of ageing on work life should be taken into consideration more often. Functional capacities, mainly physical, show a declining trend after the age of 30 years. In order to maintain sufficient work ability especially physical workloads should be decreased with advancing age and regular exercise should be performed to upkeep the cardiorespiratory and musculoskeletal capacity to at least age related average. Regular physical activity can keep physical capacity almost unchanged between 45–65 years, and a lack of appropriate physical activity can make a 45 year old worker less fit than his or her active colleague aged 65 years. (Ilmarinen 2001b).

2.2 Financial aspects of the reduced work ability

In Finland, sickness absence rates are 3rd highest and prevalence of disability pensions 4th highest among OECD countries (OECD 2010, 22, 63). The total cost of lost labour input, direct healthcare costs and occupational accidents are enormous for the national economy. Based on the calculations by Ministry of Social Affairs and Health, loss of labor input due sick-absenteeism, presenteeism, disability pensions is about 14,8 billion euros. Together with direct healthcare costs (7,8 billion euros) and costs of occupational accidents and diseases (2-2,6 billion euros) these problems are estimated to cause a total 24-25 billion annual losses for the national economy in Finland. (Rissanen & Kaseva 2014, 11.) In Work and Health in Finland 2012 report, estimations of these costs were even larger, 41 billion euros. For comparison, in 2010 BKT in Finland was about 180 billion euros and governmental annual budget 50 billion euros. (Ahonen 2013, 12.)

2.2.1 Costs of sick absence days, presenteeism and work disability

In Finland, number of sick absence days vary a lot between genders and occupations. On average, sick-leaves cause 10 – 17 day annual absence per employee but can vary up to 30 days in some low income occupations, such as cleaners. (Elinkeinoelämän keskusliitto 2015, 5, 9; Työterveyslaitos 2016). In 2011, an average number of sick leaves in Finland was 9,4 days meaning 4,6 percent of all working days (Husman & Kauppinen 2013). The cost of one sickness-absence day naturally varies depending on employees salary and various other factors. An expense of 350 euros per day has been generally used as a rule of thumb when calculating the cost of sickness-absences for employers. Based on the calculations by Ministry of Social Affairs and Health the annual cost of the sick-absents is on average 1590 euros per person and for the national economy 3,4 billion euros. (Rissanen & Kaseva 2014, 4.)

Based on the statistics by Finnish Institute of Occupational Health (2015), musculoskeletal disorders are the most common cause for over 9-day sick absences in Finland including over 4.1 million annual sickness allowance days. (Työterveyslaitos 2015). In 2012 two thirds of the Finnish employees (66 %) reported to have frequent or chronic MSDs. Most common disorders were neck pain (49 %), low back pain (33 %) and pain in the shoulders and arms (30 %) (Perkiö-Mäkelä 2013). Direct costs of MSDs in working the life in Finland are annually over 200 million Euros and both costs and prevalence are predicted to grow in the future (Husu et al. 2011, 10.) As the proportion of ageing employees will increase in the future, preventive actions to maintain sufficient work-ability are needed.
Presenteeism, attending work while sick or unhealthy, is another big cause of lost labor input in which depression and strong pain cause the greatest losses. In total presenteeism is estimated to cause another 3.4 billion euros yearly lost for the labor input, about 1 590 euros per one wage-earner. (Rissanen & Kaseva 2014, 5.)

Work disability is a big concern in Finland and today approximately eight percent of the working aged adults are incapable to work (Aromaa et al. 2005). Disability pensions and early retirement from the working life cause yearly loss of eight billion euros for the national economy, about as much as sick-absenteeism, presenteeism and occupational accidents together (Rissanen & Kaseva: 2014, 3–9). Fortunately, the trend has been positive and the number of new disability pensions have been able to reduce for the past decades (Eläketurvakeskus 2015). Preventing work disability and supporting work ability can be seen as an effective mean to support the growth of national economy (Otala & Ahonen 2005, 18).

2.2.2 Preventive actions

Reduced work-ability is a common background factor in all of these costs. Controversially, improved work wellbeing and actions to enhance work-ability are proven to positively and cost-effectively affect these issues. (Chapman 2012.) Nevertheless, companies in Finland invest only 2 billion euros for their work wellbeing programs annually compared to expenses of 24-25 billion euros presented (Ahonen 2013, 14; Rissanen & Kaseva 2014, 3–9). As mentioned, studies show that it is cost-effective for the employers to invest on work-wellbeing. According to the Finnish Institute of Occupational Health (FIOH), return on investment (ROI), in, well-organized and tailored work wellbeing operations can be six times larger than the input, resulting from both direct and indirect impacts such as higher work satisfaction, lessen number of sick leaves and improved work effectiveness. (Työterveyslaitos & Ahonen 2015.)

A case study from Finnish metal industry company (n=829) evaluated the ROI of 3-year comprehensive work wellbeing program. The yearly financial input was 50 500 euros compared to yearly profit of 505 000 euros consisting of reduced work disability costs (270 000€), reduced sick absenteeism costs (34 000€) and improved productiveness (220 000 €). Altogether, the cost - benefit ratio was 10:1. (Ilmarinen 2005, 94.)

A meta-analysis by Chapman and his colleagues from 2012 reviewed 62 high-quality studies related to economic return of worksite health promotion programs around the globe. With almost 550 000 subjects representing diverse range of industries and organizations, they come to the conclusion that investing on work-wellbeing was significantly cost-effective. The reduce in both healthcare costs and in sick absenteeism costs was 25 percent. Altogether the cost-benefit ratio of all the evaluated areas was over 1:5. (Chapman 2012*)*. A critical meta-analysis, including 22 studies, revealed that ROI of employee's wellness program was 3,27 dollars for medical costs savings and 2,73 dollars for absenteeism reduction (Baicker et al. 2010). Although all of the workplaces examined were foreign and therefore the results and figures may not be directly applicable for Finnish workplaces, results suggests that investing on work wellbeing and health is financially profitable for employers also in Finland.

2.3 Models of work ability

Health and functional capacity (physical, mental and social) form the basis of personal resources and work ability. Therefore, changes such as reduced health will ultimately reflect on individuals work ability. Work ability is primarily a question of balance between work and personal recourses. However, work ability is not separated from life outside work and therefore environment, family, friends and other aspects in life can also affect on individuals work ability in many different ways. (Ilmarinen 2005, 79-80.)

Consequently, work ability is seen as a complex and multidimensional concept and several models have been made to describe and interpret the phenomena. So far, there is no cohesive or uniform definition for work ability. (Ilmarinen et al. 2008.) Traditional *medical perspective* determines work-ability as a health based character, independent of context of work. Work ability is closely linked to physical abilities in which a healthy individual is capable to work while sickness or disability weakens the work-ability of an individual. (Taimela 2005.)

Work ability balance model is based on stress–strain model by Rohmert and Rutenfranz 1983 and is still widely used by experts in defining occupational work ability or disability (Ilmarinen et al. 2008). Work ability is seen a balance between workers' personal resources and demands of the work in which occupational stress creates strain within the individual and quality and level of the strain is regulated by the resources of the individual (Taimela 2005; Ilmarinen et al. 2008). Therefore, work ability can change due to the changes of personal resources such as in health or due to the increased demands at work, or both. Balance can be reached either by supporting workers' resources or planning work conditions so that they are as suitable as possible for workers. (Taimela 2005; Ilmarinen et al. 2008.)

Integrated model sees work ability as a part of bigger organizational system in the working process. Decreased work ability is seen as a miss function of the working process and not as a character of an individual (Taimela 2005). In general, work-ability is nowadays broadly seen in a holistic way in which work-ability is closely linked to personal abilities, demands of the work, environment inside and outside of the work. *The tetrahedral model* describes work ability as a constant interaction between health, competences of an employee, working community and the working environment in which health and functional capacity is seen only as a one part of multidimensional ensemble of work ability. (Taimela 2005.) The aim of improving work ability is not just to enhance health and functional abilities but also to improve the work community and employees' competences (Taimela 2005). These holistic models are generally called as *multidimensional work ability models* which naturally share some similarities but also highlight different aspects. In a following chapter, model of Work Ability House, a theoretical framework of this study, is introduced more in detail.

Concept of work ability can be illustrated with a symbolic model called **Work Ability House** created by Finnish Institute of Occupational Health (Figure 3). Here work ability consists of both the resources of the individual and factors related to work and working in addition to the environment outside of work (Ilmarinen et al. 2008). The work ability house consists of four different floors, of which floors 1st - 3rd describe the different personal abilities of an individual employee. The 4th floor describes the work itself and the content and the demands of the work. Work ability is then seen as the roof of the house. Work ability house is surrounded with environmental factors such as family (close), social networks (immediate) and other (external) parts of the society which are in a constant interaction with work ability house. (Ilmarinen 2005, 79-81.)

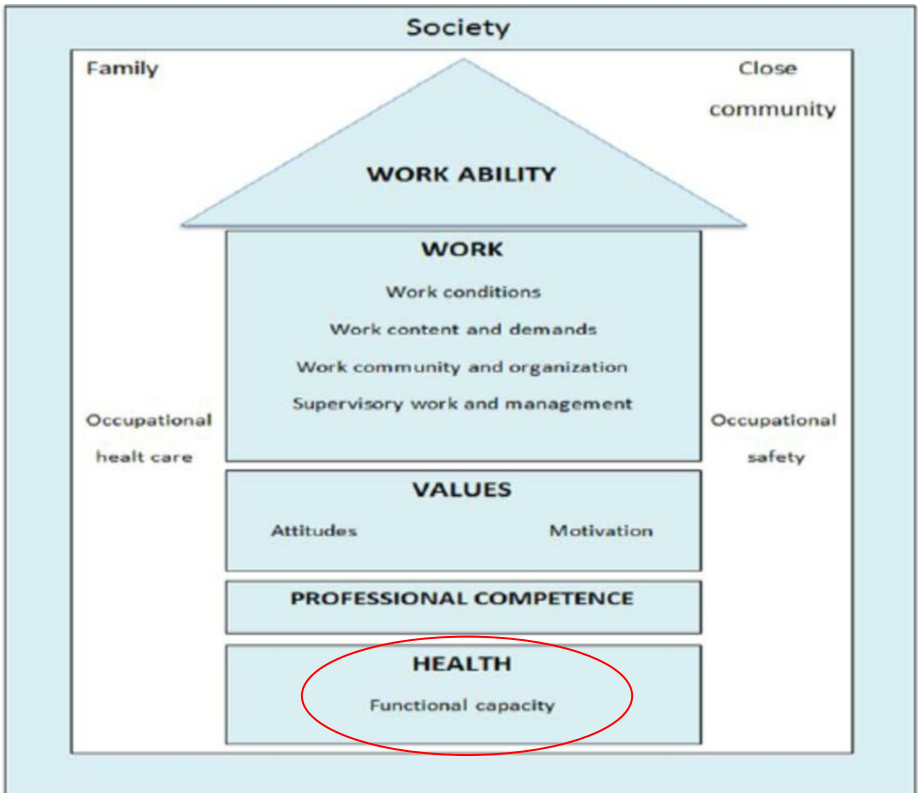

Figure 3. Model of Work Ability House adapted from the Finnish Institute of Occupational Health Work ability house image

On **the first floor**, employees' health and functional capacity is seen as a solid foundation of work ability including; physical, psychological and social dimensions. Entire weight of the building rests on the first floor and it can be seen as a basis on which the other work related abilities and skills can then be built on. (Ilmarinen 2005, 79.) From all of the four dimensions, health and functional capacity has also shown to be best predicator for work ability (Ilmarinen et al. 2005). **The second floor** represents professional competence, knowledge, education, information and variety of skills needed in the working life. Life-long learning and continuous development of these skills are needed to meet the demands of work life and important prerequisite for work ability. (Ilmarinen 2005, 79; Ilmarinen et al. 2008.) **The third floor** includes the personal values, attitudes and motivational factors related to both personal and working life. **The fourth floor** represents work itself. It is the heaviest floor of the building and it is supported by the lower floors. In addition to demands of the work, management and leadership as well as the working environment and working community are included to the 4th floor. Together these four floors, in addition to external societal factors formulate the complex concept of work ability. (Ilmarinen 2005, 80; Ilmarinen et al. 2008.)

The role of different dimensions of work ability is important to recognize when aiming to maintain and enhance work ability. Focusing on just one of the four aspects, will less likely produce sufficient results in terms of work ability. (Ilmarinen et al. 2005; Heikkinen & Ilmarinen 2001.) In today's work, good performance requires lots of knowledge and skills in addition to values and motivation which support these features. However individuals health and functional capacity (physical, mental) and social network have a significant influence on how he or she can utilize these skills. (Otala & Ahonen, 31) A study by Ilmarinen and his colleagues (2005) revealed that the dimension of health and functional capacity indicated the highest explanation rate (39 %) for work ability, followed by the factors of work.

2.4 Evaluating work-ability

Due to complex multidimensional nature of work ability, determining work ability solely according to objective measurements or expert evaluation is challenging. In fact, subjective estimations have shown to be good predictors of future work ability and disability and thus subjective estimation by the individual is necessary in the evaluation process. (Ilmarinen et al. 2008.) Over time, work ability has been evaluated in different ways. Sometimes work ability has been defined as not being on long-term sick leave, or due to the total number of annual sick leave days (Van den Berg et al. 2009). Alternatively, participants can be asked to evaluate their work ability in the three-level assessment; a) completely fit for work, b) partially disabled for work, or c) completely disabled for work (Gould et al. 2008). In work ability score (WAS) respondents are asked to range their current work ability on 10-point scale compared to their lifetime best (Gould et al. 2008). Recent study shows that this single item question is rather good indicator of work ability as strong and statistically significant correlation (r_s=0.63; $p < 0.001$) was found between WAS and Work Ability

Index - questionnaire results (El Fassi et al. 2013). However, the Work Ability Index (WAI) is by far the most used and well-accepted instrument to evaluate work ability (Van den Berg et al. 2009).

2.4.1 Work Ability Index (WAI)

The Work Ability Index is a tool to record the work ability of employees by self evaluation. It aims at identifying at an early stage health risks of the employees and risks of early retirement. (Morschhäuser & Sochert 2006, 34.) The work ability index is based on a series of questions that take into consideration the physical and mental demands of work and the health and resources of the employee (Gould et al. 2008). The questionnaire includes altogether 65 questions divided into seven different categories. Based on the answers, results can be calculated and divided into the four different classes: poor (7–27 points), moderate (28–36 points), good (37–43 points), and excellent (44–49 points) (Gould et al. 2008). Study shows that the WAI has demonstrated a high predictability for general disablement and mortality (Morschhäuser & Sochert 2006, 34). WAI is an easy tool to use and takes about 10- 15 minutes to complete. As the WAI surveys includes sensitive data about illnesses, strict data protection is always needed. (Morschhäuser & Sochert 2006, 34). Hence, new lighter version of WAI, excluding the sensitive data, has been developed by FIOH. The new short version of Work Ability Index (WAP) was piloted in this study (see chapter 5.2).

2.4.2 Factors related to reduced work ability

In 2009, Van den Berg and his colleagues conducted a systematic review on the effects of individual and work-related factors on the Work Ability Index. Altogether 20 studies from 1985 to 2006 were assessed, including 14 cross-sectional studies and six longitudinal studies. Out of those 20 studies, including participants from different segments in the working life, several factors associated with poor work ability, as defined by WAI, were identified. From individual characteristics, lack of leisure-time vigorous physical activity, poor musculoskeletal capacity, older age, obesity were associated with poor work ability, compared to work related factors of high mental work demands, lack of autonomy, poor physical work environment and high physical work load. (Van den Berg et al. 2009.)

As health and functional capacity form the base of work ability and first floor of the work ability house, it is perhaps not surprising that many of the individual characters related to reduced work ability are related to this dimension. Four out of four studies on poor musculoskeletal capacity reported a significant association with a poor WAI. In addition, lack of leisure physical activity was associated with a lower WAI in 4 / 5 studies and overweight was positively associated with a poor WAI in 4 / 7 studies. (Van den Berg et al. 2009.) Interestingly, only one out of three studies found a positive association between better cardiorespiratory fitness which is often seen (Heiskanen 2011, LIKES 2015) to be associated with work ability. According to the authors this may have related to small sample size. In addition, poor functional balance was associated with poor WAI in home care workers but not among fire fighters. (Van den Berg et al. 2009.)

In general, many of the individual characters related to the problems in work ability were associated with health and physical capacity. Sufficient amount of weekly physical activity can be seen one of the key component of improving work ability in terms of these areas. Individuals who are more active exhibit a higher level of cardiorespiratory and muscular fitness, have a healthier body mass and composition and are more likely to achieve weight maintenance (World Health Organization 2010, 25.) In terms of work ability, employees, especially the least active ones, should be encouraged and supported to be more physically active. Screening workers' health and physical fitness may provide valuable information on both individual and organizational levels and provide an opportunity for preventive and maintaining actions from work ability perspective.

3 PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR AMONG WORKING AGED POPULATION

The national recommendations for health-enhancing physical activities for adults include 150 minutes of moderate activity or 75 minutes of vigorous activity in addition to muscle-strengthening and balance training at least twice a week (Liikunta 2016). Both, nationwide surveys and results from objective measurements indicate that vast majority do not fulfill these recommendations (Husu et al. 2014; Mäkinen et al. 2012; Mutikainen et al. 2014). Men and older age groups tend to be less active than women and younger age-groups. Participation on physical activities is also very polarized, especially among young men. (Husu et al. 2014.) In the one end there is big group of adults who have very active lifestyle and fulfill and exceed the PA recommendations regularly. In the other end of the spectrum is a growing group of sedentary people who do none or very little physical activities. In total, 19 % of Finnish men and 13 % of women do not engage on physical activities on a weekly basis. (Husu et al 2011, 36.)

3.1 Meeting the physical activity recommendations. Does the working aged in Finland engage enough in physical activities?

From the public health point of view, insufficient physical condition can be seen as a significant challenge in order to prolong careers (Suni et al. 2012). Keeping that in mind, the current status of physical condition on Finnish employees appears to be somewhat alarming. Results in different studies vary, but it is evident that most of the working-aged Finns do not meet the national physical activity recommendations. In Health-2011 survey roughly ten percent of those over 30 years met PA recommendations and about 24 percent met the recommendations of cardiorespiratory fitness. (Mäkinen et al. 2012.) With a new type of questionnaire of screening the PA habits of 15-64 years old, Husu and her colleagues similarly reported share of roughly ten percent of those meeting the PA recommendations. However, the share of meeting the recommendations of cardiorespiratory fitness was larger, around 50 percent . (Husu et al. 2011, 36.)

In comparison, Mutikainen and her colleagues (2014) measured the overall physical activity of 9554 Finnish employees by using HRV data from workdays and days off. Based on objective measurements, about 54 percent of men and 33 percent of women meet the current aerobic physical activity recommendations. (Mutikainen et al. 2014.) A cross sectional study by Husu and her colleagues (2014) used tri-axial accelerometers to asses physical activity and sedentary behavior of the Finnish adult population (n=1589) aged 18-85 years (average 53 years). Nearly one fourth (24 %) of the participants met the recommendations for health-enhancing aerobic physical activity. Nonetheless on average, participants were most of their awake time sedentary spending 76 percent of their awake time either sitting, lying or standing compared to time sent in light intensity PA (19 %), moderate (4 %) and vigorous (1 %). (Husu et al 2014.)

Physical inactivity, insufficient participation in physical activity during leisure time and an increase in sedentary behaviour during occupational and domestic activities, is a growing problem worldwide. According to World Health Organization (WHO) physical inactivity has been identified as the fourth leading risk factor for global mortality after high blood pressure, high blood glucose and tobacco use. (World Health Organization 2010, 10) Results in different vary but approximately on fifth one fifth of the working aged Finns can be categorized as physically inactive (*sedentary*) (Husu et al 2011, 36; Sjöström et al. 2006).

In general, individuals with lower educational background and socioeconomic position have a tendency to be less physically active. Working conditions are also shown to affect on the level of physical activity. Especially men with long background in physically demanding work and women with physically demanding work tend to be physically inactive. (Husu et al. 2011, 57-58.)

3.2 Sedentarism among Finnish working aged population.

Studies in the recent years have identified a new health risk called sedentarism or sedentary behavior (Fox 2012). Sedentarism and prolonged sitting are now seen independent risk factor for health, regardless of the level and amount of physical activity (Husu et al. 2014). Sedentarism (or sedentary behavior) is defined as any waking activity characterized by an energy expenditure $\leq$ 1.5 metabolic equivalents (MET), including usually sleeping, lying down, sitting such as watching television and other screen-based entertainment (Vasankari 2014).

Concepts of physical inactivity and sedentarism are commonly misused as synonyms. Being sedentary is essentially thought as the lowest end of the spectrum of physical activity classification (Fox 2012). In other words, sedentarism is likely to be wrongly presumed of being opposite of physically active, or engaging in insufficient amounts of physical activity. Therefore, it is important to recognize the difference that *sitting too much* is different from *exercising too little*. (Fox 2012.)

The term sedentarism refers to actions that are often performed in the states of low energy consumption (sitting, lying down, watching TV and computer use) in prolonged periods. A person with high amount of these low-energy activities in everyday life can be characterized as exhibiting sedentary behavior. (Fox 2012.) According to current knowledge, daily total sitting time, exceeding seven hours in total, is associated with a greater risk dying from all causes (Vasankari 2014).

Excessive sitting is a large part of problem of sedentary behavior and approximately one-quarter of Finnish employees reported that their work includes mostly sitting (Pehkonen & Nevala 2013). Questionnaire based results by Sjöström and his colleagues indicated that and about half of the Finnish adult population (46 % of women and 51 % of men) sit more than six hours per day (Sjöström, 2006). FINNRISKI 2007 survey reported that an average working aged spends roughly seven hours per day sitting of which 3,5 hours took place at work (Husu et al. 2011, 36). However, recent accelerometers based objective measurements revealed that Finnish adults spent on average roughly 9 hours per day (Men 9:32 h / W 8:48 h) either sitting or lying (Husu et al. 2014). This can be considered as a severe health risk.

To sum up, majority of Finnish adults have too much sedentary time and do too little physical activities which both are seen as independent health risks in the light of current evidence. When reflecting the current state of working aged into future prospects, predictions of physical fitness on the working aged Finns in the future, are even more alarming. From a sample of 12 000 tested Finnish employees, researchers from LIKES – Research Center for Sport and Health Sciences, calculated the current health status of the employees and generated predictions 25 years ahead. The proportion of young individuals in poor physical condition, especially in men, was now much higher than 20 years ago. Since the cardiorespiratory fitness decreases annually 1 - 1,5 percent due to physiological reasons, the proportion of unfit men, incapable to perform their work tasks is estimated to double or even quadruple by 2035. (Heiskanen et al. 2011, 9, 44).

In the light of these findings, the goals of postponing the retirement age seems hard and unlikely to achieve. As mentioned, the society has changed rapidly which have also affect on participation on physical activities. On a population level, leisure time physical activity has steadily increased for the past decades and Finns actually participate on sport-like physical activities more than ever before (Figure 4). Due to the decrease of physical load at the workplace and reduced physical activity on a way and back to work, the overall physical activity of working-aged Finns has generally dropped (Husu et al. 2011, 30). Therefore, the most effective means to improve public health, fitness and work-ability would be by increasing the level of overall physical activity throughout the day especially on the most sedentary individuals. A modest increase of 10 percent in VO^2max in the lowest physical condition group in men, would halve the number of people in the risk of work disability in the future (Heiskanen et al. 2011, 9, 52).

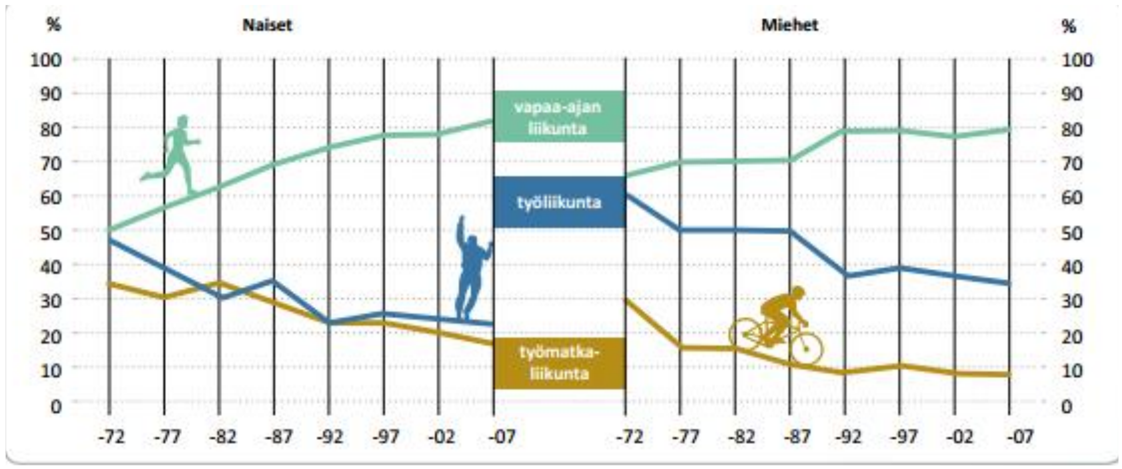

Figure 4. The proportion (%) of different kind of physical activities among Finnish women and men aged 25-64 in 1972-2007. Green: leisure time PA, Blue: work- related PA, Orange: way to work - related PA (Husu et al. 2011, 30).

3.3 Relationship between physical activity and work ability.

Physical activity has significant health benefits and contributes to prevent non-communicable diseases (NCDs) such as cardiovascular diseases, cancer and diabetes (World Health Organization 2010, 10). It has also proven to have favorable impacts on mental health and is one of the key components in prevention and rehabilitation of musculoskeletal disorders - the two most common reasons for both sick-leaves and disability pensions in Finland (Liikunta 2016).

According to Heikkinen and Ilmarinen (2001), physical activity does not affect directly to work ability but indirectly to the foundation and basis of it, highlighting its importance to both work ability and overall health. In general, low level of physical activity seems to be associated with lower work ability among working aged population. In addition, increased physical activity, is associated with increased work ability (Heikkinen & Ilmarinen 2001).
But can physical activity be used as a tool to reduce sick-leaves, disability pensions and improve work ability? Secondly, can physical activity and fitness testing such as Energy Test use as a tool to measure and effect on work ability? Despite the indisputable evidence of the benefits of physical activity on health, the direct relation to improved work ability is

still debatable and results in different research vary. Due to the multidimensional nature of work-ability, it is difficult to assess the direct relation between physical activity and work ability and only rarely an intervention focusing only on one of the dimensions, can produce (statistically) significant improvement on overall work ability (Heikkinen & Ilmarinen 2001).

Results in TYKY (workplace health promotion) -activities, are sometimes seen inefficient and have received critique (Taimela 2005). A study by Sörensen et al. (2008) examined middle-aged construction and industrial workers (n=196) attending on occupationally orientated early medical rehabilitation and found no connection between physical activity or cardiorespiratory fitness and WAI. In randomized controlled trial by Brox & Frøystein (2005) a six month once a week exercise class actually slightly increased the number of sickness absence days of the employees in the community nursing home (n=129). However, there was statistical difference between the exercise group and the control group.

Correspondingly, a 11-year follow-up study by Tuomi, Ilmarinen and their colleagues in 1997 including 818 municipal workers, revealed that out of all the lifestyle factors, physical activity habits was the only one effecting on work ability. Moreover, results in several other studies indicates that there is a positive association between physical activity and work-ability. (Heikkinen & Ilmarinen 2001)

Arvidson et al. (2013) reported that the level of physical activity seems to be associated to work ability. A two-year follow-up study included over 2500 participants, health care workers and employees at the Social Insurance Offices in Sweden. Cross-sectional analysis showed that with an increased level of physical activity, self-reported poor or moderate work ability decreased. In addition, and after two-year follow-up participants reporting higher level of physical activity also reported more likely higher work ability. Authors concluded that assessment of physical activity may also be useful as a predictive tool, potentially making it possible to prevent poor work ability and improve future work ability. (Arvidson et al. 2013.)

A study by LIKES (2015), including over nine thousand (n=9210) Finnish men aged 20-64 years revealed a clear association between physical fitness and work ability. Body Fitness Index indicating physical fitness was calculated from fat percentage, endurances fitness (VO2max), visceral fat, muscle mass and grip strength. Work ability was assessed by using WAP scale (0-10). The higher the Body Fitness Index was the higher the self assessed work ability was. Men in good or athlete level condition assessed their working ability higher than unfit men as 87 % of them rated good (8-9) or excellent (10) working ability. Similar results were found when working ability and exhaustion were compared with the endurance fitness. In comparison, the risk of work disability was three times higher among the unfit men compared to fit men. (LIKES 2015)

A research study by Holopainen and her colleagues (2012) examined the association of leisure time physical activity and long, over three-month sick leaves due to all causes and more in detail within two most common subgroups of work-disability, musculoskeletal and mental health disorders. The research included over 6200 employees of the city of Helsinki between age 40-60 years. Higher level of physical activity was associated with lower incidence of long sick leaves and in general and also within the groups of musculoskeletal and mental health disorders., Odd-ratio for long sick-leaves due to all causes was 2,32 higher for the physically inactive individuals compared to highly active participants. Corresponding results were 2,41 in musculoskeletal disorders and 2,80 in mental health disorders. Interestingly, lower risk of sickness leaves was related to the higher intensity but not the total amount of PA. Adjustmenst of covariants (gender, age, BMI, smoking, working environment, mental and physical pefromance) did not have effect on the results. (Holopainen et al. 2012.) Lahti (2011) utilized the same research population in his academic dissertation and concluded that high physical activity also reduced the risk of all-cause work disability retirement and retirement due to musculoskeletal and mental causes.
A study by Sörensen (2008) focused on the relationship between the perceived work ability and health-related quality of life in middle-aged police officers. Based on the findings, WAI correlated strongly with muscular fitness of upper and lower limbs, sit-ups and cardio-

respiratory fitness assessed by the UKK Walk Test. However, cardio-respiratory fitness assessed with the cycle-ergometer and leisure time physical activity had only weak correlations with the work ability indicating that ability to walk and muscular fitness may be contributing factors for both work ability and quality of life at least in the case of blue collar workers. (Sörensen 2008.)

Kettunen, Vuorimaa and Vasakari (2014) executed a 12-month physical exercise intervention for healthy working adults (n= 371), followed by a 12-month follow-up. The aim was to assess the impact of the physical exercise intervention on work ability and on cardiorespiratory fitness. Group was divided into exercise group (n=338) and control group (n=33). and the exercise group was divided into subgroups according to baseline WAI classifications (poor/moderate, good, excellent). During the 12-month intervention, exercise group improved WAI by three percent ($p < 0.0001$) while WAI decreased in the control group. Improvement in the poor WAI group was 13 percent ($p < 0.0001$) suggesting that a physical exercise intervention seems improve work ability, especially among those with lower work ability.

To sum up, physical activity appears to have numerous of different direct and indirect positive effects on health, quality of life, working capacity and work ability. According to WHO (2010) physical activity has significant health benefits and contributes to prevent non-communicable diseases such as high blood pressure, diabetes, coronary heart disease, stroke, breast and colon cancers. Physical activity is positively associated with work ability (Kettunen et al 2014; Arvidson 2013, LIKES 2015; Heikkinen & Ilmarinen 2001; Van den Berg et al. 2009) and quality of life (Pucci et al. 2012). In addition, physical activity is also associated with lower prevalence of sick absences in general and reduces the risks of long sick leaves and risk of work disability (Amlani & Munir 2014; Holopainen 2012; Lahti 2011). It has also positive effects on both mental- and musculoskeletal disorders (depression, anxiety, low back pain, neck pain), which are the most common reasons for sick absences work disability pensions in Finland (Liikunta 2016; Työterveyslaitos 2015; Eläketurvakeskus 2016). Regular exercise can hinder the age-related decline in cognitive-and cardiorespiratory capacity and musculoskeletal function in older population and thus enable work ability (Ilmarinen 2001b: ODPHP 2016).

Benefits of physical activity on stress management are broadly well known (Liikunta 2016) Higher physical activity is shown to be associated with lower stress levels and higher mental resources in working aged population (Kettunen 2015, 32). Additionally, Föhr (2016) concluded that higher level of PA and better fitness were associated with a lower amount of stress reactions on workdays and better fitness was associated with lower degree of stress reactions and better recovery during sleep after workdays. Physical activity has also shown to have both immediate and long term positive effects on cognitive capacity (Hogan et al. 2013; Zhu et al. 2014).

3.4 Evaluating and measuring physical activity

In order to be able to increase ones physical activity or reduce prolonged sitting and sedentary behavior one should be able to estimate or measure his or her own physical activity or sedentary behavior. Traditionally the information has been collected by using a questionnaire based on individuals subjective estimations. According to Husu and Suni (2011), self-evaluated physical fitness (questionnaire) appears to associate with measured physical fitness (e.g. fitness test) somewhat accurately in a *group level*. However, on an *individual level* it is not a reliable tool to evaluate physical fitness or identify individuals in poor condition. The association between self-evaluated and measured fitness appears to be weaker in the older age groups. Moreover, individuals doing very little physical activities tend to overestimate their level of fitness. These very same groups tend to be the most common target groups in the actions of enhancing and maintaining work ability and work wellbeing. Authors conclude that a subjective evaluation of physical fitness using only single-item question can provide approximate information but is not suitable to replace fitness test measurements. (Husu et al. 2011, 69, 75). As presented, several studies have been conducted in corporate settings and results have promising. However, the scientific evidence on the effectiveness of physical activation programs at worksites is still limited (Reijonsaari et al 2012).

Based on barometer of worksite physical activity in Finland 2015, 87 percent of the employers support their personnel physical activities. Employers spend yearly approximately 400 million euros on activating their staff and increasing their level of physical fitness. Per worker the amount is approximately 233 euros and it has increased continuously over the past decade (Henkilöstöliikuntabarometri 2015). In the current circumstances probably the biggest challenge is that already physically active individuals participate and utilize these services and less active do not take part. When corporations and organizations were asked about what kind of employees are utilizing the provided sport services only 1 percent answered *Mostly the ones doing very little physical activity* and 59 percent answered *mostly the ones who are already active* (Henkilöstöliikuntabarometri 2015). In the terms of maintaining and improving work ability, supporting more the less physically active individuals would be important. It would be beneficial for both management and individuals better understand the contents of the physical fitness and activity and their relation to work and health.

Laturi Energy Test and Energy Index have their core in physical fitness assessments. The scientific evidence of connections between health, fitness and activity is high. Additional to health benefits, physical fitness and physical activity have positive effects on other good life-habits, relaxation, and stress management as well as on cognition and learning. Physical fitness obtained by being physically active is related to work performance and means better capacity for work life. Mental benefits of being more active are emphasized since most works require good mental stamina and health. The positive impact of physical activity to both mental health and psychological well-being is broadly well known. Although the mechanism between physical activity and stress in not fully understood results of cross-sectional and longitudinal studies are more consistent in indicating that aerobic exercise training has antidepressant and anxiolytic effects and protects against harmful consequences of stress (Salmon 2001). Meeting the global recommendations, 150 minutes of vigorous physical activity per week has also proven to better the quality of sleep and lower the tiredness during the day (Loprinzi & Cardinal 2011).

The Energy Test is targeted to corporate and other groups for work-related wellbeing evaluation. Test concept is designed to be efficient especially in mass testing of groups. However, it can be used for individual testing as well. The target is, that based on the Energy Test people understand their capacity for daily work and leisure time activities in terms of daily energy reserve. Hours and minutes are used as a measure of this daily energy (Index). Sleep time of eight hours is taken into account resulting that the maximum result in Energy Index is 16 hours whereas the minimum result is four hours. (Laturi 2013, 2)

4 AIM OF THE STUDY

The Energy Test have base in scientific findings and literature. However, the scientific evidence on the association between Energy Test solution and self-evaluated work ability is limited and needs to be strengthened. Aims of the study was to

1) clarify the connection between Energy Index and short version of Work Ability Index, in a working age population.

2) evaluate these two variables independently and the feasibility in different subgroups based on position at work, age, gender, work type and nature of the work and physical activity habits.

5 DATA & METHODOLGY

This study was a part of a larger “Active Life and work” -study in Kainuu region in the North-East of Finland by the University of Jyväskylä, Department of Biology of Physical Activity Sport technology unit. Ethical approval for the study was received from the North-East ethical committee prior starting the study. All participants were fully informed of the procedures and possible risks of the experiment and they gave their informed consent to participate in this study. They were also told, that they can withdraw from the experiment at any time.

5.1 Participants

Altogether 39 executives and 222 employees from 39 local companies in different sectors were recruited to the program. Basically healthy participants from enterprises with minimum of 5 workers were mapped out by newsletters and by the occupational healthcare doctors and other stakeholders using their personal contacts in the Kainuu North-East Finland area. Five voluntarily participating employees under each executives were selected to the program. Executives were advised to also encourage those employees to participate who may yet be physically active. The test protocol differed between the executives and employees’ former being more extensive. The executives were individually tested during January and February in 2014. Employees were tested in small groups varying from 2-10 individuals in the following six weeks in February and March.

Altogether 205 healthy participants (109 women and 96 men) out of 222 recruited took part to the study. From those 197 (106 females and 91 males) completed all the needed tasks in order to be able to calculate results both form the Energy Test (Energy Index) and short version of Work ability questionnaires (WAP). The main reasons for the absence and cancellations in participation was acute illness or tight timetable at work. Eight participants took part into the Energy test and filled the WAP questionnaire, but didn't complete the online registration information in Laturi website. From those participants Energy Index results were not able to calculate. Total of 106 participants were female compared to proportion of males with 91 participants. Gender distribution in employers group was 91 females representing 55 percent compared to 75 males and 45 percent. In the group of executives distribution was 18 females (46 %) and 21 male participants (54 %). The distribution of genders and position at work is presented in Figure 5, in addition to distribution of educational level (Figure 6) and age (Figure 7).

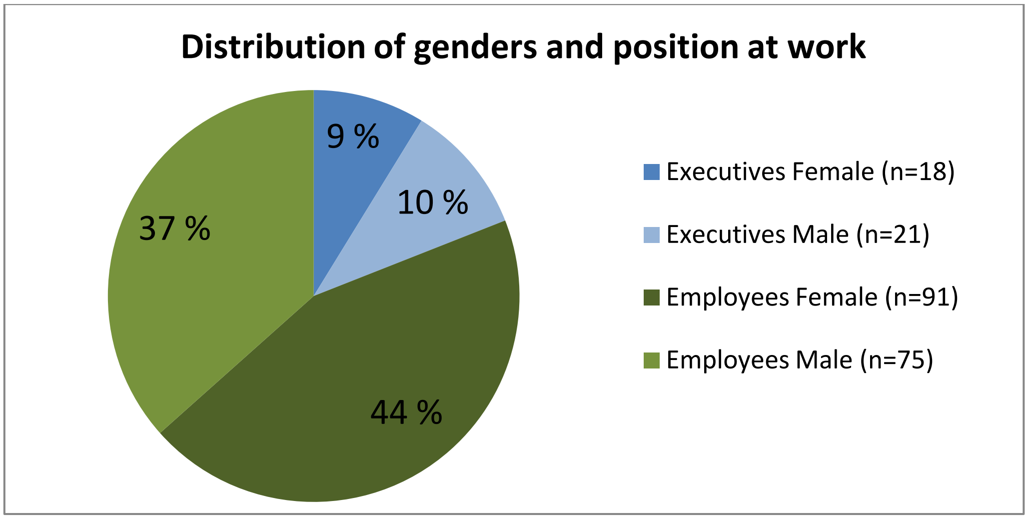

Figure 5. Distribution of genders and position at work

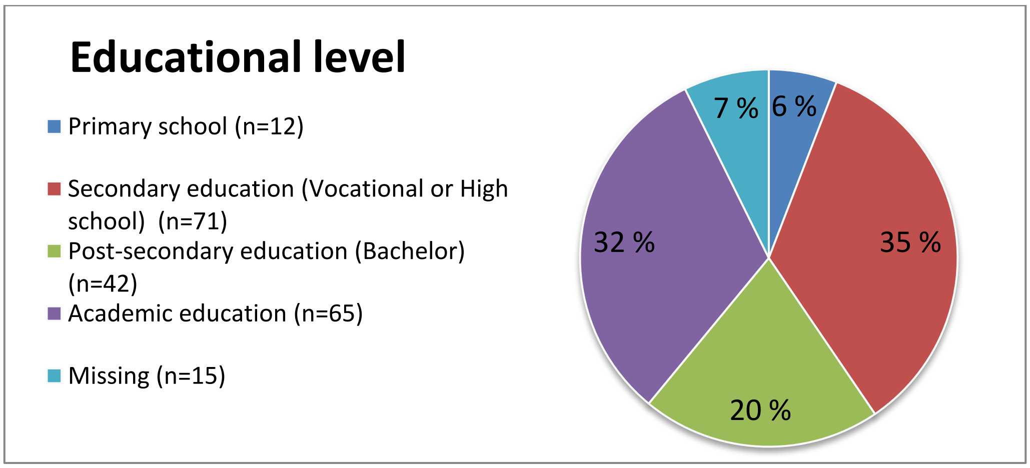

Figure 6. Distribution of educational level

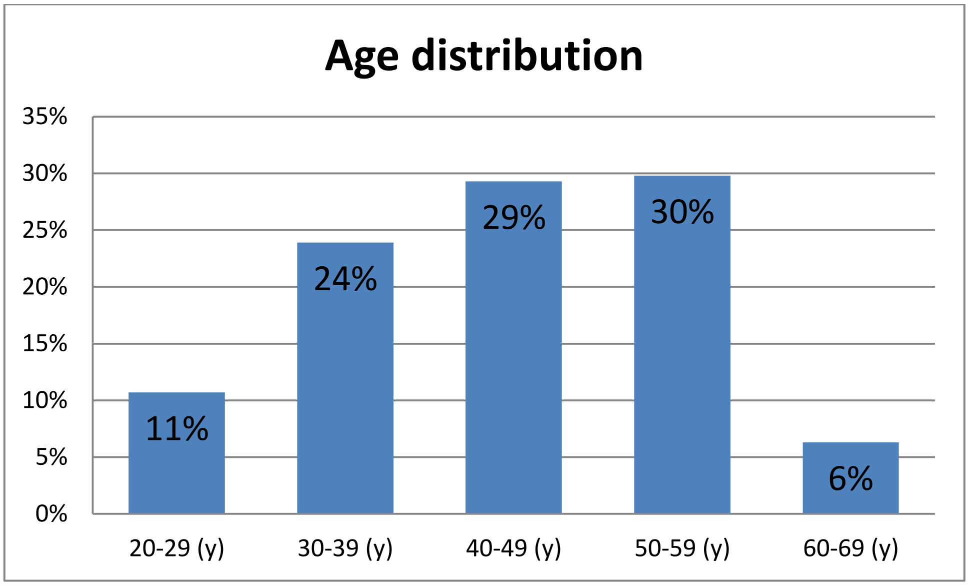

Figure 7. Distribution of participants in different age categories

Based on preliminary information from Energy Test, over the half of the participants described their work type to be sedentary, followed by varied work and physical work. (Figure 8).

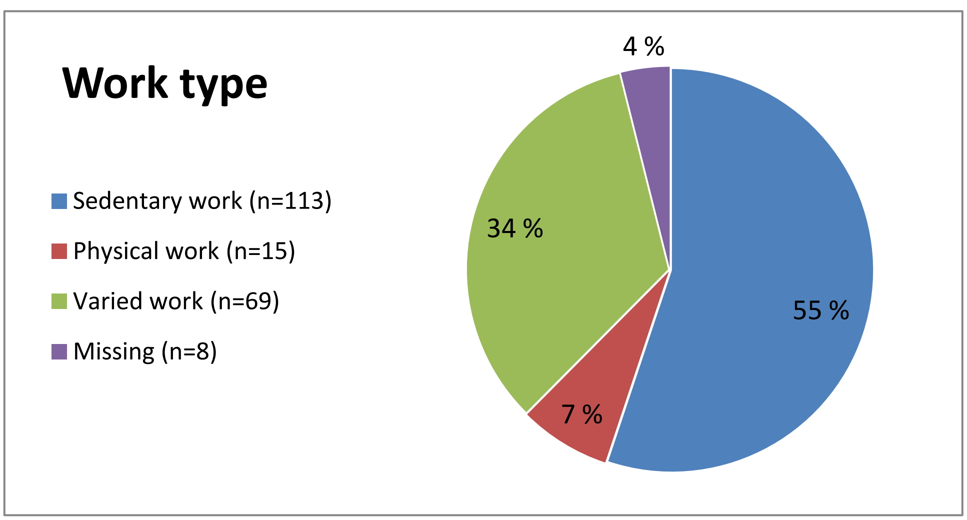

Figure 8. Distribution different work types

Self-reported physical activity (PA) was asked to assess in the preliminary information. Approximately half of the participants (49 %), reported their PA to be in moderate level with 1-3 hours of physical activity during the week. Almost one third (30 %) reported to engage in physical activities three hours or more. On a contrary 21 percent of participants reported none or very little (0-1 h) weekly physical activity (Figure 9).

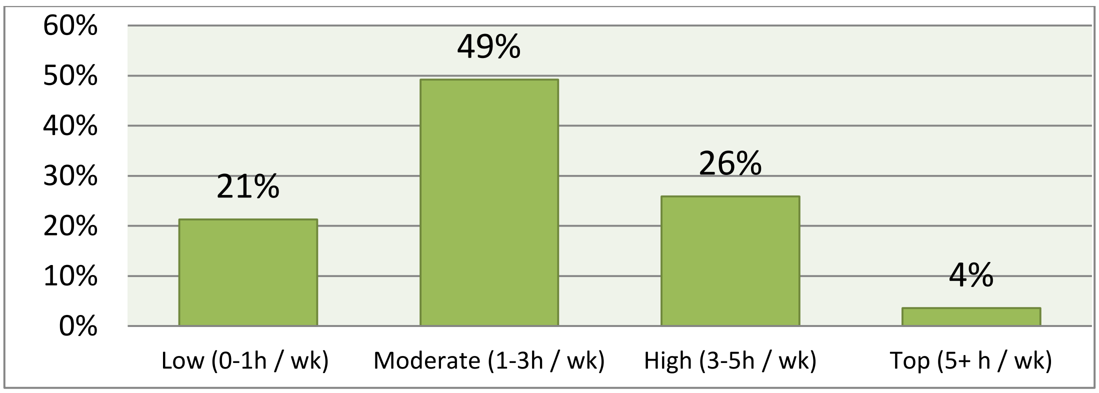

Figure 9. Distribution of self-reported physical activity in different categories

Over half (57 %) of the executives, reported their PA to be moderate, compared to 48 percent in the employees group. Moreover, 16 percent of the executives reported their physical activity level as low compared to 22 percent in the group of employees. However, none of the 39 executives reported to take part in to physical activities more than five hours a week (Figure 10).

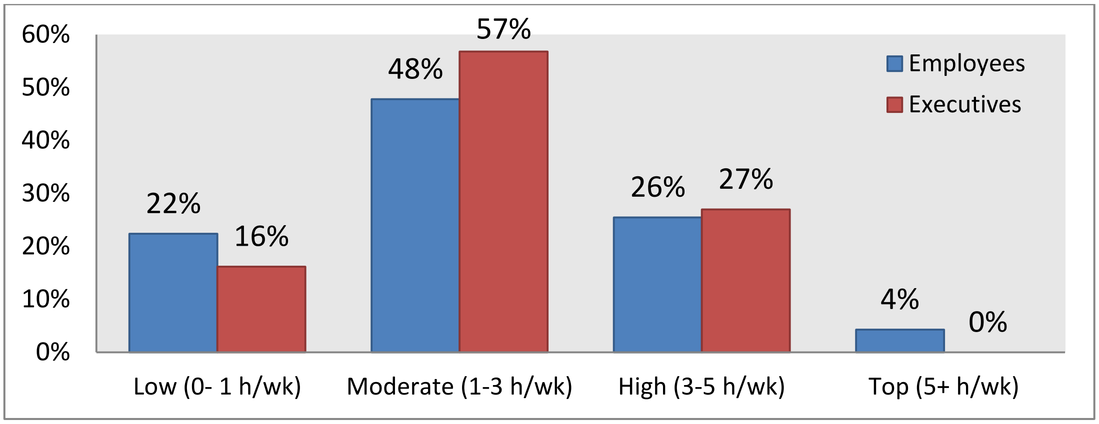

Figure 10. Self-rated PA according to position at work

Distribution of different PA categories based on different work types are presented in Table 1. Despite the large variation, there was no statistically significant changes between the groups.

Table 1 Self-rated PA based on the work type

	Top (+5 h / wk)	High (3-5h / wk)	Moderate (1-3h / wk)	Low (0-1h / wk)
Sedentary work n=113	3 % (3)	29 % (33)	48 % (54)	20 % (23)
Varied work n=69	1 % (1)	22 % (15)	51 % (35)	26 % (18)
Physical work n=15	20 % (3)	20 %(3)	53 % (8)	7 % (1)

5.2 Short version of Work Ability Index

Short version of the Work Ability Index (WAP), a novel questionnaire created by Finnish Institute of Occupational Health (Jorma Seitsamo, personal communication 15.5.2014) was used in this research (see Appendix 1). The questionnaire is based on the international Work Ability Index (Ilmarinen et al. 1998). The index is determined on the basis of the answers to a series of questions, which take into consideration the demands of work, the worker’s health status and resources. As a result, Work Ability Points (WAP), varying from 0-100 points, was calculated.

The short version of Work Ability Index has been developed for research purposes to meet the need for more practical questionnaire which is easy and quick to complete and excludes personal medical history, which make it easier to conduct from privacy and confidentiality point of view. Therefore, it is easier to use within people outside of occupational healthcare and in research projects. The two versions of Work Ability Index are designed to corroborate each other. WAP consists of eight (8) different questions with multiple option items. The score describes worker's own perception of his/her work ability. WAP is calculated by divining the questions into four (4) different subdomains. A score was calculated for each subdomain (see Appendix 2). The mean of subdomains was then multiplied by 100. In this study, the questionnaire was filled before Energy Test, using either a paper version or online version. Filling the questionnaire took approximately five minutes.

5.3 Energy Test- Energy Index

Energy Test provides information about health and body’s potential performance. The test uses fitness level indicators and the Energy Index calculations, which are based on extensive international scientific data where age and gender are also taken into account. The test pattern includes eight different subtests including fitness assessment, wellness questionnaire and biometric data, wherefrom the result – a personal Energy Index is calculated. The Energy Index has maximum of 16 hours, which corresponds to the average waking hours in a day. The Energy Index sums up person’s overall energy level in hours and minutes during which an individual can experience to be energetic whether at work, routines or in recreational activities. The minimum result in the Energy Index is four hours.
The Energy Test consist of e-mail invitation including preliminary registration request and eight different subtests. The Energy Index result is calculated based on preliminary information and the subtest results. These calculations emphasize important factors such as

age, gender, blood pressure and aerobic and musculoskeletal fitness. Differences in the level of physical demands in different work types are taking into consideration as and they are weighed differently depending on occupational status of a person (sedentary work, varied work, physically active work). In a result calculation for the Energy Index and each of the subtests are classified according gender and age.

In general, in the Energy Index calculation aerobic fitness is weighted the most since it is the most important element in human performance. Other two sub tests which are weighted the most are blood pressure and waist circumference since they affect strongly to physical health and life expectancy. Other measurements such as muscle endurance, balance and flexibility are weighed less in results and relatedness varies depending on work type.

5.3.1 Test Protocol

Energy test was performed by the qualified and trained personnel. All of the executives were individually tested at the Snowpolis, University of Jyväskylä Vuokatti campus premises during January and February in 2014. Employees were tested in small groups during February and March either at their own work site or at the Snowpolis depending on their own desire. Depending on the group size, completing the both Work Ability Index questionnaire and the Energy Test took usually a bit over one hour. The participants were informed in full detail about the study background and test procedures when signing the contracts. They were free to withdraw from the research at any point.

Due to the fact that some of the tests were completed in the work sites, the conditions varied slightly. At first the participants filled paper or online version of WAP-questionnaire in a sitting position. After completing the questionnaire blood pressure and waist circumference were individually measured by the researcher. In employees group, aerobic fitness was then measured with Polar Fitness Test. The executives completed sub-maximal bicycle test after last subtest (balance) in the Energy Test.

Table 2. Energy Test protocol

Subtests	Tools
1. Registration and preliminary information	Laturi Web-service
1.1 Work type, questionnaire	(3 categories)
1.2 Stress, questionnaire	(9- point Likert-scale)
1.3 Vitality, questionnaire	(5- point Likert-scale)
2. Blood pressure	Omron M5-1 (mmHg)
3. Waist circumference	Measure tape (cm)
4. Aerobic fitness	Employees: Polar Fitness Test Executives: Sub-maximal bicycle test ** (VO_2max ml/kg/min)
5. Muscle strength core)	Sit-ups (repeats in 30 s)
6. Muscle strength lower body	Squats (repeats in 30 s)
7. Muscle strength upper body,	Push-ups (max repeats)
8. Flexibility	Sit and reach (cm)
9. Balance	One leg stand (s)

** Sub-maximal bicycle test was completed after balance test.

5.3.2 Registration and preliminary information

All of the participants received an e-mail invitation to the Energy Test and preliminary registration request to the Laturi web-service approximately one week before the test date. The invitation contains accurate information about the test location and time as well as preparatory information. Drinking alcohol and heavy physical exercise was instructed to avoid one day before the test. Heavy meals, smoking, coffee, and energy drinks were advised to avoid three hours before the test. Contraindications for participation were suffering from a cold, fever, stomach aches, headaches, or other ailments that affect performance. In the registration the participants were asked to fill the preliminary demographic information; gender, height, weight, age, and level of physical activity during the past 3 months using a four-item scale:

1. Low (0-1 hours per week),
2. Moderate (1-3 hours),
3. High (3-5 hours)
4. Top (over 5 hours)

Among the employees, the Energy test was always carried out using the same protocol which was instructed in Energy Test guide (see Table 2). However, in the group of executives, height and weight were based on measurements conducted by the research staff, compared to subjective estimations in the employees group. In addition, the executives' aerobic capacity (V02max) was evaluated using sub maximal bicycle test whereas employees V02max were estimated by non-exercise Polar Fitness test. Work type was reported by choosing one of the three different options: *sedentary work, varied work, physically active work.* Stress level was self-evaluated by nine-point Likert-scale (see Table 3) choosing the option describing best their perceived stress level and their performance during the past two weeks. The optimal situation lies in the middle of the scale. Each of the 9 options were explicated with a short description or examples. Vitality was assessed by using a 5 -point Likert-scale and choosing the option which best describes their perceived vitality level and their performance during the past two weeks. Each of the five options were also explicated with a short description or examples.

Table 3. Stress level and Vitality in Likert scale

Stress level
Very low - Low - A bit low - Almost Optimal – Optimal - Almost Optimal - A bit high – High - Very High
Vitality level
Very low – Low - Slightly low –Good – Optimal

5.3.3 Blood pressure

Blood pressure was measured separately from all the participants of the group after fulfilling the WAP questionnaires and before the exercise tests. All the participants were measured using the same Omron M5-1 blood pressure meter. Before the measurement the participant was asked to sit still for a minimum of two minutes. Each participant was measured three times, always from the right arm. Measurements were conducted in a peaceful and silent environment in a seated position. Best result in millimeters of mercury (mm Hg) was documented.

5.3.4 Waist circumference

Waist circumference was measured using a 150 cm long measuring tape. The measurement was performed immediately above the iliac crest or at the narrowest point of the waist. The measuring tape was wrapped horizontally around the participant making sure it's level. Tape needed to go snugly around the waist without pressing in the subcutaneous fat. Result was recorded in full centimeters.

5.3.5 Aerobic fitness

Due to more extensive test procedure, aerobic capacity (VO_2max) of the executives, was evaluated in sub-maximal bicycle test in Vuokatti Sport Testiasema Oy by qualified personnel. Fitware® has been shown to be a valid (r=0.92) method in predicting VO2max (Takalo, T. 2001). Generally, the start of the test involved cycling for 2-min at 40 W for women and 50 W for men as a warm-up. Thereafter, exercise intensity was increased every 2-min by increasing the workload by 20 W for women and 25W for men up to the point of when at least 85% of the predicted maximal heart rate was achieved. VO2max was calculated by the equation: VO2max (ml/kg/min) = 12.35 x P/kg + 3.5, where P/kg is the highest workload (W) divided by body mass, 12.35 is constant and 3.5 resting metabolic rate. (Takalo 2001.**)**

Employee's aerobic capacity were evaluated using Polar Fitness Test with Polar FT40 heart rate monitors. VO2max (ml/kg/min) is estimated by a combination of preliminary information (age, gender, height, weight, level of physical activity) and the measurements from Polar Fitness Test (Laturi 2013, 4-5). The test was conducted in supine position on top of the exercise mat. Before the test participants were asked to lay still two minutes in order to obtain their resting heart rate. Duration of the test is approximately 3-5 minutes meanwhile the monitor measures resting heart rate and heart rate variability. With a combination of preliminary information (age, gender, height, weight, level of physical activity) and the measurements from Polar Fitness Test the monitor reflects the person's

VO_2 max result (maximal oxygen uptake as milliliters per kilogram per minute, ml/kg/min). Results were then marked to the score card.

5.3.6 Warm-up

A light 5-minute warm-up was done before the muscle strength, flexibility and balance tests in order to prevent any injuries and prepare the body for the upcoming tests. Warm-up included moderate tempo stepping, lifting of legs, light lunges, arm and shoulder rotations, and short dynamic stretches.

5.3.7 Muscle strength

Muscle strength tests were done in the following order – 1) core (sit-ups), 2) lower body (squats), and 3) upper body (push-ups). Before each of the test, oral instructions were given, right techniques demonstrated and common mistakes were pointed out. Also the requirements for acceptable perform were informed as the acting pairs were responsible for counting the score. Each participant was asked to perform one test try in order to check that the instructions were understood correctly. Participants were advised to skip or pause the test in case of pain while doing the test or an injury. Participants were advised to mark their score into the score card after every subtest.

***Sit-ups*.** The movement started from lying down on the back on top of an exercise mat. The knees were up, and were kept at a 90 degree angle, heels on the floor about eight in / 20 cm apart. Hands were kept behind the neck, fingers crossed, and elbows face the front. The pair took a firm grip to support the ankles of the one performing the movement. At the upright position elbows touched the knees. Otherwise, the up position was the same as the starting position. At the downward position shoulder blades needed to touch the ground. The result was the number of fully completed repetitions done within 30 seconds counted by the pair.

Squats. Lower body muscle performance was measured with a 30-second squat test. In a starting position participant stand hip wide and well balanced stance legs and feet 20-35 cm apart, arms touching the sides of the body. In a down position fingertips touched the floor while heels remained against the ground and back remained straight. The movement was considered done when back in the up position. Result was the number of fully completed repetitions done within 30 seconds counted by the pair.

Push-ups. Upper body muscle performance was measured with maximal repetition push-up test without time limit. Push-ups were performed with narrow stance, elbows next to the sides and palms under the shoulders, fingers forward. Men did their pushups with a straight body toes supporting the feet in a hip-width stand. Women did their knees and shins on the floor, ankles flexed, legs together. In a starting position (both female and men) participant lied down on the stomach, palms under the shoulders. In a up position elbows were extended and middle-body remains straight. In a down position elbows are flexed until the chin, nose or chest touches the ground. The back needed to remain straight throughout the movement and movement needed to be continuous. The result was the number of fully completed repetitions, performed in continual movement, counted by their pair.

5.3.8 Flexibility

Flexibility was measured with sit and reach test. Each participant had two attempts, without time limit. In a starting position the participant was sitting on the exercise mat with legs straight, heels and ankles hip-width apart. The end of the exercise mat was in the same line with heels. A measuring stick was placed between the legs and the 38 cm point of the measuring stick is set flush with the heels. Reading of the stick goes down toward the body. The participant then starts bending over their legs as far as they can reach without flexing their knees. When achieved the maximal reach, the position was kept for two seconds. Better of the two attempts was documented in full centimeters.

5.3.9 Balance

Balance was measured with one leg stand test. Each participant had two attempts. The test ends when the participant has remained in balance for 60 seconds, or has tried the position twice. In a starting position the participant was standing on both legs on the ground. Time counting with a stopwatch started when performing pair lifted the sole of the free foot against the knee of the supporting leg, knee of the free leg pointing out. Hands were allowed to move below the shoulder height and eyes were kept open. If the sole of the foot dethatched the knee or the supporting leg moved from its place, the timing stopped. Better result of two attempts (max 60s) was documented.

6 STASTISTICAL ANALYSIS

Data were analysed using SPSS Statistics 20– software and the results are expressed as mean ± standard deviation (SD). Participants were divided into subgroups based on their position at work and gender. Comparison based on work types, age groups, academic background, physical activity and nature of the work was also included. One-Way ANOVA and independent samples T-Test with Turkey's post hoc testused to identify significant differences between the groups. In addition, crosstabs and Pearson's correlation coefficients were evaluated. Statistical significance was set at $p \leq 0.05$.

Table 4. Different subgroups in the study population

Subgroups	**Options**
Position at work	Executives / Employees
Gender	Female / Male
Age	Age 20-29 (y) / Age 30-39 (y) / Age 40-49 (y) / Age 50-59 (y) /Age 60-69 (y)
Work Type	Sedentary work / Varied work / Physical Work
Nature of the work	Mentally demanding, Physically demanding, Equally demanding
Physical activity	Low (0-1h/wk), Moderate (1-3h/wk), High (3-5h/wk), Top (5+h/wk)
Education	Primary school, secondary school, post-secondory, academic

7 RESULTS

Demographic information of the participants from the Energy Test are presented in the Table 5 & Table 6.

Table 5. Demographic information according to position at work

		N	Mean	SD	Range
Age (years)		205	44	±11	21 -66
Executives		39	50	±8	34-66
Employees		166	43	±11	21-66
VO_2 max (ml/kg/min)		197	38	±8	20-62
Executives*		37	37	±7	20-53
Employees**		160	38	±8	21-62
Weight (kg)		197	77.8	±16.6	45-149
Executives		37	84.7	±15.3	57-115
Employees		160	76.2	±16.5	45-149
Height (cm)		197	171.3	±9.4	153-198
Executives		37	174.3	±9.2	158-197
Employees		160	170.6	±9.3	153-198
Waist circumference (cm)		197	90	±15	64-138
Executives		37	96	±14	67-126
Employees		160	89	±14	64-138
Flexibility (cm)		197	50	±9	10–73
Executives		37	44	±12	10-61
Employees		160	51	±8	13-73
Blood pressure	**Systolic (mmHg)**	197	133	±18	97-188
Blood pressure	**Diastolic (mmHg)**	197	84	±11	58-117
Executives	Systolic	37	131	±17	98-169
	Diastolic		81	±10	58–97
Employees	Systolic	160	133	±18	97-188
	Diastolic		85	±12	58–117
Balance (s)		197	56	±11	5-60
Executives		37	53	±16	7-60
Employees		160	57	±10	5-60

* VO_2max was estimated by submaximal bicycle test, ** was estimated by Polar Fitness Test with Polar FT40

Table 6. Demographic information according to gender

		N	Mean	SD	Range
Age (years)		205	44	±11	21 -66
Female		109	44	±11	21-66
Male		96	45	±11	23-64
VO_2 max (ml/kg/min)		197	38	±8	20-62
Female		106	35	±8	21-62
Male		91	40	±9	20-62
Weight (kg)		197	77.8	±16.6	45-149
Female		106	68.3	±11.2	45-99
Male		91	88.8	±15.0	50-149
Height (cm)		197	171.3	±9.4	153-198
Female		106	164.8	±5.2	153-179
Male		91	178.9	±7.1	160-198
Waist circumference (cm)		197	90	±15	64-138
Female		106	83	±11	64-121
Male		91	100	±11	79-138
Flexibility (cm)		197	50	±9	10–73
Female		106	52	±8	17-73
Male		91	47	±10	10-66
Blood pressure	**Systolic (mmHg)**	197	133	±18	97-188
	Diastolic (mmHg)	197	84	±11	58-117
Female	Systolic	106	127	±17	97–188
	Diastolic		83	±11	58–116
Male	Systolic	91	140	±16	109–181
	Diastolic		85	±12	58–117
Balance (s)		197	56	±11	5-60
Female		106	56	±11	5-60
Male		91	56	±11	7-60

7.1 Energy Index

The average Energy Index among all participants was 10:39 ± 2:14 h:min, varying from 4:43 h:min to 15:21 h:min.There was a main effect of gender ($p = 0.001$), while the main effect of position ($p = 0.593$) and the gender-position interaction ($p = 0.293$) were non-significant. Energy index did not differ between executives and employees ($p=0.83$). However, female had higher Energy Index than male ($p=0.001$). (Table 7).

Table 7. Energy Index results among main groups

Group	N	Mean (h:min)	SD (h:min)	Range (h:min)	p-value.
Energy Index Total	197	10:39	±2:14	4:43 – 15:21	-
Executives	37	10:43	±2:13	5:42 – 14:34	-
Employees	160	10:38	±2:14	4:43 – 15:21	-
Female	106	11:08	±2:13	5:36 – 15:21	***
Male	91	10:04	±2:07	4:43 - 14:54	

*compared to Male P < 0.001 ****

As the Energy Index varied from 4:43 hours to 15:21 hours the results were also divided into six different time categories. Participants with Energy Index of 10 - 12 hours formed the biggest group with 32 percent and participants scoring eight hours or less represented 13 percent of the participants. The distributions are presented in Figure 11.

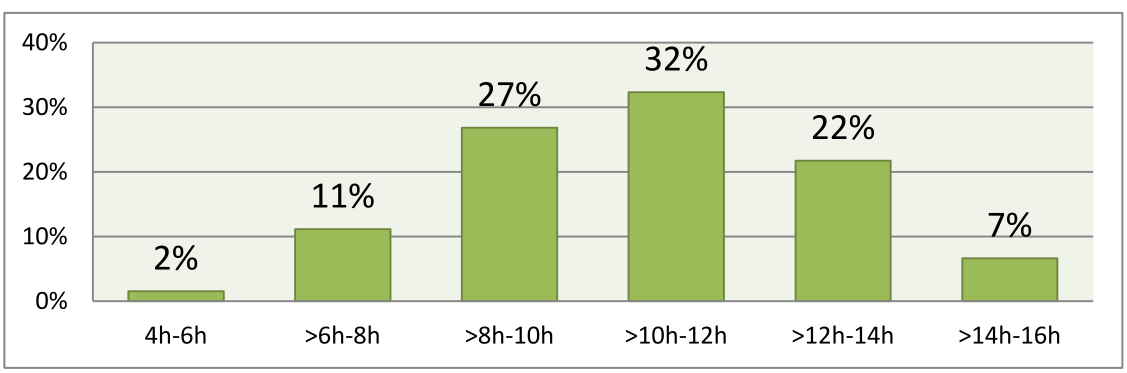

Figure 11. Distribution of Energy Index results

Energy Index were the highest in Top physical activity group, 13:22h ± 1:20 hours and second highest in High physical activity group 12:03h ± 2h. Energy Index in these groups were significantly higher compared to two lower PA groups (Table 8.). The results were parallel when the same comparison was made between subgroups of executives and employees.

Table 8 . Energy index among different PA categories

Group	N	Mean (h:min	SD (h:min)	Range (h:min)	P –value
Low	42	9:19	±2:03	4:43 - 13:27	^^^ ***
Moderate	98	10:14	±1:55	5:42 - 14:07	^^^ ***
High	51	12:03	±2:00	6:28 - 15:21	
Top	7	13:22	±1:20	11:33 -15:17	

*compared to High ^^^P < 0.001, compared to Top *** P<0.001*

Energy Index results were higher among participants with academic education compared to primary school education (p=0.047) and secondary education (p=0.035) (Table 9).

Table 9. Energy Index results based on Education

Group	N	Mean (h:min)	SD (h:min)	Range (h:min)	P-value
Primary school	12	9:23	±1:32	6:28 - 11:26	^*
Secondary education (Vocational or High-school)	67	10:09	±2:16	4:43 -15:21	
Post-secondary education (Bachelor)	40	10:49	±2:15	6:37- 14:48	
Academic education	64	11:12	±2:15	6:5- 15:17	

*Compared to post-secondary ^ P < 0.05, compared to Academic * P<0.05*

Sedentary workers had highest Energy Index when comparison was made between different work types. However, differences between the groups were statistically non-significant. (Table 10). The lowest Energy Index results according to the nature of the work was among participants doing physically demanding work, compared to mentally demanding work (p=0.01). Otherwise there were no differences between the groups (Table 11).

Table 10. Energy Index based on Work type (Energy Test)

Group	N	Mean (h:min)	SD (h:min)	Range (h:min)	P-value
Sedentary work	113	10:45	±2:16	5:42- 15:21	-
Physical work	69	10:29	±2:08	5:36 - 14:39	-
Varied work	15	10:32	±2:24	4:43 - 14:54	-

Table 11. Energy Index results based on nature of work (WAP -questionnaire)

Group	N	Mean (h:min)	SD (h:min)	Range (h:min)	P-value
Mentally demanding	129	10:53	±2:16	5:42 - 15:21	**
Physically demanding	30	9:39	±2:19	4:43–14:54	-
Equally demanding	38	10:32	±1:53	6:37–13:49	-

*Compared to Physically demanding **P < 0.01*

Energy Index did not differ between the age groups. Notably the oldest age group, 60-69 years received the highest results of 11:21 h:min ±1:53 h: (Table 15).

Table 12. Energy Index results based on age categories.

Group	N	Mean (h:min)	SD (h:min)	Range (h:min)	P-value
Age 20-29 (y)	22	9:44	±2:11	4:43– 13:33	-
Age 30-39 (y)	49	10:53	±1:57	6:37–15:17	-
Age 40-49 (y)	59	10:52	±2:15	5:36–15:21	-
Age 50-59 (y)	56	10:20	±2:28	6:11–14:54	-
Age 60-69 (y)	12	11:21	±1:53	8:49–14:33	-

Most of the participants reported their stress level to be optimal or almost optimal. These three categories represented 67 percent of total share. Almost half of the participants (49 %) reported their vitality level to be good. The distributions are presented in Figures 12 and 13.

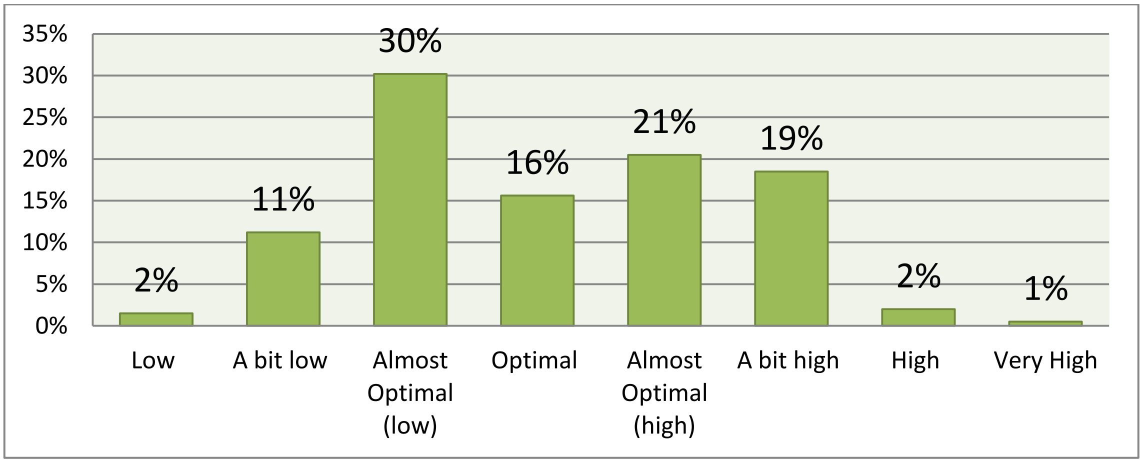

Figure 12. Distribution of stress level in different categories

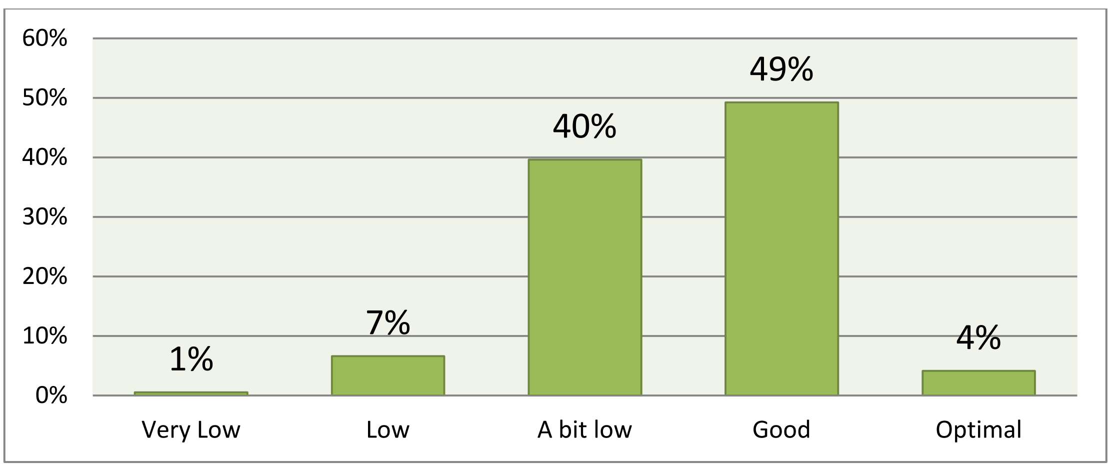

Figure 13. Distribution of vitality level in different categories

7.2 Short version of Work Ability Index (WAP)

The mean results of all the participants in WAP was 83.86 ±10.19 points. Results did not differ between executives and employees or between genders. The differences between different age-categories were neither statistically significant (Table 13).

Table 13. WAP points among different subgroups

Group	N	Mean	±SD	Range	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
WAP Total	203	83.86	±10.19	39 – 100	82.45	85.27
Executives	39	83.56	±9.72	57 – 100	80.41	86.71
Employees	164	83.93	±10.32	39 – 100	82.34	85.52
Female	107	83.82	±9.57	48 – 100	81.98	85.65
Male	96	83.90	±10.89	39 – 100	81.70	86.11
Age 20-29 (y)	22	83.42	±7.56	66 – 96	80.07	86.77
Age 30-39 (y)	49	83.24	±9.59	51 – 98	80.49	86.00
Age 40-49 (y)	58	85.50	±9.44	57 – 100	83.02	87.99
Age 50-59 (y)	61	82.44	±11.60	39 – 100	79.46	85.41
Age 60-69 (y)	13	86.23	±12.35	58 – 100	78.77	93.70

The distribution of WAP in seven score categories is presented in Figure 14. In total, 70 percent of the participants scored between 81-100 points.

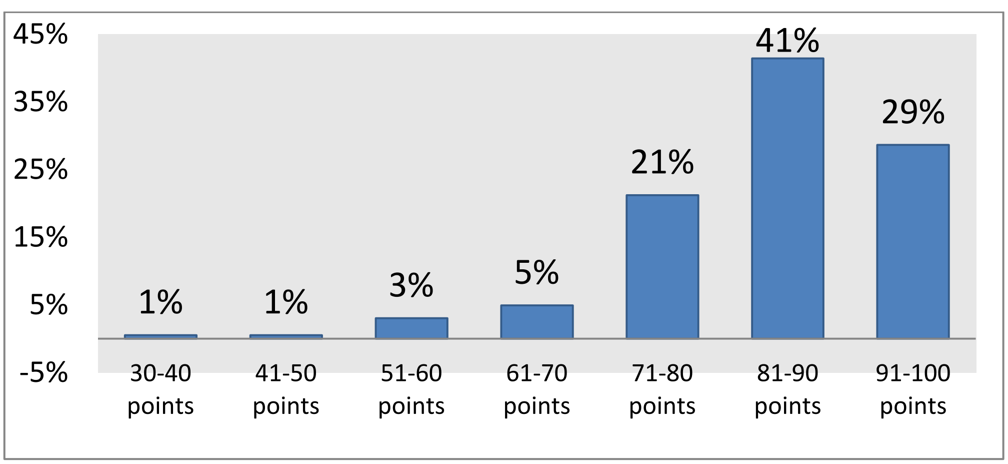

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Figure 14. Distribution of WAP points

The group with *mentally demanding* work scored the highest WAP but there were no statistically significant differences between the three groups according to nature of the work. Based on the work type, participants doing physical work achieved the best results but there were no statistically significant differences between groups either. (Table 14).

Table 14. WAP according to nature of work and work type

Group	N	Mean	±SD	Range	p-value
Nature of work					
Mentally demanding	132	84.70	±10.57	39- 100	-
Physically demanding	31	81.92	±11.65	48- 100	-
Equally demanding	40	82.57	±7.15	66 -94	-
Work type					
Sedentary work	113	83.96	±10.77	39-100	-
Physical work	68	84.75	±8.00	58-100	-
Varied work	84	79.33	±13.23	48-100	-

Participants in *High* physical activity group had better WAP compared to moderate PA group (p=0.007). There was no statistical difference between other groups. (Table 15).

Table 15. WAP among different PA categories

Group	N	Mean	± SD	Range	P –value
Low	42	82,73	11,39	39- 100	
Moderate	97	82,17	9,83	48- 100	
High	51	87,67	8,06	61 -100	**
Top	7	86,67	14,38	58 -100	

*Compared to moderate ** p<0.007*

7.3 Comparison of Work type and Nature of work

The relationship between of work type in Energy Index and nature of work in WAP was statistically significant ($p<0.001$). Crosstabs analysis (Table 16) revealed that from those participants who categorised their work type as sedentary, 96 percent described their work mentally demanding. Participant who categorised their work type as varied work, 28 percent classified their work mentally demanding, 24 percent physically demanding and 49 percent equally demanding. Almost all, 93 percent of the participants who categorised their work type as physical work also described their work physically demanding.

Table 16. Distribution of nature of work in different work types.

	Mentally demanding	Physically demanding	Equally demanding	Total
Sedentary Work	96 %	0 %	4%	100 %
Varied work	28%	24%	49%	100 %
Physical work	0 %	93%	7%	100 %

Pearson chi-squre p<0.001

The distribution of genders based on work type and nature of work is presented in Table 17. In the groups of *Varied work* and *Equally demanding*, females represent approximately 2/3 of the sample. In other groups, genders are rather evenly distributed

Table 17. Distribution of male and female based on work type and nature of work.

	Mentally demanding	Physically demanding	Equally demanding	Sedentary work	Physical work	Varied work
Female	51 %	42%	65%	47 %	53%	65%
Male	49 %	58 %	35%	53%	47 %	37%
Total	100%	100%	100 %	100 %	100 %	100 %

Distribution of *nature of work* and *work type* based on genders are presented in table 18. Approximately 2/3 in both genders defined their nature of work to be mentally demanding and over half of the participants categorized themselves as sedentary workers.

Table 18. Distribution of nature of work and work type by genders

Nature of Work	**Mentally demanding**	**Physically demanding**	**Equally demanding**	**Total**
Female	64%	12%	24%	100%
Male	67%	19%	14 %	100%
Both Genders	65%	15%	20%	100%
Work Type	**Sedentary work**	**Physical work**	**Varied work**	**Total**
Female	51%	8%	41%	100%
Male	65%	8%	27%	100%
Both Genders	57%	8%	35%	100%

7.4 Correlation between Energy Index and WAP

In total there was a light positive correlation between Energy Index and WAP (r=0.27, p<0.001) . From the main sub-groups, correlation was found also among executives' (r=0.34, p=0.038) and among employees (r=0.25, p=0.001). The positive correlation was significant also among male (r=0.30, p=0.004) and female (r=0.25, p=0.01) participants (Figures 15, Figures 16a and 16b).

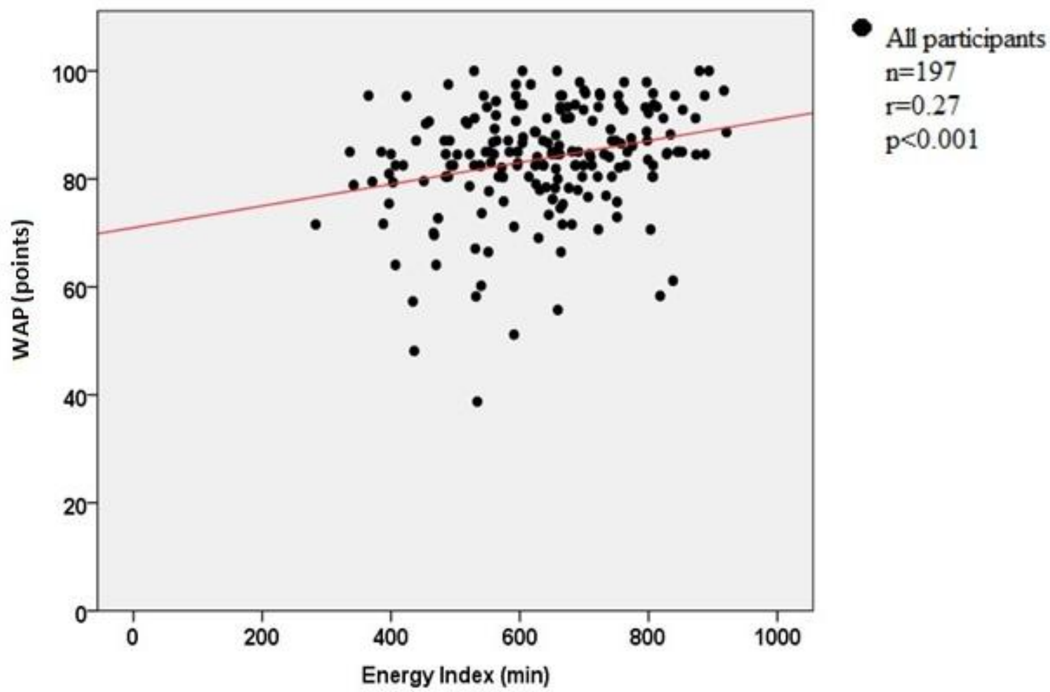

Figure 15. Correlation between Energy Index and WAP (r=0.27, p<0.001).

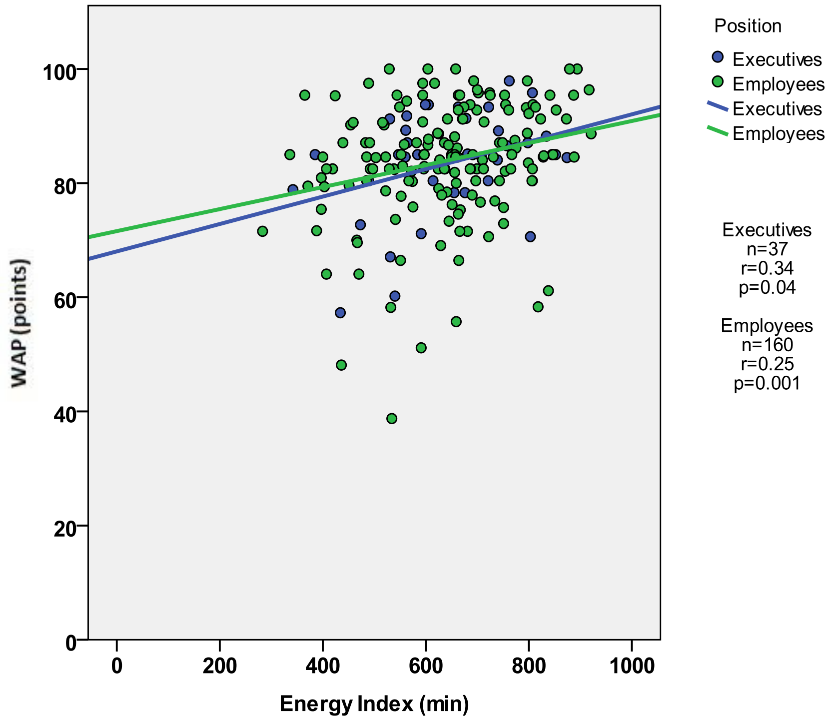

Figure 16a. Correlation between Energy Index and WAP according to position at work

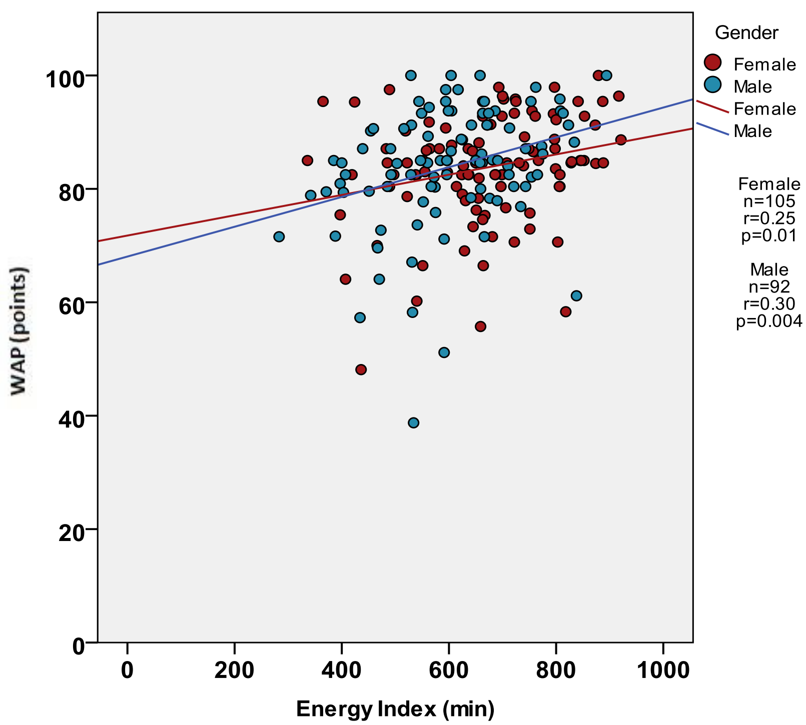

Figure 16b. between Energy Index and WAP according to gender

In other sub-groups, participants whose nature of work was mentally demanding Energy Index and WAP (n=128) correlated positively (r=0.29, p=0.001). For physically demanding (n=30) and equally demanding (n=38) – workers the correlations were statistically non-significant. (Figure 17a).

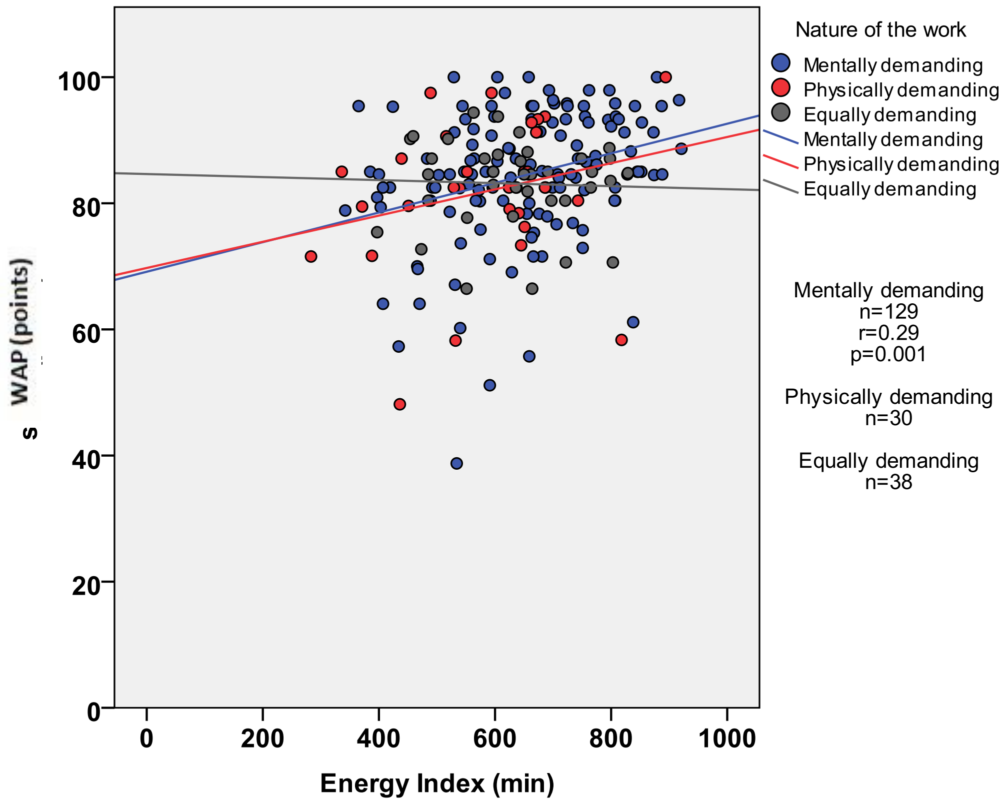

Figure 17a. Correlation between Energy Index and WAP according to nature of work

A similar trend was seen when compared Energy Index and WAP depending on work type. Statistically significant correlation (r=0.27, p=0.004) was found among sedentary workers (n=113). The correlation among physical workers (n=15) and among varied work (n=69) was statistically non-significant (Figure 17b).

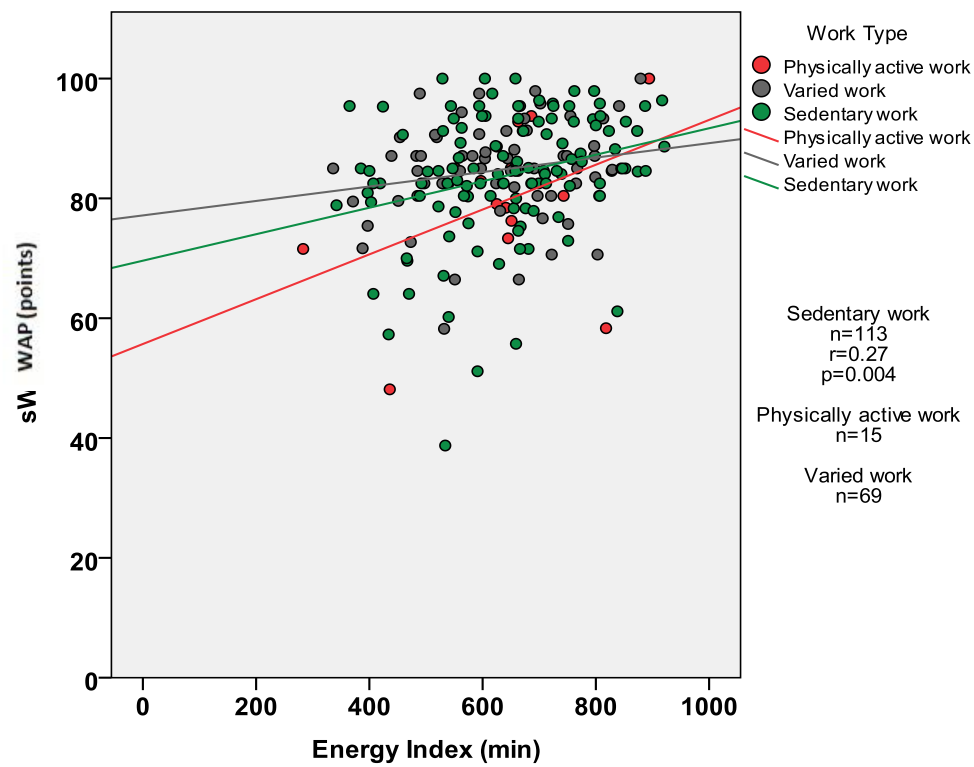

Figure 17b. Correlation between Energy Index and WAP according to work type

As shown in figure 18, WAP scores can vary a lot among individuals in the same Energy Index category. No correlation was found between WAP and Energy Index results in different time categories.

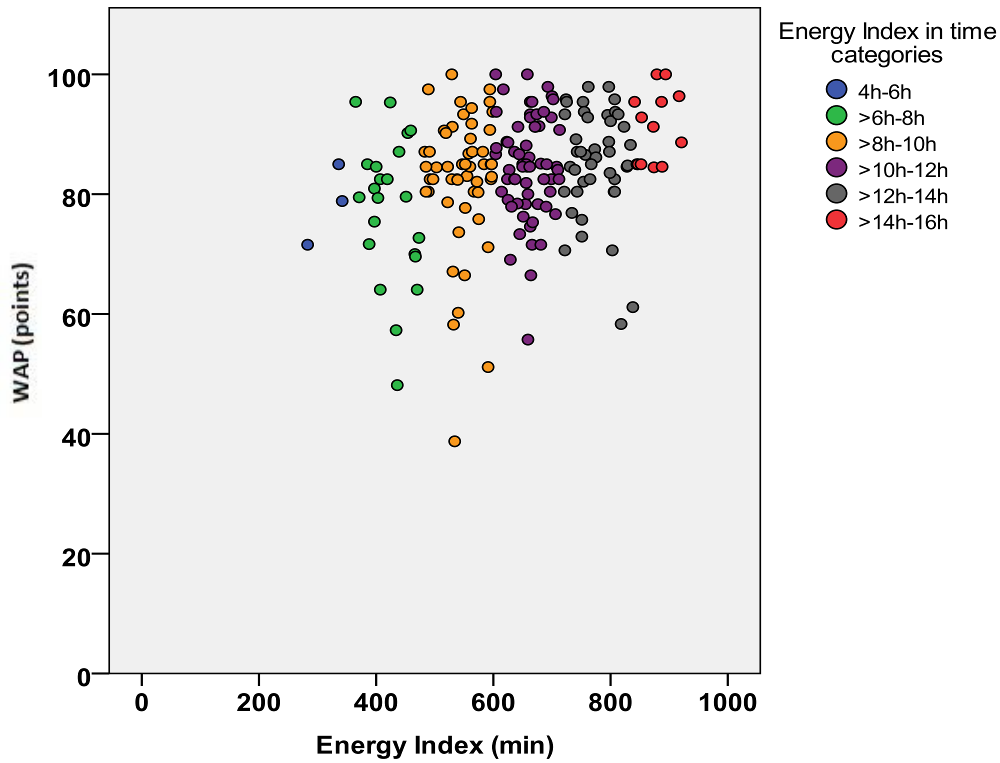

Figure 18. WAP and Energy Index results in different time-result categories in Energy Index

9 DISCUSSION

The purpose of this study was to clarify the connection between Energy Index and short version of Work Ability Index in a working age population and thus lighten the feasibility of Energy Test on evaluating and promoting work ability.

A positive correlation between Energy Index and WAP was found in this research. Positive and statistically significant correlation was also found within the main subgroups, executives, employers, female and male. Correlation was also found among participants doing mentally demanding (n=129) and sedentary work (n=113). However, most likely due to smaller sample sizes, the connection could not yet be proven in other subgroups (physically active work n=15, varied work n=69 & physically demanding n=30, equally demanding n=38). Results indicates that both tools Energy Index and WAP are applicable specially workers in different positions for both genders and for mentally demanding and sedentary work types.

In general, results in this study are fairly in line with the theoretical model of Work Ability House. Ilmarinen et al. (2005) calculated that the health and functionality, 1st floor of the Work Ability House predict about 39 percent of the total work ability Index in which symptoms were more pronounced than the functional capacity. In this study Energy Index, emphasizing health and functionality aspects predicted about seven percent of WAP results. Since Energy Test focuses on the dimension of health and functional capacity from the perspective of physical capacity and participants with medical conditions were mostly excluded from participants, lower explanation rate is more plausible. Due to the complexity of work ability concept, additional tools may be needed to utilize together with Energy Index, in order to fully evaluate the work ability. Together used, WAP and Energy Index tools can be very informative and enlighten the situation of and individual worker and the working community.

Average result in Energy Index was 10 hours and 39 minutes. Unfortunately, so far there is no published reference data available for comparison. However the average Energy Index from over 10 000 Energy Tests is 10 hours and 40 minutes indicating rather normal sampling in our study population (Laturi Corporation 2016 unpublished data, personal communication). Almost one-third of the participants (29 %) scored more than 12 hours in Energy Index, indicating sufficient functional capacity both at work and leisure. (Figure 11.) Nonetheless, from both occupational- and individual health point of views, it can be seen alarming that 13 percent of all the participants scored lower than eight hours, less than a length of an average working day. There was a lot of variation in Energy Index results between individuals. The lowest result in Energy index was 4h 43min compared to the highest result of 15h 21min resulting a difference 10h and 38 minutes between these two individuals. Among all participants, the standard deviation in Energy Index was ± 2 hours and 14 minutes indicating smaller variation.

The mean result among all the participants in WAP was 83.86 points. Due to the fact, the WAP is still in progress, there are not yet reference values to compare or rate the results. Therefore, strict conclusions is needed to avoid but some careful estimations can be done. In total, work ability within this population seems to be rather good. Almost one-third (29 %) scored between 91-100 points and 90 percent of the participants scored 71 or above (see Figure 12). In other words, only 10 percent scored less than 71 points. In general, there was no differences in WAP between any of the subgroups, which can be considered notable and positive outcome. These results are mostly in line with previous studies conducted in this area. In Work and Health 2012- survey, employees in Finland evaluated their work-ability on average 8,3 by using a WAS scale from 0-10, compared to 83,86 in this study. In Health-2011 -survey there was no difference in work ability between genders as the average score was 8,3 on females and 8,2 on male participants (83.82 and 83.90 respectively in this study) Although the methods are not directly comparable, the results appear to be rather similar

Interestingly, WAP was significantly higher ($p<0,007$) among participants reporting *high* physical activity (WAP 87,67) compared to participants with *moderate* physical activity (WAP 82,17). However, statistically significant difference between other groups were not found. This result suggests that increased physical activity is positively associated with work ability.

Another interesting point was that, there was no decline in WAP scores in the oldest age groups (see table 12). According to the literature and previous studies, work ability tends to decline by age (Ilmarinen 2008a; Gould et al. 2011). Moreover, the oldest age group (60-69 years) scored the highest average score. However, no statistical differences between the groups in WAP were found. The group of 13 participants consisted of seven males and six females, from which eight were employees and five executives. Since gender or the position at work appeared not to be significantly associated with WAP, one of the explaining factors might be physical activity. Energy Index results in this age-group support this assumption. The oldest group 60-69 years received also the highest Energy Index from all age groups. Since the sample size in this age-group is rather modest, no conclusions strict can be made. It appears that these individuals, close to the retirement age, have been able to found balance between their personal resources and demands of their working life and are living physically active life and maintained their functional capacity, health and work ability.

From socioeconomic point of view, it can be seen as positive, yet perhaps unexpected outcome that results in Energy Index or in WAP did not differ between employees and executives. Traditionally blue-collar workers have rated their work ability lower than white-collar workers. (Gould et al 2008c). There was neither difference in WAP between the groups in different educational background. However educational background seems to be a predictor for Energy Index results. Higher the educational level - higher the Energy Index was also. The difference in Energy Index results between primary school and academic degree was 1 hour 49 minutes in favor of the latter one. On the other hand the sample size in the primary school group was just 12 participants, so strict conclusions is wise to avoid.

The health gap between genders in Finland for example in life expectancy is broadly well known (THL 2016). Energy Index was, unfortunate but expected, higher in female compared to male. Interestingly, even though male scored lower than female in Energy Index, they assessed their work ability to the same level. Yet, an average difference of one hour four minutes in Energy Index between genders can be considered significant and raises questions about how can we effect on these health inequalities when it comes to worksite practices and occupational healthcare. The differences were seen already in basic health barometers such as in blood pressure and in waist circumference. The average blood pressure among female was 127/83 mmHg compared to men's 140/85 mmHg (Table 5). Women scored normal category in both systolic and diastolic pressures whereas men's average systolic pressure was elevated and diastolic slightly elevated. In waist circumference females (83cm) were in the low health risk category compared to men's (100 cm) elevated risk category.

Findings in Energy Index results according to the participant’s nature of work were notable. Mentally demanding workers had over one hour higher energy index compared to physically demanding workers (Table 10). Male gender (58 %) might be one of the explaining factors in this group. On the other hand these findings are in line with previous studies as decreased work ability is twice as common among employees doing physically demanding work compared to mentally demanding jobs (Gould et al. 2006). According to Kauppinen et al (2013), also the risk of work disability is twice as high in blue collar occupations compared to expert professions. In order to improve work ability and overall health within this group, comprehensive approaches might be needed. Nevertheless, Ilmarinen (2001b) pointed out that physically demanding work does not prevent a decline in musculoskeletal function and also these individuals need physical activity and exercise to maintain sufficient level of age related fitness.

All in all, the differences in average WAP between different PA groups were much smaller than in Energy Index. Results suggest that increasing physical activity will likely increase the comprehensive well-being and health, in terms of Energy Index results, but it is not necessarily as strongly connected with better work ability. As the model of Work Ability House suggests, functional capacity and health form the solid base for work ability. Yet, several other individual related (skills, attitudes and motivation) and work related factors (leadership, work demands, working community) effect on work ability and therefore comprehensive methods needs to be utilized in order to maintain or improve work ability in general.

Findings in this study are in line with the theoretical framework of Work Ability House model. Even though health and functionality (1st floor) is the strongest single predictor of work ability (Ilmarinen et al. 2005), it is only one of the four internal dimensions affecting on work ability. Therefore, good Energy Index, emphasizing health and functionality, does not necessarily mean as good work ability, and high WAP doesn't necessarily mean good physical condition if the demands of the job are for instance more in the mental side. In fact, the relation between Energy Index and WAP can be rather mixed, which underlines the complexity of work ability concept (see Figure 18). Participants scoring around 600 minutes/10 hours (orange color) in Energy Index scored very differently in WAP varying from 40 to 100 points. Vice versa, participants who scored full 100 points in WAP varied in Energy Index from 250 to 900 minutes. For this reason, it is important to identify the causes of declined work ability and act on it. Subjective evaluation is essential in work ability assessment process but sometimes, other -objective measurements are needed. As Husu et al. (2010) pointed out, self-evaluation of one's physical activity habit on an individual level can be a bit inaccurate in older age-groups and there is a tendency to overestimate the amount of PA especially if you are doing very little physical activities. These very same groups also have the highest risks of declined work ability.

Solutions such as Energy Index can provide additional information, particularly about the dimensions of functional capacity and health, both on individual and organizational level. Other tools, questionnaires or instruments, developed for the certain task, can then provide additional information about other dimensions of work ability, such as about the attitudes and motivation of the worker and about the state of leadership, content of the work or the demands in the certain working place. With that combined information the corporation (organizational level) or occupational healthcare professional (individual level) can then scan then overall situation and if needed, determine the areas which need some improvements.

Lack of physical activity and excessive sedentarism can be seen as one important aspect when considering reduced work ability on a population level. As Husu et al. (2010) reported, the large majority (90 %) does not meet the recommendations of physical activity and adults spend on average nine hours (76 %) of their waking time sedentary (Husu et al. 2014). Enhancing and maintaining physical fitness and capacity in the work site setting could be one way to ensure and maintain work ability and health. After all, full time worker spends about 35-45 percent of his/her weekly awake time at work and way to work.

On a population level, there appears to be clear connection between sufficient physical activity and work ability (Tuomi et. al 1997; Arvidson et al. 2013; Kettunen et al. 2014 & Van den Berg et al. 2009) and individuals in poor work ability in WAI appear to benefit the most from PA (Kettunen et al. 2014). Also the number of sick leaves appears to be connected to physical activity habits as more active workers usually have less long sick-leaves (Holopainen et al. 2012). A review from Amlani & Munir (2014) including 37 studies support this assumption and authors conclude that the evidence from the review suggests that physical activity is effective in reducing sickness absence.

Nevertheless, the physical activity interventions which are implemented to the work sites do not always support this and in some of them found no significant improvements in work ability or number of sick-leaves after the intervention (Sörensen et al. 2008; Reijonsaari et al 2012; Brox & Frøystein 2005). Amlani & Munir (2014) also conclude that due to the low quality of many of the 37 studies, evidence is still limited and more detailed descriptions of the PA interventions and use of more reliable objective measures of physical activity such as accelerometers and fitness tests are needed in the future.

Vehtari and his colleagues (2014) examined the factors that characterize employees who did not participate in a physical activity intervention in an occupational setting and does the selective and voluntary participation to the results. They conclude that participants who volunteered (n=544) had already better health behaviors and fewer health problems than those who did not participate (n=273) and for that reason selective participation may reduce the potential benefit of PA interventions and limit generalizability of findings. Findings from Henkilöstöliikuntabarometri (VALO 2015) supports these findings. Even though 87 percent of all the organizations support physical activities of their staff, and utilization of different approaches has become more diverse in recent years, yet about half of the workers (53 %) do not participate on these activities. In addition, majority of the users (59 %) are individuals who are already physically active. Organizations have recognized this challenge and 62 percent of them report that the focus of next two years will be in activating the sedentary individuals. Then again, when asked about the largest obstacles of supporting physical activity, the primary outcome (43 %) was the lack of employees' interest followed by lack of resources to organize (30 %) and lack of financial resources (29 %).

Unfortunately, barometer doesn't reveal the means how the organizations are going to activate the sedentary individuals. Since the largest obstacle was the lack of interest, just by increasing the number or ways to support physical activities will most likely not be enough. If organizations want to enhance the of motivation of their employees towards physical activity, other more comprehensive actions including multi-disciplinary approach by different occupational experts, might therefore be needed. That said, 45 percent of the organizations reported that their co-operation with occupational healthcare in terms of improving physical activity of their staff is irregular and mostly circumstantial (VALO 2015). However, the organization cannot be the only responsible for taking care of workers' health and wellbeing. Even more important is the individual motivation and commitment to maintain and improve one's health and wellbeing (Otala & Ahonen 2005, 34).

But how to encourage and support sedentary individuals to become more physically active? This area of health behavior still needs more research. In order to succeed, it is needed to identify the largest obstacles and main reasons not to participate on physically activities both on individual and population level. Also, utilizing and sharing knowledge and experiences from successful interventions and projects is vital, in order to succeed on a larger scale.

Experimenting and utilizing new innovative approaches are also needed. Sjögren (2006) examined the effectiveness of regular, 5-minute exercise sets during the working days. Intervention included 90 municipal office workers and exercises were performed at the office. Already in 15 weeks, the prevalence of headache (p=0.041-0.047), neck (p=0.003), shoulder (p=0.007) and low back (p=0.000) symptoms decreased and also lessened the intensity of headache (p=0.001), neck (p=0.002) and low back (p=0.020) symptoms. After 12 months also the functional capacity, work ability and general subjective well-being were evaluated at a higher level than at the baseline measurements. (Sjögren 2006). This example shows that physical activity at the worksites doesn't necessarily have to be something you would need change sport clothes on. It also provides a new pioneering alternative compared to traditional gyms and sport vouchers.

It is also believed that the threshold of engaging on physical activities is lower if the worker can participate on activities during the working time. Another innovative approach is to reward the employees of healthy behavior. Perhaps the most famous example in the Finnish context is a company called Pekkaniska. Employees are paid bonuses for quitting smoking (1000 €), being a non-smoker (170€/year), running (1€/km), and cycling way-to-work. (0,25€/km). As a result, number of sick-leaves in the company has dropped to only 2 percent compared to 5,9 percent on an average worker in industrial sector in Finland.

Employees also smoke less and are more physically active than their colleagues in other companies. (Kärki 2007; Elinkeinoelämän keskusliitto 2015).

According to Huhta and Pyykkönen from Statistics Finland (2013), over half (59 %) of the population live within 10 km radius from the working place. Supporting active ways to transport way-to-work by providing sufficient facilities (showers, dressing rooms, bike-parks) is needed to encourage employees more active lifestyle (Kolu 2015). Kilometer allowance for cyclists like in the example of Pekkaniska, would most likely also be very effective and would improve populations physical activity which would also reflect on work ability. On a national and municipal level, other additional benefits might also emerge, such as in reduction of the car traffic jams.

As a conclusion, this study succeeded in strengthening the association of physical fitness and work ability on cross-sector worker population. All in all, both evaluation tools Laturi Energy Index and short version of Work ability Index proved to be applicable in different kind of worksite setting and worker groups. The statistically significant correlation between Energy Index and WAP indicates that health and functional capacity are significantly related to work ability in occurring now.

Energy Index showed to be useful tool when evaluating health and functional capacity aspects of work ability. Results from different subtests provide important detailed information of the current health status, which in a long run is essential for work ability. Lack of published reference values from Energy Index and WAP can be seen as a limitation. Another limitation can be considered the small sample sizes in some of the subgroups, which set challenges for the reliable analyzing. In the future we need more research and detailed information about different dimensions of physical activity (duration, frequency and intensity) and types of physical activity (endurance, interval and strength training) and their relations on work ability. By identifying these important factors we can better resolve how can physical activity be better integrated in workdays.

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11 APPENDIX 1. SHORT VERSION OF WORK ABILITY INDEX

Question 1. Are the demands of your work primarily?

Mental...	1
Physical	2
Both mental and physical	3

Question 2. Current work ability compared with the lifetime best

Assume that your work ability at its best has a value of 10 points. How many points would you give your current work ability? (0 means that you cannot currently work at all)

0 1 2 3 4 5 6 7 8 9 10

completely unable to work — work ability at its best

Question 3. How do you rate your current work ability with respect to the **physical** demands of your work?

very good	5
rather good...	4
moderate..	3
rather poor...	2
very poor...	1

Question 4. How do you rate your current work ability with respect to the **mental** demands of your work?

very good..	5
rather good..	4
moderate...	3
rather poor...	2
very poor...	1

<u>Question 5</u>. Do you believe that, from the standpoint of your health, you will be able to do your current job **two years from now**?

unlikely..	1
not certain..	4
relatively certain..	7

<u>Question 6</u>. Have you recently been able to enjoy your regular daily activities?

often..	4
rather often...	3
sometimes..	2
rather seldom..	1
never...	0

<u>Question 7</u>. Have you recently been active and alert?

always...	4
rather often...	3
sometimes...	2
rather seldom..	1
never...	0

<u>Question 8</u>. Have you recently felt yourself to be full of hope for the future?

continuously..	4
rather often..	3
sometimes..	2
rather seldom..	1
never..	0

12 APPENDIX 2. HOW TO CALCULATE WAP SCORE

Subdomain 1 consist only from question Q2, $\underline{sub1 = Q2 \div 10}$

Table x. Content of sub1

Question	Scale	Formula
Q2 Current work ability compared with the lifetime best	0-10	$sub1 = Q2 \div 10$

Subdomain 2 consists of three different questions Q1,Q3 and Q4. The answers in subdomain 2 were weighted differently based on the answer about the physical or mental demands in question Q1. Questions Q3 and Q4 were focusing on work ability in relation to the demands of the job and were rated from 1 - very poor to 5 - very good.

If the participant answered to the Q1 that his/her job is mentally demanding, the answer of the Q3 (physical demands) was hindered by multiplying it with 0,5 and the answer to Q4 (mental demands) was weighted by multiplying it with 1,5. If the answer to Q1 was physically demanding the coefficients were contrary. If the answer was equally demanding no coefficients were used.

If answer to Question 1 was 1 then (Question 3 × 0.5) + (Question 4 × 1.5)
If answer to Question 1 was 2 then (Question 3 × 1.5) + (Question 4 × 0.5)
If answer to Question 1 was 3 then (Question 3 × 1) + (Question 4 × 1)
Depending on the option above Sub2 was calculated using a formula below:

Table x. Content of sub2

Question	Scale	Formula
Q1 Are the demands of your work primarily	1,2,3	$Sub2 = [(a_i Q3_i + b_i Q4_i) - 2] \div 8$, where i = Q1
Q3 How do you rate your current work ability with respect to the physical demands of your work	1-5	
Q4 How do you rate your current work ability with respect to the mental demands of your work	1-5	$a = \begin{bmatrix} \frac{1}{2} & \frac{3}{2} & 1 \end{bmatrix}^{\mathrm{T}}$ $b = \begin{bmatrix} \frac{3}{2} & \frac{1}{2} & 1 \end{bmatrix}^{\mathrm{T}}$

Subdomain 3 consist of question Q5 with three different answer options. Result for subdomain 3 was calculated with formula $sub3 = (Q5 - 1) \div 6$

Table 19. Content of sub3

Question	Scale	Formula
Q5 Do you believe that – from the standpoint of your health – you will be able to do your current job two years from now?	1,4,7	$sub3 = (Q5 - 1) \div 6$

Subdomain 4 consists of three questions; Q6, Q7 and Q8. Result for subdomain 4 was calculated with formula: $sub4 = [(Q6 - 1) + (Q7 - 1) + (Q8 - 1)] \div 12$

Table 20. Content of sub4

Question	Scale	Formula
Q6 Have you recently been able to enjoy your regular daily activities?	1-5	
Q7 Have you recently been active and alert?	1-5	$sub4 = [(Q6 - 1) + (Q7 - 1) + (Q8 - 1)] \div 12$
Q8 Have you recently felt yourself to be full of hope for the future?	1-5	

Finally, the short version of Work Ability Index (WAP) was calculated:

$$WAP = 100 \times (sub1 + sub2 + sub3 + sub4) \div 4$$